PERSONAL FITNESS TRAINER MANUAL

Fundamental Theory And Application For Personal Trainers

7th Edition

NFPT

National Federation of PROFESSIONAL TRAINERS

Reference Manual for the Application of

Fundamental Exercise Science Concepts and Fitness Training Methods

for the

Certified Personal Trainer, CPT

Seventh Edition

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INTRODUCTION

The National Federation of Professional Trainers (NFPT) would like to welcome you to the world of personal training! Interestingly enough, the personal training industry is only about 40 years old. Personal training started with only a small number of people who were either preparing for a serious bodybuilding competition, or employed by wealthy elite; obviously, a lot has changed since the introduction of personal training into mainstream fitness – personal training is now a booming multi-billion dollar business. You can hardly step foot into a gym, at any hour of the day or night, and not see someone working with a personal trainer. You'll also see trainer's clients in all types of shapes and sizes, with vastly different goals and needs. This isn't a one size fits all business. As a personal trainer, you will need to use a variety of exercises, motivational techniques, and business logic to be successful in this profession.

About NFPT

NFPT was founded in 1988 with a mission, in part, to provide foundational, comprehensive and applicable education to aspiring personal fitness trainers. This NFPT Study and Reference Manual has been designed around fundamental exercise science concepts and independent research that will complement current trainer knowledge at any level of fitness experience or academic background. NFPT education strives to equip personal trainers with tools and resources that add to the development of individual trainer skill sets. Successful completion of the NFPT certification program will provide you with an industry recognized credential that supports your ability to offer safe and effective fitness training services to apparently healthy individuals.

Since 2005, NFPT's personal trainer certification program has been accredited by the National Commission for Certifying Agencies (NCCA). Accreditation of the NFPT personal trainer certification program assures highly esteemed recognition, authority and reliability of the NFPT certification credential in the fitness industry. NFPT policies and processes for examination development and delivery, organizational governance, certification maintenance and more have been reviewed and approved by third party standard setting organizations. NFPT will continue to support industry wide efforts that further public and government respect, trust and confidence in fitness trainer certification.

Manual Scope and Organization

This manual is designed to provide you the tools that are essential to being a personal trainer. It is not meant to be a complete scientific study, but rather a tool for learning the fundamental elements and methodologies of personal fitness training. We'll cover the aspects of health, fitness and the human body that will make for a well-rounded and comprehensive experience through this learning material. NFPT does offer various continuing education courses so that you can go deeper into the learning of specific subject areas, but, with this manual, we will strive to give you the step-by-step learning of the concepts that will keep your personal training safe, effective and successful.

The NFPT Study and Reference Manual is a recommended tool for exam preparedness because it provides a foundation for learning and a reinforcement of necessary trainer skill sets. We highly recommend that you are familiar with the exercise principles and concepts that are provided in this text because they are important to successful job performance; however, understand that the NFPT Certified Personal Trainer (CPT) exam is an all-encompassing assessment that is derived from industry research and on-the-job expectations of personal fitness trainers, it is not constructed from one textbook exclusively; therefore, NFPT encourages a variety of educational resources for developing and growing in your profession.

The NFPT – CPT exam, and respective credential, acts as a measurable demonstration of your fitness training knowledge, skills and abilities (KSAs). This NFPT Study and Reference Manual will try to keep things simple and focused on what will aid you in being a successful personal trainer. It has not been designed specifically for the purpose of passing the certification exam. The focus of this manual is *personal trainer responsibilities*, or a **scope of practice**, that includes the following:

- enhancement of overall health and well being to the apparently healthy population that is appropriate for the individual
- identification of potential risk factors associated with exercise, using protocols for medical release or referral when needed
- implementation of appropriate fitness program based on physical screening, health consultation, consistent evaluation and reasonable goals of the client
- promotion of the safe and effective use of fitness equipment, techniques and program design
- application of fundamental exercise science and fitness program design principles in a one-on-one or small group setting
- motivation, support and teaching of clients and fitness enthusiasts in an effort to improve levels of fitness and maintain an enhanced health and well-being

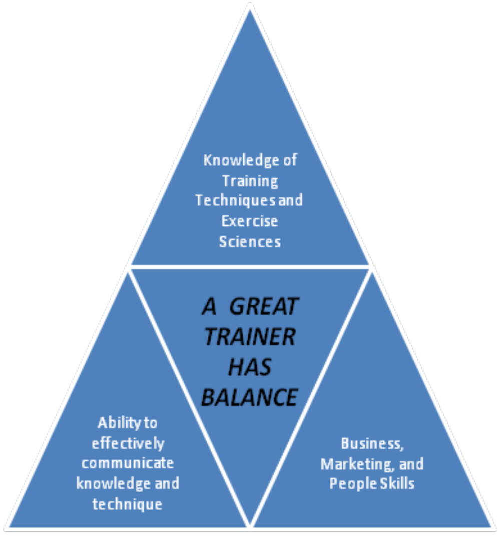
What is a personal trainer?
Before we get started on the knowledge and concepts that you should be familiar with as a NFPT Certified Personal Trainer (CPT), we want to discuss what it means to be a NFPT – CPT , "what is the role of a personal trainer"?

Let's start here…

A personal fitness trainer is a health and fitness professional possessing the knowledge, skills and abilities for safe and effective exercise and fitness program design, instruction and assistance for the purpose of training his or her client to reach personal health and fitness goals.

Now, thanks to television shows and celebrities who hire personal trainers, the career of the personal trainer has a high profile in today's culture. Unfortunately, the depiction of this profession is often distorted and/or misunderstood. For example, some people judge a trainer only by how he or she looks when, in actuality, things like passion, purpose, caring and coaching are key qualities, above most others, in fitness professionals. A focus and work ethic, driven by the qualities that motivate you, and coupled with the right credentials, education and experience, will have the biggest positive impact to long-term success in the fitness industry. To help you recognize your future role as a personal trainer, be familiar with your **scope of practice** and follow the procedures that are permitted as standard for the certified personal fitness trainer. As the result of your learning and growth in the fitness profession, through education and training, you should be able to successfully and consistently demonstrate the following:

1. Knowledge of human anatomy and the concepts of functional exercise, basic nutrition and basic exercise science
2. An ability to design individual and group exercise programs tailored to the needs of specific clients
3. An ability to conduct and understand the need and importance of screening and client assessment, initially and progressively
4. An ability to execute individual fitness program design in a safe and effective way
5. A desire to help clients reach their health and fitness goals through appropriate cardiovascular, flexibility and resistance exercise
6. An ability to motivate others to improve their overall fitness and health
7. A dedication to maintaining integrity and your own personal health and fitness



A good personal trainer delivers safe, effective, fun and interesting workouts (in that order) to all fitness training clients. The training programs you develop should be varied and progressive, and geared toward improving your clients' health and wellness. As a trainer, you should be enthusiastic and supportive, so that your clients remain interested and stimulated, which helps ensure they stick with the program – and with you. While personal trainers often assume multiple roles with their clients, including being a coach, cheerleader and sometimes confidant, there are some things that personal trainers should avoid. For example, it is NOT expected or appropriate for a personal trainer to:

1. Give medical advice, physical therapy advice or attempt to make a medical diagnosis
2. Provide more than general nutritional advice
3. Provide body massage to clients
4. Serve as a psychological counselor to clients
5. Have a romantic relationship with a client
6. Push personal preferences for fitness goals on clients who do not seek out those same goals
7. Push product or extended services for financial gain that is not in the overall best interest or demonstrable benefit to the client

Avoiding these areas mentioned will help you to stay within your scope and maintain a high degree of professionalism as a personal trainer.

After Certification: Continuing Education
As a certified fitness professional, you will need to meet certain continuing education requirements after the initial certification process in an area that you take interest in; this will help you to stay current in the fitness industry, advance your skills and knowledge base, and learn new approaches to fitness training.

Continuing education (CE) acts to evaluate and validate the continued competency of a trainer's current, applicable knowledge; it is a necessary part of personal and professional development. Many times, this may simply mean attending educational workshops, conferences and/or courses. Giving attention and consistency to your professional development will keep you current, refreshed and is extremely beneficial to your career. CE is more than just a recertification requirement - it means going beyond the initial CPT credential to serve your clients in the best way possible. At NFPT, we do offer our own in-house CE programs and processes that will keep your certification on track and current.

Whether you take a NFPT CE course, or not, we encourage you to stay within your personal training scope of practice at all times. While you may know some tips and tricks in one specialty area or another, without the proper education and/or credential for dispensing such advice, you will put yourself and your clients at risk. Remember, a certified personal trainer is an expert on the “healthy side” of the equation; you are not a nutritionist, massage therapist or guidance counselor unless you have taken the proper courses and earned the respective title for your specialty area. Continuing to learn is an essential element to ensure that you make the safest and most effective programming choices, and for your long-term success as a personal trainer.

The Evolution of Personal Training Education

There will always be new ways of looking at the same subject, especially as new knowledge and technology is discovered. The field of exercise goes through these perspective shifts as well; but, a lot of times, we notice that these shifts involve a ‘going back to basics’ philosophy. For example, the term “functional training” or “functional exercise” is being applied to many areas now. Some of these “functional” programs are really just complex, destabilized training that is not truly functional; yet there are other programs that do address the human system in a logical, stepwise manner and can be considered truly “functional”. By definition, functional training focuses on movements or exercises that improve a person’s ability to complete their daily activities or to achieve a specific goal. Therefore, success with this type of training is best established by first going back to basics, as is the case in all specialty areas.

As a personal trainer, you need to build your fitness knowledge on foundational properties that keep your “house” firm and grounded. Avoid jumping into a rush to train someone using the techniques of the latest popular trend without first being fully comfortable with basic principles. Listen and understand the individual needs of the client, you will most often find that it is the foundational fitness principles that will best assist him or her in reaching their goals. Just like in the nutrition field, where more and more attention is being focused on the individuality of the client/patient and how they respond to a given nutrient, exercise or lifestyle change, personal training is also about the individual. It is this careful attention to the individual client that warrants the term “personal” training.

The fitness industry has transitioned back to basic training equipment and apparatus as well, and for good reason. Free weights, heavy ropes, suspension and body weight training devices, dumbbells, balls, tubes and bands are all simple but effective ways to develop functional movement and promote weight loss as well as tone muscles. But, as you know, or will learn in this course, no matter what equipment you use, the client must first be assessed. The “personal” aspect of training should come before the actual training; you have to start by getting to know the needs, limitations and realistic goals of your client. We will provide you with the tools and the information that you need to properly assess your clients - but, remember, as a personal trainer, you have a very high level of responsibility, and liability, that must be taken into account every time that you take on a new client. You are working with a very complex “machine”, the human body, and the more that you know about how it “runs” for your client, the better off you and your client will be.

To be sure that your clients are ready and able to begin a training program, use professional assessment documents like the “Cardiovascular Risk Profile” and the “PAR-Q & You” forms as a starting place for uncovering any areas of concern with your clients. These assessment documents, and others, will be covered in the Consultation Guidelines section of this manual. It is often these simple client assessments that will detect weakness and imbalances, and that will keep you and your clients safe. After a general health assessment is done, and you’re given the “good to go” from the assessments, the physician’s release and the client waiver of liability, it’s time for a fitness assessment using the basic training elements that will guide you in establishing a sound baseline for where your client is currently, and where you want to take them in the future.

After you have completed your thorough assessments of health and readiness, and after you have developed a fitness activity plan/program, it will then be time to start addressing the basic issues of postural alignment and how to get the most out of the movements by using the proper form. You may even want to consider specialty areas of training for techniques like myofascial release and corrective exercise that may be beneficial for your clients. There are also specialty areas for heavy lifting programs that include core training, balance training, and multi-joint muscular endurance training that would be good for you to know when working with a specific client base.

This manual addresses the areas that we consider to be fitness fundamentals; we will keep a focus on the skills and knowledge areas that will assist you in being a better trainer, above all else. Of course, there is a revolution of sorts in the fitness industry, given the amount of available technology at our fingertips. Fitness consumers have all kinds of product available to them that will do everything short of shrinking down their trainer to miniature size to put in their pocket and take everywhere they go – there's probably an app for that! Then there are videos and video games, offering the convenience of an at-home fitness atmosphere to appeal to the video age that we now live in; though fitness videos have been available to consumers for decades, they are an entirely different animal now and more available in an instant. Just remember this: the evolution of this industry through technology will never replace a person - hence, the "personal" trainer. It will no doubt make fitness programming and tracking a much more convenient thing to do for the consumer, and for you as well – so you would do well to learn and embrace the tools that new technologies have afforded us – but no matter the fancy gadgetry, you will always be able to better determine what a client needs individually and how to motivate them to get it; an app can't stream inspirational consciousness and personal accountability.

Remember, the job of a good trainer is to deliver a safe, effective, fun, and interesting workout (in that order). So, very basically, your job is to keep your clients from injury and to give them a workout that actually improves their health and performance, is fun for them to do, and stimulates their interest to keep coming back and trying new things and exploring new areas or activities.

If you are reading this education manual so that you may better prepare for the NFPT personal trainer certification exam, we recommend the additional reading of the 'NFPT Exam Content Outline' as a checklist for your studies. This document is an outline of the specific subject matter that you can expect to find on the NFPT - CPT exam; it is located within the supplemental NFPT Study Guide for your convenience. Please note that this manual will cover some of the many intricacies of the make-up, systems and functions of the human body so that you may have a more well-rounded understanding of how our bodies work. This does <u>not</u> mean that memorizing the higher level science concepts or fine prints of the provided charts and tables will benefit you directly on the exam; but we do believe that a deeper level approach to some of the more science-based subjects will give you a greater cognitive understanding and appreciation for health, the human body and the respective successes of your fitness conscious clients.

We can't teach all of the qualities that will make you a successful personal trainer, some of these are inherently you – like enthusiasm, leadership, dependability and trustworthiness. If these characteristics describe you and who you strive to be, and you have the desire to keep learning and growing, then you are already on your way to being a great personal fitness trainer - now let's get started!

CHAPTER 1

Understanding Health and Wellness

When the average person thinks of "personal training", they commonly think of a "hard body" person who is trying to make another person into a "hard body" – but that is a misconception of the profession based on only one aspect of it, the outer self. Though a fit-looking outer self is a big part of why an individual starts to train, it is not exclusively the biggest factor in, or the resulting benefit of, fitness training. There is a balance between health, wellness and conditioning that serves a bigger and broader purpose for the individual who seeks meaningful and positive life change, that will last. Great *physical* condition (in a 'surface' sense) is, well, great! *But*, greatness on the surface is <u>not</u> interchangeable with great health or wellness.

This chapter will look at wellness and the factors that constitute overall health. Health can be described as encompassing the current state of physical, mental and social well-being of an individual; or, more simply, the absence of disease or injury. The definition of health can be paralleled to that of "wellness", though there are distinctions. A few definitions of wellness include:

"the quality or state of being in good health, especially as an actively sought goal".

Webster's Dictionary

"the active process of becoming aware of and making choices toward a more successful existence".

National Wellness Institute, Stevens Point, Wisconsin

"a direction in progress toward an ever-higher potential of functioning… it [wellness] requires that the individual maintain a continuum of balance and purposeful direction within the environment where he is functioning".

Halbert L. Dunn, M.D., (a pioneer of the modern concept of wellness)

Whatever the exact definition, it is clearly not about physical fitness alone, it is about overall functioning with a purposeful initiative for achieving a greater well-being.

Components of Wellness

The physical health of an individual is usually dictated by the exercise or activity that they get, and how well they eat or how the foods they eat promote health. When we look at this in conjunction with wellness, we see the need for a balance that addresses all aspects of both health and wellness. Let's refer to the mnemonic "SPICES", which was developed by Dr. Terry Fulmer in 1988 as a means for evaluating geriatric patients. "SPICES" is a great tool for assessing general health; although developed specifically for the field of geriatrics, its general purpose helps us to identify the need for further health evaluation by looking at six (6) common components of wellness.

SPICES

S – **Social Health**: this includes our relationships and connections with others in our family, our friends and even those in our community. Many people maintain their social connections through online social networking. While this is an efficient way to reach out to people, it does not constitute social health. Social health is predominately gained by face to face, or voice, interactions with genuine emotion and feelings of well being for those with whom you are interacting.

P – **Physical Health**: this is perhaps the most significant as it relates to personal trainers, and it will be what we focus on.

Physical health is commonly identified by five (5) Components:

1. *Cardiorespiratory Conditioning:* also known as "endurance"
2. *Muscular Endurance:* the amount of strength that can be repeated several times
3. *Muscular Strength:* the shear amount of strength in one repetition
4. *Flexibility:* the range of motion (ROM) in given joints
5. *Body Composition:* the amount of body fat relative to the total weight or as compared to the lean mass (not described by body weight)

Three (3) additional factors that are specific to the fitness regimens of athletes and sports teams are: agility, speed, and mobility (or quickness)

I – **Intellectual Health**: this is the capacity to assimilate and integrate new information into one's thinking/thought processes. We should all work to understand and comprehend new concepts on a daily basis, even when it is not "formal education".

C – **Cognitive Health**: this is often grouped into a "mental health" category as it has mostly to do with how we process information in the brain. It would include the way that we see, or conceptualize, the world around us – it includes brain functioning in the areas of conceptual and perceptual skill, language learning and processing as well as many other brain development functions.

E – **Emotional Health**: many of the "self" concepts fall into this category, including: self-esteem, self-awareness, self-acceptance, self-image, and our capacities to deal with adversity and stress. This also includes our ability to be intimate, not just sexual, with a significant other. For example, an inability to maintain a long-term relationship is often indicative of weakness in the area of emotional health. Problems in this category are usually why many seek counseling.

S – **Spiritual Health**: While many give this a religious context, it is focused on the connection of ourselves with a higher power, a sense of purpose, self-actualization, and an inner joy. It is often described by self-acceptance, repentance for misdeeds, a willingness to give to and forgive others and a desire to seek peace with the community and world overall. This dimension is closely tied to emotional and social health, but is clearly its own category.

As a personal trainer, your attention will be on the physical training aspect of wellness. However, it is still important that you not completely desert the other aspects of wellness with your clients. You may want to consider researching holistic health and even take a course or attend educational sessions for understanding the mind, body and spirit (or soul) connection. Holistic health is an alternative form of health care that looks at the person as a whole, but that is not necessarily based on science. Elements of holistic health include mind, body and spirit/soul. A skillful, veteran trainer can integrate these elements and other aspects into their training services without crossing the line of their scope. This, again, comes back to the individual client and their needs. Though you will do well to listen to your client, and to support them as much as possible, you still need to be very much aware of when it is necessary to recommend a professional counselor, psychologist, doctor, pastor, or friend.

Your Role in Health and Wellness

Wellness is more than the absence of disease, just as being an athlete is more than simply exercising to avoid disease. Wellness strives to have the individual function at his or her maximum or optimum level. It requires a "zest for life", so to speak. Wellness is purposeful. Health is the condition of your current state. As you purposefully improve upon the components of your wellness, your health will improve respectively. Improving upon one component of wellness, take 'physical health' for example, will no doubt improve the condition of that particular state of health, but this does not constitute 'wellness' as a whole. Think about the many people who consider themselves healthy if they are not sick; now, how many of those people would consider themselves rich if they are not poor…not many. Therefore, to say that one is healthy simply because there is no disease or sickness present, just doesn't make good sense and offers no recourse for improvement. An improved state of health requires a purposeful desire for improved wellness – and, like all things worth having, it takes work.

As a personal trainer, you should identify the ways that your clients are compromising their health and well being for the sake of convenience or temporary fulfillment. You are, in a sense, a wellness coach who is focused on the physical health component of your clients' overall wellness. You can make a huge impact on your personal training client in many ways, and it is important that you understand the responsibility that you have in doing so. You are definitely within your scope as a personal trainer to inform, and remind, your clients that a healthy lifestyle consists of combining regular exercise with a balanced diet. There are many benefits of being healthy; maximum benefit requires maximum health, it is an exponential health to benefit ratio. The benefits of good health go hand-in-hand with the results of maintaining a healthy lifestyle. The more that you reap the benefits, the easier it becomes to stay disciplined around the maintenance of a healthy lifestyle. It's habit forming, in a good way.

Some of the many great benefits of being healthy are:

- Weight control/maintenance
- Reduced cholesterol
- Improved blood sugar control
- Improved joint function
- Decreased tissue inflammation
- Increased energy
- Better quality sleep
- Increased mental acuity
- Lower risk of illness
- Reduced mental and physical stress
- Improved self-confidence
- Ability to actively age and live longer
- Overall better quality of life

Even though you are, or will be, trained to deliver programs in physical health, you may also be in situations of addressing issues of emotional or mental health. Fortunately, exercise indirectly addresses many mental and emotional areas on its own. Just remember, you are training a human being first and a physiological 'machine' second. Though you are not qualified as a CPT to offer mental health therapy, you may be inadvertently offering a listening ear and possibly suggesting that your client seek out the appropriate professional for mental wellness.

Your role is to stay within your scope of practice as a personal trainer. Within that role, it is important to understand what your client will positively respond to, versus what they will absolutely dismiss. Keeping your client motivated to continue with their training program is crucial for several reasons: your long term success as a personal trainer, your clients' achievement of goals, and your clients' overall improvement in their physical health (hence then, a natural gravitation toward other areas of health, which positively impacts overall wellness). It is important that you get to know your client from a place of general health, wellness and motivational aspects. Now, we all know that no single theory for how humans think will explain, without a doubt, why certain people behave in a certain way; but, we can come close by recognizing the characteristics of positive behavior. This is important to recognize because the determining factor/s/ in how you may or may not get a positive response from the training program can assist you in altering the course of your programming to meet the individual need.

In general, we can look at the motivating factors of positive behavior as an outcome of three (3) interconnected influential aspects:

1) Predisposing Factors: knowledge, attitude, beliefs, values, and perceptions
2) Enabling Factors: skills, resources, physical and mental capabilities
3) Reinforcing Factors: praise from others, rewards, encouragement, recognition

Where you come in is number 3) 'Reinforcing Factors'. You can't significantly, or at all, alter the enabling or predisposing factors which are part of the client's self; but, you can recognize how those factors promote or inhibit positive behavior, and you can work to reinforce positive behavior with forms of encouragement. Ultimately, it is the responsibility of your client to be in charge of their health and overall wellness, but you can help them. Their doctor may tell them to lose weight, but rarely will he or she say how to do it. Their doctor may tell them to lower their fat intake, but rarely will he or she give any tips, recipes, or ways to adjust the grocery list to help with this. Simply put, it is not his or her job, it's yours! Many trainers are leaving money on the table by not embracing all aspects of wellness. As long as your advice is related to the right side of the spectrum, physical fitness programming for the apparently healthy client, then you can make recommendations, not mandates, to your clients. Keep it all within the confines of your scope of practice, but don't shy away from wellness issues. Consider areas of wellness, especially the physical health component, that interest you and that compliment your training profession. For example, you may decide to go deeper into educating yourself as a personal trainer by taking courses in sports conditioning or youth fitness or wellness coaching - the more that you know, the better that you will serve the needs of your clients, and yourself.

Earning Health and Wellness

There are a lot of things someone can do to literally “re-engineer” their lives so that fitness and health become more of a priority. The most obvious of these are the clearly ‘bad’ behaviors that should be avoided, like tobacco use, excessive alcohol or drug use, promiscuity, sleep deprivation, food deprivation and a high consumption of bad fats (‘junk food’) in the diet. On the other hand, there are things that can be added to life to invoke positive change, like taking time for meaningful reflection, reading a book, being creative, socializing with friends and family, adding a physical component and healthy eating to daily living. One of the best ways for implementing positive change in one’s life is to write it down – take inventory of the activities of daily living (ADLs) and make a list of the areas where positive change can be made. Milestones start out as goals. Remind your clients that they can achieve their goals, but it takes work. There will be, of course, varying degrees of work for your individual clients, but, for all of us, overall health and wellness is earned. Determination, will power and most certainly the acknowledgment of time and patience will get them to the milestone. Consider the length of time that it took your client to get into the poor physical shape that he or she is in (if that applies), and use that as an encourager – yes, it should be encouraging for them to know that, obviously, realistically and by no supernatural force, can there ever be an expectation for an overnight fix to a decade old problem (for example); and that can be encouraging because they are certainly not alone. Once an inventory of ADLs and associated goals have been written down and designated, a set of objectives can be established that can be specifically assigned to each goal. The assignment of objectives are specific tasks, with realistic time frames, that can be accomplished given the necessary and available resources, like education, time management, motivation, perception and rewards. Of course, you are a client’s personal trainer, so you will be focusing on the physical health attributes of their life goals; however, it is still important for you to understand the high level basics of formulating and acting upon a set of goals. As you can tell, and have probably experienced, change does not come easily. Avoiding negative behaviors, or adopting positive ones, can be easier said than done. So, remember to “celebrate” the small victories; but do so with recognition of hard work and something that promotes the positive behavior, not with something that could counteract the positive behavioral change (i.e. no donuts for the dieter). Often times, the best encouragement is the spoken word; a reward does not have to be something material.

Self-Responsibility

To have self-responsibility is to have self-efficacy and self-discipline. This means that you not only believe that you can do a given task, but you consciously know that you need to do it. A sense of obligation and personal well being must be recognized in order to have self-responsibility for health. It is also very important for your client to know that any given behavior will either lead or detract from a desired goal. Trying to get your client to gain self-responsibility is not an easy task, but you can be the best example. Tell your ‘change story’, show your client how they too can change and give them a sense of obligation or commitment to the change that they desire. You are their accountability partner. Some trainers will have their clients sign a behavioral contract for change as a tool to keep their clients accountable and motivated.

Wellness is a dynamic state of health and well-being. Wellness, through the components of health, does not “stick around”, it must be earned and constantly nurtured. Like nature and all living things, a state of wellness is constantly changing;

your mind-set, skill set, and daily practices must adjust accordingly - sometimes in a day, and sometimes over years. This literally is the process of evolution - not the Darwinian Theory type of evolution…but, on an individual basis, the process of evolving physically and mentally in order to better fit in with your internal and external environments. For the most part, anyone can be 'trained' and have their physical condition improved. Even an Olympic athlete can be improved in an area outside of their current specialty. But, although it would be nice to train an Olympian, the focus of most trainers will be on the average person who seeks to improve their overall health and wellness through weight management and fitness conditioning. It is not within the scope of this manual to teach exercise therapy for special populations. Though it is somewhat general practice today to recognize exercise as 'medicine' for some conditions, it is still the responsibility of the individual to seek professional medical advice. Exercise is preventative medicine, and acting pro-actively to improve your physical condition is time and energy that is well invested! Exercise can significantly decrease the risk of certain disease; but, this does not remove the need from diagnosing a health condition that may already exist. As a certified personal trainer, you must stay within your scope of training the apparently healthy client (unless you have the appropriate additional license/s/ and/or degree/s/ to practice beyond this scope). The main areas of exercise therapy concern, where a highly trained exercise physiologist or physician should 'prescribe' appropriate regimes would be:

- cardiovascular disease (avoidance or rehabilitation)
- respiratory disease
- joint injury (avoidance or rehabilitation)
- obesity/metabolic disorders, which includes diabetes and ***hypertension***

There will be more discussion on special populations in Chapter 16. It is crucial to your longevity as a trainer that you are able to discern between the 'apparently healthy' and those who you are not equipped to train. This is self-responsibility on you, the trainer. There will be more information to come on this topic.

Whether pertaining to your own self-reflection or your encouragement for the betterment of another, it is always important to remember the adage "Rome wasn't built in a day". You have to start somewhere, and you have to take responsibility for where you're going and how you get there. Be careful to find the balance between reasonable expectations, that you can be encouraged by accomplishing, versus those that are well beyond reason and will ultimately disappoint. Shift the mind-set from *what* you are doing to *why* you are doing it. The mental feeling of 'balance' is why many people exercise, foster that sensation. Next time that you exercise, be challenged to think about the incredible machine that is made to work within your body, brain and soul. Feel your muscles working and your heart pumping. Think about what your body is experiencing during exercise. Allow yourself, and encourage your client, to think of your body as more than what's on the outside. Stop to recognize that you've moved your mind and body to reach a goal for the day, which is part of a bigger goal that may not have a definite endpoint.

CHAPTER 2

Basic Human Anatomy

This chapter provides an overview of important systems of the body: muscular, skeletal, circulatory, respiratory, nervous, digestive, immune and endocrine systems.

Whether at work or rest, in peak condition or not, the human body is an amazing example of coordinated systems acting together for one purpose. It is made up of an astounding number of working parts that come together for its overall benefit. Our bodies are designed to perform voluntarily at our command, and involuntarily to sustain life.

All qualified personal trainers begin their careers with a basic understanding of how the human body works. Understanding the makeup of the human body, and how it functions, is a key component to providing safe and effective fitness programming for a variety of situations and clients.

MUSCULAR SYSTEM

Muscles work to produce force, maintain posture, allow for movement and produce heat. Muscles are made up of special ***tissues*** that can contract when they receive a signal from the brain. All muscle action originates and is controlled by our brain, which sends and receives signals through the nervous system. When our muscles contract they pull on ***tendons***, the strong connective tissue that connects muscles to bones, which pulls on the bones and causes our limbs to move. In most cases, when the muscle contracts, it moves only one bone – like when the biceps in the arm contracts, the radius moves but the scapula does not. This is where we get points of muscle ***origin*** and ***insertion***. The origin is considered the point at which the muscle joins the stationary bone at the end closest to the center of the body; and the insertion is the point at which the muscle joins the moving bone. When a muscle contracts, the insertion moves towards the origin.

Muscles hardly ever work alone; they are joined together to form muscle groups for the purpose of executing bodily movement. They can get shorter and pull, but they cannot push. Therefore, most muscles are arranged in opposing "teams" so that, when one team pulls the body part one way, the other team pulls it back again – achieving the proper movement response. As each team pulls, the other team relaxes and is stretched.

There are 656 muscles in the average adult body; these muscles consist of 3 distinct types: skeletal, smooth and cardiac muscles. Within these types, there are muscles that we have no control over (involuntary muscles), and there are those that we have the ability to control (voluntary muscles). 430 of our body's muscles are voluntary, controlling 206 bones. These are skeletal muscles which make up the muscular system. Interestingly, the majority of these muscles are in the hands and feet!

Involuntary muscles, the smooth and cardiac type, are those that we have no conscious control over. These include cardiovascular tissue (heart and ***blood vessels***) and the lining of the intestinal and respiratory tracts, which are under neurological control and therefore part of other systems. Considering the "machine" that is our human body, the cardiorespiratory system supplies muscles with the necessary oxygen and nutrients to survive, and the skeletal muscles allow the body to perform work – so the cardiorespiratory system is somewhat of a close relative, functioning as a direct "support system" for the muscle machine.

Conscious control over voluntary muscles, those that we can contract – like in our arms and legs – provide support for skeletal tissue, coordination, locomotion, and the ability to perform work. As a future personal trainer, you will become familiar with many of the skeletal muscles – or the skeletomuscular system – and how they function in relation to exercise. For your purpose, as a personal trainer, you won't have to name all 656 muscles; but, you must be able to identify all major muscle groups and know how they function. In Chapter 3, *Anatomical Terms and Biomechanics*, we will take a more in-depth look at the make-up of skeletomuscular structure and function.

SKELETAL SYSTEM

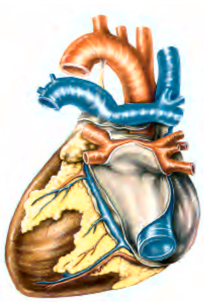
Much like a bony piece of artwork, the skeleton is the collection of bones that holds the rest of our body up and in place. Although humans are born with 350 bones, that number will decrease to 206 by adulthood. As we grow from children to adults, some bones join together to form one bone. The skeleton has five major functions:

1. Protects vital internal organs
2. Supports our body's framework, giving us an upright, vertical shape
3. Produces red and white blood cells in the bone marrow
4. Stores minerals and fats
5. Regulates mineral balance, releases minerals into the blood as needed

Bones come in all shapes and sizes and serve our bodies in many complex ways. Consider the smallest bones in the body, the tiny bones in the middle ear that allow us to hear, to the largest bone in the body, the femur, that allows us to walk. There are bone elements, like ***tubercles***, the rounded nodules, or outgrowths, on bones that generally act as sites for muscle insertions - like the tibial tuberosity that creates an attachment point for the patellar ligament, for example; or other bone elements that are unique in their shape and structure, like grooves and crests, that also act as specific points of attachment, protection and support. Bones are lightweight, and yet they are considerably strong and hard. They join together to form joints. A ***joint*** is the location at which two or more bones come together for movement and mechanical support; the 'intersection' of bones. Joints are held together by strong stretchy bands of fibrous tissue called ***ligaments***. Covering the end of each bone is ***cartilage***, a tough yet flexible connective tissue that has a smooth, shiny surface. The cartilage-coated ends of bones are kept apart by a thin film of slippery fluid called ***synovial fluid*** that works like oil in a car, keeping the bones from scratching and bumping against each other during movement.

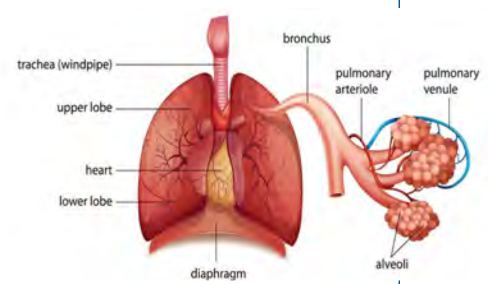
CIRCULATORY SYSTEM

On average, the human body contains 4-5 liters of blood. The blood is the transport system by which oxygen and nutrients reach the body's cells and waste materials are carried away. In addition, blood carries ***hormones***, which are regulatory substances transported in tissue fluids for stimulating specific cells that control the specific body process. The heart, a muscular organ positioned behind the rib cage and between the lungs, is the pump that keeps this transport system moving. The body's circulation system is sustained by the heart and lungs. The heart acts as a double pump in that it pumps blood both to the lungs and to the rest of the body. The blood that enters the right side of the heart is dark red (bluish) and is low in oxygen; this blood travels from the right side of the heart along pulmonary ***arteries*** to the lungs, where it receives fresh supplies of oxygen and becomes bright red. It then flows along pulmonary ***veins*** to the heart's left side pump. Blood then leaves the left side of the heart and travels to the rest of the body through *arteries, going away from the heart,* that gradually divide into capillaries. ***Capillaries*** form a network of blood vessels between the arterioles and the venules. In the capillaries, food and oxygen are released to the body cells, and carbon dioxide and other waste products are returned to the bloodstream. The blood then travels in *veins, coming back towards* and into the right side of the heart; and the whole process begins again.



RESPIRATORY SYSTEM

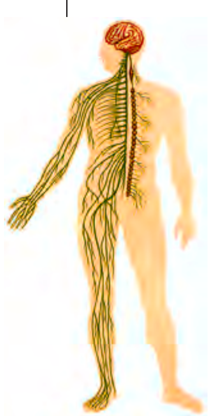
The respiratory system is the system of the body that deals with breathing. When we breathe, the body takes in the oxygen that it needs and removes the carbon dioxide that it doesn't need. We take in air through our nose or mouth and down through the trachea (windpipe). The trachea, pipe-shaped by rings of cartilage, allows the passage of air into the left and right bronchus. The bronchi (plural) become smaller and smaller tubes, called bronchioles, the closer they get to the lung tissue. Small air sacs called alveoli are found at the end of each bronchiole.



Capillaries, which are small blood vessels with thin walls, wrap around these alveoli. The walls are so thin and close to each other that the air easily seeps through. More specifically, oxygen in the lungs seeps through the thin capillary walls and into the bloodstream, while carbon dioxide from the bloodstream seeps through into the alveoli. This carbon dioxide is then removed from the body when we breathe out. This breathing process is controlled by a muscle located in the torso under the lungs, called the diaphragm. As the diaphragm contracts it flattens, causing the chest to expand and air to be sucked into the lungs. When the diaphragm relaxes, the chest collapses and air in the lungs is forced out. The respiration process occurs about 12-15 times per minute, in the healthy adult.

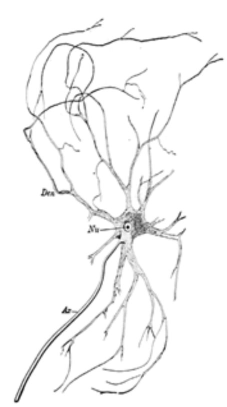
NERVOUS SYSTEM

The brain is the center of the nervous system, and the nervous system, itself, is the most complex and delicate of all the body systems. The brain sends and receives messages through a network of nerves. This network is similar to a road network: The spinal cord – a thick bundle of nerves running down the center of the spine – is similar to a freeway. Along the spinal cord, bundles of nerves branch out, like the main streets of downtown. Individual nerves branch out to every part of the body, like smaller side streets that are connected by the main thoroughfares to the large freeway. This network of nerves allows the brain to communicate with every part of the body. Nerves transmit information as electrical impulses from one area of the body to another. Some nerves carry information to the brain, allowing us to see, hear, smell, taste and touch. Other nerves carry information from the brain to the muscles, thereby controlling the body's movement.



The nervous system is divided into a central nervous system (CNS), which is the processing 'hub' that sends and receives information to and from the entire body, it consists of the brain and spinal cord; and a peripheral nervous system (PNS), which consist of nerves that attach the CNS to the body's organs and extremities. The PNS is like a messenger between the brain and the rest of the body; the sub level of the PNS is the autonomic nervous system (ANS) which operates involuntary motor nerve processes. Drugs like alcohol and tobacco affect the way that our nerves work, impairing body response and control to varying degrees.

How Nerve Cells Communicate



Each microscopic nerve cell (or neuron) has a blob shaped main part (the cell body) with thin spider-like dendrites and one much longer wire-like nerve fiber (or axon). The axon's branched ends have button shaped axon bulbs which almost touch other nerve cells at junctions called synapses. Electrical impulses, or nerve signals, travel along the axon and 'jump' across synapses to other nerve cells. This communication occurs at speeds of more than 100 meters per second.

DIGESTIVE SYSTEM

Food provides us with fuel to live, energy to work and play, and the raw materials to build new cells. The food we eat is broken down by the digestive system and transported to every part of the body by the circulatory system.

The main part of the digestive system is the digestive tract, a long tube (roughly nine meters in total) that runs through the middle of the body. It starts at the mouth, where food and drink enter the body, and finishes at the anus, where leftover food and wastes leave the body. Here's a more detailed look at the digestive process:

1. Mouth: Our teeth bite off and chew food into a soft pulp that is easy to swallow. Chewing mixes the food with watery saliva from 6 salivary glands around the mouth and face.

2. Esophagus: The esophagus (or gullet) is a muscular tube. It takes food from the throat and pushes it down through the neck and into the stomach. It moves food by waves of muscle contractions, called peristalsis.

3. Stomach: The stomach has thick muscles in its wall which contract to mash the food into a "sloppy soup". The stomach secretes strong protein digesting juices and acids that attack the food in a chemical way, breaking down and dissolving its nutrients. Depending on the quantity of food consumed, the stomach can take between 30 minutes to a few hours to digest a meal. Food from a meal, after its initial break down in the stomach, will then go into the small intestine.

4. Pancreas: This is a glandular organ in the digestive and endocrine system. In the digestive system, it acts much like the stomach in that it makes powerful digestive juices, called ***enzymes***, that further break down food as it enters the small intestines.

5. Gall Bladder: This small bag-like part is tucked under the liver. It stores fluid, called ***bile***, which is made in the liver. As food from a meal arrives in the small intestine, bile flows from the gall bladder along the bile duct into the intestine. This bile acts especially to further digest fatty foods.

6. Small Intestine: This part of the tract is narrow but very long – about 20 feet! In the small intestine, more enzymes continue the chemical attack on food; this is where most of the absorption of nutrients occurs. Finally, the nutrients are small enough to pass through the lining of the small intestine and into the blood. These nutrients are then carried away to the liver and other body parts to be processed, stored and distributed.

7. Liver: Blood from the intestines flows to the liver, carrying nutrients, vitamins/minerals, and other products from digestion. The liver stores some nutrients, changes them from one form to another, and then releases them into the blood according to the activities and bodily needs.

8. Large Intestine: Useful substances in the leftovers, such as spare water and body minerals, are absorbed through the walls of the large intestine and back into the blood. The remains are formed into semi-solid waste product, feces, to be removed from the body.

9. Rectum and Anus: The end of the large intestine, the rectum, stores the feces which are squeezed through a ring of muscle (the anus) and out of the body.

IMMUNE SYSTEM

Pathogens, or infectious agents (a.k.a. “germs”), are common in even the cleanest of places. These microscopic living things, like bacteria and viruses, can be found on our skin, in our food, in the air we breathe, and can enter the body through a cut or wound. Now, keep in mind that a normal flora of healthy bacteria, which live in our digestive tract and on the surface of our skin, is important for keeping balance in our internal ecosystem; not all bacterial organisms are fought off by the immune system, only those that are harmful to this balance.

Fortunately, the immune system provides for many lines of defense when it comes to harmful pathogens. Some of the body’s defense mechanisms include:

- the skin
- the linings of the respiratory and digestive passageways
- the blood-clotting process
- the white cells and other substances in the blood
- the thymus gland in the chest, and the small lymph nodes or glands that are located throughout the body

The body’s immune system includes several kinds of white cells found in blood, body fluids, and lymph nodes. These white cells attack any germs that are present in the body. White cells can be found in the following areas:

Lymph Nodes

Lymph nodes, distributed widely throughout the body, act as filters – or germ traps. They contain billions of white blood cells, which multiply rapidly to fight off invading pathogens. During illness from infection, lymph nodes fill up with millions of extra white cells and “dead” pathogens. A noticeable swelling of the lymph nodes may occur and can be an indication of infection. When you are healthy, lymph nodes are the size of a pea or grape; but, during illness, they can grow to be as big as a golf ball.

Thymus Gland

The thymus gland, located in front of the heart and behind the sternum, is a specialized organ that produces and “educates” T-cells (T-lymphocyte cells). T-cells are orchestrated in the thymus for the purpose of attacking foreign substances and responding to infected cells. The thymus is larger and most active during childhood and through puberty; but, during the aging process, will slowly shrink, eventually degenerating into tiny islands of fatty tissue.

Spleen

The spleen is located just behind the stomach, on the left side. It makes and stores various kinds of white and red blood cells. Essentially, the spleen is a blood filter that functions in the immune system to decrease susceptibility and fight off infection.

Tonsils and Adenoids

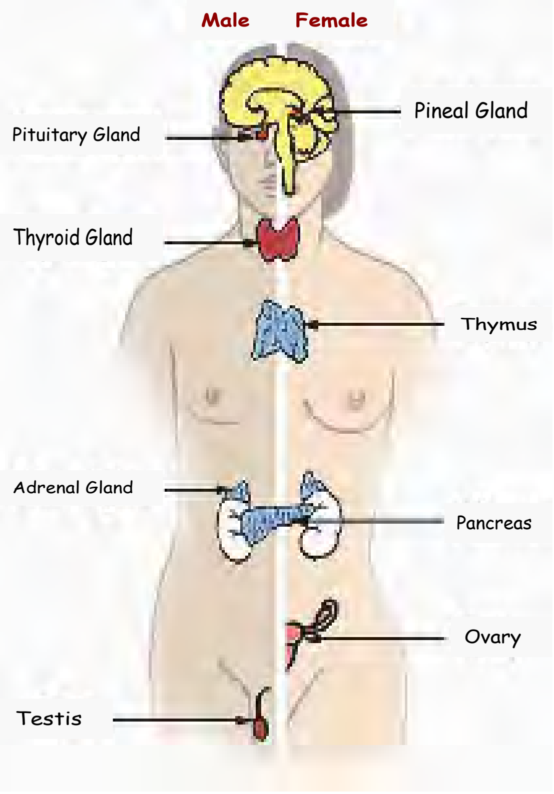
The tonsils are patches of lymph tissue at the upper rear part of the throat. They help to destroy foreign substances that are breathed in or swallowed. Adenoids are similar patches at the rear of the nasal cavity in the nose, where the nose and throat meet.

ENDOCRINE SYSTEM

The endocrine system is an “information signal system” much like the nervous system except that, instead of using nerves to conduct information, the endocrine system is made up of glands that mainly use hormones as information channels.

Glands, located in many regions of the body, release chemical messengers called hormones into the bloodstream. Hormones transport signals from one cell to another, for the purpose of generating a specific response, regulating the varied functions of an organism – such as mood, sleep, growth and development, and ***metabolism***.

The pituitary, thyroid and adrenal glands are examples of more commonly known endocrine glands. Like all glands of the endocrine system, these glands play independently significant roles in varying processes for homeostasis – or the regulating and stabilizing of the body’s internal properties. For example, and put simply – the pituitary gland is the “master” endocrine gland; it is the junction where the nervous system and the endocrine system come together at the hypothalamus, the portion of the brain responsible for activities of the ANS and for maintaining homeostasis throughout the body. The pituitary gland, attached to the bottom of the hypothalamus at the base of the brain, secretes hormones that affect and control functions like skeletal growth, development of sex glands (i.e. ovaries and testes), blood pressure and pain relief, and the stimulating functions of other endocrine glands; like the thyroid gland which controls how quickly the body uses energy and regulates metabolism. The adrenal gland synthesizes and releases hormones in response to stress, such as adrenalin and noradrenalin (a.k.a. epinephrine and norepinephrine, respectively). The pineal gland produces the hormone melatonin which stimulates and affects our sleep and daily rhythmic patterns. The pancreas, an organ playing roles in the digestive and endocrine systems, is an endocrine gland that secretes the hormones insulin and glucagon for blood sugar regulation. Each gland is part of a balanced process for maintaining a stable physiological ***equilibrium***. Unlike endocrine glands, that secrete hormones *directly* into the bloodstream (rather than through a duct), exocrine glands, such as salivary glands, sweat glands and glands within the gastrointestinal tract, excrete their product to an external environment by way of ducts.



Overview of Body's Major Systems

Muscular System: consists of skeletal muscles to produce force, perform movement, support posture and produce heat

Skeletal System: provides body's structural support and protection

Circulatory System: pumps blood to and from the body, sustained by the heart and lungs (composed of the cardiovascular and cardiorespiratory systems)

Respiratory System: the organ system for breathing, it takes in, transports and removes gases to and from the blood for continued cellular function

Nervous System: communicates all autonomic and voluntary messages to all body parts with the brain, spinal cord and nerves

Digestive System: takes in, breaks down, transports, potentially transforms, and eliminates all food substances so that they can provide energy or substances for growth, maintenance or repair

Immune System: protects the body from attacks by unwanted foreign invaders. Although it is one of the smallest systems in the body it is one of the most spread out and important systems

Endocrine System: the system of glands that communicate and maintain homeostasis using specific hormone secretions into the bloodstream

Other Systems:

Integumentary System: protects the body, consists of fat, skin, hair and nails

Reproductive System: system of sex organs that work together for reproduction

Urinary System: also known as renal system, supports elimination of waste, regulation of blood volume/pressure/pH and controls levels of electrolytes and metabolites

CHAPTER 3

Anatomical Terms and Biomechanics

Knowing the appropriate uses and definitions of specific concepts and terminologies is very important when it comes to your success as a personal fitness trainer.

Human ***anatomy*** is the scientific study of the form and structure of the human body.

Biomechanics, where mechanics and ***biology*** meet, is the study of the mechanical movement of the human body within the actions of external and internal forces.

For our purposes, we will be reviewing terms and definitions as they relate to the anatomy and biomechanics of the skeletomuscular system. Understanding fundamental anatomical terms and skeletomusclar biomechanics at this level is a must. This chapter will provide you with common terms relating to anatomical structure, planes of motion, positioning and movement.

Anatomical Positioning

When you refer to the positions of the body, or the positions of bodily structures to other bodily structures, use the correct terminology. This is important because it provides a standard of reference and relationship between body parts that is common among all fitness professionals, and it also legitimizes your understanding of the human body and how to correctly describe its position and function.

The position of structures, relative to the body or to other structures, respectively, when standing upright with palms facing forward…

***Anterior* (Ventral):**	toward or on the front of the body EXAMPLE: the pectoralis major muscles are anterior
***Posterior* (Dorsal):**	toward or on the back of the body EXAMPLE: the rhomboid muscles are posterior
***Superior*:**	above, toward the upper part of the body EXAMPLE: the humerus is superior to the ulna
***Inferior*:**	below, toward the lower part of the body EXAMPLE: the tibia is inferior to the femur
***Proximal*:**	closest to the point of origin from the center of the body EXAMPLE: the knee is proximal to the ankle
***Distal*:**	furthest from the point of origin from center of the body EXAMPLE: the ankle is distal to the hip
***Medial*:**	towards the middle of the body EXAMPLE: the sternum is medial to the humerus
***Lateral*:**	away from the middle of the body EXAMPLE: the arms are lateral to the chest

GENERAL TERMINOLOGY

***Bilateral*:** both sides of the body

***Unilateral*:** one side of the body

***Peripheral*:** toward the extremities

***Superficial*:** toward outer surface

***Deep Muscle*:** towards the inner body

Biomechanical Movement

Biomechanics, where mechanics and biology meet, is the study of the mechanical movement of the human body within the actions of external and internal forces. There are several areas of study with regard to human movement, let's take a high level look at Kinesiology and Biomechanics, for a better understand of their meanings.

Kinesiology: study of anatomy, physiology and mechanics of human movement, also known as human kinetics.

Biology**:** the scientific study of life and living matter, including structure and function.

Kinematics**:** a branch of biomechanics that specifically studies the time taken to carry out an activity.

Biomechanics**:** kinesiology applied to the biological function of human movement, it is a specific area of kinetic study that focuses on the effects of the "forces of life", external and internal, on human mechanics, especially on skeletomuscular and joint structure and function.

Movement Basics

The body can make gross movements, which are big moves that use larger muscles (i.e. the movements of your arms and legs); or the body can make fine movements, which are those that use smaller muscles and are more precise (i.e. the movements of your wrist and fingers). The following are considered the basic motions of the body by which most movement can be referred to singularly or paired together to describe; most having a distinct opposite, as would be expected. Reinforce your understanding of these movements by performing each as you read through their descriptions.

<u>Abduction</u>**:** movement away from the body or body part's midline; lifting your arm up to the horizontal position at your side
<u>Adduction</u>**:** movement toward the body or body part's midline; lowering your arm from the horizontal position back down to your side

<u>Flexion</u>**:** the bending of a joint that decreases the angle; bending at the elbow
<u>Extension</u>**:** the straightening of a joint that increases the angle; reaching out your arm, straightening at the elbow

<u>Circumduction</u>**:** the motion of a circular movement, like rotating the foot around the ankle – note, this movement uses abduction, adduction, flexion and extension movements in a ball-and-socket joint. Doing arm circles is a classic example of this.

<u>Rotation</u>**:** internal rotation is the movement of the body part about its axis turning inward or toward the center/midline of the body; external rotation is the movement of the body part turning outward or away from the center/midline of the body

<u>Protraction</u>**:** forward (anterior) movement of a body part; generally referring to scapulae and skull/cervical spine
<u>Retraction</u>**:** backward (posterior) movement of a body part; generally referring to scapulae and skull/cervical spine

***Hypoextension*:** extension that is less than normal, under-extended; not being able to extend at the knee because of a tight hamstring (the prefix 'hypo-' means to be less than normal, deficient)
***Hyperextension*:** extension beyond normal limits, over extended; a body part or joint is bent backwards too far (the prefix 'hyper-' means more than normal, in excess)

***Gliding*:** Movement of non-angular joints over each other
***Deviation*:** Departure from the midline

Movement specific to hands/palms and feet

***Pronation*:** palm of hand turning downward into a posterior position when arm is down at side; the inward roll of the foot/arch decreased during normal walking motion
***Supination*:** palm of hand turning upward into an anterior position when arm is down at side; the outward roll of the foot, 'under-pronation'/arch heightened during normal walking motion

***Inversion*:** turning both feet inward so the soles face each other
***Eversion*:** turning both feet outward so the soles face away from each other

***Dorsiflexion*:** (ankle) pointing foot up towards the shin
***Plantar flexion*:** (ankle) pointing foot downward (e.g. going up on tiptoes)

Biomechanical Movement: Muscle Contraction and Function

As a fitness professional, it is crucial for you to understand and be able to apply the principles of biomechanics as it relates to locomotion and exercise. Referring specifically to muscle contraction, know that there are four main types: isometric, isokinetic, and isotonic concentric and isotonic eccentric. These contractions allow for the given muscle to perform work and move within its range of motion (ROM), or the degree of freedom for which a joint can move through, usually referring to its full range of flexion and extension.

Isometric contraction

This type of contraction, where the load on the muscle is greater than the generated tension, results in no movement taking place. Tension is developed but no mechanical work is done. This would happen when the muscle attempts to push or pull a load/object that is immovable, or when you purposely hold a static position against resistance. There is no appreciable joint movement and the overall length of the muscle stays the same.

Isokinetic contraction

This type of contraction, where the muscle contracts and shortens at a constant rate of speed, allows the muscle to gain strength evenly all through the entire ROM. It is the quickest method for increasing muscle strength, but it requires equipment that increases the load as it senses the contraction speeding up. This type of equipment is a very specialized type, usually very expensive, and is therefore not as commonly used.

Isotonic contraction

This term is basically a technical term for what we recognize as being a simple contraction. An isotonic contraction, where the load on the muscle is less than the generated tension, results in movement taking place. Tension is developed and mechanical work can be done, like when successfully pushing or pulling a load/object.

Isotonic contractions are one of two types:

- **Concentric contraction**

Concentric muscle contraction causes the muscle belly to decrease/shorten in length, and the angle at the joint to decrease. This action is referred to as the "positive" part of the repetition. This motion brings the involved bones together. This is usually an active and voluntary action resulting in movement.

- **Eccentric contraction**

Eccentric contraction causes the muscle belly to increase/lengthen in length, and the angle at the joint to increase. This action is referred to as the "negative" part of a repetition where the controlled resistance is returned to the starting position of an exercise. This contraction can be either voluntary, in order to stimulate adaptation, or involuntary, in order to protect the joint.

Planes of Motion

The human body is broken up into three (3) primary planes, or flat surfaces, on which a straight line passes through and divides the body into parts: sagittal, frontal and transverse. These flat surface sections are cut/drawn through the center of the body and describe movement that is parallel to the plane. These sections represent the planes of motion that the body is capable of moving through; their axis is the stationary and invisible straight line around which the body rotates.

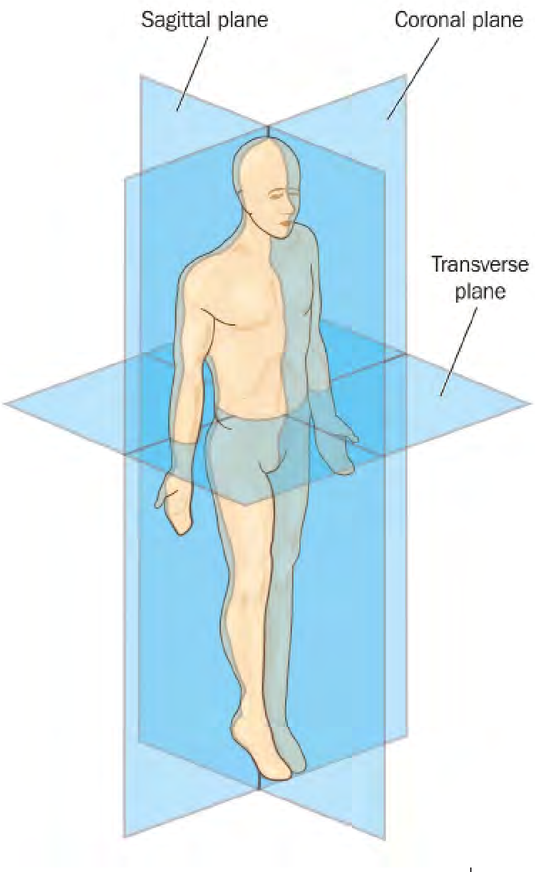
It is first important to understand that functional movements are tri-planar, or three dimensional in that all three planes will experience motion – however, when describing a movement, it is common practice to refer to the plane in which the movement is bio-mechanically dominate.

SAGITTAL PLANE:
DIVIDES: right and left sides, lies vertically
MOTION: Flexion/Extension
EXAMPLES: Squat, Bicep Curl, Lunge, Walking
**PARASAGITTAL PLANE is any plane that runs parallel to the sagittal plane*

FRONTAL PLANE (a.k.a Coronal or Lateral Plane):
DIVIDES: front half (anterior) and back half (posterior), lies vertically
MOTION: Abduction/Adduction
EXAMPLES: Lateral Raise, Pull-down, Side Bends, Military Press

TRANSVERSE PLANE:
DIVIDES: below (inferior) and above (superior) parts, lies horizontally
MOTION: Internal Rotation/External Rotation
EXAMPLES: Rotation at waist (e.g. swinging a golf club or baseball bat), Bench Press

Oblique is a term used to describe diagonal movement, or a hybrid/combination of two planes; the angle, or exact combination of planes, is not specified by the term.



Basic Movement in "Plane" Context

Our limbs can move in multiple directions; raising the arm straight to the side (abduction in the frontal plane) is quite different from raising it straight forward (flexion in the sagittal plane). Let's look at some basic movements again in the context of the planes of motion.

SAGITTAL PLANE:

Flexion occurs when the angle of a joint is decreased between two bones. Thus, it does not matter if the joint is facing forward or backward. In anatomical, or standing, position, flexion of the knee will move the foot up and initially backward, while flexion of the hip would move the knee forward and upward. This movement occurs in hinge joints and ball-and-socket joints.

Extension occurs when the angle is increased between two bones. So a push-up (on the way up) is extension at the wrist, elbow, and slight flexion at the shoulder joint. Hyperextension occurs when the extension is beyond 180°. The neck is hyperextended when the chin tilts up toward the ceiling or when someone leans back. Some people with flexible ligaments and tendons can hyperextend the elbows and knees, which can cause injury in these joints. Flexion and extension of the ankle are dorsiflexion and plantar flexion, respectively.

FRONTAL PLANE:

Abduction is the movement of a limb away from the midline of the body; it is movement in the frontal plane.

Adduction occurs when bringing the limb back, toward the midline of the body, in the frontal plane. A way to remember this: think of 'adding' when you think of 'add'-uction; as in you are bringing limbs back toward the middle, "adding" them to the core as you pull them in.

Elevation is the motion of a limb superiorly, only occurring at the scapula (i.e. lifting the shoulders toward the ears during a shoulder shrug). **Depression** is the opposite of this, at the scapula, when moving to an inferior position.

Lateral flexion of the spine is a side to side movement, it is the bending of the vertebrae in the frontal plane away from the midline, in a lateral direction. This is torso or neck movement performed when stretching the vertebrae out, left and right.

TRANSVERSE PLANE:

Internal and External Rotation

Rotation is movement of a body part around the longitudinal axis of that bone or the proximal joint. Lateral (or external) rotation occurs when the anterior aspect rotates outward, and medial (or internal) rotation occurs when it rotates inward. Turning the head to look to the side is lateral rotation, and bringing it back to the center is medial rotation. These movements primarily occur at ball-and-socket joints.

Pronation and **supination** occur at the elbow to rotate the wrist and it can be used to describe the ankle to rotate the foot. Pronation is the turning of the palm from the anatomical position to face backward. Turning the palm forward is supination. If you were to bend your elbows and then cup your hands to hold a soup bowl you would be supinating your wrist joint. Inversion is a movement of the foot to turn the sole medially, while eversion turns it laterally. The terms of pronation and supination are also used for the ankle joint. If someone is running and lands on their heel on the lateral corner and then rolls their foot in and takes off from their big toe, they would be pronating.

Protraction and Retraction

Protraction is the anterior movement of bone in the horizontal plane. It can also be known as scapular abduction which has to do with the medial border of the scapula moving away from the midline of the body. Retraction occurs as the joint moves back in position. It can also be known as scapular adduction, which is the medial border of the scapula moving toward the mid line of the body. This movement has to do with the scapulae moving along the Sagittal plane, unilaterally or bilaterally. The purpose of the shoulder girdle is to enhance the movements of the shoulder joint (glenohumeral). If the shoulder joint moves into horizontal adduction, the action of protraction aides in adding range of motion to the upper extremity. The same concept gets applied for retraction and horizontal abduction.

During a seated row, as the person pulls the V-handle back towards their thorax, they will be retracting their scapulae. Many trainers try to stop this action by having the client bending at the elbow joint and only slightly at the glenohumeral (shoulder) joint. This is not a natural motion and NFPT does not advocate “partial lifts” in healthy general fitness clients.

Visualize and practice these movements while describing them in their planes of motion. Use NFPT resources in your online account, or a multitude of other online tools and video resources, to practice the visualization of these movements while describing them out loud and in their planes of motion as you practice. Get familiar with these terms while using “anatomical vocabulary”. For example, when performing a squat, start by noticing the following:

What direction or plane is the movement occurring in?
Sagittal

What joints are being exercised/worked significantly?
Hip and Knee

What is the basic term for that movement at that joint?
Hip= extension; Knees= flexion

At which joint positions should there be focus on control and holding the joint position as to avoid impingements/injuries?
Scapulae, Spine, Hips, Knees, Ankles

Bones and Joints

As previously mentioned, adults have 206 bones (with more than half of them being in the hands and feet). One of the hardest structures in the human body, bone possesses properties that are both rigid and elastic. The ratio of rigidity to elasticity increases over time, which is why babies have flexible bones and many older adults have brittle bones and/or osteoporosis. Bones can bend or stretch to very small degrees, allowing certain stresses to be placed upon them. Once that limit is exceeded, however, a fracture can occur. Like most tissues in the body, bones are in a constant state of replacement. For example, bone cells called osteoclasts, break down bone; and others, called osteoblasts, build it up.

Adult bone structure is divided into two parts:
Axial skeleton: the trunk, or center of the body
Appendicular skeleton: limbs and extremities

	NUMBER of BONES
AXIAL SKELETON	
Vertebral Column	26
Skull	22
Auditory Ossicles (in middle ear)	6
Hyoid	1
Ribs and Sternum	25
APPENDICULAR SKELETON	
Upper Extremities	64 (54 of these are in the hands/wrist)
Lower Extremities	62 (26 of these are in the foot)
TOTAL NUMBER	**206**

BONES

As a personal trainer, it is important that you be familiar with, at least, the most commonly referred to bones and joints. You should be able to name and identify location of the following:

Axial Skeleton

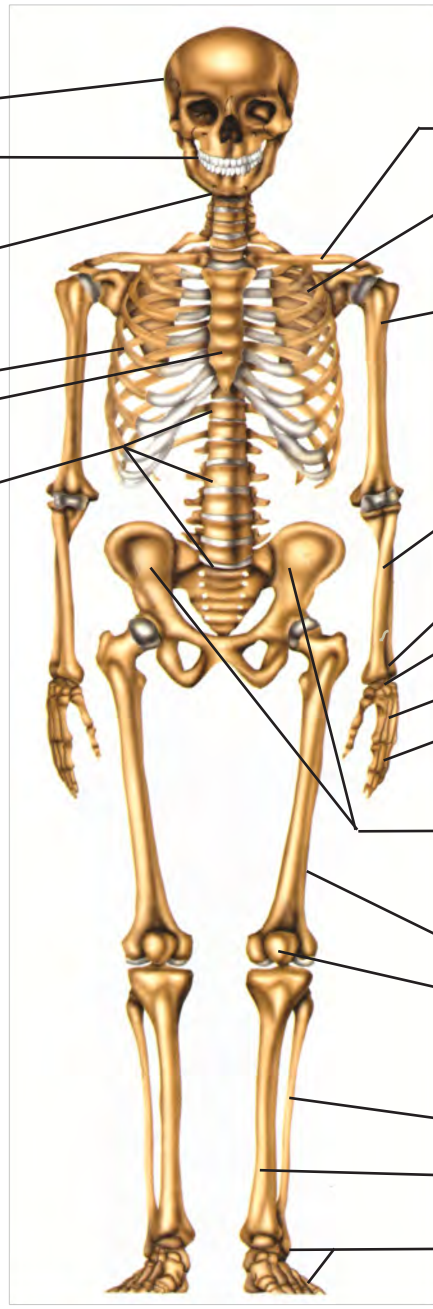
Consists of 80 bones of the head and trunk, it is the medial core of the body (Central Axis)

Skull:
Cranium
Mandible

Throat:
Hyoid (anterior midline of neck)

Thoracic Skeleton:
Ribs
Sternum

Vertebral Column:
Cervical, Thoracic, Lumbar, Sacrum, Coccyx (tailbone)



Appendicular Skeleton

Consists of 126 bones, it is the ‘appendage’ of the axial skeleton

UPPER EXTREMITY

Shoulder Girdle:
Clavicle (collarbone)
Scapula (shoulder blade)

Arm:
Humerus

Forearm:
Radius (lateral)
Ulna (medial)

Wrist:
Carpals

Hand:
Metacarpals
Phalanges

LOWER EXTREMITY

Pelvic Girdle:
Ilium, Ischium, Pubis

Thigh:
Femur

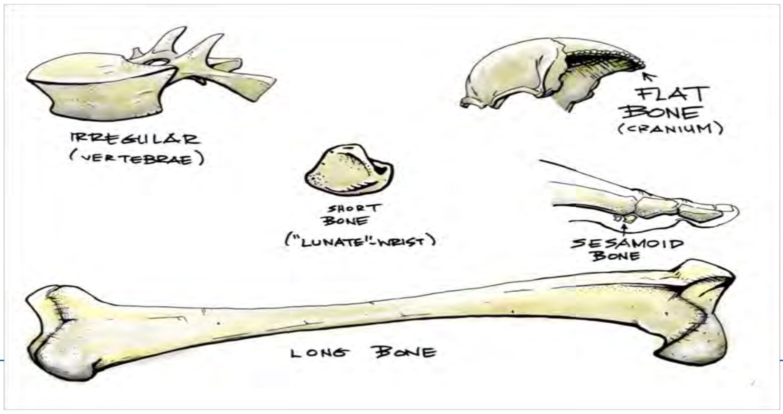
Knee:
Patella

Leg:
Fibula (lateral)
Tibia (medial)

Foot:
Calcaneus, Talus, Tarsals, Metatarsals, Phalanges

Bone Classifications: Bones can be divided into five (5) types:

CLASSIFICATION	DESCRIPTION
Long Bones Examples: clavicle, humerus, radius, ulna, femur, tibia, fibula, metacarpals, metatarsals, phalanges	Long bones make up the limbs/extremities and are crucial for the load bearing and mobility of our body. Each long bone consists of a “body,” or diaphysis, which is cylindrical. Long bones have a central cavity and a wall of dense, compact bone. The cavity in the middle of the “body” (known as the medullary cavity) contains cancellous bone (or “spongy” bone with porous areas) that allows blood to pass through and bone marrow to be formed. The ends of long bones are for articulation (where two bones are attached) and to create surfaces for muscular attachment. The end part of the long bone is called the epiphyses. It consists of cancellous tissue that is surrounded by thin, compact bone.
Short Bones Examples: tarsals (in feet) and carpals (in hands)	Short bones are located in parts of the skeleton that are intended for strength and compactness. They provide for stability and support, but very limited movement. These bones consist of cancellous tissue, covered by a thin layer of compact substance supported by the periosteum (a dense layer of connective tissue surrounding the bone).
Flat Bones Examples: Cranium, scapula, sternum, ribs, ilium (pelvis)	Flat bones are very broad, flat plates, like the skull and the scapula. The basic structure of flat bones is two thin layers of compact tissue with cancellous bone (or spongy bone) in between. They function mainly for protection and provision for muscular attachment.
Irregular Bones Examples: vertebrae, sacrum, coccyx, mandible, hyoid	Irregular bones are odd-shaped bones that don’t fit in the other categories; mainly function as a point of attachment for various muscle as well as protection for the nervous system. They are named for their irregular form and are grouped separately because, due to their various shapes and sizes, they don’t fit neatly into long, short or flat bone categories. Like long bones, they have a central cavity of cancellous/spongy bone. The outside layers of these bones are thin and compact bone.
Sesamoid Bones Examples: joint bones in hands, knee (patella), and feet	Sesamoid bones are found where tendon passes over a joint; it is the bone that is embedded in the tendon such as the knee, hand or foot. These bones increase tendons’ mechanical advantage and help protect tendons from flattening into the joint.



VERTEBRAL COLUMN (SPINE): STRUCTURE & FUNCTION

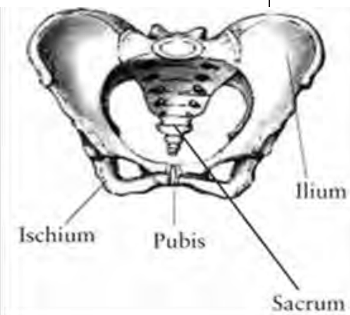
The adult spine contains 24 vertebrae, plus the sacrum and coccyx (a small, triangular bone at the base of the spinal column). The spine is capable of extension and flexion and can also rotate and bend sideways. The cervical and lumbar spine curve inward, known as a lordotic curve, these sections allow for more extension/bending backwards. The thoracic spine curves slightly outward, known as a kyphotic curve, this section allows for more flexion/bending forward. When the spine curves sideways in the transverse plane, it's known as a scoliotic curve, or scoliosis. The Spine is:

- incredibly strong, protects the spinal cord and sensitive nerve roots
- very flexible, allows for multi-planar movement
- the base for attachment and structural support

Cervical Spine **(neck)**	7 vertebrae (C1-C7) Forms a gentle lordotic (inward) curve	Protects nerves coming from brain to the body
Thoracic Spine **(upper/mid back)**	12 vertebrae (T1-T12)	Provides for firm attachment of rib cage, protecting vital organs Little mobility for stability & structural support
Lumbar Spine **(lower back)**	5 vertebrae (L1-L5)	Provides for mobility and structural support of the torso
Sacral Region **(bottom)**	Sacrum = 4-6 fused vertebrae Coccyx (tailbone) = 3-5 fused vertebrae connected to end of Sacrum	The sacrum connects the spine to the lower half of the body (at the iliac bones); it is the fused portion of the spine that forms the center of the pelvis and supports the back/posterior wall of the pelvis Coccyx is an end point of attachment for various ligament, tendons and muscles; also serves to distribute weight when sitting

PELVIC GIRDLE: 2 Coxal (Hip) Bones Made Up of 3 Fused Parts

Ilium: the largest and uppermost pelvic bone, is divisible in two parts, the body and the wing of the ilium. The body of the ilium, on both left and right sides, connects to the sacrum at the sacroiliac joint. The sacroiliac joint is a slightly moveable joint that is partly synovial and partly cartilaginous. The wing of the ilium is the outermost edge, commonly referred to as the iliac crest (it is the edge of the hip that you can feel through your skin)



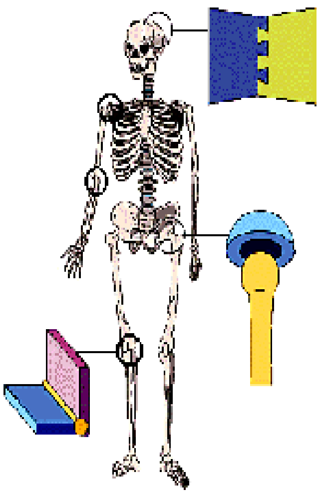
Ischium: below the ilium and behind the pubis, it forms the lower and back part of the hip bone and is the strongest of the hip bones.

Pubis: where the left and right hip bones join.

In short, the pelvic girdle consists of 2 coxal (hip) bones, right and left, that join to the sacrum to complete the pelvis. The coxal bones (ilium, ischium and pubis), sacrum and two femoral (thigh) bones create a weight-bearing arch to accommodate the weight of the body and to withstand the impact forces from landing on the feet.

JOINTS

A joint, or articulation, is defined as a connection between two bones or a bone and cartilage. Joints may be moveable or immovable, and some fall in between. The stability and integrity of a joint is due to ligaments that connect two bones together, and how "snug" their fit is. For example, the more stable joints, such as in the knee or hip, tend to have a "snug" fit and less range of motion. On the other hand, the "looser" the fit is at the joint, the more range of motion that joint has. However, with more range of motion comes less stability. The shoulder is an example of a less stable joint with lots of range of motion. The normal range of motion for joints is expressed in degrees.



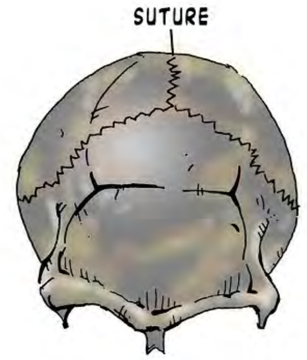
The degree of movement possible at a joint depends on a number of factors, including:
• The type and structure of the joint
• The structure or shape of the articulating bones, which determines "fit"
• How flexible or inflexible the joint ligaments are. Tight ligaments restrict range of motion and direct the movement of the articulating bones on each other.
• The arrangement and strength of the associated muscles and tendons. Tension of the muscle commonly reinforces ligaments.
• Soft tissue may limit mobility of a joint (e.g., the amount of flexion at the elbow may be limited by the amount of ***adipose*** tissue, muscle tissue, and skin of the forearm and upper arm).
• Hormone production, such as relaxin which is a protein hormone that increases in production to relax the joints in pregnant women to facilitate childbirth.

Joints are primarily classified by **structure** and **function**. Structurally, the joints are identified by how the bones connect to each other (what they are made up of). Functionally, they are identified by their range of motion in the planes that the joint can move along at one time (how they move).

There are three (3) main structural classifications of joints, identified by their function (i.e., mobility):
1) Ligamentous: immovable
2) Cartilaginous: slightly moveable
3) Synovial: highly moveable

1) **Ligamentous/Fibrous**
(synarthrosis, or immovable):
These joints have no joint cavity and are bound together by strong, fibrous connective tissue permitting little to no movement

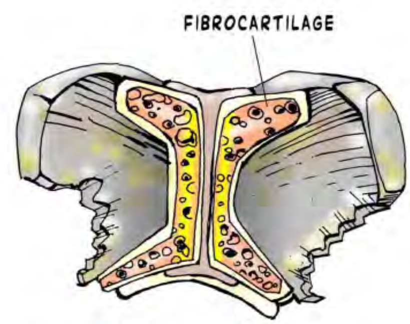
EXAMPLES: between bones of the skull (specifically referred to as a “suture” joint); between the tooth and socket of the mandible



LIGAMENTOUS/FIBROUS

2) **Cartilaginous**
(amphiarthrosis, or slightly moveable):
These joints are attached by cartilage or fibro-cartilaginous tissue and allow for only slight movement

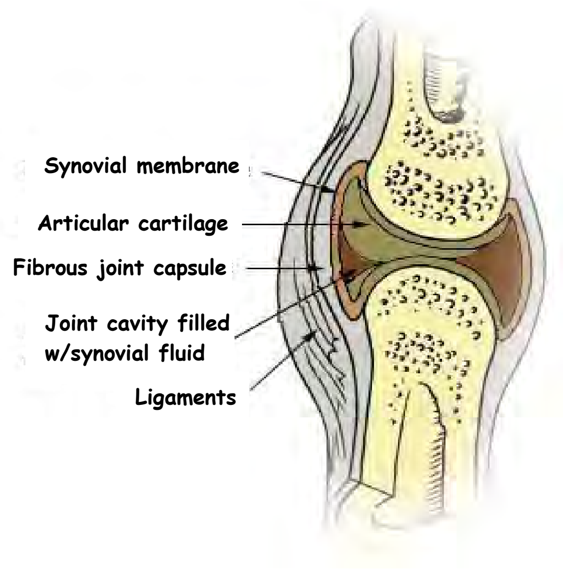
EXAMPLES: growth regions of immature long bones (in children); discs between spinal vertebrae



CARTILAGINOUS JOINT

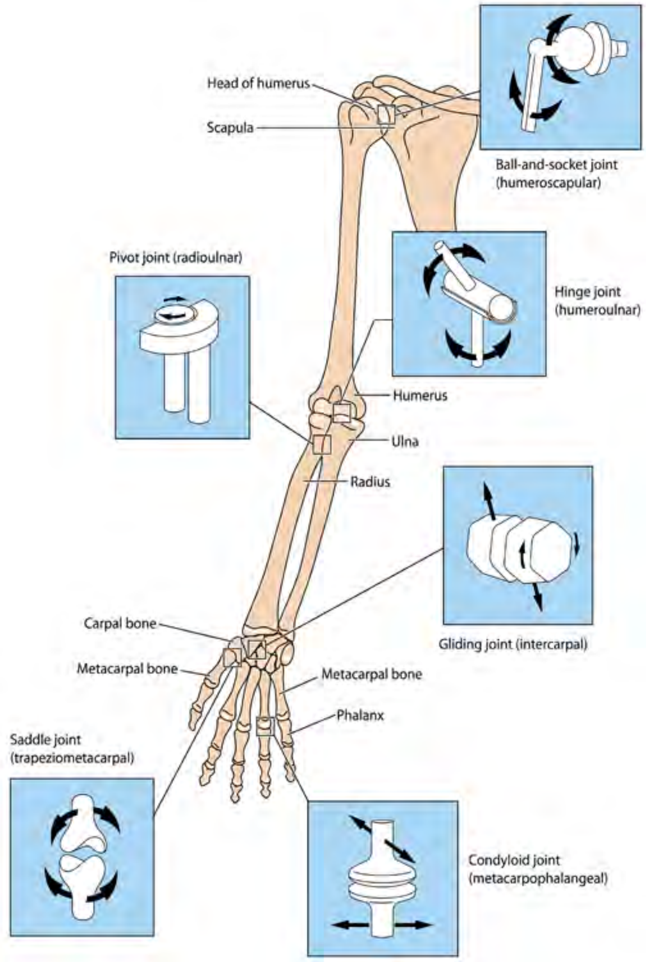
3) **Synovial**
(diarthrosis, or highly moveable):
These joints have space between the articulating bones, filled with synovial fluid. The articular ends of the bones have cartilage that cushions the bones and decreases friction. The synovial cavity is the space between the articulating bones. An articular capsule contains the two bone ends in a fluid environment. They are the most moveable

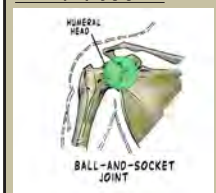
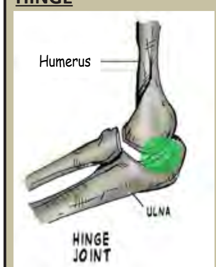
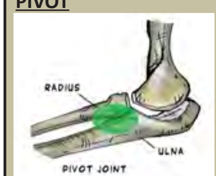
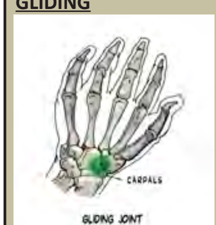
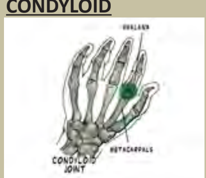
EXAMPLES: Ball and Socket (shoulder); Pivot (elbow)



SYNOVIAL JOINTS: STRUCTURE and FUNCTION

The synovial joint is a structural classification, identified by what the joint is made up of (a synovial capsule, filled with synovial fluid). Functionally, the synovial joints are identified by how they move, classified as diarthrosis (freely/highly moveable). The articular surface of these joints is the surface distinction of the point of contact between the joining bones. We look at these joints in more depth as they are the most applicable to fitness programming and injury prevention. Synovial joints are one of the following types:

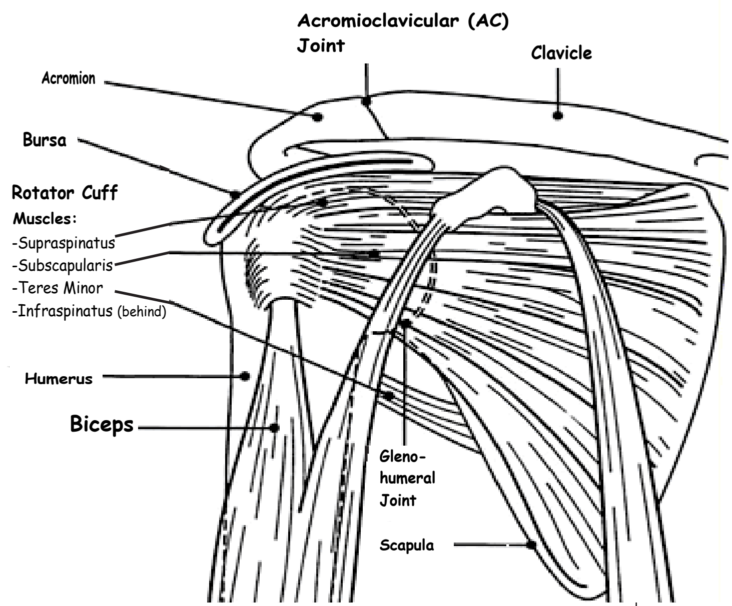


BALL and SOCKET 	• Highest degree of freedom compared to all other joints • 3 degree joints, moves in 3 planes at one time • Multiaxial, Permits movement in several axes, allows for a wider range of motion than any other joint • *Articular Surface: A rounded head that fits into a concavity, or cup shaped cavity, of another bone* *EXAMPLES:* **-Shoulder** **-Hip** (acetabulofemoral joint: between femur and concave surface of pelvis)
HINGE 	• Hinge and Pivot joints have similar mobility, they are also known as 'cylindrical' joints • 1 degree joint, moves in only 1 plane • Uniaxial, Permits movement in one plane/around one axis • Allows for flexion and extension; dorsi- and plantar flexion, typically moves within the sagittal plane • *Articular Surface: A convex part of one bone fits into the concave ligamentous socket of another bone (e.g. works like a door hinge)* *EXAMPLES:* **-Knee** (tibiofemoral joint: hinge joint between tibia and femur) **-Elbow** (humeroulnar joint: hinge joint between humerus and ulna) **-Ankle** (talocrural joint: hinge where foot and leg meet)
PIVOT 	• Pivot and Hinge joints have similar mobility, they are also known as 'cylindrical' joints • A pivot joint is a 'rotary joint' • Permits rotation: in the cervical vertebrae (between C1 and C2) this permits rotation of the head from left to right • Allows for pronation and supination at the elbow: the head of the radius rotates within the notch of the ulna • *Articular Surface: A section of a cylinder of one bone fits into a corresponding cavity on the other bone* *EXAMPLES*: **-Neck** (atlantoaxial joint: between 1st and 2nd cervical vertebrae, or C1 (atlas) and C2 (axis)) **-Elbow** (radioulnar joint: head of the radius and radial notch of the ulna)
GLIDING 	• Also known as 'sliding' or 'plane' joints • Permits sliding and twisting movements in the plane of articular surface, is non-axial as movement does not occur about an axis • Allows for flexion and extension; radial and ulnar deviation (in the hand); pronation and supination (in the foot); slight rotation possible • Movement limited by tighter joint capsules • *Articular Surface: May be slightly curved, but nearly flat, allowing bones to slide past each other (e.g. the rounded end of one bone fits into a ring formed by the other bone)* *EXAMPLES:* **-Hand** (between carpals) **-Foot** (between tarsals) **-Spine** (between articulating processes)
SADDLE 	• Permits movement in 2 planes/axes of movement (similar to condyloid joint function) • Allows for flexion and extension; adduction and abduction; and circumduction • Small amount of rotational movement • *Articular Surface: Concave and convex surfaces, one bone fits the complimentary surface of the other (e.g. one bone is shaped like a saddle, the other bone rests on it like a rider on a horse)* *EXAMPLE:* **-Thumbs** (carpometacarpal, CMC, joint of the thumbs: base of the thumb and wrist)
CONDYLOID 	• Also known as 'ellipsoidal' • Permits movement in 2 planes, angular movement along 2 axes • Allows for flexion and extension; adduction and abduction (these combined seemingly perform circumduction, but it is not true circumduction) • No rotational movement • *Articular Surface: An oval shaped condyle, or round prominence at the end of a bone, that fits into an elliptical cavity of another bone* *EXAMPLES:* **-Fingers** (metacarpophalangeal joints: between phalanx/metacarpal) **-Jaw** (temporomandibular joint, TMJ: between mandible and temporal bone)

JOINTS: A Closer Look

Let's take a closer look at some of the most 'used' joints in human movement that apply most to your training goals. Of course, this is not a comprehensive list of all joints in the human body; however, these are joints that are most susceptible to injury because of their use in training and daily activity.

<u>Shoulder Joint</u>: A Closer Look



The scapula (shoulder blade) and the clavicle (collarbone) make up the shoulder girdle. The scapulae (plural form of scapula) are secured to the axial skeleton by multiple muscles exerting multiple lines of pull. This allows for considerable movement of the upper back. The positions of the scapulae are important for initiating and controlling proper posture during many exercises. The medial end of the clavicle (the end that is closest to the midline of the body) is rounded and articulates with the sternum. The shoulder girdle's mobility, as well as that of the upper humerus (upper arm bone), is largely dependent on three joints in this area known as the **shoulder complex**, which are comprised of the following:

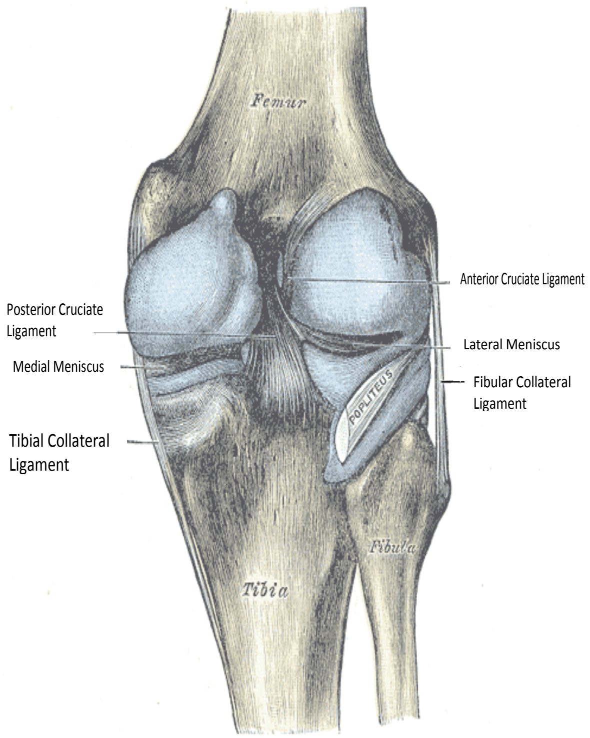
1. the sternoclavicular (SC) joint is a saddle type synovial joint that occurs between the clavicle and the sternum. *(not shown)*
2. the acromioclavicular (AC) joint is a gliding type synovial joint which is the other end of the clavicle that articulates with the scapula.
3. the glenohumeral (GH) joint is a ball and socket joint with multiaxial movement; it is the place where the humerus joins the scapula.

Shoulder ROM:
Abduction: 180^o, bring arm up sideways
Adduction: 45^o, bring arm toward the midline of the body
Horizontal Abduction (abduction in transverse plane): 45^o, swing arm horizontally backward
Horizontal Adduction (adduction in transverse plan): 130^o, swing arm horizontally forward
Vertical Extension: 60^o (raise arm straight backward)
Vertical Flexion: 180^o (raise arm straight forward)
Medial and Lateral Rotation in transverse plane: Turn arm in and out while hands at sides or extended laterally
Circumduction: in all planes

Knee Joint: A Closer Look

The knee joint is the largest in the human body. It is comprised of articulations at three long bones: femur, tibia and fibula. The femur is connected to two parallel forelimb (i.e., lower leg) bones: tibia and fibula. The tibia of the lower leg is larger than the fibula of the lower leg. The tibia lies medially to the fibula – these two bones form the shin and serve the primary function of bearing weight. The tibia articulates at the proximal end with the femur and at the distal end with the talus bone in the ankle. The joint between the tibia and femur is known as the tibiofemoral joint. The tibiofemoral joint is located between the flat surface of the tibia and the condyles of the femur, with the patella (kneecap) in front of it. The prime movement of the knee joint is flexion and extension, or bending and straightening the leg. The head of the fibula, or the proximal end, articulates with the tibia just below the level of the knee joint. The distal end of the fibula articulates with the talus bone of the foot.

The encompassing knee joint is a hinge joint, but it also includes condyloid joints of the tibiofemoral and a partly gliding joint of the patellofemoral joint, which connects the patella and femur. The deep surface of the patella is cartilaginous and can be exposed to premature wear and tear. The patella is a sesamoid bone that is seated in the patellar (quadriceps) tendon. The tendon attaches on the tibia at the tibial tuberosity. The patella helps to resist the stress that is placed on the patellar tendon during movement of the knee. Another key structure for knee movement is the popliteus muscle, originating from the lateral surface of the femur with insertion on the posterior surface of the tibia, it laterally rotates the femur on the tibia, unlocking the knee in movements that require flexing the leg, or bending the knee. The collateral ligaments, cruciate ligaments and ***menisci*** (plural form of 'meniscus') are three of the supportive structures of the knee:



The **tibial (or medial) collateral ligament** and the **fibular (or lateral) collateral ligament** originate on the condyles (i.e., rounded protuberances) of the femur and attach to the tibia on the medial side and the fibula on the lateral side. These ligaments resist lateral and medial displacement and rotation.

The two cruciate ligaments - the **anterior and posterior cruciate ligaments** - resist extreme flexion, extension and twisting motions. The anterior cruciate ligament (ACL) resists hyperextension and the posterior cruciate ligament (PCL) resists hyperflexion. Because most impacts in sports come from the lateral side, the opposite ligament is the one that gets stretched and, therefore, injured.

Two in each knee, the inside (or medial) and the outside (or lateral) ***menisci*** are thin cartilage in the knee that can also become injured. A meniscus is a crescent-shaped structure that partly divides a joint cavity. The menisci in the knee provide for cushioning at the joint surfaces of the femur and tibia.

The stability and integrity of the knee joint is the function of the ligaments and muscles that cross that joint. The knee joint is the most common location for athletic injuries. The lateral movement and likelihood of collisions in sports are primary reasons for injury.

Knee ROM:
Flexion: 130^{o}, touch calf to hamstring
Extension: 15^{o}, straighten out knee as much as possible
Internal rotation: 10^{o}, twist lower leg toward midline

<u>Wrist Joint</u>
The radius is the smaller of the two bones in the forearm (the other being the ulna). At its distal end (the end situated away from the center of the body), the radius becomes wider and thicker, forming the radiocarpal joint, or main wrist joint. The radiocarpal joint is a biaxial, condyloid type of synovial joint.

The ulna and radius form a joint distally called the distal radioulnar joint. The distal radioulnar joint is a pivot type synovial joint. The bump that you might see on your wrist on the same side as your little finger is the head of the ulna bone.

Wrist ROM:
Flexion: 80-90^{o}, bend wrist so that palm nears lower arm
Extension: 70^{o}, bend wrist in opposite direction
Radial deviation: 20^{o}, bend wrist so that thumb nears radius
Ulnar deviation: 30-50^{o}, bend wrist so that pinky finger nears ulna

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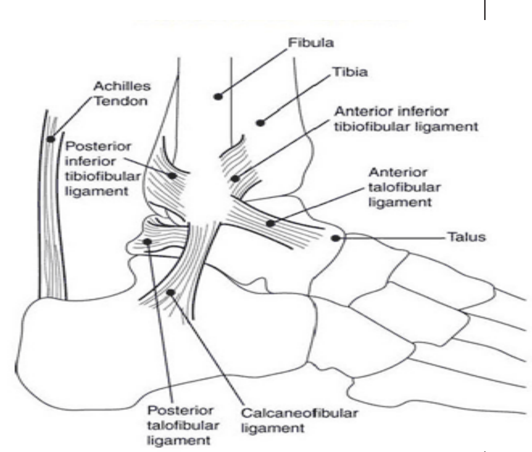
<u>Ankle Joint</u>
The ankle joint, or talocrural joint, is a hinge type with movement in only one plane. It is formed in the region where three bones meet: the talus (also called the 'ankle bone'), and the tibia and fibula. The only motion that occurs directly at this point is dorsiflexion (pointing toes up) and plantarflexion (pointing toes down). The tibia and fibula are bound together by strong tibiofibular ligaments which produce a socket that the body of the talus fits snugly into. The ankle has strong medial ligaments and weaker lateral ligaments, which explains a higher number of inversion ankle sprains.

The foot and its joints, the predominant being the subtalar joint (where the talus and calcaneus meet), and other joints between the tarsal bones contribute to movement of the ankle and adjust to movement on uneven and unstable surfaces. The subtalar joint allows for inversion (turning feet inward) and eversion (turning feet outward).

Ankle ROM:
Dorsiflexion: 20^{o}, bend ankle so toes point up
Plantar flexion: 45^{o}, bend ankle so toes point down

Foot ROM:
Inversion: 30^{o}, turn foot so the sole faces in
Eversion: 20^{o}, turn foot so the sole faces out



Note again, there are many other joints in the body that have not been mentioned in this section. However, you should be familiar with the main joints and movements at these joints so that you can really understand what is happening when you or your client perform movement. Here are some other joints, applicable to training and daily life, with their basic movements:

Neck: flexion/extension, abduction (lateral flexion)/adduction (reduction), rotation
Shoulder Complex:
Acromioclavicular: elevation, depression
Glenohumeral: extension, abduction, adduction, rotation - internal and external
Scapula: protraction/retraction
Elbow:
Humeroradial: flexion/extension
Humeroulnar: flexion/extension
Radioulnar: pronation/supination (of the forearm and hand)
Fingers: flexion/extension, abduction/adduction
Toes: flexion/extension

Connective Tissue: Tendons, Ligaments, Fascia

Connective tissue functions to:

- Protect and insulate internal organs
- Bind together and support other tissue in the body
- Compartmentalize or divide structures, like skeletal muscle

NOTE: Adipose tissue, or fat, is also a connective tissue and it is a major site for the storage of energy. Blood is also considered a connective tissue, serving as a major transport system in the body.

Tendons and ligaments are formed from dense connective tissue and permit a certain degree of stretch. ***Ligaments*** attach bone to bone and provide integrity and strength, both inside and outside the synovial joint. Ligaments are strong and less elastic than tendons. They are less likely to return to their normal resting length when overstretched. Because they are less elastic, ligaments are more prone to tearing than tendons are. Ligaments can be permanently lengthened if kept in a lengthened or stretched position for sustained periods of time.

Tendons connect skeletal muscle to bone, cartilage or an adjoining muscle (such as those with multiple "heads"). Formed from fibrous tissue, tendons can be ruptured; however, they are much stronger than muscle and the periosteum of the bone. Often, muscle or bone is injured before the tendon is damaged.

Fascia a thin sheath of fibrous tissue, that is loose but strong, which provides support and some protection by enclosing the muscle, or organ. Research suggests that the role of fascia is more complex than once thought. It is arranged in continuous 'lines' throughout the body, each line encasing a specific muscle group, allowing force to be generated through the entire group. A dysfunction in one muscle will impact another in that group. Trauma, inactivity and muscle tension can reduce blood flow and cause painful inflammation of the fascia and its corresponding muscle. If this condition persists, fibrosis (i.e., thickening or scarring of connective tissue) can occur, causing more inflammation. Myofascial release is a soft tissue therapy that helps to break the cycle of this condition by stimulating the stretch reflex, improving blood flow and relaxing contracted muscles.

Prime Movers: Major Skeletal Muscles

The larger, major skeletal muscles that are primarily responsible for movement of resistance in a given exercise is called a ***prime mover***, and it is not uncommon for there to be more than one prime mover in an exercise. Prime movers are known also as "***agonists***" (easily remembered because an "agonist" is one who starts a struggle or competition, just like the agonist muscle that is primarily doing the work to start the movement). Prime movers are the working muscles that are involved in the activation of smaller muscles and major joints to complete the respective movement, but they don't work alone. In general, when a muscle acts to cause the limb to move through the respective joint's ROM, they work together as follows:

AGONISTS **(Prime Movers)**	These muscles contract to create the ROM in a joint, they are primarily responsible for the movement *APPLIED TO:* **Concentric Contraction** – the muscles that are shortening are the agonist, doing all of the work **Eccentric Contraction** – the muscles that are lengthening are the agonist, doing all of the work to decelerate the muscle's return to the starting point of the exercise (which occurs, most importantly, at the end range of the joint to prevent injury)
ANTAGONISTS	These muscles act to return a limb to its original place, they oppose the movement of the agonist *APPLIED TO:* **Muscle Groups** Pectoralis minor/Rhomboids (shoulder girdle) Pectoralis major/Infraspinatus & Teres minor (shoulder joint) Latissimus Dorsi/Deltoid Anterior Deltoid/Posterior Deltoid Left and Right External Obliques Quadriceps/Hamstrings Biceps/Triceps Forearm flexors/Extensors **Exercise Movement** Tricep push downs/Curls Bench press/Wide row Front squat/Supine leg curl Reverse wrist curls/wrist curls
SYNERGISTS	These muscles neutralize the extra motion from the agonists; sometimes referred to as neutralizers, they provide balance for the working muscles; they make sure that the force of the movement is acceptable for the desired plane of motion
FIXATORS	These muscles provide stabilization to support the rest of the body during the respective movement, and are sometimes referred to as stabilizers

The best way to start to familiarize yourself with these muscles is to identify them as part of their muscle group. Muscle groups include several muscles and their structures that are part of the "team" that performs the work.

MUSCLE GROUPS

The skeleton and joints can't move on their own, of course – and that's where the muscles come into play. When a muscle shortens (i.e. contracts), it pulls the bone that it is attached to, causing movement at that joint. When there is movement that uses only one joint to target only one muscle, it is said to be a **simple movement**. Conversely, when there is movement that uses more than one joint and targets more than one muscle/group, it is said to be a **compound movement**. In this section, we will review the major muscles in the body, their locations and their main functions, to include an *example* exercise. You will need to know this information in order to plan well-rounded exercise programs that complement how the major muscles function.

CHEST:

Pectorals: Located on the left and right side of the anterior (front) side of the body, this muscle group is the prime movers of the chest and are critical to the pushing movements of the upper body; functioning primarily to adduct, flex and medially rotate the arm at the shoulder joint.

Pectoralis Major: originates at the anterior surface/medial side of the clavicle and anterior surface of the sternum; inserts at lateral lip of bicipital groove of humerus

MAIN FUNCTION: Adduction and flexion of the humerus

EXERCISE FOR THIS MUSCLE: Chest Press

Pectoralis Minor (under Pectoralis Major): originates at 3rd, 4th and 5th ribs; inserts at superior surface/medial portion of the coracoid process of the scapula

MAIN FUNCTION: Depresses and protracts the scapula

EXERCISE FOR THIS MUSCLE: Dips

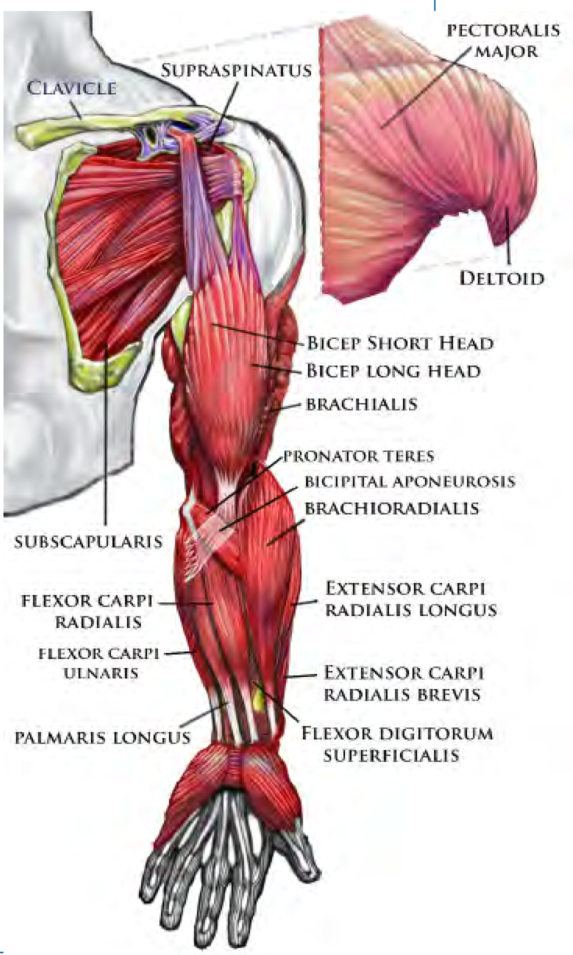
ARMS & SHOULDERS:

Deltoids: These shoulder muscles, stretching from the clavicle to the humerus, are made up of three (3) parts – the front (anterior), middle (lateral) and back (posterior). They are the prime movers for arm abduction; originating through the anterior border/lateral part of the clavicle around through the upper part/posterior border of the scapula, they insert together at the middle/anterior surface of the humerus (i.e. deltoid tuberosity). They work with the chest and back muscles for abduction and adduction of the humerus, and for extension and flexion of the shoulder joint at the humerus. They also, with help from the chest muscles, work for overhead pushing movements.

MAIN FUNCTION: Abduction of the humerus; medial rotation of humerus

Posterior Deltoid: Horizontal abduction; Extension, abduction and external rotation of the shoulder joint at the humerus

EXERCISE FOR THESE MUSCLES: Lateral dumbbell raises



Anterior View

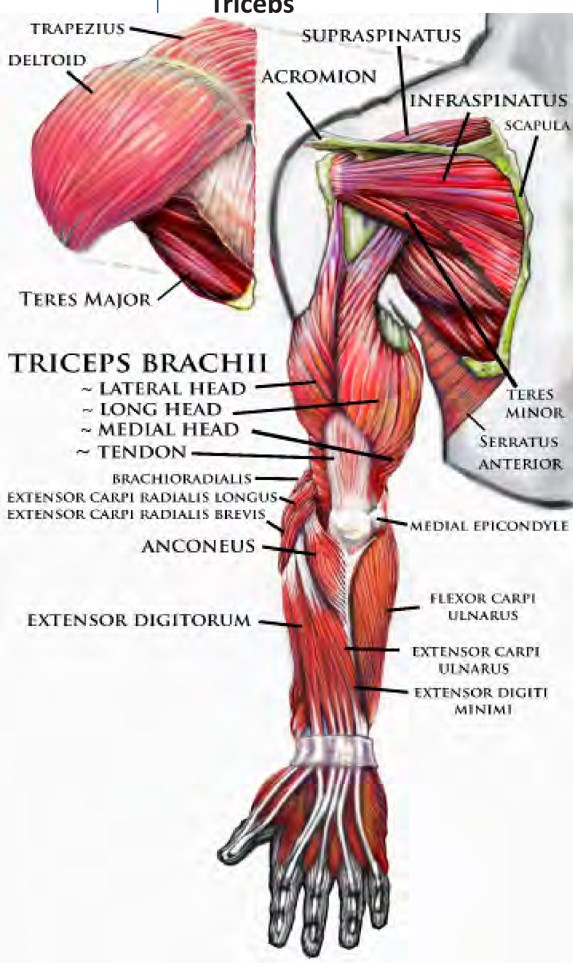
Rotator Cuff: Beneath the deltoids, this is a group of four (4) muscles that originate from the scapula and connect to the head of the humerus. The rotator cuff muscles and respective tendons act to support the arm, keeping the head of the humerus firmly in its shoulder socket, during movement of muscles at the shoulder joint.

Supraspinatus: *abducts the arm*
Infraspinatus: *externally rotates the arm*
Teres Minor: *externally rotates the arm*
Subscapularis: *internally rotates the humerus*

Biceps & Triceps: The biceps brachii (or "biceps", Latin for "two-headed muscle"), is made up of two (2) bundles of muscle that both originate from the scapula stretching downward to form one single muscle attaching/inserting to the medial part of the forearm, at the radial tuberosity. It works as the prime mover to supinate the forearm and flex the elbow. Triceps brachii (or "triceps", Latin for "three-headed muscle"), is made up of three (3) bundles of muscle each of different origins, joining at the proximal end of the ulna at the elbow; they work together for the extension of the elbow (NOTE: triceps are the biceps antagonists)

Biceps
MAIN FUNCTION: Elbow Flexion
EXERCISE FOR THIS MUSCLE: Curls

Triceps
MAIN FUNCTION: Elbow Extension
EXERCISE FOR THIS MUSCLE: Tricep extensions



Posterior View

Forearms: The region between the elbow and the wrist that is comprised of many muscles which allow for movement at the fingers, elbow and wrist. In general, the anterior forearm muscles are flexors and the posterior arm muscles are extensors.

MAIN FUNCTION: Flexion, extension, radial and ulnar deviation of wrist
EXERCISE FOR THIS MUSCLE: Wrist curls and reverse wrist curls

<u>Forearm muscles shown here</u>:
Brachioradialis
Pronator Teres
Flexor Carpi Radialis
Flexor Carpi Ulnaris
Flexor Digitorum Superficialis
Palmaris Longus
Extensor Carpi Radialis Longus
Extensor Carpi Radialis Brevis
Extensor Carpi Ulnaris
Extensor Digiti Minimi
Extensor Digitorum
Anconeus

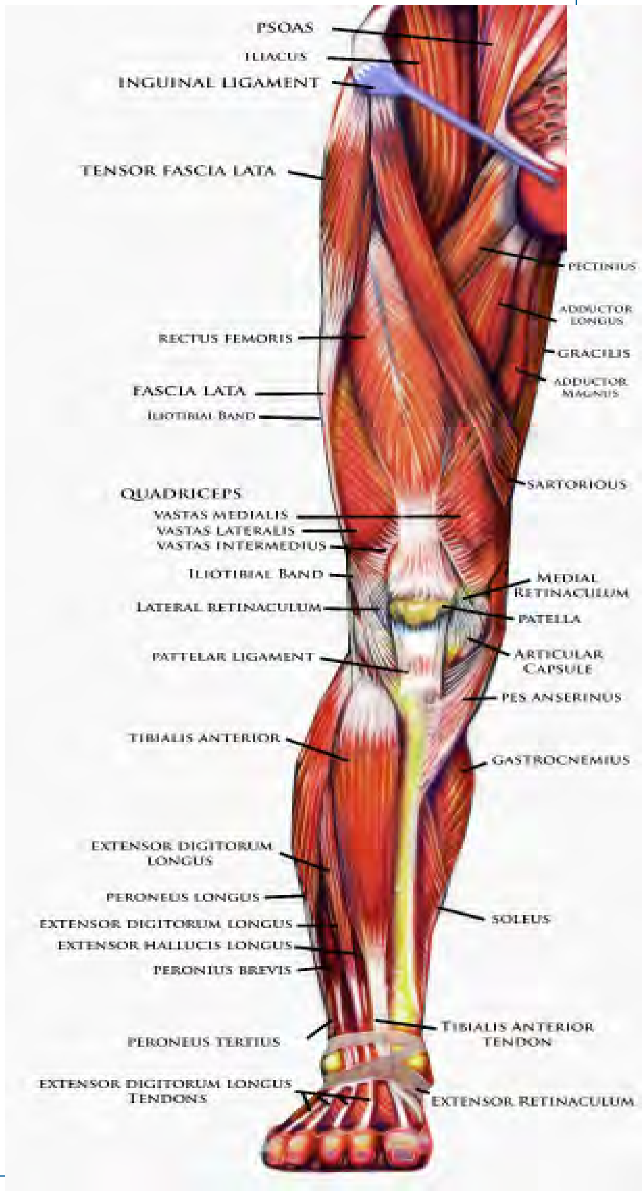
LEGS and BUTTOCKS

Adductors: Located on the medial side of the thigh, this group of muscles acts functionally on the hip; also known as the muscles of the hip. The adductors originate on the pubis and ischium bones (coxal/hip bones), mainly inserting on the medial posterior surface of the femur. The adductors shown here include: adductor longus, adductor magnus, pectineus, gracilis. Not shown are the adductor brevis (behind the pectineus and adductor longus) and the obturator externus (covers outer surface of the anterior wall of pelvis, also considered part of the lateral rotator group)

MAIN FUNCTION: Brings legs across midline of body
EXERCISE FOR THESE MUSCLES: Sumo squats

Quadriceps (Quads): Located on the anterior (front) of the upper thigh, this large muscle group is made up of 4 muscles: rectus femoris, vastus lateralis, vastus medialis and vastus intermedius. The quadriceps are the prime movers of extension at the knee joint; all of the quad muscles originate from areas of the femur, with exception of the rectus femoris. The rectus femoris is located at the middle, front of the thigh, and originates from the ilium. All four of these muscles insert into the tibial tuberosity of the tibia, where the quadriceps tendon becomes the patellar ligament.

MAIN FUNCTION: Extension at the knee joint
EXERCISE FOR THESE MUSCLES: Squats and leg press



Anterior View

Hamstrings: Made of 3 separate muscles found on the posterior (back) side of the upper thigh: biceps femoris, semitendinosus, semimembranosus. The hamstrings are the prime movers of flexion at the knee joint, or bending at the knee and lowering of the leg. The semitendinosus and semimembranosus both originate on the tuberosity of the ischium, while the biceps femoris (short head) originates on the posterior crest/ ridge of the femur; the semitendinosus and semimembranosus both insert into medial portions of the tibia, and the biceps femoris (both short and long heads) insert into lateral portions of the fibula.

MAIN FUNCTION: Flexion of the knee and aids in hip extension
EXERCISE FOR THESE MUSCLES: Hamstring curl with resistance band

Calves: a pair of muscles, the gastrocnemius and the soleus, that both insert into the calcaneus (heel bone). The gastrocnemius is the superficial muscle portions that are made up of medial and lateral heads, which originate from the base of the femur; the soleus is the deep muscle that forms the third head, it originates at the superior posterior area of the tibia.

MAIN FUNCTION: Plantar flexion of the foot and stabilization of the ankle
EXERCISE FOR THESE MUSCLE: Calf raises

Gluteals (Glutes):

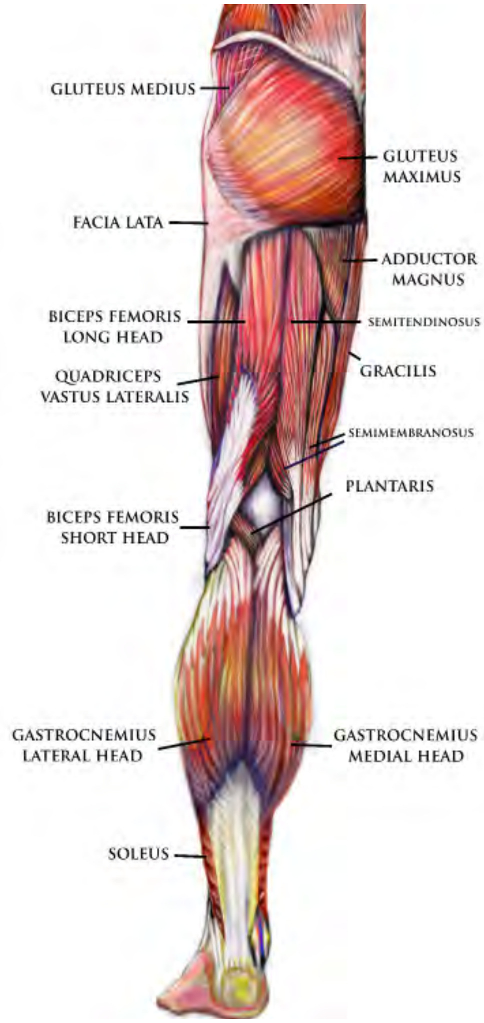
The gluteus maximus functions primarily for hip extension, whereas the gluteus medius and minimus perform abduction. These muscles originate at locations on the gluteal surfaces of the ilium, lumbar fascia and sacrum; and primarily insert at the gluteal tuberosity of the femur.

MAIN FUNCTION: Stabilization of the pelvis
EXERCISE FOR THESE MUSCLES:
Clams and side band walks

Lateral Rotator Group:

This is a group of six (6) muscles of the hip (not shown), in the gluteal region, that laterally rotate the femur at the hip joint. Like the adductors, they originate from the hip bones. These muscles, the piriformis, gemellus superior and gemelius inferior, obturator internus and obturator externus, and quadratus femoris, insert on the superior surface of the femur.

**for some people, the sciatic nerve runs through the piriformis muscle, predisposing them to 'piriformis syndrome' which is the compression of the muscle on the sciatic nerve causing the irritation and pain that is associated with sciatica*



Posterior View

BACK:

Latissimus Dorsi (Lats): A triangular muscle covering the broadest area of the back on the right and left posterior side. It is the largest, widest and most powerful muscle of the back; it is a spinal stabilizer which originates in several locations from the thoracolumbar fascia and the lumbar vertebrae, 3-4 inferior ribs, the inferior angle of scapula and the sacrum and pelvis; it travels superiorly to the humerus and inserts along the floor of the intertubercular groove of the humerus. It assists in lumbar extension and stabilization and also performs pulling motions through the arms.

MAIN FUNCTION: Extension, internal rotation and adduction of the shoulder joint
EXERCISE FOR THIS MUSCLE: Pull-ups or Lat pull-down

Teres Major: A muscle of the upper back/extremity which arises from the dorsal surface of the scapula and runs through the axillary space between the rotator cuff muscles, teres minor and infraspinatus. Its tendon lies behind the lats and inserts into the medial lip of the intertubercular groove of the humerus.

MAIN FUNCTION: Extension, internal rotation and adduction of the shoulder
EXERCISE FOR THIS MUSCLE: Internal rotation with cable

Rhomboids (major, minor): These are rhombus shaped muscles that originate from the end of the cervical vertebrae (neck) through mid-thoracic vertebrae, and insert at the medial border of the scapula.

MAIN FUNCTION: Retraction of scapula
EXERCISE FOR THIS MUSCLE: Shoulder blade squeeze

Trapezius (Traps): A flat, triangular muscle that covers the back of the neck, shoulders and thorax; it has three functional areas that work to rotate, elevate and retract the scapula – the superior, middle and inferior areas.

MAIN FUNCTION:
Superior (Upper) Trapezius: *Upward rotation, elevation; Bilaterally - cervical spine extension; Unilaterally - cervical spine lateral flexion, cervical spine rotation*
Middle Trapezius: *Retraction*
Inferior (Lower) Trapezius: *Depression, Downward rotation*
EXERCISE FOR THIS MUSCLE: High pull and depression exercises

Erector Spinae/Lower Back: Made up of several muscles that allow for forward bending (flexion) and backward bending (extension), the main muscle group of the lower back is the erector spinae. The erector spinae, which is commonly referred to as the 'lower back', actually extends the vertebral column through the cervical, thoracic and lumbar regions and is made up of three (3) distinct muscle groups: iliocostalis, longissimus and spinalis. These groups of muscles work together to counterbalance all the forces involved in spinal flexion. The erector spinae begins as the sacrospinalis tendon which attaches at the sacrum and ilium. This tendon gives rise to the different muscle groups that run up the spine and obliquely to attach at lateral parts of the vertebrae and ribs. In the cervical region, muscles of the erector spinae attach at the base of the skull.

MAIN FUNCTION: Lumbar extension
EXERCISE FOR THESE MUSCLES: Deadlifts and hyperextensions on a ball or bench

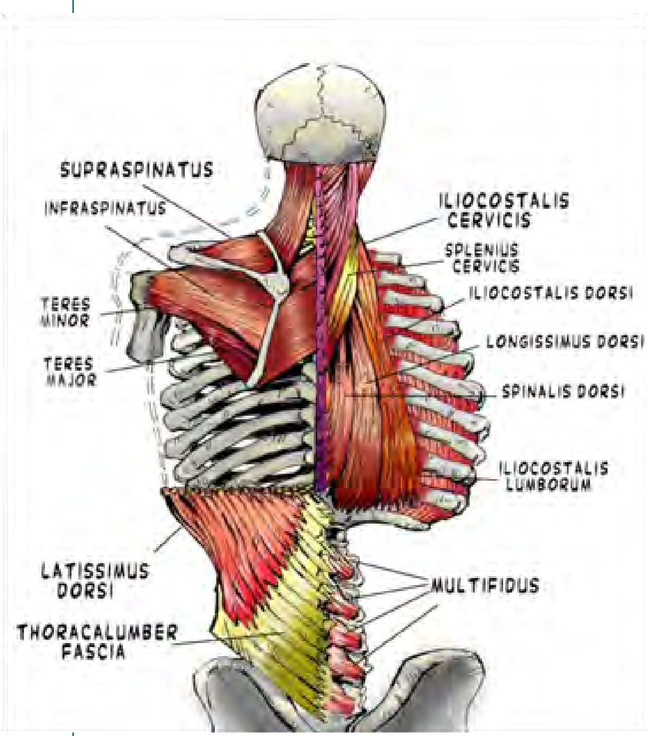
ABDOMINALS (ABS): A three (3) layered group of muscles that work together to perform and assist in many important bodily functions, such as breathing, protection of organs, postural support, multi-directional movement of the body and its parts.

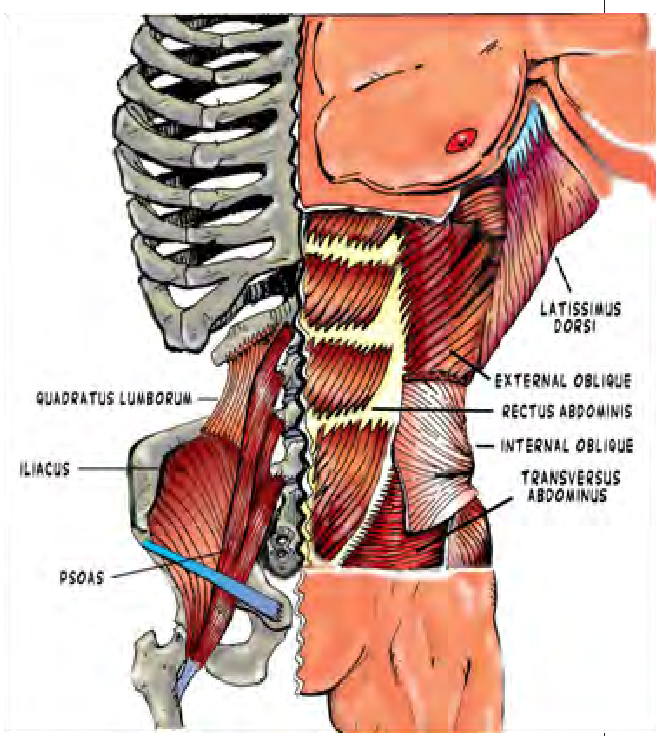
Rectus (straight) abdominis: flat, long muscle extending the entire length of the abdomen
MAIN FUNCTION: Lumbar spine flexion

External obliques: largest and outermost (superficial) muscles of the abdomen
MAIN FUNCTION: Bilateral flexion of the trunk; Lateral flexion of the trunk to the same side; Unilateral rotation of the torso to the opposite side (left external oblique rotates to right)

Internal obliques: runs below (deep) and perpendicular to the external obliques
MAIN FUNCTION: Bilateral flexion of the trunk; Lateral flexion of the trunk to the same side; Unilateral rotation of the torso to the same side (left internal oblique rotates to the left)

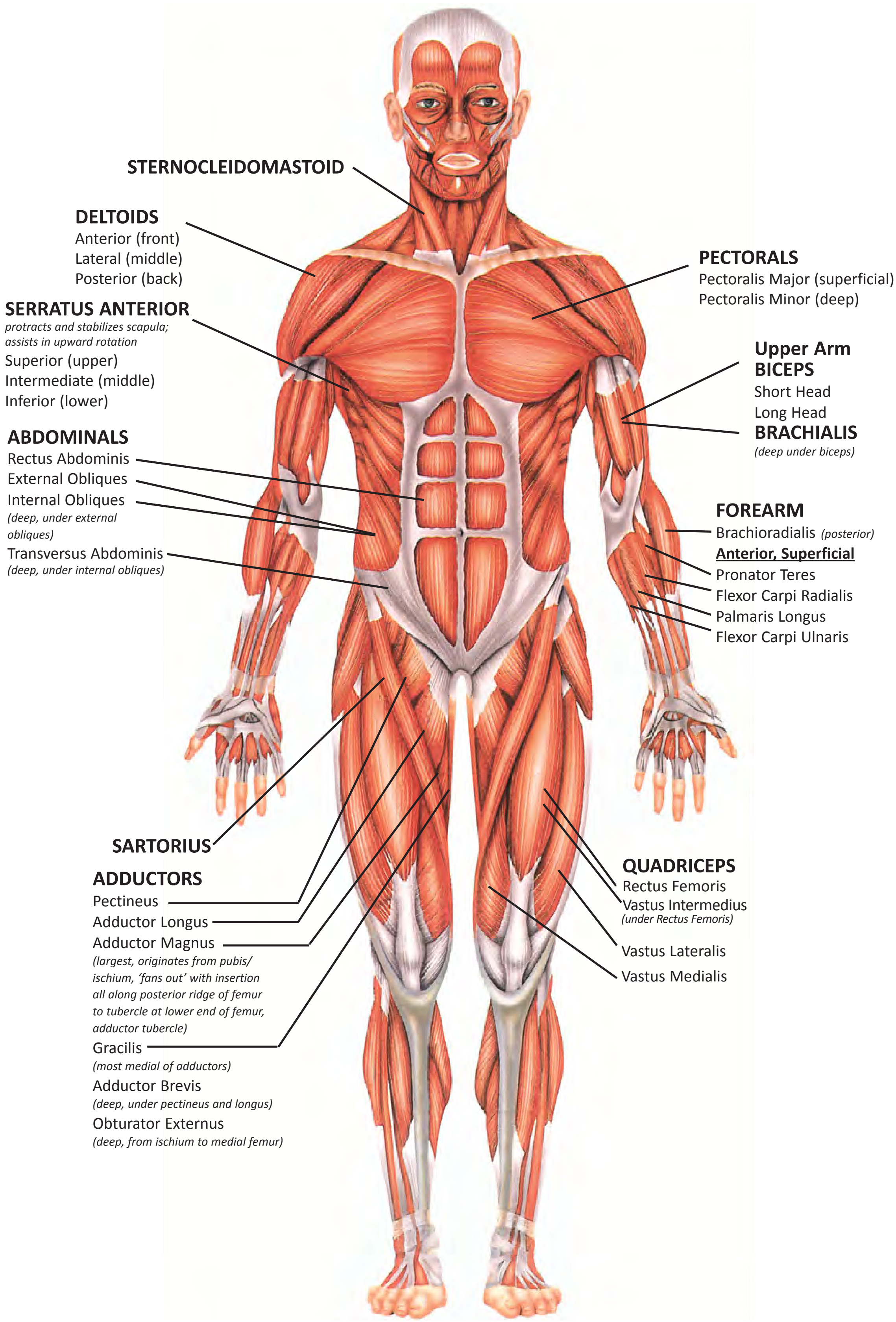
Transversus (across) abdominis: runs below (deep) the internal obliques, it is the innermost muscle of the abdomen
MAIN FUNCTION: Stabilizes trunk

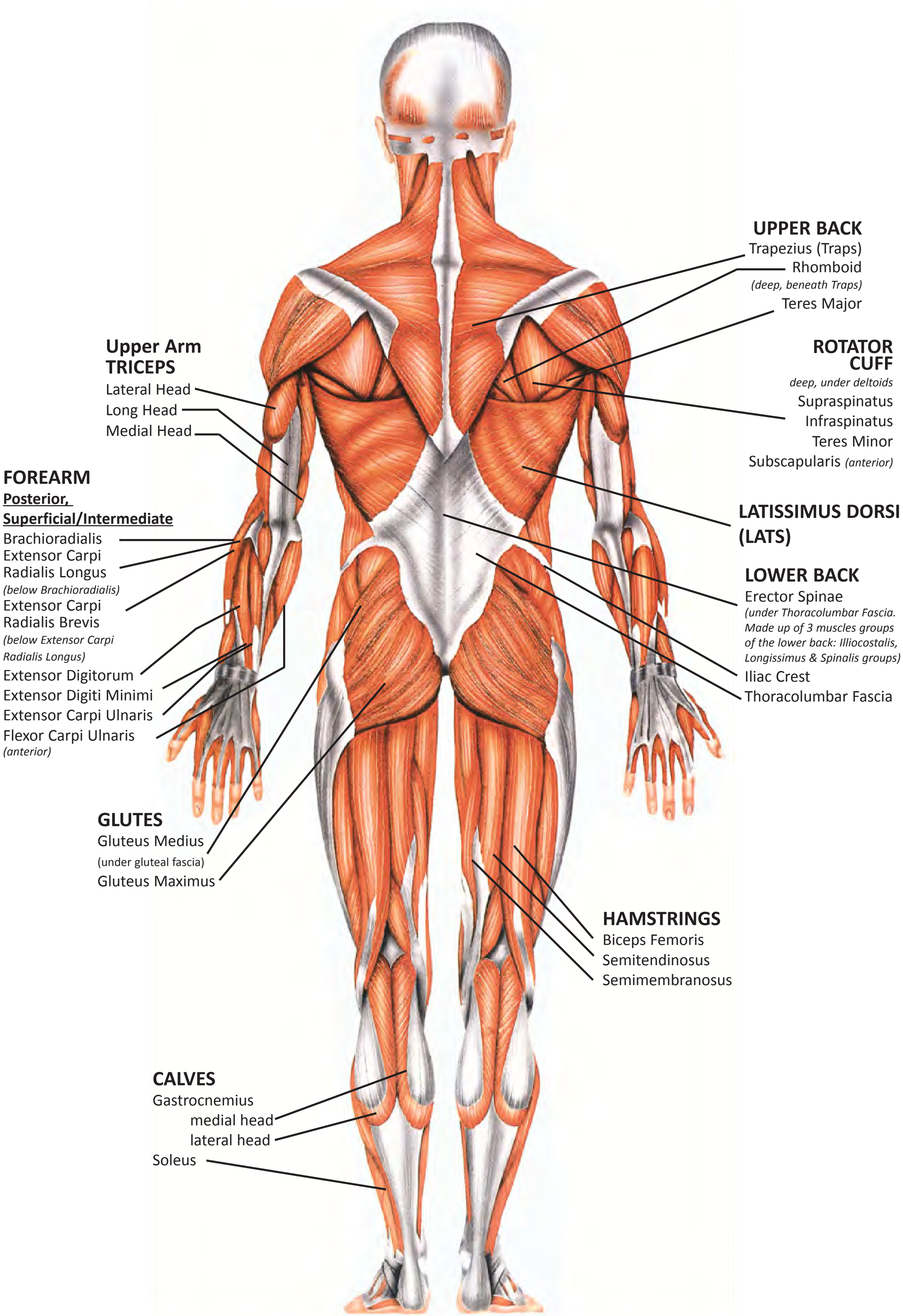




**Note: the exercises that have been recommended in this section offer only one example of the suggested movements for the respective muscle/s/, there are many other productive exercises for these areas.*

ANTERIOR VIEW: major muscles




UPPER BACK
Trapezius (Traps)
Rhomboid
(deep, beneath Traps)
Teres Major
ROTATOR CUFF
deep, under deltoids
Supraspinatus
Infraspinatus
Teres Minor
Subscapularis *(anterior)*
LATISSIMUS DORSI (LATS)
LOWER BACK
Erector Spinae
(under Thoracolumbar Fascia. Made up of 3 muscles groups of the lower back: Illiocostalis, Longissimus & Spinalis groups)
Iliac Crest
Thoracolumbar Fascia
Upper Arm TRICEPS
Lateral Head
Long Head
Medial Head
FOREARM
Posterior, Superficial/Intermediate
Brachioradialis
Extensor Carpi Radialis Longus
(below Brachioradialis)
Extensor Carpi Radialis Brevis
(below Extensor Carpi Radialis Longus)
Extensor Digitorum
Extensor Digiti Minimi
Extensor Carpi Ulnaris
Flexor Carpi Ulnaris
(anterior)
GLUTES
Gluteus Medius
(under gluteal fascia)
Gluteus Maximus
HAMSTRINGS
Biceps Femoris
Semitendinosus
Semimembranosus
CALVES
Gastrocnemius
medial head
lateral head
Soleus

The CORE

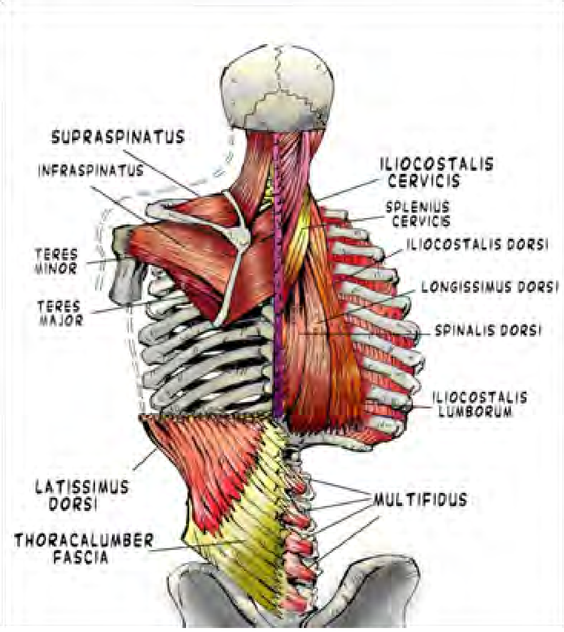
The core is where most of the body's power is derived. It provides the foundation for all movements of the arms and legs. The core must be strong, have dynamic flexibility, and function synergistically in its movements in order to achieve maximum performance. Motion of the human body is not isolated to one muscle or tissue moving in one specific direction. It is a complex event involving agonist and antagonist structures that work together to create changes in position and stabilizes the body in all three directional planes of motion. Regardless of the type of sport, it is essential to have core strength and trunk stability to maximize performance and prevent injury, especially in active daily living.

The foundation of the core consists of more than just the abdominal muscles. It includes muscle attachments deep within the torso, from the pelvis up to the neck and shoulders. Abdominal muscles work together to transmit a compressive force and act to increase intra-abdominal pressure that stabilizes the lumbar spine. They can work individually to perform trunk rotation, while the internal and external obliques on the same side can work synergistically to laterally flex the spine. The muscles of the core include the following structures:

Erector Spinae: the foundation of the core, it is made up of three (3) separate muscle groups, inferior to superior in this order: Illiocostalis, Longissimus, Spinalis groups.

Multifidus: Deep spinal muscles that run segmental from the cervical spine (C2) to the sacrum. They allow for extension, and, to a lesser degree, rotation and lateral flexion providing stability of joints at individual discs of the spine.

Interspinales, Intertransversarii, Rotatores (not shown): <u>Deep structures</u> that directly attach to the spinal column. These are very important for rotational motion and lateral stability.



External Obliques: Abdominal muscles that attach at the lower ribs, pelvis, and abdominal fascia.

Internal Obliques: Abdominal muscles that attach at the lower ribs, rectus sheath, pelvis and thoracolumbar fascia (beneath the external obliques).

Transversus Abdominis: Abdominal muscles that attach at the lower ribs, pelvis, and thoracolumbar fascia, and rectus sheath (beneath internal obliques).

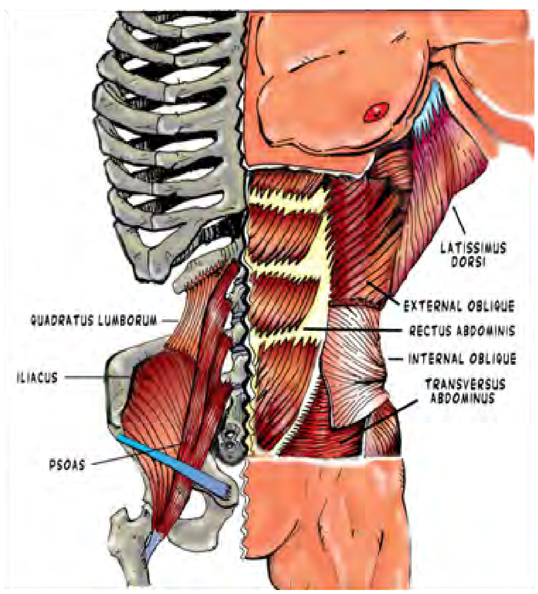
Rectus Abdominis: Abdominal muscle that attach at the fifth through seventh ribs, the lower sternum and the front of the pubis bone. This muscle flexes the spine, compresses the internal organs of the abdomen, and transmits forces laterally from the obliques. NOTE - it is a common fallacy that the upper and lower rectus are isolated.

Latissimus Dorsi: It assists in lumbar extension and stabilization, and also performs pulling motions through the arms.

Quadratus Lumborum: Attaches at the 12th rib and the upper 4 lumbar vertebrae and the pelvis. It stabilizes the lumbar spine in all planes of motion while stabilizing the 12th rib. It attaches to the diaphragm during respiration and laterally flexes the trunk.

Thoracolumbar Fascia: Connects the latissimus dorsi, gluteal muscles, internal obliques and transverse abdominis, supplies tensile support to the lumbar spine, and is used for load transfer throughout the lumbar and thoracic regions.

Abdominal Fascia: Three (3) layered membrane that covers the deep muscles of the lower back. Enclosed between the middle and posterior layers is the erector spinae. It connects to the obliques, rectus abdominis, and pectoralis major. Fascia connections that cross the midline transmit forces to the muscles opposite side.



Postural Alignment

Just as you must align your car's wheels for proper performance, you must align your body, or your client's body, for proper functioning. A quick gauge for recognizing proper posture is to look at your client from both the front view (anterior view in the sagittal plane) and the side views in the frontal plane. Do this from at least 5-6 feet away. Your client should not be wearing shoes or baggy clothes when you are assessing posture. You should first assess in an open, free space and then against a wall. Look at these aspects for indications of muscle imbalance and improper posture:

Lateral Side View

- Ears over shoulders?
- Shoulders over hips? The middle of the humerus should be aligned with the middle of the hips, at about the head of the femur.
- Hips over knees? The middle of the hip should line up with the back of the patella or shin bone tibial crest.
- Knees over ankles? The protruding aspect of the lateral ankle joint should be in line with the back of the patella.

Lateral Side View: Against a Wall

Back against the wall, are the buttocks touching the wall?
Are they bending or changing their knees to maintain back/buttocks against the wall?
Are they throwing their shoulders back?
How far is the lower back from the wall? (Should be 1-2 inches)
How far is the scapula from the wall? (Should be about 1 inch)

Anterior Front View

Are shoulders horizontal? The clavicle should be level.
Are hips horizontal? Look at shoulder to hip comparison.
Are feet pointed straight forward or angled outward slightly? If one foot is angled differently than the other, try to look for some inversion or eversion of the ankle.

It is a fairly common concept that conditioning of your core will return gains in stability. The problem, however, lies in *how* people go about trying to do this. Many will do crunches or sit-ups to strengthen the abs, but this is not actually training the core very well at all - in actuality, it really only helps you to get up from a lying position more efficiently. Doing crunches and sit-ups will not train the entire core to compensate for imbalances, nor will it keep the trunk rigid when standing. Good core training will work several thoracic muscles at once, and often in a counterbalancing type of way. Take a look at the common plank, for example. Have your ever felt your abdominals during this exercise? Not only are they tight but so are the side muscles, or obliques, and the lower back muscles as well. Another example: notice the difference in performing a one-handed seated row versus a two-handed, what muscles would need to contract to stabilize the torso?

Here are a couple of postural scenarios and likely corrections:

Shoulders slump forward (Kyphotic posture) - strengthen the rotator cuff muscles, rhomboids and lower trapezius. Rounded shoulders are generally an indication of tight rhomboids. It is best to focus on strengthening external rotators while stretching internal rotators. Scapula retraction and depression exercises are very beneficial for correcting this dysfunction. Stretch the chest, upper trapezius, sternocleidmastoid and deltoids.

Excessive curve in lumbar area (lordosis) - strengthen the abdominals, hip flexors, pelvic floor muscles: like the multifidus, quadratus lumborum, and stretch muscles like the erector spinae, the psoas and iliacus, and hamstrings. Practice tucking hips under (posterior tilt)

Winging Scapula (shoulder blades stick out) - strengthen the latissimus dorsi, rhomboids, serratus anterior, infraspinatus and upper erector spinae; stretch the pectorals, front deltoids and work on thoracic extension exercises.

Knees cave in during squat or lunging - this is due to tight adductors and weak glute muscles; which are common and do cause knee and back pain. Strengthen the glute medius and maximus, and stretch the short and long adductors. Many trainers make the mistake of training the adductors on machines, or targeting them specifically. If you have a client who has proper flexibility and needs inner thigh work, it is best to train them synergistically, like with a sumo squat.

Eversion of one or both feet, or external rotation of a single leg - there could be multiple reasons for this, therefore making corrective measures more difficult to pinpoint. To keep this simple, we will assume that this is because of tight or weak hip muscles - the peroneals and tibialis posterior are usually weak. Mobilizing and strengthening all the hip muscles, especially stretching the adductors, is usually the best place to start.

Note: none of the above corrections are guaranteed ways to correct for these issues, they are only general remedies for the otherwise healthy client - if you notice more serious concerns, then it is always best to refer your client to their physician. Chiropractors and physical therapists should also be well versed in the area of corrective or adaptive exercises to perform; it is important that you research local professionals for recommendations in these areas when needed.

Stabilization of the Spine: Core Training

Interestingly enough, most of the exercises that are used to increase balance are also beneficial for stabilization of the spine - often labeled as "core training". The term core training is often times overused and sometimes not completely understood. The core consists of the muscles which stabilize the shoulder and pelvic girdles and those involved with the spine, as we have looked at in this section. We will continue to touch on core training concepts throughout this manual, but, for now, let's look at a practical example and core considerations with progression in mind:

If you were to throw a baseball pitch, correctly, you would be transferring force in this way: from the legs to the pelvic girdle, from the pelvic girdle to the lumbar spine, up through the thoracic spine to the shoulder girdle, and then through the rest of the upper body (shoulder, elbow, wrist, and metacarpal joints) to finally deliver the baseball off of the finger tip. Considering high speed pitches, there is a transfer of momentum up the kinetic chain that makes this possible. Likewise, if you were to steal a base, you would be facing the plate perpendicular to the base; so, you would need to twist and lean the upper body to transfer momentum and your center of balance toward the next base. The faster the twist, the faster the legs can start moving in the forward direction.

It starts to become clear that what seems like one simple movement is a string of bodily events, each relying on different parts that can be enhanced overall to maximize the movement - and it often times starts with spine stabilization through core training. The spine needs to be stabilized on all sides and thus all sides need to be strengthened or exercised. In the front, we have the rectus (meaning straight) abdominis, and the transversus (meaning across) abdominis; on the sides, we have the serratus anterior, internal and external obliques, and ***intercostal*** muscles; and, in the back, there are several muscles which have a smaller contribution by comparison to the erector spinae (composed of three muscles/groups and the quadratus lumborum) which have significant roles.

Many yoga and functional training programs are effective in giving the spine and core the necessary flexibility as well as stability. However, many yoga poses are not meant for the beginner, as they can be difficult to get into or to hold for a given period; more difficult movements should be considered as progression towards the goal of achieving better flexibility and balance. To start off with, a simple move like a deep squat, lunge, and leg raise are good starting points to enhance range of motion with balance and core stability. First, start by going into a deep squat with hands held in front of the body. Notice the balance, or lack thereof, when coming out of the deep squat - good balance in this movement would be if your client was able to touch their buttocks to their heels and come back up without knocking knees or going off balance. If good balance was used, then try it with hands held over head. More challenging yet, raise a single arm overhead and look toward that arm throughout the movement, then repeat with the other arm. The basic premise here is to take steps of progression - don't just dive into a power program when your client isn't balanced visual-spatially or muscularly, or both. Recognize the need to progress from being aligned with proper posture, then balanced and stable, and then able to train for endurance, strength and power, respectively. Deviating from this order of training 'events' puts your client, and you, at risk.

CHAPTER 4

Skeletal Muscle: Structure and Function

Consider this: every breath, every heart beat and almost all of the calories that you ingest are a means to sustain life on a cellular level; and considering that there are some 100+ trillion cells in our body, carrying somewhere in the neighborhood of ten times that many micro-organisms - wow, that's a whole lot of cellular activity and energy being used and produced every literal second of your life! Add all of that activity to the replacement of dead cells, through cell division, which is consistently occurring at rates of a million+ per second, and you can quickly see just how impressively vast and incredibly vital the unseen can be. Now, note that approximately 60% of all of the cells in our bodies are muscle tissue cells!

Like all of our body's systems, our muscular system is a fine tuned machine, demanding constant attention and support from all parts of the body. It must function as one unit, with many working parts. In the case of skeletal muscle tissue, for example, each must function as an individual organism, requiring food, water, oxygen, exercise and rest. These organisms depend on other parts of the machine, such as the cardiorespiratory system, for its ability to function and do its job for the rest of the body.

Consider just one of the machine's parts, the skeletal muscle cell fiber. If you could isolate and cut a cross section of an individual skeletal muscle cell fiber, and look inside, you would see that it consists of several components, each having a specific function. We'll take an in-depth look at these cellular components and their functions, especially the **myofibril** and **mitochondrial** components.

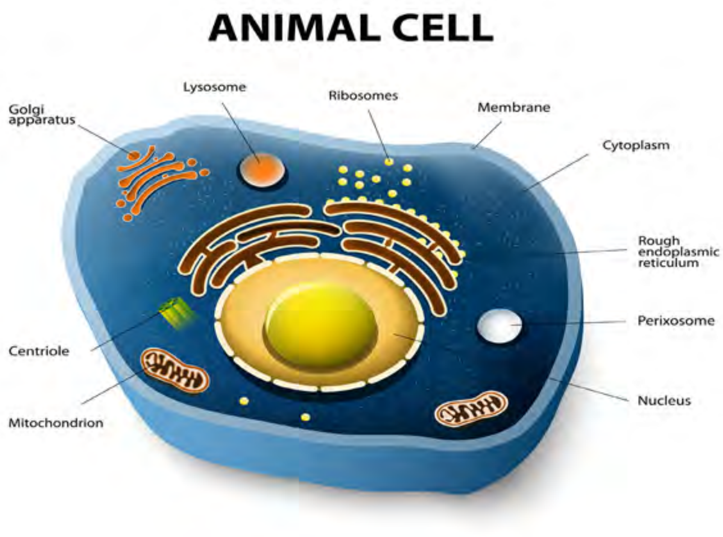
Keep in mind, the more that you understand cell function and how to intelligently effect it individually, the more seriously productive your training will be.

Physiology is the study of the activities and functions of the living body and support systems. This includes organ systems, organs, cells and bio-molecules that carry out the functions for sustaining life. The basic unit for life is at the cell level; understanding cellular function, particularly in skeletal muscle, will make your fitness training efforts more productive and effective overall. Here's a quick snapshot of molecular progression:

Molecule: the smallest unit of a chemical compound, always in motion, made up of atoms that are held together by chemical bonds formed from sharing or exchanging electrons

Sub-Cellular/Organelle: any organized/specialized structure within a living cell (e.g. nucleus, mitochondria)

Cell: known as the 'building blocks of life', able to independently replicate themselves, they are the smallest structural and functional unit of all living things. Two types of cells, prokaryotic (no nucleus, e.g. bacteria) and eukaryotic (has nucleus, e.g. animals/humans and plants)



Human (Animal) Eukaryotic Cell

Tissue: a collection of similar cells from the same origin that function together for a specific purpose

Organ: a group of tissues joined together to function for a specific purpose inside the living organism

Organ System: a group of organs working together to function as an entire system inside the living organism (i.e. digestive system)

Organism: the material structure, as a whole, of any living thing

In the human body, during embryogenesis (or the process by which the embryo forms and develops), we start developing our 3 different "germ layers": the ectoderm (outer layer), the mesoderm (middle layer), and the endoderm (inner layer). These germ layers eventually go on to be differentiated into tissues, organs and bodily structures. Very generally stated, the endoderm becomes the nervous system, and linings of various tubes and vessels with its epithelial cells. The ectoderm becomes the skin and other outer covering structures. The mesoderm becomes most everything else including the skeleton, connective tissue, the heart and muscle tissue.

MUSCLE TISSUE TYPES

There are three types of muscle tissue:

1) *__Skeletal Muscle__*: This type of muscle tissue is found in the skeletomuscular system – i.e., the muscles that your clients will be most aware of during exercise (e.g., biceps, quadriceps, etc.). Skeletal muscle is under voluntary control and is responsible for movement at all bodily joints. It can contract with a powerful force, or with a slow and precise action as is required by the body for a given purpose. This type of muscle is called striated muscle because of its appearance under a microscope, it looks as though it is striped because of where the muscle's various sub-portions are aligned.

Skeletal Muscle Architecture

Muscles throughout the body have a variety of shapes and architectures. The force delivered by a muscle is the result of how many muscle fibers are in line with the pull on that bone, and how the insertion angle of tendon is in line with the movement. Have you ever noticed a thin, non-muscular guy seeming to lift really heavy weight pretty easily? If so, it is likely that this person either has a good tendon insertion angle or a high percentage of white, fast twitch muscle fibers in that muscle (more on this later in the chapter). The uni, bi, and multi-pennate muscles, as well as the triangular muscles, are trying to fit in more fibers on a given tendon. This is done at the expense of the angle of pull being compromised. The fusiform, longitudinal, and quadrate muscle are often in more narrow areas. See if you can identify some muscles in the human body that resemble these shapes. Most skeletal muscles are either fusiform or pennate fibers.

__Skeletal Muscle Forms__

There are seven forms, or shapes, that help us to identify and classify skeletal muscle. The structure of a muscle is specific to its purpose and function. The different forms are:

1) __Fusiform__: a muscle that has the shape of a spindle, which is wider in the middle and narrows at both ends. This allows for greater range of motion but limited strength.

2) __Quadrate__: a muscle that is square shaped, with parallel fibers that run directly from origin to insertion

3) __Triangular__: a wide origin that converges to a narrow insertion resembling a triangular shape

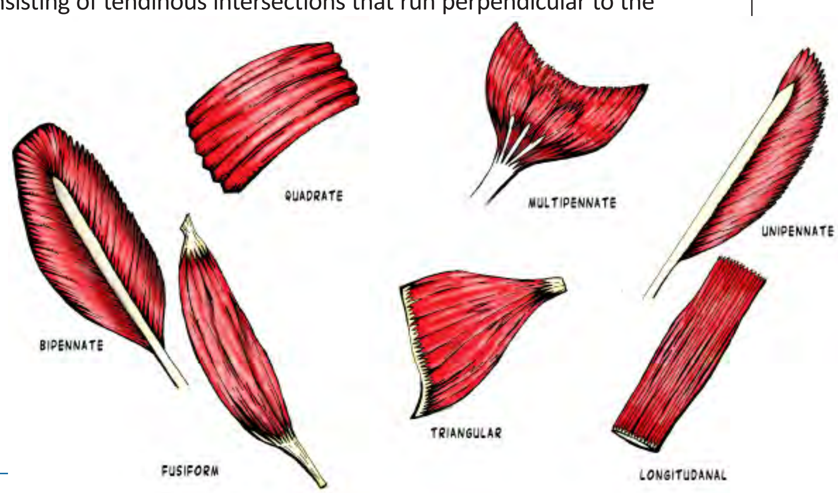
4) __Longitudinal__: parallel fibers consisting of tendinous intersections that run perpendicular to the direction of the fibers

__Pennate muscles__: fibers run obliquely with respect to the tendon

5) __Unipennate__: fibers are on the same side of the tendon

6) __Bipennate__: fibers on both sides of the central tendon

7) __Multipennate__: central tendon branches within a pennate muscle



2) *Smooth Muscle*: Smooth muscle is involuntary, meaning there is no "conscious control" over the muscle's contraction. Instead, it is under the control of the autonomic nervous system. Smooth muscle is found throughout the body in the walls of hollow organs and tracts and in blood vessels. Smooth muscle in blood vessels causes ***vasoconstriction*** (narrowing) and ***vasodialation*** (widening) of the blood vessels, which increases and decreases blood pressure, respectively. This widening of vessels in the area where blood is needed, and narrowing of vessels in all other areas, is a basic requirement for blood movement. Smooth muscle is also found in the digestive tract, moving food and fluid down the tract through vasoconstriction of vessels in the area of digestion. Smooth muscle is also present in the reproductive, respiratory and urinary systems.

3) *Cardiac Muscle*: Like skeletal muscle, cardiac muscle has a striated appearance and can hypertrophy (grow larger) as a result of exercise training. However, it is involuntary and exhibits inherent rhythmicity of contraction, like smooth muscle. You will learn more about cardiac muscle in Chapter 5: *Cardiac & Smooth Muscle: Structure and Function*.

COMPARISON OF **SKELETAL**, **SMOOTH** and **CARDIAC** MUSCLE

	SKELETAL	**SMOOTH**	**CARDIAC**
FUNCTION	Attaches muscle to bone by tendons Aids in locomotion and movement Works voluntarily Stimulated by the nervous system to work	Surrounds hollow bodily structures, such as arteries, intestines and veins Maintains flow of fluids and nutrients along its structures Involuntarily controlled Regulated by the autonomic nervous system	Squeezes heart wall inward Only found in the heart and cardiac ends of main blood vessels Involuntarily controlled Rhythmic contractions, controlled by central nervous system
APPEARANCE	Striated, arranged in regular parallel muscle fiber bundles Striated appearance comes from the alignment of actin and myosin muscle fibers	Smooth, no regular arrangement of muscle fiber bundles or sheets	Striated, connects at branching irregular angles
PRESENCE OF MYOFIBRILS	Yes	No	No
SPEED OF: CONTRACTION/ REFRACTION	Slow-Fast Short Capable of slow, small contractions or fast, short contractions Fatigues more quickly than Cardiac and Smooth muscle	Slow Long Maintains a slow rhythmic contraction Can maintain its function by contracting for long periods; fatigues slowly	Slow Long Doesn't fatigue

SKELETAL MUSCLE: A Closer Look

The skeletal muscles can be voluntarily contracted, and these contractions provide support for skeletal tissue, coordination, locomotion, and the body's ability to perform work. There are three main functions of the skeletal muscles:

1) Motion or resistance to external force
2) Stabilization
3) Heat Production

1) <u>Motion or resistance to external force</u>

All muscle contracts, or attempts to shorten, when activated. Movement then occurs on the same side of the joint where the muscle is shortening. For example, when the biceps brachii in the upper arm are activated, elbow flexion (bending the arm) occurs because the biceps are superior and anterior to the elbow joint. In other words, the biceps are above and in front of the elbow joint. When the triceps are activated, elbow extension (straightening the arm) occurs because that muscle group is at the back of, or posterior to, the elbow joint.

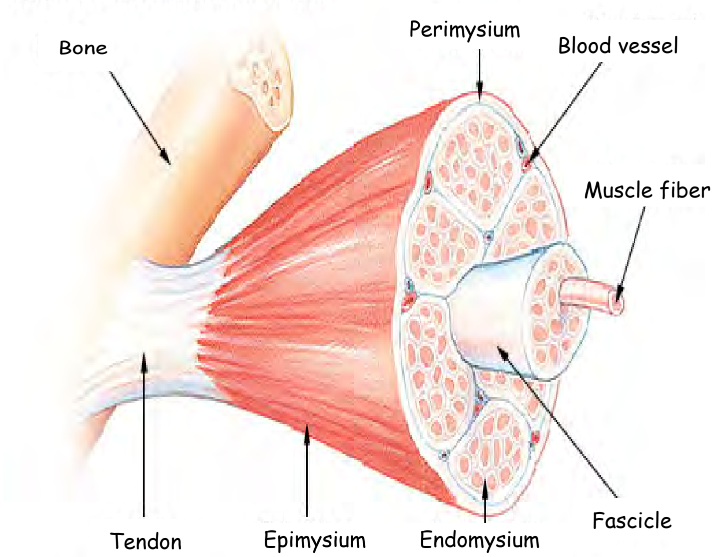
2) <u>Stabilization</u>

During most movements, several muscles must activate to stabilize the joint that is not moving so that force can be transferred to the moving joint. When a person stands, for example, many postural muscles are activated for long periods to prevent that person from falling down.

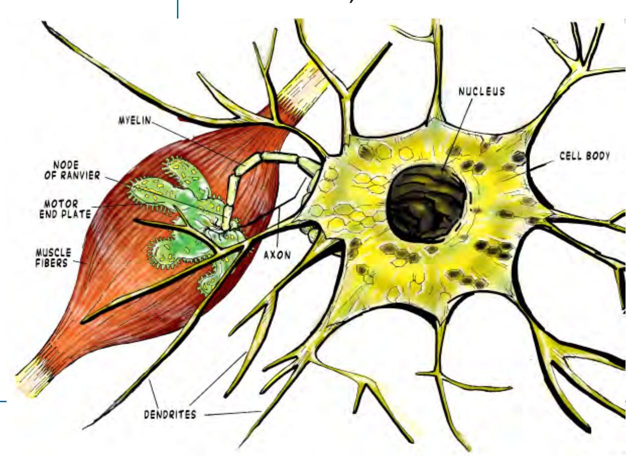
3) <u>Heat Production</u>

The body produces a lot of heat, especially during exercise. Heat production during activity produces calorie expenditure.

Structure of a Skeletal Muscle



Different muscles of the same group may have more than one origin (starting point) but they will share a common insertion (ending point). The biceps- brachii or femoris, triceps-brachii, and quadriceps would be examples of these configurations with 2, 3, and 4 muscle bundles, respectively, connecting to a common tendon. An entire muscle group, such as the biceps, is surrounded by a sheath of connective, fibrous and elastic tissue called the ***epimysium*** (also referred to as deep fascia). Within the epimysium, are bundles of muscle fibers, or fascicles, which are 'held together' by a sheath of connective tissue that surrounds the bundles, called the ***perimysium*** (this tissue is what gives the 'shredded' appearance in extremely lean athletes or bodybuilders). The next level in is the muscle fiber itself, which is surrounded by connective tissue that connects the fibers together inside the fascicle, called the ***endomysium***.



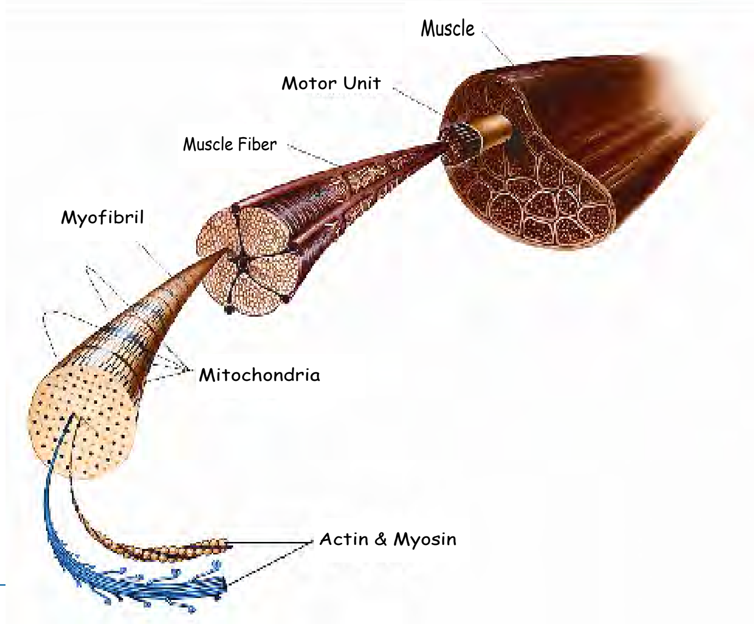
Now that we've looked at the basic muscle belly structure, let's discuss function at the cellular level. The individual muscle fiber, or ***myocyte***, is the actual cell found in muscle tissue. Muscle fibers are long, tubular cells that are stimulated to contract by motor neurons that send signals through the transmitting axon branch. A ***motor unit*** consists of one motor neuron, its axon and the muscle fiber that it innervates, or stimulates to action. When a motor unit is activated by the motor neuron, all of its fibers contract in a simultaneous response. All fibers innervated by a common neuron are of the same fiber type. Let's take a deeper look into important cellular components that make the skeletal muscle 'tick' - especially the myofibril and mitochondrial components.

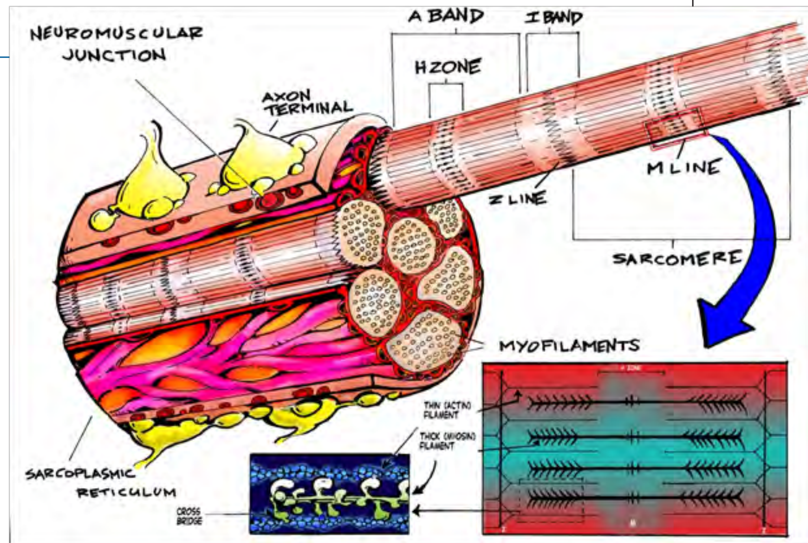
Unlike most other cells in the body, there are several nuclei in the muscle tissue cells. They are positioned along the entire length of the muscle fiber and are embedded in the cell membrane, or sarcolemma. The nuclei contain DNA, Deoxyribonucleic acid. DNA controls all cellular functions and responds to various hormonal stimulations from the pituitary, adrenal, and thyroid glands. The absence of this hormone stimulation would result in the inactivity and degeneration of the muscle tissue cell.

The DNA transfers information from the ***nucleus*** to the mRNA (messenger RNA) housed in the ***nucleolus***. The function of the mRNA is to take instructions from the DNA to the ***ribosomes***, allowing the ribosomes to convert mRNA into protein. Ribosomes are protein builders, performing protein ***synthesis*** by connecting one ***amino acid*** at a time so that it can be used as part of a larger protein. Ribosomes can be found in many places in and around the cell and are classified as either "free" or "membrane-bound". They do their work in either state depending on the protein that it is manufacturing. Free ribosomes are floating inside the cell cytoplasm (***cytosol***) and make proteins to be used specifically inside the cell. Membrane-bound ribosomes occur in the ***rough sarcoplasmic reticulum***, which is a specific type of endoplasmic reticulum that is located around and along the entire length of the myofibril components as a point of "deposit" for proteins that are needed within the plasma membrane. The ribosomes are the "assembly line" that actually builds and repairs the contractile proteins, actin and myosin, in the damaged myofibrils, using available ***intracellular*** amino acids, resulting in growth of tissues.

MYOFIBRILS

Before differentiating between muscle fiber types, we'll start by taking a closer look at the muscle fiber's sub-level of contractile components, the myofibrils. Myofibrils are the contractile components that allow for strength and performance of the muscles, they are composed of repeating sarcomeres that give skeletal muscle cells a striated look, thus the name 'striated muscle'. A myofibril is further composed of protein filaments, or myofilaments, called ***actin*** and ***myosin***. These protein filaments possess the cross-bridges, or actual contractile units, along their length. Myofilaments vary in their make-up of the proteins actin and myosin; various arrangements of myofilaments create different muscle types. Here we see a skeletal muscle closer up – let's look at the relationship between the myofibril, shown here protruding from a muscle bundle, and the myofilaments that it consists of.





You'll notice that the ***sarcomeres****, the functional units of skeletal muscle occurring in repeating segments along the myofibril*, are made up of the following distinctions:

Z-line: the "end caps" of the sarcomere, or discs in between the I-bands, where actin is secured
I-band: the area that contains the Z-line, where thin filaments, actin, are found
A-band: the area where the entire length of a single thick filament, myosin, is found
H-zone: the section inside the A-band where the thick filament doesn't mix with the thin filament; it contains only thick filament, myosin
M-line: is the middle of the sarcomere, within the H-zone, where a cross bridge occurs between the myofilaments

When the fiber is stimulated to contract, the myofibrils experience a contractile shortening and increase in circumference. The contractile proteins, actin (thin filaments) and myosin (thick filaments), actually slide into each other during contractions, actin sliding over myosin, which occurs in the A-band of the sarcomere. As actin slides over myosin, the space between the H-zone and the I-band decreases, pulling the Z-lines closer together. This is known as the ***sliding filament theory***. The term "sliding filament theory", used to describe this muscle contractile process, is the result of this repetitive cycle of thin filaments sliding over thick filaments, generating tension in the muscle, thus shortening the length of the sarcomere which shortens the length of the muscle fiber, enabling the contraction. The protein tropomyosin, together with troponin, regulates and controls the interaction of actin and myosin. Tropomyosin is located on the groove of the actin (thin) filament when there is no nerve impulse (when the muscle is at rest). It acts as a blocking mechanism to the myosin-binding sites in actin. A nerve impulse creates a chain of reactions releasing calcium ions from the sarcoplasmic reticulum (SR). The SR is a system of tubules, surrounding each myofibril, that transmits electrical impulses to 'excite' the sarcolemmal membrane into releasing the calcium ions and activating the contraction. In short, the ***Sarcoplasmic Reticulum*** *releases* calcium ions *during muscle contraction,* and *absorbs them during relaxation.* The calcium released during contraction then binds to troponin and changes the position of tropomyosin-troponin on the actin filament. This unblocks the myosin-binding cross-bridges and allows the myosin to bind with actin filaments. As a result, the muscle contracts. Once the calcium levels diminish, the troponin-tropomyosin shifts back and blocks the myosin-binding sites.

Heavy, intense, low rep resistance training has its primary effect on the actin and myosin in the myofibril. This type of heavy resistance training leads to the damage that is done to actin and myosin, which can be too extensive for complete repair, or insufficient to stimulate adaptation. Therefore, the "controlled" damage (or exercise) and repair (or recovery) of the actin and myosin is the key to optimizing myofibril growth. The process by which actin and myosin are repaired is commonly known as ***hypertrophic protein synthesis***. This process can be likened to the repair of damaged skin, resulting in scar tissue or calluses. The scar tissue will be much stronger and thicker than the original tissue. Muscle is the same, with the end result being a much larger and stronger myofibril component. Heavy, intense training that is too frequent is similar to "picking a scab" on the skin's surface, not allowing it to heal or become stronger. This analogy can be used to describe overtraining.

MUSCLES GET BIG ONE FIBER AT A TIME

The stimulus for muscle repair and growth is damage or exhaustion of a given process. For example, when someone lifts weights, damage occurs at a cellular level in the muscle fiber. The body will repair that damage and prepare for future demand to the muscle (i.e., another workout) by adding girth to that fiber via a process known as hypertrophy. Hypertrophy, in weight-room lingo, means muscles that are getting bigger. This process is where the meaning of the expression "no pain, no gain" comes from. Conversely, the expression "use it or lose it" is describing the process of ***atrophy***, where a given fiber will shrink as the result of it getting no use. This process is similar with cardiovascular exercise. When an endurance athlete maximally uses his or her fuel delivery and oxygen providing systems, there may be a depletion or exhaustion of a given system. This system will prepare for the next demand (i.e., workout) by increasing the amount of enzymes responsible for that reaction (mitochondrial enzymes) or by increasing the number of receptors on a cell.

MITOCHONDRIA

The ***mitochondria***, commonly referred to as the "powerhouse" of the cell, are organelles inside a cell that work primarily to produce the energy needed for daily activity and recovery - they are the structures that provide for ***cell respiration*** and energy production. There are literally zillions of mitochondria in the body; the number of mitochondria found in each cell varies a great deal depending on the need for energy in the particular organ or tissue within which they are working. For example, a skin cell may only contain 100 mitochondria while a muscle cell may contain 1000, because muscle cells work harder than skin cells. For our purpose in the fitness training profession, we are looking at the function of mitochondria in skeletal muscle cells.

Along the myofibiril are the sarcomere "segments". Each sarcomere segment has a membrane that the myofibrils are wrapped in, called a ***sarcolemma***. The sarcolemma is filled with a gelatinous viscous material, called ***sarcoplasm**,* that encloses the individual fibers. Sarcoplasm is like the cytoplasom found in other cells, where a number of cellular components are found; though it mostly houses the myofibril containing sarcomeres, it is also where mitochondria are found. The primary function of the mitochondria is to produce ***aerobic*** (oxygen dependant) energy, in the form of ***ATP (Adenosine Triphosphate)***, which is used for contraction at the actin-myosin cross bridge. With low intensity, long duration cardio training, the mitochondria, like muscle cell furnaces, becomes more efficient at burning ***fatty acids*** for ATP.

You will read more about energy systems and ATP later in this manual; but, for now, understand that ATP is a continuously recycled molecule that transports chemical energy within cells for metabolism. ***Metabolism*** is the chemical reactions that are required for maintaining a living state of cells in an organism. What is important to know, at this stage, is that regular and intense high rep resistance training causes the cell to adapt and build more mitochondria. This process boosts ATP production and the capacity to save ***glycogen***, the substance deposited in bodily tissue as a store of carbohydrates, in the muscle for when it is needed.

Contraction Types, Overloads, and Force Delivery

In Chapter 3: *Anatomical Terms and Biomechanics*, we introduced the main types of muscle contraction. In this section, we will look more closely at the four main types of contractions that prime movers can be used to perform. The first one is most common during weight lifting, isotonic concentric contraction. This is where a shortening of the length of the muscle occurs as you lift a given weight against gravity, it is sometimes referred to as "positive lifting". Since we are not measuring forces at the muscle, it is best to refer to the external resistance being placed on that joint, or joints – ***Dynamic Constant External Resistance (DCER)*** is the best way to describe normal dumbbell, barbell, even bodyweight exercises. DCER is resistance training where joint flexion and extension occur with each repetition; external resistance does not change. ***Dynamic Variable External Resistance (DVER)***, where external resistance is variable, can be seen on machines with cams that change radius, or curvilinear type machines. If you were to perform a lateral raise with a dumbbell, you would actually experience variable resistance as you went from horizontal movement at the beginning, to vertical movement at 90 degrees, at the end.

When moving the opposite direction (lengthening the muscle) it is known as an isotonic eccentric contraction. This is sometimes known as "negative lifting", or "doing negatives". This causes much greater strain on the tendon because the muscle is actually contracting while lengthening so the tendon is pulled from both ends. Thus, the ***delayed onset muscle soreness (DOMS)***, often experienced a day or two after training, is commonly the result of eccentric contraction damage. During this type of lifting, the muscle is broken down quite a bit, and therefore injury is more likely to occur.

Another type of contraction (and overload) is called an isometric contraction. This literally means 'same length', and this is where you push against an immovable force, a wall for example. Although this method won't help you to become good at sports, it is sure to help develop extreme strength. If the load placed on the muscle is such that you can't move it, this would be an isometric load. The act of shortening a muscle actually uses 20% of the force. By the same token, as you lengthen the muscle you gain 20%. So, an isometric contraction actually measures the true muscle force. If the isometric force delivered was 100 lbs, then the concentric and eccentric contractions would yield 80 and 120 lbs., respectively.

The final type is isokinetic contraction, which literally means 'same speed'. This type is not seen much because it requires an expensive machine which can alter the resistance quickly in order to maintain speed. In isokinetic contractions, the load or tension that you put against the bar or pad can vary, but the speed of movement stays the same. Isokinetic training for speed and power sports has been shown to be extremely effective, and it seems to have many applications in the rehabilitation field as well. Plyometric training uses explosive jumps and bounding for developing power because this is using an eccentric contraction to tighten the tendon, and then a rapid concentric contraction utilizing the tight tendon for additional force output. While very effective, it has a high risk of injury.

	ISOTONIC	ISOMETRIC	ISOKINETIC
WHAT STAYS CONSTANT	The weight/tension	The position of the joint	Speed of Movement
WHAT VARIES/MEASURABLE	Speed/repetitions	Tension (true max)	Force/Tension & Reps
PERFORMANCE GAINS	Strength and power	Strength	Power and Speed

Muscle Fiber Types

It is important to have a basic understanding of muscle cell physiology so that you know the "why" of what you are doing in your training. Such knowledge will allow you to adjust clients' programs based on their goals. This section examines muscle fiber types and the importance of understanding their various make ups and functions in skeletal muscle structure and performance. We will review how muscle function is actually coordinated by the nerves that fire, and how the amount of force needed for a certain activity is actually controlled by the number of nerves that fire.

Muscle fibers are coordinated and categorized by metabolic capacities. We know that a given muscle fiber is contracted by only one neuron that activates its respective motor unit; hence, all of the fibers in any given motor unit have the same, or highly similar, metabolic capacities. There are three muscle tissue fiber types which are based on their type of myosin profile:

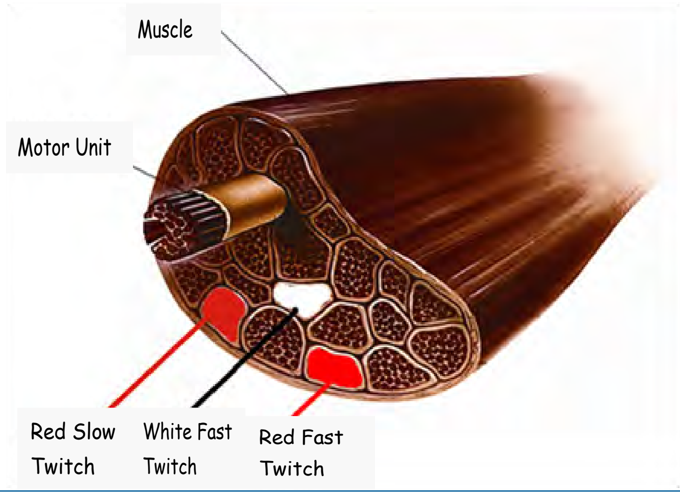
1) **Red, Slow Twitch (also known as Type I)***
2) **Red, Fast Twitch (also known as Type IIa)**
3) **White, Fast Twitch (also known as Type IIb)**

*have the highest mitochondrial density of any fiber, thus they are also the most resistant to fatigue

These fibers types have:

- exactly the same internal components, except that these components vary in number and size
- differing levels of a substance called myosin-ATPase, which breaks down ATP for energy. The more of this enzyme that exists in the muscle fiber, the faster and more powerful the contraction
- differing cardiovascular "support systems" and fuel-utilization characteristics
- different types of nerves that stimulate them and are therefore coordinated or organized functionally as well as structurally

The individual fiber is stimulated to contract by a branch of the neuron, an axon, which varies in thickness and by the degree of myelination (or insulation) it possesses. The more myelinated (or the thicker the insulation), the faster the signal can travel down it.



Varying numbers of all three fiber types make up groups of fibers, or motor units.

A motor unit is a single motor neuron plus all the muscle fibers to which it connects. Some motor neurons only connect to a few muscle fibers, while other motor neurons connect to hundreds of muscle fibers. All the muscle fibers occur together in small bundles in genetically predetermined proportions; these bundles are the motor units and they are named after the predominant type of fibers located inside them.

If a motor unit is made up of white, fast twitch fibers, then that motor unit is called a white, fast twitch motor unit. If a motor unit is made up of red, fast twitch tissue fibers, then that motor unit is called a red, fast twitch motor unit, and so on. Motor units are triggered to contract through nerve ***innervation*** at an impulse speed dictated by the predominant fiber type. For example, the "fast" twitch motor unit receives stronger more efficient impulses from its motor neuron than the "slow" twitch motor unit.

Difference between Fast and Slow Twitch Fiber Types

Myofibrils: There are differences in the makeup of all three muscle tissue fibers. For example, white, fast twitch muscle fibers contain a greater number and size of the myofibril components than red, fast twitch muscle fibers. When comparing red, fast to red, slow, there are a greater number and size of myofibril components to red, fast twitch muscle fibers.

Another difference is that white, fast twitch fibers have very few mitochondria, restricting the duration of its contractions. On the other hand, red, fast twitch fibers have many more mitochondria than the white, fast; meaning that the red, fast fibers can contract for longer periods before fatiguing. By comparison to both, it is the red, slow twitch fibers that have a tremendous number of mitochondria, allowing for contractions that last much longer than either of the other muscle fiber types.

For these reasons, strength athletes should target white, fast twitch fibers first in their training sessions, while energy and mental focus is still strong. If higher rep sets are performed first, then the already low energy stores that are available to the white, fast fibers may be undesirably depleted prematurely and one may lose the necessary mental intensity needed to tap into these "fast and furious" fibers.

Capillaries and Energy: For highly-efficient ***aerobic metabolism*** to occur, oxygen must be present. Oxygen-rich blood is delivered to the muscle cell by a very small tube called a capillary. The red, slow twitch fibers have a greater number of capillaries (thus their red appearance). Because they receive a lot of blood and are full of mitochondria they are known as fatigue-resistant, they will outlast the other types. However, the red, slow twitch do not have as much myosin-ATPase and therefore generate less tension than fast twitch fibers. The white, fast twitch fibers have fewer capillaries and therefore must rely on glycolysis (i.e., the breakdown of ***glucose*** by enzymes) for energy, and thus have been given the name 'fast-glycolytic fibers'.

Glycolysis: Occurring in the cytosol of the cell, this is the initial pathway of aerobic metabolism where the break down and conversion of glucose into pyruvic acid for the production of ATP energy occurs.

Contractile speed: In coordination with the speed of contraction is the tension produced by a given motor unit. White, fast twitch fibers are stimulated by a fast twitch motor neuron that connects to a lot of fibers. The girth or diameter of the individual fiber is also large due to more contractile proteins. Red, fast twitch motor neurons also connect to many fibers but do not have quite the force output of white, fast fibers.

Note that red, fast twitch fibers are able to use either oxidative (aerobic) or glycolytic (anaerobic) metabolic pathways and are sometimes called fast oxidative fibers because of the ability to function this way (it is commonly believed that the overwhelming success of very high ability long distance runners is contributed in part to high proportions of these).

Finally, the red, slow twitch muscle fibers contain fewer fibers in each motor unit. Each fiber is also thinner than its fast, twitch cousins, so they produce less tension per twitch. The Table, *Association of Muscle Fiber Types to Metabolic and Performance Characteristics*, illustrates how different muscle fiber types are associated with the demands of different activities. You'll notice that, basically speaking, fast twitch fibers are power and speed producing while slow twitch are endurance producing muscle fibers.

Practical Illustration of Muscle Fiber Types

The proportions of white, fast twitch muscle fibers; red, fast twitch muscle fibers, and red, slow twitch muscle fibers occurring within each muscle is genetically predetermined. Proportions of fibers vary per muscle, as well. For example, a postural muscle like the soleus in the lower leg is used during standing to keep balance. The soleus has a high percentage of red, slow twitch fibers. Alternately, the gastrocnemius (calf muscle found just above the soleus) is used for explosive jumps and has much more fast twitch fibers.

Generally speaking, white, fast twitch motor units are responsible for speed and strength, and a person who has a predominance of these white, fast twitch fibers would be best suited for strength events. The red, fast twitch fibers are responsible for sustaining a load over prolonged periods; therefore, a person with a predominance of these red, fast fibers would be best suited for events requiring stamina, such as boxing, football and basketball. The red, slow twitch fibers are responsible for producing energy over long periods, so a person with a predominance of these red, slow fibers would be best suited for endurance events. However, physical training can certainly make a significant impact on the capacities of all of these fiber types.

OVERVIEWS FOR UNDERSTANDING

METABOLIC AND STRUCTURAL ASSOCIATIONS OF MUSCLE FIBER TYPES

	Red, Slow/ Type I/ Slow Oxidative	**Red, Fast/ Type IIa/ Fast Oxidative**	**White, Fast/ Type IIb/ Fast Glycolytic**
Activity Example/s/	Marathon/Endurance	Basketball/800m - 1 mile run	High jump/Short sprint
Contraction Speed	Slow (long duration)	Fast (short duration)	Fast (short duration)
Myoglobin (oxygen & iron binding protein) Content	High	High	Low
Glycogen (storage form for converting glucose) Stores	Low	Intermediate	High
Rate of Fatigue	Low (fatigue resistant)	Intermediate	High (fatigues quickly)
# of Fibers/Motor Units	Small	Moderate to Large	Large
Type of Fatigue	Energy/Mitochondrial	Lactate Build-up	Myofibril/ATP
Color	Red	Red/Pink	White
Fiber Diameter	Small	Medium	Large
Mitochondrial Capillaries	Many	Many	Few

ASSOCIATION OF MUSCLE FIBER TYPES TO METABOLIC & PERFORMANCE CHARACTERISTICS

FIBER TYPE	MOTOR UNIT PROPERTIES	FUEL SOURCE	OXYGEN NEEDED	INTENSITY	DURATION	SAMPLE ACTIVITY
White, Fast (IIb)	Fast, Large	ATP-Creatine Phosphate	No	Extreme	8-10 seconds	100 yard dash, shot-put, power lifting
White Fast (IIb) & Red, Fast (IIa)	Fast, Mid-sized	ATP-Carb	No	Very High	20 seconds - 3 minutes	400-800 meter dash, soccer, basketball, bodybuilding
Red, Slow (I) & Red, Fast (IIa)	Fast, Slow	ATP-Carb	Yes	High	3-20 minutes	cycling, running, swimming
Red, Slow (I)	Slow, Small	ATP-Fat	Yes	Moderate	>20 minutes	hiking, long distance running, yard work

QUICK COMPARE: ***Greatest to Least***	Blood Flow	Strength	Endurance	Optimal Rep Range
Greatest	Red, Slow	White, Fast	Red, Slow	Red, Slow (20-25)
Moderate/Average	Red, Fast	Red, Fast	Red, Fast	Red, Fast (12-15)
Least	White, Fast	Red, Slow	White, Fast	White, Fast (4-6)

MUSCLE STRUCTURE: smallest to largest

Actin & Myosin (myofilaments) → Myofibril (composed of sacromere segments) → Muscle Fiber (Myocyte: type of cell found in the muscle tissue) → Muscle Bundle/Fascicle (Motor Unit) → Muscle Belly → Entire Skeletal Muscle

MOTOR UNIT RECRUITMENT: The Size Principle

Immediate Recruitment

As a general rule, only the minimum number of motor units required to move a given weight will contract to perform the work. For example, if you pick up a very light object, bend your arm and feel the contracted biceps, the muscle will feel somewhat soft. That's because red, slow twitch motor units are contracting. The remaining motor units are not required to assist with the movement. If, however, the resistance is slightly greater, red, fast twitch motor units will assist the red, slow, twitch motor units. So if you pick up a heavy object, you will feel that your contracted biceps are harder than when lifting the light object. This is because there are more motor units at work and, therefore, more muscle fibers are recruited and more tension is generated. If the resistance is greater still, white, fast twitch motor units will assist in the work, as well.

Of course, picking up a very heavy object makes the biceps feel hard and you will feel the strain against the resistance. With the lift of a very heavy object, most, if not all, motor units in the working muscle are involved. The immediate involvement of varying numbers of motor units based upon the amount of weight lifted is one form of motor unit "recruitment." Thus, smaller to largest motor units are recruited as needed.

Immediately providing heavy resistance ensures an earlier "recruitment" of white, fast twitch motor units, which provides the greatest potential for growth. Regarding light resistance exercise, there is some growth stimulation of the red, fast and red, slow twitch motor units; however, they can experience only limited growth by comparison, due to the tissues differing compositions. Therefore, light resistance exercise will provide little value for optimizing muscle growth.

Depleting Energy Recruitment

Another type of motor unit recruitment occurs as a result of depleting energy. For example, during contractions of a muscle group against light resistance, each repetition steadily depletes the working motor units of energy, and other motor units are called upon to assist the fatigued motor units in the same order as before.

First, the red, fast twitch motor units assist the already working red, slow twitch motor units. Then, as the red, slow and red, fast twitch motor units tire, the white, fast twitch motor units are called upon. By the time the white, fast twitch motor units start working, the entire muscle group is rapidly exhausting and ***lactic acid*** is building up. It is also quite probable that, by the time the white, fast twitch motor units are called upon, the muscle contraction will fail due to lack of energy production, caused by the waste build up in the muscle.

Depleting energy recruitment results in increased muscle energy storage, but minimizes the involvement and growth stimulation of the white, fast twitch motor units, which are known to have the greatest potential for growth.

A practical example: To experience this type of motor unit recruitment, pick a relatively light weight and begin to perform repetitions. As the muscle becomes more and more fatigued, you will begin to notice a burning sensation, and a slight pump or swelling in the working muscles. As the exercise becomes more and more difficult, especially when performing a movement involving a very large amount of muscle tissue, such as the squat, your heart rate will become elevated and your breathing labored. As the movement is becoming more and more difficult with each repetition, there are more and more white, fast twitch motor units coming into play - these white, fast twitch motor units are reserved until last as the work becomes more strenuous. When you finish the set, after performing as many as 25 repetitions, the white, fast twitch motor units may only have performed optimally for 2 to 3 of those last reps; hardly enough to stimulate optimum involvement as you would have with heavier, low rep movements.

<u>Contractile Speed Recruitment</u>

Yet another type of motor unit recruitment is based on the speed of contraction. A maximum contraction against a submaximal resistance (i.e. a resistance that is less than what the individual is fully capable of) will, in theory, call on the red and white, fast twitch motor units, due to their faster contractile speeds. This can be accomplished through ***compensatory acceleration*** training, or by performing Olympic style weight lifting, also called ***ballistics***. Ballistic training, or “power training”, is a form of strength training where the athlete lifts, accelerates, and then immediately releases the weight, rather than slowly lowering it, forcing the recruitment of fast twitch muscle fibers. Basically, this method is intended to increase muscle tension and resistance with increased weight and acceleration. This type of training has been practiced for years by strength trainers. However, it is used most frequently when training for specific events that require explosive movements, and, without proper execution, can increase the risk of injury. Therefore, the frequency of this type of training should be controlled.

Reflexes in the Motor Units

When a doctor taps your knee and looks for your leg to bob up a little, he or she is testing the tendon stretch reflex. Like most reflexes in our body, this reflex is designed to be protective and it does not require processing in the brain or central nervous system. Reflexes follow a neural path known as a reflex loop which only goes up to the spinal cord (motor neuron) level.

When quickly stretching a muscle, the body will react to make sure the muscle does not get damaged, and the muscle itself will contract. If the stretch on the tendon is too great, you can damage the tendon, the bursa (which houses the tendon), or the muscle itself. At the same time as the contraction occurs, there is reflexive relaxation of the antagonist muscles. Stretching, using these reflexes, is known as ***Proprioceptive Neural Facilitation*** or PNF stretching. One example of this technique is to contract your quads while you are trying to stretch your hamstrings.

The Nervous System: its role in muscular movement

Initially, most personal trainers will see little value in studying concepts involving the nervous system. However, upon deeper examination, you will realize that all activities in the body are due to the nervous system, and voluntary actions are highly dependent on many central and peripheral nervous system functions. The focus of this section is to introduce you to basic concepts in the nervous system anatomy and physiology and their application to movement, balance and coordination.

Central Nervous System

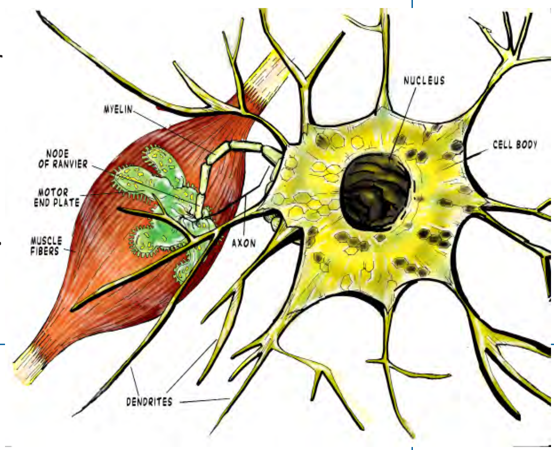
The nervous system is divided into a central nervous system (CNS) and a peripheral nervous system (PNS). The central nervous system is composed of the brain and spinal cord. In general, the closer the region is to the surface of the skull, the more advanced the function it serves. The outer regions are known as cortical regions, the middle areas are medullary, and the deepest regions are the primitive brain and brain stem regions.

The peripheral nervous system seems as if it has little to no effect on the movement processes, but there is actually a good deal of adjustments that occur "on the fly" in a reflexive manner. After a "message" leaves the spinal cord it travels in the ventral or front facing aspect and encounters a sympathetic ganglion, or batch of nerves, before traveling to the skeletal muscle. At the skeletal muscle site, in the tendons, are ***Golgi Tendon Organs (GTO)***, which protect against too much contractile force. The GTO is a proprioceptive sensory nerve ending embedded among the fibers of a tendon. This sensory nerve shuts down muscle contraction just short of serious ***acute*** muscle injury related to extreme overload. The muscle will reflexively relax (due to inhibition) to avoid injury to the muscle and tendon. During proper strength training, overload is not extreme enough to trigger this function. In addition to the GTOs, there is a protective measure against too much stretch. The muscle spindles are stretch receptors that act by causing a contractile response in the muscle just short of over-stretch tissue tearing. These spindles act to prevent stretching injuries and joint dislocation. They lie within the muscle belly and protect against a ballistic lengthening that can occur with dynamic stretching. We will take a closer look at the pros and cons of stretching methods in Chapter 9: *The Beginner Client*.

The Neuromuscular System

As mentioned, all physical activities occur because of a nerve stimulating a muscle. It is good to note here that major nerve tracts do not regenerate; however, smaller nerve tracts and neurons do, and there is great redundancy further down the line of regeneration.

Let's examine a few levels of the neuromuscular system. A neuromuscular unit is described as the muscle and the nerves that serve it. The motor neuron is a nerve cell that is located in the spinal cord and has nerve fibers (axon) that carry the signals/information away from the spinal cord to the muscles that it is communicating movement to (conversely, the dendrites are message receivers, not information givers like the axon). A motor unit is the entire structure, consisting of the motor neuron and the muscle fibers that it innervates. At the very end of the axon is the neuromuscular junction or motor end plate. This illustration is an exaggeration of the size of cell bodies to muscles and motor end plates to muscles. In reality, a single motor neuron is 100,000 to 1,000,000 times smaller than a whole muscle and has the ability to communicate to action hundreds of fibers at once, but will only activate the fibers that are specifically needed to achieve a certain movement, based on the stimulus. The finer the motor control needed, the fewer the fibers contacted to activate. Remember also, the size and characteristics of the motor unit will vary with the muscle fiber type it innervates.



Muscle Contraction Process: A Recap

Nerves connect the spinal column to the muscle. The nerve and muscles meet at the neuromuscular junction. Acetylcholine is released by the axon into the synapse, where it then stimulates the target sarcolemma. Inside the muscle fibers, the signal stimulates the flow of calcium, which causes the thick and thin myofilaments to slide across one another. When this occurs, it causes the sarcomere to shorten, which generates force. When billions of sarcomeres in the muscle shorten all at once, it results in a contraction of the entire muscle fiber. Its main purpose is to move you. It connects to the bones, and makes them move, or not.

Here's a summary of the process:

- Motor nerve cell (neuron) carries stimulus to motor end plate
- Acetylcholine crosses the neuromuscular junction and stimulates sarcolemma
- After acetylcholine reaches muscle fiber, it stimulates a release of calcium in the cell, which triggers action of troponin and tropomysin (complex of proteins found between actin filaments in muscle tissue that are integral to contraction)
- Cross bridges pull thick and thin myofilaments over each other, shortening the length of the fiber
- One neuron may innervate hundreds of muscle fibers at once, but will only inner vate the number of fibers that is minimally needed for the movement
- Motor unit: unit of muscle fibers innervated by one single neuron
- The less muscle fibers innervated by one neuron, the more fine control over the muscle (fine movements)

Neurologic Rest vs Aerobic Rest

When you are lifting heavy weights, you are likely utilizing white, fast twitch fibers (Type IIb) and fast-glycolytic motor units. Since these neurons fatigue quickly they need time to recover. Oddly enough, you may feel fine or non-exhausted from an aerobic standpoint, but to get another maximal lift, or close to maximal, the neurologic system needs to recover. Doing back to back sets (drop sets) with little rest will result in dramatic fatigue to the neuromuscular system.

Dispelling a Couple of Common Myths

Motor Units and Depleting Energy Recruitment

All the tissue fibers within a motor unit will contract together because the entire motor unit is stimulated to contract by the same neuron, regardless of the angle of resistance (innervation). With this in mind, it is not significantly important to perform a wide variety of strength training movements aimed at stimulating a unique adaptive size and strength effect from different angles. However, altering movements from time to time may be mentally refreshing, reduce boredom, and prevent injury.

Strength training movements should be selected that allow the target muscles to be stressed by the heaviest amount of weight possible, calling on the involvement of the greatest number of motor units possible. This is the desired method of motor unit recruitment for the goal of size and strength increase. Extremely heavy compound movements are said to have the greatest degree of leverage and, when possible, should be used in preference to simple, single-joint movements when the goal is to optimize size and strength increase.

Hence the ‘myth’ that strict isolation of one muscle or group is possible, it’s not. Strict isolation is an anatomical impossibility since one muscle group cannot function on its own (i.e. you can do sit-ups all day long and that doesn’t mean you’ll be showing off your six pack any time soon). Understand that there are always at least two muscle groups involved in every movement. All muscle tissue fibers run the entire length of the muscle group, from its origin (closest to the midline) to its insertion (farthest from the midline), and receive growth stimulation uniformly throughout their entire length. With this in mind, it is physiologically impossible to shape a muscle. Muscle tissue structure and shape are strictly genetic.

“The Pump”: Swelling of the Working Muscle – is it a good thing?

For decades there’s been conflicting theories on the use of “The Pump” for size and strength. It is common, and unfortunate, that experienced resistance athletes take “The Pump” at face value, and many times don’t really understand what it actually means.

Generally speaking, the majority of molecular elements are either carried or diffused across microscopic capillary and cellular membranes, if the concentration of that molecular element is lower on the other side of the membrane. However, relative to exercise, if the pressure of fluid on the outside of the muscle cell membrane is greater than on the inside of the membrane, the molecular element, lactic acid, and wastes accumulating inside the muscle cell during long sustained contractions, cannot be excreted. Research shows that the build-up of excessive amounts of the intracellular fuel, lactic acid, is partially responsible for contractile failure in high rep sets. Though there is also current research that questions if lactic acid is responsible for muscular failure, making the concepts of “The Pump” controversial, NFPT believes there is value in both sides of the research and we will approach it fundamentally as such. Ultimately, the training techniques designed to reduce this effect are still effective, but may be for different reasons than once thought.

When size and strength is the goal, avoid pre-workouts with excess of the nonessential amino acid, L-Arginine. Arginine causes vasodilation which in turn causes an increase in peripheral blood flow to the extremities. When Arginine is mixed with high rep exercises, it results in a temporary inflation of skeletal muscle, causing a constriction of the interstitial spaces acting as a blockade.

If sticking to the fundamental principle of “The Pump”, as a technique that you should be at least familiar with, then this lactic acid does not allow maximal adaptive stress, and therefore compromises size and strength increase. All of this means that “The Pump” inhibits the ability of the muscle cell to maximize the performance of growth stimulating (heavy) contractions because the blood flow against the working muscle cells blocks removal of waste and lactic acid. Since the cell membrane is ***impermeable*** during contractions, unused amounts of lactic acid cannot escape. The longer the contraction is maintained, the greater this lactic acid build-up. During this light, high rep training, the contracting muscle tissue not only experiences a build-up of lactic acid it also expands in circumference causing a constriction of blood flow in the microscopic capillaries in the ***interstitial*** spaces. After a long set, when the muscle relaxes, the back pressure of blood flow is relieved. This rush of blood into the working muscles makes them appear much larger which subsides upon completion of the workout. This tremendous amount of blood, immediately re-entering the microscopic capillaries, is then perfused into the interstitial spaces where it exerts pressure against the cell membranes. This pressure then prolongs the presence of unspent intercellular lactic acid which will cause premature failure of contraction in sets to follow if not given ample time for removal - and this is the occurrence known as "The Pump".

Training for "The Pump" does have some general health benefits and potential growth improvement, in the long run, by allowing enhanced blood flow and subsequent provision of oxygen and nutrients aiding in more efficient recovery. It also results in new energy-creating organelles and intercellular fluid increase; but, this is why a pump is fleeting and not real growth, real growth comes with consistent, and persistent, heavy training and adequate recovery. Certainly getting a great pump is healthy but we have to be careful we do not take the great feeling we get from "The Pump" out of context. In summary, "The Pump" is not an effective method for size and strength because it inhibits contractions, causing failure prior to optimally damaging the myofibrils, which is required for growth.

CONTRACTILE FAILURE

Cellular Energy Depletion

Light, high repetition sets, primarily result in energy depletion, recovery fat conversion, and a degree of aerobic conditioning. While heavy, low repetition sets result in myofibril damage and growth stimulation. Performing several sets of compound movements, in high rep ranges, will maximize energy depletion due to the tremendous amount of muscle tissue involvement (the larger the volume of muscle involved, the greater the depletion). The rapid depletion of cellular energy and excessive lactic acid accumulation is indicated by a burning sensation experienced in the working muscle during prolonged resistance exercise or, in some cases, during intense aerobic exercise, such as running up an incline or picking up the running pace.

Offsetting Energy Depletion

Allowing for a momentary relaxation between repetitions will allow additional oxygen to be taken up by the working muscle fibers. And, generally speaking, the greater the oxygen taken up by the muscles during resistance exercise, the slower the use of stored muscle glycogen. This will offset the depletion of cellular energy, allowing for the desirable performance of more repetitions. Take caution NOT to provide relaxation pauses during heavy intense training as this may expose the client to hard tissue injury (bones are supporting the weight).

The energy efficiency of a muscle is somewhat like the carburetor in a car. If there is not much oxygen, the fuel mixture will be too rich and you will run out of gas sooner. By simply increasing the oxygen provided to the carburetor, the mixture would be much leaner, allowing for a more efficient and prolonged use of energy. All things considered then, we can establish a scientific approach to resistance exercise. There are three (3) reasons why a muscle fiber stops contracting when trained to failure:

1) Myofibril Failure
2) Intermediate Failure
3) Mitchondrial Failure

1) Myofibril Failure

This type of failure occurs if the resistance is so great that the contractile components fail; immediate energy stores rapidly deplete and nervous input is no longer effective in causing further contraction. Of the three general types of failure, this type will cause the greatest amount of muscle damage and will result in the optimized recruitment and growth of existing myofibrils, especially in the white, fast twitch motor units. We'll call this Myofibril Failure. In order to establish a working training methodology, the optimum recommended rep range to use for this effect is the 4 to 6 rep range. Frequent uses of sets using fewer repetitions to failure can result in acute or accumulative damage to hard and soft tissues. If you were to train to failure in the 1 to 3 rep range, over a long period of time, you may not outwardly feel pain from accumulative tissue injury; but, in reality, microscopic tears can occur in the tissues that require repair. The greater the damage, the larger the scar tissue, but, if the scar tissue is too great, it may inhibit proper musculoskeletal function.

Soft and hard tissue damage is also possible if you typically lock out joints at the end of extremely heavy pushing movements, or fully extending at the beginning of extremely heavy pulling movements. This damage can occur because, while in these positions, passive structures such as the bones and ligaments (not the muscle) are supporting the weight.

2) Intermediate Failure

The second of the three reasons for contractile failure occurs when the contractile components are failing at, or about, the same time that the short term energy stores are depleted. This, in theory, will result in adaptation through the building of new myofibrils and mitochondria, especially in the red, fast twitch motor units. We call this type of failure Intermediate Failure. In order to establish a working training methodology, the optimum rep range to use for this effect is 12 to 15. When you perform sets of about 7 to 11 reps, there is joint participation on the part of both the white, fast twitch motor units and the red, fast twitch motor units. This should be avoided because neither type of motor unit will be stressed optimally, they would share in the work.

3) Mitochondrial Failure

The third of the three types of contractile failure occurs as a result of depleted energy stores and a subsequent excessive accumulation of the unused contraction inhibiting substance, lactic acid. This, in theory, will result in adaptation through the increased storage of energy, and the building of new mitochondria, especially in the red, slow twitch motor units. We'll call this type of failure Mitochondrial Failure. In order to establish a working methodology, the optimum rep range to use for this effect is 20 to 25 reps. Sets performed in the 16 to 19 rep range will, once again, call on the varying involvement of both the red, fast twitch motor units, and the red, slow twitch motor units. This will not provide the optimum involvement of either of the two fiber type motor units individually.

RESISTANCE EXERCISE AND WEIGHT MANAGEMENT

Resistance exercise obviously has much more to offer than just an increase in size and strength. Increased lean muscle from heavy, intense resistance training causes a desirable increase in metabolism and a loss in body fat. In addition, there is also a tremendous weight management benefit to performing high repetitions with light weight for fat loss and muscle tissue maintenance as well. Resistance training is by far the most efficient form of exercise for long-term weight management because it changes your body's energy needs and combats one of the biggest challenges with stand-alone dieting, which is the loss of muscle mass along with the fat, which, in turn, reduces your body's energy needs. Remind your client's - the fact is, muscle burns fat and the more muscle you have the more fat you burn. This is true even at rest. With appropriate resistance training you can maintain and even increase your lean body mass as you lose fat, which ensures your fat loss success for the future.

When the muscle energy stores have been depleted during resistance exercise, the replacement of these stores becomes a priority to the body. During recovery, while on a negative calorie intake, extramuscular fat (***triglycerides***) is broken down for energy and a portion of that fat (***glycerol***) is used by the muscle tissue to help fill these stores back up again, while the fatty acids from triglyceride breakdown, during recovery, provide the fuel needed to perform the repletion process. Basically then, on the proper diet, ***adipose*** tissues are drawn from to provide fatty acids and glycerol in order to replete exhausted muscle stores. This decreases the fat weight and increases the muscle weight. The key to resistance exercise, and this "fat conversion" (for the beginner, fat loss client), is to perform high rep, low intensity, long duration, and frequent exercise using basic compound movements. Exercises must involve as much tissue as possible to maximize the depletion of muscle energy, promoting a greater recovery fat release during repletion.

The fact also remains that you can stimulate somewhat of an aerobic effect through the proper resistance training routine. Of course, this effect is still more ***anaerobic*** (muscle energy production in the absence of oxygen), than aerobic (energy production in the presence of oxygen) when compared to typical steady-state aerobic exercise. The characteristics of resistance-based aerobic stimulation are:

- the decrease of recovery between sets
- the increased number of sets (increased training volume exceeding 20 minutes in duration)
- the use of compound exercises to maximize tissue involvement
- the decrease in the amount of resistance while increasing repetitions

Be mindful when using this type of training that attention is paid to the ***contraindications*** to exercise (symptoms of overexertion or injury); some of these include joint pain, dizziness, nausea, rapid pulse, excessive sweating, extreme muscle soreness, cramping, or chest pain. Since you are always performing resistance exercises, the body is convinced not to cannibalize muscle tissue for energy during low calorie intake, because it is being forced to maintain muscle tissue to comply with the demand to maintain muscle activity. This is desirable and will result in greater fat loss and less muscle loss. It is also extremely important to mention to the beginner or intermediate trainee that lean and total body weight may increase for as long as two weeks after starting this type of training, even while restricting calorie intake. This occurs because there is an increase of fluids and energy stored as glycogen in the muscle tissue (which is comparably more dense) and a decrease of energy stored as triglycerides in fat tissue (which is comparably less dense). It is important to understand that a pound of fat and a pound of muscle will both weigh a pound, but the amount of space that each takes up is different. If you were to lay a pound of fat and a pound of muscle out on a table, the fat will take up much more of the table's surface area than the muscle will. Muscle is more compact, more dense, so a pound of muscle takes up less space in the body than a pound of fat. Conversely, adipose tissue (fat) is less dense, can be described as 'fluffy', and it takes up more room in the body than muscle tissue.

When there is greater and greater fat loss with gains in muscle tissue, you get:

- an increase in lean weight: because body mass is made up of more lean tissue (muscle) as you lose adipose (fat) tissue
- an increase in total body weight: because you are adding dense, compact, tight muscle mass as you are taking away the less dense, 'fluffy' fat mass
- a decrease in fat mass: because fat takes up more space than muscle, a decrease in fat will mean a decrease in the amount of physical space that your body takes up

As a personal trainer, it is important that your clients understand the impact that their fitness program will have on their total body weight, and why. Many clients will only look at a number on their scale and misinterpret that as being unsuccessful in their training program. Therefore, it is crucial to perform body composition tests regularly to show your clients, using real comparable measurements in context, that they are in fact gaining increased muscle volume and achieving overall fat loss. It is important that you be able to demonstrate the benefits and effectiveness of the training program that you implement with your clients.

CHAPTER 5

Cardiac & Smooth Muscle: Structure and Function

We've taken an in-depth look at skeletal muscle, now we'll look at the functions of smooth muscle and cardiac muscle. The cardiovascular system is responsible for a wide range of adaptations in the body during exercise.

"Cardio" (from the Greek word "kardia", meaning "heart") and "vascular" (meaning "related to blood vessels"), come together to form the cardiovascular system, or the transportation and distribution network for oxygen, nutrients, hormones and cellular waste in the blood. The cardiovascular system's power source is the hardest-working, never-tiring and most amazing organ in the human body – the heart. Cardiac muscle refers to the involuntary muscle of the heart itself; while smooth muscle refers to the involuntary muscle found in digestive, respiratory and vascular tissues. Smooth muscle, which can be best remembered as the muscle that makes up the walls of hollow organs, is extremely important to the effectiveness of the respective organ's tasks. For example, smooth muscle is found in the walls of blood vessels and small arteries, and, therefore, has crucial circulatory functions related to the heart. Smooth and cardiac muscles function involuntarily, and, unlike skeletal muscle, are both crucial to the body's survival. It is important not to confuse an organ system with a type of muscle. In the case of the cardiovascular system, it is comprised of both cardiac (heart) and smooth (vascular) muscle.

The human heart is one of the most amazing organs in the body. The average heart beats more than 40 million times per year – that amounts to 2.8 billion beats for a 70-year-old! Located just left of the center of the sternum, the human heart is composed of four chambers that support two circulation paths. About the size of a clenched fist, the heart does much more work than the largest muscles in the body.

Links in the Cardiac Chain

<u>Heart</u>: pumps blood to the body and lungs

<u>Vascular System</u>: these are vessels and tissue, made up of smooth muscle, that transports blood. The purpose of the vascular system is to direct blood flow, controlling how much of the flow goes to certain areas of the body based on need.

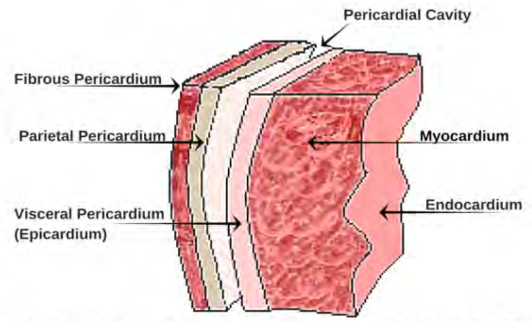
<u>Capillaries and Tissues</u>: the purpose of the capillary and tissue interaction in the body is to:

1) exchange and deliver oxygen, metabolites and other products (such as proteins)

2) pull out carbon dioxide (CO_2) and other waste from the cell for disposal.

These links are equally important – if one link is weak, or missing, the whole system fails!

Layers of the Heart



Like skeletal muscle, there are various layers to cardiac muscle tissue. The ***Visceral Pericardium*** is the layer that closely envelops the heart, it is also known as the ***Epicardium***. The ***Epicardium*** has two coats. The outer that is tough and fibrous, the ***Fibrous Pericardium***, and the other that lines the thick outer coat, the ***Parietal Pericardium***. There is a fluid space in between the pericardial coats and the ***Epicardium***, called the ***Pericardial Cavity***. The middle and thickest layer of cardiac muscle tissue is the ***Myocardium***, where the cardiac muscle itself exists. The inner-most layer is the ***Endocardium***, a smooth membrane that lines the inside of the heart chambers and forms the surface of the valves. The greater the need for contraction, the thicker the cardiac muscle. For example, the left ventricle pumps blood to the entire body and is, therefore, thicker than the right ventricle, which only pumps blood to the lungs.

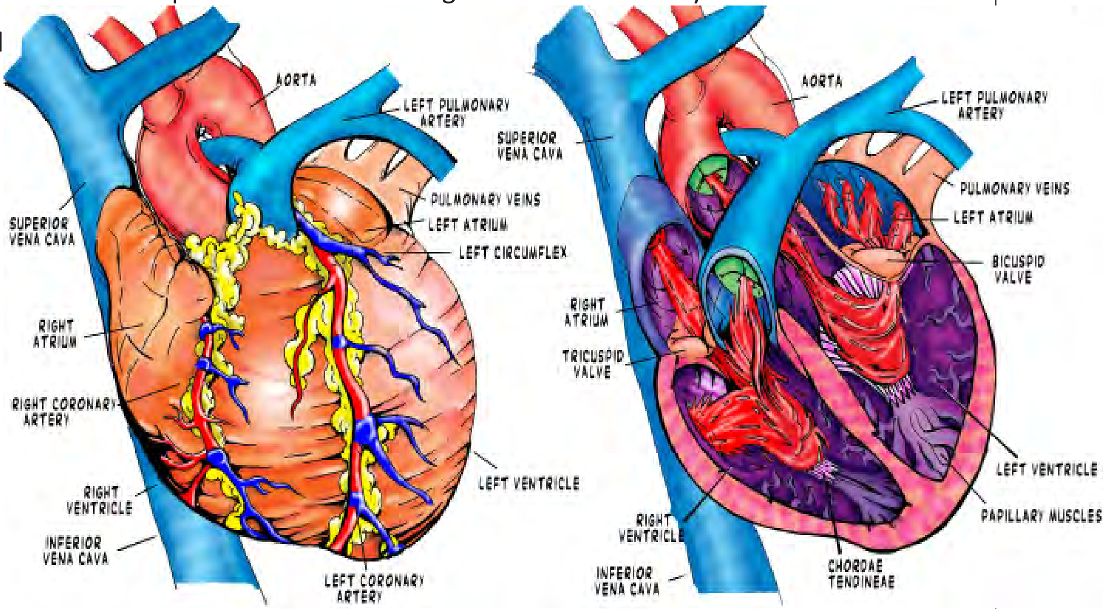
For the heart to perform its essential function of delivering oxygen to tissues and extracting and eliminating carbon dioxide, it must work in concert with the respiratory system. Like the closely linked skeletal and muscle systems (working together as the skeletomuscular system), the cardiovascular (or circulatory) system and respiratory system work together as the cardiorespiratory system to regulate blood pressure, deliver oxygen to tissues and remove carbon dioxide.

Regular exercise produces more efficiency in both the cardiovascular and respiratory systems. Exercise benefits the circulatory process by aiding in the development of the heart muscle, which enables more blood to be pumped with each stroke and increases the number of small arteries in skeletal muscle, allowing for the supply of more blood to working muscles. Exercise is also invaluable for the respiratory cycle because it allows for an increased amount of oxygen to be inhaled and distributed to body tissue. The benefits of regular exercise, relating to the ability to supply oxygen to skeletal muscle during sustained physical activity, is referred to as cardiorespiratory fitness. The benefits of cardiorespiratory fitness are lasting. These benefits include improved lung and heart condition, a more sustainable feeling of overall well being, and substantial risk reductions of stroke, heart disease, lung cancer and ***Type 2 Diabetes***.

Blood Flow

The heart is comprised of four (4) chambers. It contains two (2) chambers that *receive* blood from the body and two (2) chambers that *send* blood out of the heart back to the body. The receiving chambers are called atria (plural) or ***atrium*** (singular). The sending chambers are called ***ventricles***. The blood vessels (arteries, veins and capillaries) are responsible for the delivery of oxygen and nutrients to the tissue.

This illustration shows the chambers of the heart and the structures associated with it. Follow the circulatory process. Let's start with the forceful contraction of the heart's left ventricle which sends oxygen-rich blood into the blood vessels through the heart's main artery, the aorta (the largest artery in the body). The aorta branches off into smaller arteries, ***arterioles*** and capillaries that run throughout the entire body.



Oxygen and nutrients are then released where needed in the body and waste is picked up as the deoxygenated blood is returned. The return of deoxygenated, waste-rich blood flows through the veins, back to the heart through the lower inferior and upper superior vena cava, and into the right atrium. ***Systemic circulation*** encompasses the entire process by which oxygenated blood is *carried away from the heart to the body* (supplying nourishment to body tissue) and then deoxygenated, waste-rich blood is r*eturned back to the heart into the right atrium*.

Systemic circulation does not refer specifically to the circulatory process between the heart and lungs, this is called ***pulmonary circulation***. Pulmonary circulation is the process by which the *blood flows between the heart and lungs*; once the right atrium has filled with deoxygenated, waste-rich blood, the right atrium then contracts and pushes the blood through a one way valve into the right ventricle. The right ventricle then contracts and pushes the blood through the pulmonary artery, which leads to the lungs. In the lung capillaries, the exchange of carbon dioxide and oxygen occurs, preparing the now oxygen-rich blood to return to the heart through pulmonary veins and into the left atrium. The oxygen-rich blood then passes through a one way valve and into the left ventricle, where the process of systemic circulation starts its concert once again. Thinking about this very basically, the right side of the heart is responsible for pulmonary circulatory functions; and the left side is responsible for the rest of the body. And, together, they sustain ***coronary circulation***, which refers to the movement of blood through the heart

Special Circulation for the Brain
-The Cerebrovascular System-

The human brain accounts for 2% of body mass, yet it consumes about 20% of the oxygen at rest. The massive carotid artery has such a strong pulse that it is often the site for taking the pulse rate. However, recent AHA research finds that **the radial artery (in the wrist) is the best place to take the pulse.** The jugular vein is also very large and carries a significant amount of blood. The carotid gets 70% of the cerebrovascular blood supply, and serves the superior brain regions; and the vertebrobasilar artery gets 30% and supplies the inferior regions. The blood supply is well protected by the blood brain barrier. When a blood clot stops blood flow, thus stopping oxygen from reaching a portion, a stroke may result. A minor stroke-like event is called a 'transient ischemic attack', it may last 1-2 hours and does not have long-lasting effects. This is often a warning sign of a potential stroke. Because the brain must have oxygen and glucose at all times, it will cause changes to occur in the body to make sure that this happens.

– remember, the heart is the hardest working of all muscles and must receive nourishment through the capillaries located inside of it. Coronary circulation is different from the rest of the body in two critical ways. First, there is very little to no redundancy in the circulation so if one artery is blocked, blood flow may not reach that area. Second, due to the forceful contraction of the heart and the need to serve the deep portions of the myocardium, blood flow can only reach the heart during diastole, or filling of the chamber, which we will discuss in more depth later in this chapter.

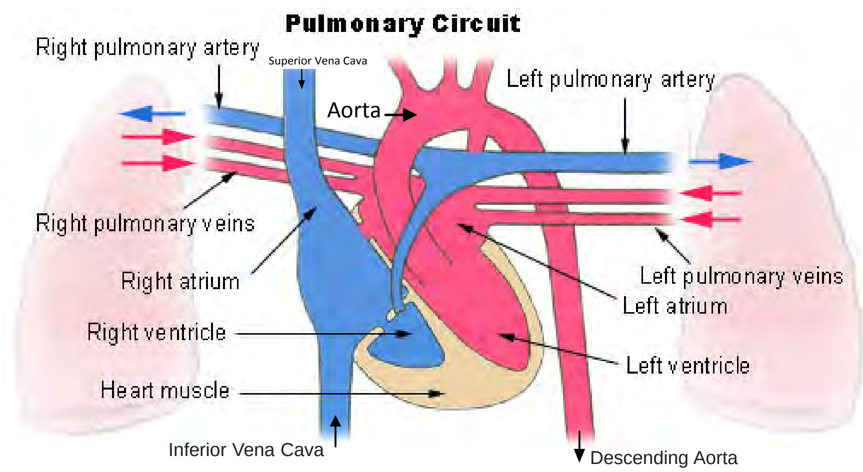
Think of someone swimming and only being able to take a breath at certain limited intervals, this is a similar response. These two factors are very important because if the heart does not get enough blood flow, then the muscle does not function in that region. If the cardiac muscle does not function as a single unit, then major problems exist, such as a myocardial infarct or a heart attack. Secondly, because there is such limited time for the myocardium to get its oxygen supply, it must do it efficiently. If there is any blockage, this hinders or eliminates the myocardium to get its oxygen, and ischemia (lack of oxygen) ensues. Unfortunately, those who eat a high fat diet and don't exercise are prime targets for heart attacks because they often have blockages in their coronary arteries, with little reserve capacity.

It is the cardiovascular system's job to provide nutrients and oxygen to body tissues to sustain life. Thus, it is valuable to track the movement of blood from the heart to the muscle tissue and back again. Blood, oxygenated through pulmonary circulation, leaves the heart via arteries, travels through smaller arteries (arterioles), and then on to the arterial portion of the capillaries. The oxygen and nutrient rich blood is then perfused into the ***intramuscular*** areas. The process of perfusion allows for oxygen to enter the blood stream from the lungs for delivery to body tissues.

Pulmonary and Systemic Circulation: An Overview

Pulmonary Circulation

Right Atrium to Right Ventricle to Pulmonary Artery to Lungs: Pulmonary Arterioles to Alveolar Capillaries, Exchange of O_2/ CO_2 and back to heart: Pulmonary Venules to Pulmonary Veins to Left Atrium



Systemic Circulation

Left Atrium to Left Ventricle to Aorta to body: Arterioles to Capillaries, Exchange of O_2/CO_2 to Systemic Venules and back to heart: Systemic Veins to Vena Cava (inferior and superior)

We often don't think of the involuntary functions of our body and just how intricately designed they are in order to sustain human life; but, when studied, we find that it is truly amazing! The very small details of these processes, like the one way valves in the heart which act to keep the blood gases from mixing, for example, are intricately delicate, crucial and beneficial to our well being. In the case of the heart, a breach in the systematic blood flow process would cause a serious threat to life.

EXERCISE AND MUSCLE FUNCTION

Cardiac Muscle: Resistance Exercise

The cardiac muscle is similar in many ways to skeletal muscle. For example, they are both striated and will house the same cellular components in varying proportions. The heart muscle will also adapt to resistance exercise in much the same way that skeletal muscles do, it will get stronger. If the heart is forced to pump against an increased amount of resistance for prolonged periods, such as is common in higher intensity anaerobic exercise, the cardiac tissue (or heart muscle) will most likely adapt by increasing in size/thickness and strength. This is known as cardiac hypertrophy, or a thickening of the myocardium which results in increased pumping ability; this most frequently occurs in strength and speed athletes.

Cardiac Muscle: Aerobic Exercise

In the case of aerobic activity, the heart's contractile strength is sufficient; however, the heart will find it more difficult to provide sufficient amounts of oxygen to the working muscles. The heart will most likely adapt by increasing the capacity in actual blood volume that it can pump per contraction, enabling it to accommodate the greater volume of blood demanded by the working muscles. This is most generally accomplished through a slight increase in the size of the left ventricle to accommodate more blood. This is a common occurrence among endurance athletes.

Smooth Muscle: Vascular Tissue

Vascular tissue, or blood vessels, function in a variety of ways in response to exercise, adrenal hormone stimulation and sympathetic nervous system stimulation. Let's take a brief look at these responses:

Response to Exercise

During exercise, blood flow is re-routed to the working muscles and away from the major organs and the rest of the body. This allows for the increased transport of nutrients and oxygen required to sustain muscle activity. It is quite interesting to note that resistance exercise increases the strength, elasticity, and permeability of the blood vessels.

Response to Adrenal Hormone Stimulation

After eating, adrenal hormones stimulate the blood vessels around digestion to dilate for the purpose of optimizing the transport of nutrients from digestion into the main vascular tree. Since the total blood volume tends to remain the same, this ***dilation*** of vessels around digestion calls for an equal and opposite constriction of other vessels not involved in the digestive process.

Response to Sympathetic Nervous System Stimulation

The autonomic nervous system (ANS), which is a part of the peripheral nervous system (PNS), controls involuntary visceral functions, like heart and respiratory rate. It is broken up into two (2) sub-categories, the sympathetic nervous system (SNS) and the parasympathetic nervous system (PSNS).

Though heart rate is technically under involuntary control, it is possible to influence it based on psychological state, such as when you're nervous or excited. When the nervous system perceives a stressful situation, it reacts by activating the sympathetic nervous system, causing an accelerated heart rate. The heart responds to ***stress hormones*** and contracts more strongly with each beat. This reaction also constricts blood vessels in certain areas and dilates others, which prepares the body for a "fight or flight" response. This widespread coordination is accomplished in part through the release of stress hormones called epinephrine and norepinephrine. Conversely, on the other end of the continuum, is the parasympathetic nervous system. After eating, and during a relaxed state, hormones such as serotonin are released.

In basic terms: The sympathetic nervous system "hypes up" the body to prepare it for action; the parasympathetic nervous system "calms down" the body.

Blood Movement

Dependent on the tissue's needs, the appropriate amount of oxygen and nutrients are then mediated and/or diffused through small, microscopic holes in the capillaries, into the spaces between the muscle tissue known as the interstitial space. The muscles then take up oxygen and nutrients at a very gradual rate, even if they are desperately needed. Working muscles, and muscles recovering from work, will demand more oxygen and nutrients than muscles at rest; this uptake of oxygen and nutrients will occur until the muscle is fully recovered.

The remainder of plasma fluids not taken up by the muscles, along with the wastes excreted from the muscle fibers, accumulates in the interstitial space which is the narrow space that surrounds the cells of body tissue. These fluids and wastes are then siphoned into ***lymphatic vessels***, thin walled structures that carry lymph, that transport this oxygen- and nutrient-deficient fluid away from the muscles through venular capillaries. From here, blood is returned through the veins to various visceral organs for nutrient enrichment and waste processing, then on to the pulmonary circulation to be oxygenated. This nutrient-rich and oxygenated blood is once again delivered to the heart which completes the basic blood movement cycle.

Fluid Movement

Aside from fluids in the visceral organs and in the major cavities of the body, there are two main "categories" of fluids: ***intracellular*** and ***extracellular***. These fluids are constantly moving across separating membranes in order to maintain osmosis. They continue to balance one another out by passing molecules through a semipermeable membrane from a less concentrated solution into a more concentrated one, to equalize the concentrations on each side of the membrane.

1. **Intracellular fluid**, or cytosol, is the fluid found inside the cell itself. It is made up of approximately 70% water and is separated by membranes into compartments that house separate cellular components.

2. **Extracellular fluid** is the term used to describe all fluids that are found outside of the cell. The two main types of extracellular fluids are blood plasma and interstitial fluid.

2.a. **Blood plasma**, also called intravascular fluid, is the light yellowish part of blood that makes up over 50% of the total blood volume of the body. It is crucial in many of the body's fluid transport functions and particularily vital to the movement of elements in the blood through the circulatory system. Plasma is a fluid in which solids, blood cells and platelets are suspended; and elements like hormones, proteins and nutrients are transported where the body needs them.

2.b. **The interstitial fluid**, is the liquid found outside the vessel walls, in between the cells, and surrounds all muscle tissue fibers. It "communicates" with the plasma to deliver materials to the cells and to remove metabolic waste.

Understanding Blood Pressure

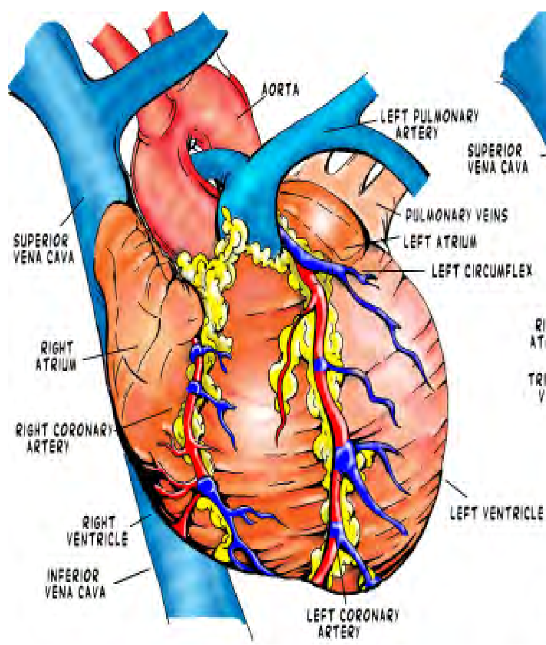
Studying the cardiovascular system involves an overview of blood pressure. As a personal trainer, you will likely deal with clients who have different ranges of blood pressure. Many trainers recognize what blood pressure is, but they might not know how to interpret blood pressure from a functional standpoint or how to help clients reduce blood pressure if needed.

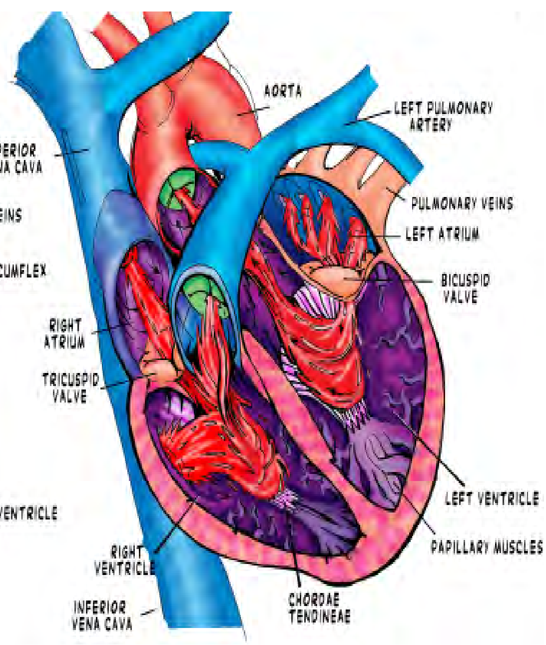
Pressure Gradients in the Heart

Each chamber of the heart contains valves. The chamber opens or closes when the pressure on the other side of the chamber is greater or less, respectively, than the pressure in that chamber. For example, when pressure builds in the left atrium, it will eventually become greater than pressure in the left ventricle. As a result, a valve called the Mitral Valve will open, letting blood into the left ventricle. In turn, when the pressure in the left ventricle exceeds the pressure in the aorta, the aortic valve will open. The aorta is the main artery of the body, which supplies oxygenated blood to the circulatory system. Upon the return of the blood to the heart, it will go through its pulmonary circulation cycle and then return to the heart, slowly filling its need.

A single cycle of cardiac activity can be divided into two basic phases: ***systole*** and ***diastole***. In terms of blood pressure, systole represents the contraction prior to expulsion of the contents of the chamber; diastole represents the relaxation, or filling, of that chamber. The two phases must be well coordinated so blood flows properly. In a blood pressure reading, measured in millimeters of mercury (mmHg), the top number is a measurement of systolic pressure (contraction); and the bottom number is the measurement of diastolic pressure (resting/filling with blood). The difference in pressure between the systolic (higher number) and diastolic (lower number) is known as pulse pressure. For example, if blood pressure is 120/80mmHg, then the pulse pressure is 40mmHg (120 - 80 = 40); pulse pressure between 30-50mmHg is considered normal. Pulse pressure can be an indicator of a person's cardiorespiratory fitness; it is also representative of arterial stiffness, which is the elasticity of the arteries influencing how hard the heart has to work to pump blood through the body. A widening pulse pressure (e.g. increased difference in systolic and diastolic blood pressure) is an indicator of arterial stiffness. Increases in arterial stiffness have direct negative implications for how the heart interacts with the vascular system and is associated with an increased risk of heart attack or stroke. Arterial stiffness occurs with aging, but it is not a direct correlation as arterial age occurs more slowly with consistent exercise and a healthy diet.

SYSTOLE	DIASTOLE
Represents the time during which the left and right ventricles contract and eject blood into the aorta and pulmonary artery, respectively. During systole, the aortic and pulmonic valves open to permit ejection into the aorta and pulmonary artery. The atrioventricular valves are closed during systole; therefore, no blood is entering the ventricles. However, blood continues to enter the atria though the vena cavae and pulmonary veins.	Represents the period of time when the ventricles are relaxed and blood is going from the left atrium and right atrium into the left ventricle and right ventricle, respectively. The blood flows through atrioventricular valves (mitral and tricuspid) that separate the atria from the ventricles. The right atrium receives venous blood from the body through the superior vena cava and inferior vena cava. The left atrium receives oxygenated blood from lungs through four pulmonary veins that enter the left atrium. At the end of diastole, both atria will contract; this allows additional blood to enter into the ventricles.





BLOOD PRESSURE CHART

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

**American Heart Association (2018) www.heart.org*

Blood pressure may fluctuate with current activity, like sleep, stress or exercise. So, not one reading of blood pressure can be the absolute determinate for finding that your client has high blood pressure, as this should take several readings over a period of time. It is important to recognize that if your client has consistent readings that are outside a normal range, you are to advise them to consult their doctor. A consistent reading at 140/90mmHg or above will most likely require a treatment program prescribed by a physician. In most cases, it will be recommended to your client that they adopt a healthier lifestyle – and that's where you can help! As recommended by the American Heart Association, a "lifestyle prescription" will include:

- A healthier diet (often reducing salt)
- Regular physical activity
- Maintaining a healthy weight
- Managing stress
- Avoiding tobacco and limiting alcohol

Not surprisingly, the same things that raise blood pressure also contribute toward other risk factors of coronary artery disease (CAD), dyslipidemia and diabetes. Smoking, a high fat diet, a lack of exercise and genetic predisposition are all contributors toward high blood pressure, or hypertension, as well as other cardiovascular conditions. Note that only in certain conditions will a high-sodium diet cause ***chronic*** hypertension. Exercise will enhance the ability of certain capacitance veins to dilate and help control pressure throughout the body.

Adaptations in the Cardiovascular System during Strenuous Exercise

As a personal trainer, you will need to consider how exercise affects the cardiovascular system. This is a brief overview of this process:

During strenuous exercise (such as 80% of maximum heart rate, HRmax), the cardiovascular system must provide sufficient amounts of oxygen to the working muscles. The cardiovascular system adapts to a state of low oxygen (called hypoxia) in several ways. One way is by increasing stroke volume (SV), or the actual volume of blood pumped from the left ventricle of the heart in one beat (which is generally about ⅔ of the actual blood that is in the left ventricle, it is not expelling all of it). The vasculature (veins/venous system) will dilate (expand) more to allow more blood to come back to the heart, this is known as venous return. Think of the heart as a bike tire pump – the tube leading away from it and the tire itself is the vascular system, and the ease of lifting up the pump is the venous return, or end diastolic volume (EDV). If you think about it, the amount of air you can get in for one pump is due to the difference between how high you start (EDV) versus how far down you go, or the end systolic volume (ESV). The faster you pump (heart rate) and larger you pump (stroke volume) the more air you will get in a tire in a given time period (cardiac output). Cardiac output is the product of stroke volume and heart rate, it is the volume of blood being pumped in one minute. First, to find stroke volume you would subtract the volume of blood at the end of a beat (ESV) from the volume of blood just before the beat (EDV). These measurements of ventricle volumes, to calculate stroke volume, are typically taken from an echocardiogram. Note that, when both the stroke volume and heart rate increase, the cardiac output dramatically increases.

SV= Stroke Volume (in milliliters, mL, per beat)
CO = Cardiac Output (in liters per minute)
EDV = End Diastolic Volume (start, in mL)
ESV= End Systolic Volume (end, in mL)
HR = Heart Rate (in beats per minute, BPM)

SV = EDV – ESV
CO = SV x HR

Using the tire analogy for high blood pressure, imagine pumping a tire that is requiring significant resistance to be filled. Thus, you would have to pump much harder. Or, consider the scenario of a leaky hose leading from the pump to the valve that, with each pumping action, would cause you to lose efficiency (air). This would be similar to poor access to lung air exchange, or faulty valves, or even blockage in the arteries and veins. Thus, ideally, the best and most efficient system is one that has smooth (not blocked) flow, where all the air that is drawn in is also delivered into the tire.

Bodily Systems Coordinating to Get Oxygen to the Working Muscle

During strenuous endurance exercise, blood flow is rerouted to the working muscles, and away from the digestive organs and the rest of the body. It is rerouted due to the local metabolites in the area – including low oxygen, high carbon dioxide, and low pH. Heat even helps this redistribution. The increase in blood flow allows for the increased transport of nutrients and oxygen required for muscle activity. Since the actual exchange is happening at the capillary level, it is important for the capillaries to dilate sufficiently for increased surface area. It is quite interesting that prolonged endurance training increases the strength, elasticity, permeability of the blood vessels over time and increases the number of capillaries in the working muscles, creating an increased capillary density. Endurance training also increases various cellular mechanisms responsible for oxygen metabolism; in particular, the number of mitochondria and the amount of enzymes in each mitochondria.

Oxygen, Carbon Dioxide, and Nutrient Movement

As you have read, the cardiorespiratory system has several components and several stages to the total process. The most important stage is the delivery and actual uptake of the blood-carried components.

The difference in oxygen content between arterial and venous blood is known as the arteriovenous oxygen difference, or a-vO_2 difference. By having more capillaries and more mitochondria in the muscle, the capacity to pull out more oxygen and nutrients is increased. By being more efficient with this process, the trained athlete has a lower submaximal heart rate at any given workload than the untrained individual. When a training program grows consistent, the sustained physical exercise will increase the a-vO_2 difference, allowing the muscles the ability to increase the amount of oxygen extracted from the blood; because of the resulting increasing performance of the mitochondria and higher myoglobin concentration. Myoglobin is the protein that carries oxygen inside the muscle tissue; and hemoglobin is the protein that carries oxygen in the blood to the body. The amount of oxygen already in the blood or tissue will determine how much is unloaded in a given trip (heart beat). If the amount is low in the tissues, as in during strenuous exercise, a lot of oxygen will be released by the hemoglobin and accepted by the myoglobin.

a-vO_2 difference = oxygenated blood (concentration of the arterial blood) – deoxygenated blood (the oxygen concentration of venous blood)

Total Oxygen Consumed = HR x SV x a-vO_2 difference

How Aerobic Exercise Can Help Cardiovascular Conditions

Exercise is good for the heart, and cardiovascular exercise can help improve certain health conditions. Here’s a brief look at some of the benefits of exercise for four major risk factors of disease. NOTE: Training clients with these conditions involves careful consideration, planning and programming - consult with that person’s doctor before training begins.

High Blood Pressure (Hypertension)
Systolic pressure is measured when the heart is in maximum contraction and diastolic pressure is at maximum relaxation. The amount of time that the heart has to get its own nutrients and oxygen occurs during diastole, or when the heart is filling. The greater the difference between these systolic and diastolic pressures, the slower the heart rate. A blood pressure reading in the normal range is one sign of a healthy, fit heart.

Diabetes
Exercise increases the sensitivity of muscle cells to ***insulin***. Insulin removes glucose from the blood stream for absorption by skeletal muscle. Since muscles are the primary users of insulin - and an exercised muscle increases in size and density of receptors – it's possible for diabetic clients to improve their condition through exercise. This makes sense considering that obesity, hypertension and lack of exercise are contributors to diabetes.

Coronary Artery Disease (CAD)
Coronary circulation is the sole source of oxygen and nutrients for heart tissue, or myocardium. This tissue is highly active and needs a constant supply of blood. If there is a build up of plaque along the inner walls of the heart's arteries, as is the case with CAD, then blood flow is obstructed and the heart is not getting what it needs - setting the individual up for a potential heart attack. Of course, some of the risk factors associated with CAD can be attributed to genetic make up or fixed demographics; but the lack of exercise is a compounding risk factor that can increase the likelihood of heart attack. Regular exercise will help to supply the active heart tissue.

Dyslipidemia (high blood cholesterol levels)
Low-density lipoprotein (LDL) transports fat toward the organs, and high-density lipoprotein (HDL) transports fats away from the organs to the liver, where it is metabolized. The greater the transport away from the organs, versus toward the organs, the better the scenario for a client's health. Aerobic exercise helps lower what is known as "bad" ***cholesterol*** in the body, "bad" being low-density lipoprotein, or LDL. Exercise also helps raise the "good" kind of cholesterol in the body, "good" being high-density lipoproteins, or HDL.

Clearly, exercise is a beneficial for just about anyone, it is an excellent course of action for the prevention and minimization of effects brought on by the client who is pre-disposed or has been diagnosed with these, or other, cardiovascular conditions.

CHAPTER 6

Physiology of Nutrient Metabolism

The process of taking in food and converting it to energy, or to structural components of the body, is anything but a simple undertaking. To do this, many body parts must communicate and coordinate their functions synergistically in order to extract a given nutrient and put it to use. ***Metabolism*** refers to all physical and chemical reactions in the body that use or convert energy. This includes the processes involved in digestion, absorption and the transport of substances between cells. In this chapter, a closer look is taken at the process and elements involved in digestion, absorption and metabolism.

The Anatomy of the Gut

The "gut" is actually a tube that consists of various parts or organs along its length. Use the mnemonic MESSLRA to remember the process of digestion: Mouth, Esophagus, Stomach, Small Intestine, Large Intestine (Colon), Rectum, Anus. The esophagus and anus are primary transportation tubes and both have sphincters, or a constrictive circular muscle that provides for body passage, which can allow or prevent flow from occurring. The other regions also have these sphincters to constrict the entrance or exit of that organ.

There are four stages to the digestive process, with digestion itself being only one of them. Ingestion is the first stage of the process. It is the actual eating by chewing. Food is converted into food bolus (a Latin term for "ball"), which is a mixture of saliva and chewed food. The bolus is transported down the esophagus into the stomach, this stage starts the process of digestion. Even though a minor portion of carbohydrate digestion is actually initiated in the mouth, the majority of carbohydrate digestion, and protein and fat digestion, occurs in the stomach. The stomach is where "churning and burning" occurs. The various longitudinal and circular muscles churn the food and the gastric acids, proteases and peptidases, which act to breakdown (or burn) food into its component parts. Then comes absorption, which is the movement of the molecules across the lining of the small intestine into the blood stream. Finally the utilization process ensues, where the molecule of nutrient is transported to the appropriate location to be utilized or stored. Portions of the digested material will of course be excreted.

Absorption

Probably the most important aspect of the digestive process is the absorption into the blood stream. The process of bringing food from outside the body to inside the body is absolutely critical for any metabolic activity to occur. Note that the gut is actually considered outside the body as its own independent structure. Thus, when something is absorbed, it is actually taken from the gut "into the body", even though it is actually traveling away from the core.

Because absorption is actually the most critical step in the whole digestive process, many nutritional supplements are designed to maximize absorption. Essentially, it does not matter how much of a vitamin or mineral is in the product; what is important is how much of that vitamin or mineral makes it into the system and is actually utilized. The benefit of a given nutrient starts and ends at the utilization stage. Absorption of most nutrients occurs in the small intestine with water, sodium, and potassium sometimes being reabsorbed in the large intestine.

Utilization

Once the nutrient has been delivered to the appropriate cell in the body, it now must cross that cell's wall, known as a plasma membrane. The nutrient then gets used by the cell as needed and may be either destroyed, remodeled chemically, or reused. There is not much that can be done nutritionally to enhance this, but the type of exercise and intensity and frequency may literally "train" the cell to perform a certain activity more efficiently. This is why some athletes can take in and use carbohydrate much more efficiently than a sedentary individual.

Regulation of Water and Minerals

The ability to conserve and excrete water and minerals is critical to life and proper functioning. The large intestine is composed of colon, cecum, and rectum. The colon (the major part of the large intestine) is responsible for water regulation of the feces. The kidneys are not part of the intake process but they do perform vital functions in the regulation of water and electrolytes. The final composition of the urine is determined by many feedback systems giving input to the kidneys.

The Role of the Liver in the Digestive Process

Often we speak of the liver but don't really have an idea of what functions it performs. The human liver is absolutely essential for life. In fact, if there is liver disease or failure, the amount of time that life can be sustained is very limited. Think of the liver as a 'specialist' in digestive functions. Anything outside the very basic energy production involves some liver enzyme or liver function. The liver has many functions, some of which we have touched on, but let's look at more specific functions to get a better understanding of just how vital this vital organ is. The liver functions to:

- produce substances that break down fats (lipases)
- convert glucose to glycogen through glycogenesis; and maintain a proper level of glucose in the blood through glycogenolysis, or ***gluconeogenesis***
- produce urea (chemical component in urine) via transamination (amino-transfer) of amino acids into ***keto acids***
- make certain amino acids
- filter harmful substances from the blood (such as alcohol) via alcohol dehydrogenase or other enzymes (detoxification function)
- storage of vitamins A, D, K and B12 and some minerals

The liver is also responsible for producing cholesterol. It produces about 80% of the cholesterol in the body. The amount it produces is in addition to the amount taken in the diet and produced from dietary saturated fat intake.

Endocrine System with Exercise

On the surface, most individuals, who are not familiar with human physiology, might ask what the endocrine system has to do with exercise. The answer is quite obvious to those who do know that the endocrine system is a major control source for pretty much all functions in the body. Simply stated, the endocrine system is the connection between the brain, the body and many body parts. Thus, during exercise, a lot of coordination needs to occur, and the endocrine system is essential to this coordination. The term "endocrine" literally means to "secrete internally". It implies that, in response to specific stimuli, the products of the endocrine system, from the endocrine glands specifically, are released into the bloodstream for a specific designated purpose.

The endocrine system is an incredibly complex system of organs, hormones, receptor activation, and even cytokine feedback mechanisms. For our purposes, we will only cover the surface of this incredibly complex system so that you will have an understanding of how it relates back to exercise. One of the primary functions of the endocrine system is to regulate other functions, in other words it keeps us in homeostasis. The endocrine system primarily uses a biofeedback system, or in a few instances a biofeedforward system, to regulate responses. In general, if the body is low in something it will be detected by some peripheral receptor, specific to that stimulus.

This will stimulate the upper brain center, such as the hypothalamus, which then releases a trophic (feeding) hormone that stimulates the pituitary gland. The pituitary gland will, in turn, secrete a “releasing factor” to stimulate some specific peripheral gland to release a hormone, to raise the level of stimulus via a physiological reaction.

Hormones are chemical messenger molecules that are produced by endocrine glands, which are ductless glands; as opposed to exocrine glands, which have ducts. The hypothalamus, pituitary gland, adrenal glands, testes and ovaries, thyroid gland, parathyroid glands, and pancreas are the endocrine glands.

The hormones produced by these glands are then carried via the blood to their target cells. Some hormones have only a few specific target cells, whereas other hormones affect numerous cell types throughout the body. The target cells for each hormone are characterized by the presence of certain and specific receptor molecules for the hormone, which are located either on the cell surface or inside the cell. The interaction between the hormone and its receptor triggers a cascade of biochemical reactions in the target cell that eventually modify the cell’s function or activity.

When someone begins to exercise, the body basically goes into a minor flight or fight reaction. In addition, the body’s chemoreceptors, or sensors that detect specific chemicals in the blood, and baroreceptors, or sensors that detect blood pressure, signal the hypothalamus that blood pressure is too low because the muscles are dilating and taking up a greater portion than normal. Chemoreceptors are specifically detecting low oxygen (O_2), high carbon dioxide (CO_2) and low hydrogen (pH) concentration, and they signal the hypothalamus as a result. The hypothalamus releases cortico-releasing hormone (CRH) to stimulate the pituitary to release adreno-cortico-stimulating hormone (ACTH) to stimulate the adrenal cortex to then release epinephrine or norepinephrine, which raises heart rate, stroke volume, and vasoconstriction to help raise the blood pressure and oxygen delivery to restore the body to homeostasis.

Another way exercise affects the endocrine system is via the pancreas. As a major role in its endocrine function, the pancreas is responsible for ***blood sugar*** regulation in the body. Two portions of it, the alpha and the beta cells of the Islets of Langerhans, which are the portions of the pancreas that contain endocrine cells, will secrete ***glucagon*** and ***insulin***, to raise and lower blood sugar, respectively. Well trained athletes become insulin-sensitive quite often. This means that the muscles become sensitive to insulin and react more than normal to store glycogen and fat in the muscle site. It also protects against becoming insulin-resistant or diabetic. Exercise is one of the best solutions to preventing and even reversing many diabetic symptoms.

One final note on the endocrine system, that has been gaining more attention with time, is the interaction it has with the immune system via the upper brain centers. This interaction of various systems is named the psychoneuroimmune system, or the neuroendocrine immune system. Basically, the immune system is talking to the rest of the body via the endocrine system. This demonstrates the mind-body reaction that has been more intriguing over recent years. Research suggests that stress lowers the ability of the immune system, and chronic stress may have some very detrimental effects on both the immune system and many other systems in the body, including the gastro-intestinal system. Therefore, one can easily see how a chronically weak immune system, in some cases caused by chronic stress, is an invitation to illness!

Fuel Sources for Metabolism

The process by which the body delivers a usable energy form to a muscle is really quite miraculous! What is even more miraculous is how fast and how often it needs to happen. While these processes may seem highly scientific and complex, being able to understand the basics will put the application of fitness training into context. It is important to understand, for example, why it is beneficial in certain activities to "carb load"; whereas, in other situations, creatine supplementation may be more beneficial for your client. This chapter contains more exercise physiology than any other in this manual. Try not to get confused by the sub-cellular components or biochemistry. Keep in mind, all body tissues have structural and energy needs – there are different fuels for different needs. Let's look at the components for these requirements and energy production at a cellular level.

Sub-cellular Skeletal Muscle Structure

Remember, as covered in Chapter 4: *Skeletal Muscle: Structure and Function*, muscles have several levels to their structure. An entire muscle, may have two portions, a long head and a short head, like the bicep, that are divided into fiber bundles, which are further divided into a muscle fiber and its neuron (the active unit). The muscle fiber is composed of myofibrils, where actual contraction occurs. These myofibrils are composed of myofilaments. Action of calcium and ATP are found at the myofilament level.

Let's review. A functional unit in the muscle, the sarcomere, is a single muscle fiber where we find thick filaments, composed of myosin molecules, and thin filaments, composed of actin. The process of muscle contraction is really quite complex and several reactions must take place before even the tiniest of contractions, in the smallest of muscles, can take place. It involves calcium, a troponin (complex of three regulatory proteins), a tropomyosin (which forms a cross bridge) and of course the actin and myosin. A full understanding of the sliding filament theory is not critical at this level, but it is important to know that the process requires calcium and ATP which is key for relaxation or release of the cross bridge. If appropriate minerals or electrolytes are not present, cramping may occur due to inefficient relaxation.

Muscle Fiber Type and Metabolic Functions

The importance of understanding muscle fiber types, especially in respect to performing certain athletic contests, is well known. As greater and greater technology develops in imaging and biochemical analysis, more and more sub-categories of fiber type will develop. The main two categories are Type I, small diameter, red, slow twitch fibers which are great for endurance but poor for power and strength; and the Type IIb, white, fast twitch fibers which produce a lot of force, but fatigue quickly and produce a high amount of lactic acid due to their anaerobic nature. The Type IIa, red, fast twitch fibers have the best of both worlds, but are not on the extreme for either.

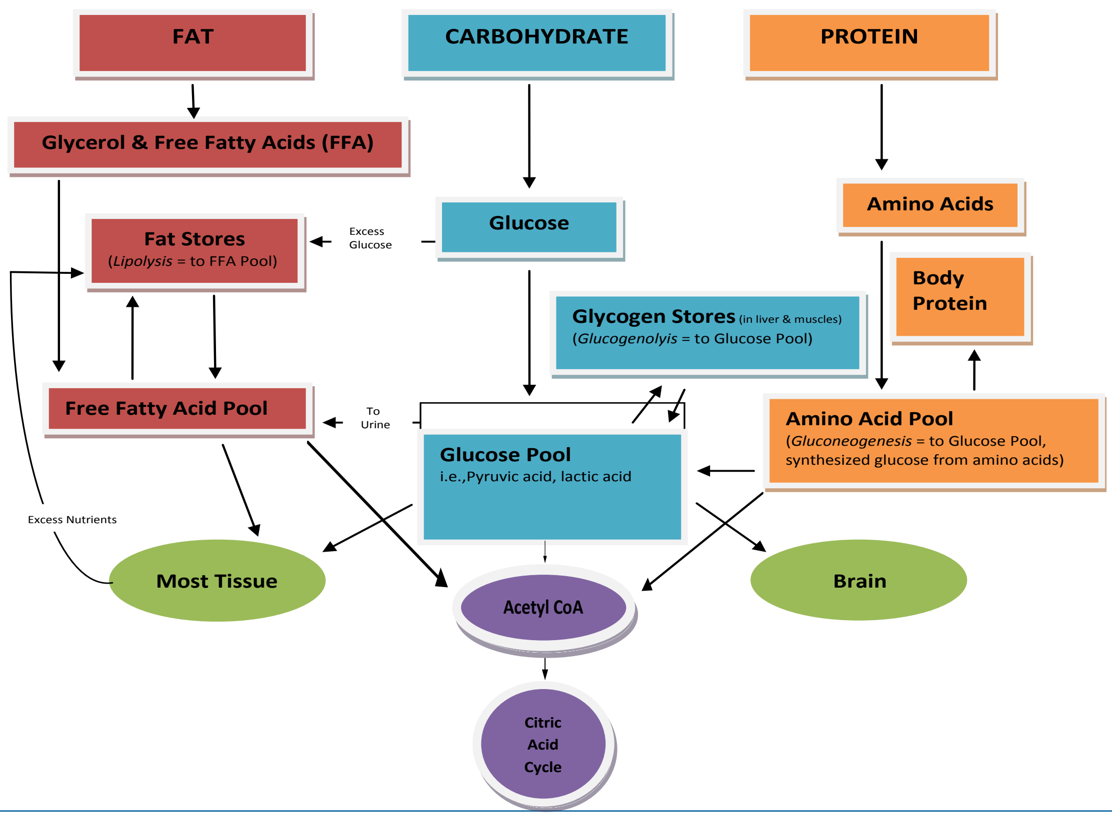
The size of the muscle fiber is also related to the size of the motor neuron. The recruitment of the motor neurons obeys the "size principle", meaning that small neurons are recruited before large ones, so the order of recruitment is:
Red, slow (Type I)
Red, fast (Type IIa)
White, fast (Type IIb)

The names of the fiber types are also indicative of their metabolic features. As we have covered, the Type I fibers are also known as slow, oxidative fibers. The Type IIb are known as fast, glycolytic fibers, and the Type IIa are known as fast oxidative, glycolytic fibers. There is still some controversy over the number of fiber sub-types and the capacity to "convert" the metabolic profiles of these particular fibers.

The main implication of knowing these muscle fiber types is to specifically understand that they are designed for certain types of activity and that their fuel source is specifically designed to support them in the respective activity. You need to train athletes for their specific type of activity and try to enhance that type of metabolic pathway. For example, if you are training a sprinter you need to train him or her to do explosive activities which enhance the hypertrophy of those white, fast twitch (Type IIb) fibers. You may want to have them try a creatine supplement and provide them with enough carbohydrates for recovery. If you are training an endurance athlete, you would train them aerobically and try to maximize the capacity to spare carbohydrate (via Anaerobic Threshold training) and maximize the speed of fat metabolism (long, slow distance training). You would likely 'carb load' them and make sure they have sufficient glucose supply in long duration events.

Nutrient Metabolism

Basically, metabolism can be broken up into two distinct parts; 1) ***catabolism***: the breakdown of molecules for energy; and 2) ***anabolism***: the synthesis of all compounds needed by the cells to repair damaged tissue. A well balanced diet supplies the elements needed to aid the process of chemical reactions involved in maintaining the living state of our cells (metabolism). Here is a summarized depiction of nutrient metabolism:



Even though your personal trainer certification will not qualify you to act as a dietitian, it is clear that fitness training and healthy eating go hand in hand. Overall improvements in physical health cannot be accomplished by paying attention to one and not the other. You can give advice on healthy eating, *you should,* but leave the details regarding portion sizes and individualized meal plans to a dietitian. See the Charts & Tables section of this manual for the *Activity Expenditure* and *General Dietary Advice Charts* which provides further explanation and recommendations. Let us first understand the macro-nutrients that provide our body with the energy it needs. Nutrients are required for all types of bodily functions, like growth and metabolism. With macro-, a.k.a. "large", nutrients, the body demands them in much larger quantities than others. There are three (3) macro-nutrients:

1. **Carbohydrates**
2. **Fats**
3. **Proteins**

Macro-nutrient Calories per Gram

Carbohydrates	4 calories per gram
Fats	9 calories per gram
Proteins	4 calories per gram

Carbohydrates

There are two basic types of carbohydrate, complex and simple sugars. If a carbohydrate is lacking in soluble fiber, or is a simple sugar, it will be absorbed too quickly into the blood. Complex carbs digest slowly, and simple sugars digest quickly. Some examples of simple carbohydrates include soda, candy, fruit juice, and cookies (or any baked good made with white flour); examples of complex carbohydrates include apples, cucumbers, oatmeal, potatoes, and multi-grain bread. Though there is an optimal time to eat simple sugars, like right after an intense workout when the body would like to quickly replenish lost muscle glycogen, it is important to know that prolonged eating behaviors of this type can lead to metabolic disorders such as ***Hypoglycemia*** and Type 2 Diabetes. These disorders are directly related to blood sugar levels and contribute to mood swings, depression, and several other mental impairments. The likelihood of the majority of these occurrences can be reduced by simply ensuring that, each time you eat, you limit simple sugars to as many natural foods as possible (such as fruits, honey and/or root vegetables) and consume at least one food that offers a soluble fiber source (such as whole grains and legumes). All-natural complex carbohydrates are sources of soluble fiber. You will know when you are eating too much soluble fiber when you are experiencing stomach cramps within about 20 to 30 minutes after eating.

While we are discussing fiber, it is also appropriate to explain the role of insoluble fiber as well. Insoluble fiber is NOT digestible. Insoluble fiber absorbs water in the small intestines, and then passes on to the large intestine using these fluids to allow for smooth passage and excretion of wastes. A diet lacking in insoluble fiber will reduce the efficiency of waste excretion. The longer that wastes are in digestion, the greater the absorption of fluids from these wastes. These fluids contain bacteria, toxins, and carcinogens which end up in the bloodstream and have been connected to several types of cancers and other metabolic disorders (which in western civilization, we practically have a monopoly on). When you are looking for a source of insoluble fiber, look for the word "BRAN" on food labels.

The Mechanisms of Carbohydrate Metabolism

When the carbohydrate is ingested it enters into the stomach, and then into the small intestine, where almost all digestion occurs. The principle enzymes that break down all carbohydrates in the small intestine are ***amylase***. These enzymes then break down carbohydrates into simple sugars like lactose, fructose, glucose, and smaller chains of glucose molecules called ***glucose polymers***. These simple sugars are then absorbed through the lining of the small intestine and are transported to the liver through the portal vein, where the liver then converts all these simple sugars into the common sugar glucose.

Glucose is the only usable form of simple sugar in the body. The liver, being the most active organ in the body and performing some 64 vital functions, then releases this new glucose into the bloodstream to raise blood sugar levels to normal. If the supply of this newly ingested glucose is too high, the blood sugar level gets too high and the excess glucose must be eliminated from the bloodstream. The pancreas houses the hormone Insulin. When the blood sugar reaches increasing levels, insulin is released and attaches to the excess glucose for delivery to body tissues. The muscle tissue is then the first stop for “insulin-carried” glucose, especially after exercise when muscle energy stores are low. Insulin actually opens up receptor sites on muscles, allowing for the uptake of glucose to replenish depleted muscle energy stores. When receptor sites do not readily take up glucose they are said to be “insulin resistant”. This condition is generally due to sedentary behavior and possibly during the onset of Type 2 Diabetes.

Once glucose is absorbed into the cell it is used for energy. The unused portion of this new glucose is then converted and stored in the muscle as glycogen. Finally, glycogen is saved in the muscle cells and used for more intense exercise. It is important to note that glucose can only be taken up by muscle tissues at a gradual rate. If excess insulin-carried glucose is available at one time in the bloodstream, insulin’s next stop for the storage of this abundant glucose is the liver.

Like muscles, the liver also can only take up glucose at a gradual rate. The liver, among its many functions, has the potential to store between 300 and 400 calories of glucose, converting and storing it as liver glycogen. This liver glycogen, in contrast to muscle glycogen, is primarily used for brain function as well as for aerobic activities. Glucose is the brain’s only source of energy. During periods of reduced carbohydrate intake, the liver is then responsible for correcting this low blood sugar problem with the help of another hormone called glucagon. Glucagon is released from the pancreas in response to low blood sugar levels. The glucagon then triggers the liver to release its stored glycogen as glucose to replenish blood sugar levels, this happens at a rate of about 26 calories per hour. This intermittent release of stored glycogen from the liver, to maintain blood sugar primarily for brain function, is the process of glycogenolysis. When the liver stores are full, and a considerable amount of excess insulin-carried glucose is in the bloodstream, it will be stored as fat in adipose tissue. Unlike muscle and liver, fat (adipose) cells store blood glucose quite rapidly.

If glucagon reaches the liver and for some reason the liver cannot provide glucose for the blood (i.e. extreme dieting or over-exertion), a sequence of events occur resulting in the eventual breakdown of blood proteins and the undesirable ‘***cannibalism***’ of organ and muscle tissue for the needed glucose energy. This is the process of gluconeogenesis, tissue breakdown for energy.

With this in mind (and leaving keto diets out of this level of discussion), at rest, the minimum daily carbohydrate intake for a healthy adult should be more than 156 grams. This is important in order that amino acids, blood proteins, and other energy reserves are spared from being converted and used for brain function. Of course, this figure should increase respectively with activity, training goals and/or condition of the individual (e.g. according to the Institute of Medicine, pregnant women should consume no less than 175 grams per day; and this should increase to 210 grams per day when breast-feeding). Whenever too few carbohydrates are ingested, the liver must, in turn, convert proteins and body tissue into glucose to provide for energy demands, through the process of gluconeogenesis. When body proteins are used for energy, there is a resulting toxin, ammonia, that must be broken down by the liver and kidneys. This can easily be prevented by either reducing the duration and/or intensity of exercise, or by increasing the carbohydrate intake.

Note: If the carbohydrates ingested are already simple sugars, or are low in dietary fiber, they are taken up into the blood rapidly. The pancreas will, in turn, react quickly resulting in an "over-release" of insulin. Since the muscle tissues and liver take up blood-glucose very slowly, the surplus of insulin-carried blood glucose will bypass the two, and be rapidly stored in fat cells. Also, since the hormone insulin "over-reacts" in this situation, and its function is to eliminate sugar from the blood, within 20 to 30 minutes the blood sugar falls below resting levels (hypoglycemia). This reduces the glucose supply to the central nervous system creating a noticeable effect on higher brain function (making you feel sluggish, tired, and run down).

Aerobics and Muscle Tissue 'Cannibalism'

When glucose is depleting during intense aerobic activity, there are stress hormones released by the adrenal glands to trigger the liver to release enzymes into the bloodstream for the ***deamination*** and cannibalism of amino acids, blood proteins, organ tissue, and muscle tissue. In the absence of glucose during intense aerobic activity, the energy needs are beyond the oxygen and fatty acids' supply, and muscle tissue will 'eat away at itself', essentially being cannibalized, to provide for the balance of the energy needed to keep up with this continued demand.

It is interesting to note that the depletion of cellular energy during intense resistance exercise triggers the cannibalism of the intracellular proteins in the working muscles only, not amino acids, blood proteins, and organ tissue, such as in the case of aerobic activity. A good way to avoid this occurrence is by eating protein regularly and ingesting a light, easily absorbable carbohydrate about 15 minutes before workouts.

Glycemic Index and The Glycemic Load

It is agreed that simple carbohydrates increase blood sugar rapidly and that complex, high fiber, carbohydrate has a slower impact on blood sugar. Research into biochemistry and food science yielded the concepts of ***Glycemic Index*** (GI), which essentially gives a measure of the quality of carbohydrate; and the ***Glycemic Load*** (GL), which indicates the quantity of carbohydrate. These concepts help to quantify our understanding of how blood sugar is affected by carbohydrate consumption. However, there is still much debate among scientists regarding the effectiveness of a low GI diet compared to traditional dieting. The 'argument' is that there is no conclusive evidence that proves that one is superior over the other, or that a GI diet yields long term results by comparison. NFPT believes that there is value in the concept and encourages trainers to understand and use the Glycemic Index as a tool to simplify, especially for new clients, the ways that certain foods react in the body. This system can help set healthy guidelines for trainers and clients who are new to nutritional understanding. The long and short of it... NFPT believes that the only way to lose weight is with a combination of safe and effective exercise and a balanced diet of whole natural foods that are in proportion to your daily calorie expenditure for activity and basic bodily function.

With that said, there is value in understanding the GI. You will also find the GI listed for foods in the *NFPT Master Food List*, located in the back section of this manual. The GI is a number assigned to each food telling how fast the carbohydrate triggers a rise in blood glucose when eaten alone, on an empty stomach. Some carbohydrates are fast release and will therefore have a higher number on the GI. For example, table sugar or sucrose has a glycemic value of 100. If a food has a low GI value that means it is slow to release its sugars, causing a slow rise in blood glucose and a slower secretion of the hormone insulin. GI basically tells you how *fast* a certain food turns into simple sugar in the blood. It does not tell you how much carbohydrate is in a serving. To understand how a food impacts the blood sugar, both GI and GL must be considered. This is where the Glycemic Load factors in. This is the figure that will tell you *how much* simple sugar is being taken up into the blood stream. Ultimately, it is a better indicator of the resulting insulin level increase leading to excess food energy (calories) being stored as fat. The GL is found by multiplying the GI by the number of carbs (minus the fiber) in grams per serving, and then dividing that number by 100. Food labels will provide you the information needed to make these calculations. For an example, let's take a look at a plain white bagel versus one plain slice of wheat bread. The plain bagel, with a GI of 72, contains about 30 grams of carbs (when taking total carbs minus fiber); and one slice of wheat bread, with a GI of 71, comes in at about 10 grams of carbs (minus fiber) - these are approximations which have slight variations depending on brand and processing. To find and compare the GL of these foods, take their GI multiplied by the grams of carbs (minus fiber) and divide by 100: **GL = [GI x (carbs - fiber, in grams)] ÷ 100**
White bagel: (72 x 30) ÷ 100 = 21.6
Wheat bread: (71 x 10) ÷ 100 = 7.1

Values for a quick reference of GI and GL are as follows:
Glycemic Index (GI): LOW = 55 or less MEDIUM = 56 to 69 HIGH = 70 or more
Glycemic Load (GL): LOW = 10 or less MEDIUM = 11 to 19 HIGH = 20 or more

Aging Considerations

With the aging process, our muscles slowly forget how to take up sugar, while our fat cells become more and more proficient; yes, a sad truth. Along the entire length of muscle tissue fibers, there are what are known as "***Insulin Receptor Sites***". These receptor sites are similar to "doors" that must be opened to allow the passage of blood glucose into the cells. When muscles are sedentary they require very little blood glucose, and, after prolonged sedentary periods, these doors are not actively functioning as they should be.

Too many carbs in the diet of an aging sedentary individual, whose receptor sites are not functioning well, results in increased fat stores. This is because the insulin carried glucose (carbs) bypasses the non-functioning receptor sites and moves directly on to storage in fat cells. Replacing some dietary carbohydrates with proteins in this instance is beneficial because the aging body's conversion of ingested protein to glucose is so slow that the resulting sugar is not as readily deposited in fat cells. As earlier mentioned, some carbs should always remain in the diet for brain function.

Exercise depletes muscle energy (glycogen), requiring these "receptor sites" to open during recovery, allowing for glucose uptake. This keeps the muscle fibers and these receptor sites active and functional regardless of age. This results in the muscles' continued ability to maintain functional receptor sites, and prevent the wasting of tissue. For the sedentary elderly individual to engage in a low to moderate amount of resistance exercise may be productive in "re-educating" receptor sites, resulting in the more efficient uptake of blood glucose by the muscles. This results in a more favorable body composition and a host of general health benefits in the elderly.

Fats

Advise your client to consult with the appropriate health professional concerning saturated fats and cholesterols, which are typically found in all foods of animal origin, including dairy products, red meats and cooking oils. Of course, fast foods, fried foods, 'junk' foods are the biggest culprit for fat sources. Heredity and/or over-consumption are two basic factors that contribute to high cholesterol levels (>180 mg/dcl)

Heredity

Since there was very little cholesterol in the diet long ago, the human body relied on the liver to make its own cholesterol. Tendencies toward high cholesterol production in the liver can be passed from generation to generation as genetic traits. Cholesterol, however, is essential for the production of hormones and for the repair of certain body tissues. When hormones are synthesized, LDLs (low density lipoproteins) and VLDLs (very low density lipoproteins) are needed. The HDLs (high density lipoproteins), or "good" cholesterols, are actually released from the liver into the blood to assist with the removal of excess "bad" LDLs and VLDLs.

Simply put, in the case of inherited problems, the liver overproduces cholesterol. It is not surprising then that we encourage those with an inherited cholesterol overproduction problem to perform resistance exercise, as exercise has a positive effect on cholesterol levels. HDLs attract and eliminate the excess LDL and VLDL cholesterols from the bloodstream. Simply cutting down on dietary intake, for those with an inherited cholesterol over-production problem, may not, by itself, have an optimal effect - and in comes exercise.

Over-Consumption

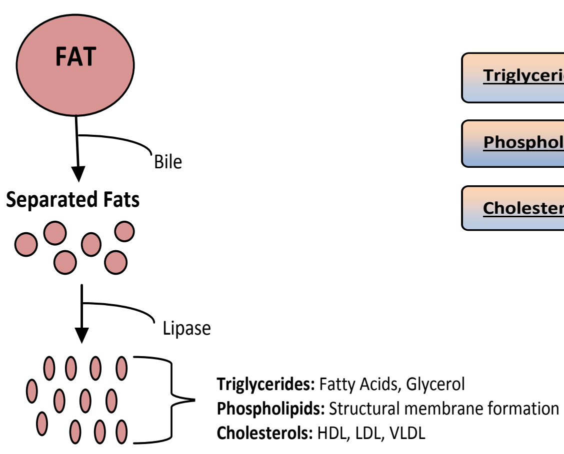
The other cause of high cholesterol is simply due to over-consumption, which is easily determined in your preliminary dietary review. If the client's food selection consists of considerable saturated fats, you may recommend he or she see the appropriate health care professional and/or have a complete blood profile performed with special emphasis on their total serum cholesterol as well as their LDL cholesterol.

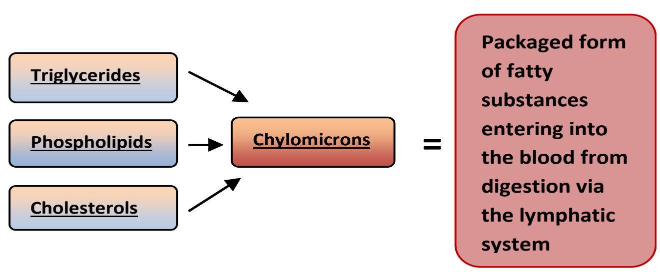
It is very important that the client know it is not simply the total serum cholesterol being too high that represents a problem; the LDL cholesterol level is a major concern as well.

The Mechanisms of Fat Metabolism

Ingested fats travel through the stomach and into the small intestine. There they are emulsified by bile and broken down by ***lipolytic enzymes***. Ingested fats are broken down by these enzymes into ***phospholipids***, triglycerides, and cholesterols. These are then packaged back into tiny fat particles called ***chylomicrons.*** Chylomicrons are lipoproteins made up mostly of fat particles, and only a small amount of protein. Chylomicrons provide for fat transport from the small intestine directly into the bloodstream by way of the lymphatic system. They are taken up by adipose (fat) tissue or by the liver where they are broken back down into phospholipids, triglycerides, LDL and VLDL cholesterols. It is interesting to note that the ingested LDLs and VLDLs are exactly the same as those cholesterols made by the liver.

The phospholipids are released into the blood for transport to cells for structural membrane formation. Some of the triglycerides are broken down into fatty acids and glycerol. Fatty acids, which are an abundant source of energy during both low level and “steady state” aerobic activity, are released into the blood. Glycerol is converted to glucose and either stored as glycogen, or released into the blood as well. Remaining triglycerides are either stored in the liver, released into the blood for storage in adipose tissue, or possibly collected in the interstitial spaces (compartments surrounding muscle fibers) for adaptive purposes. The LDL and VLDL cholesterols are released into the blood and, in excess, are responsible for plaque formation in cardiovascular tissue contributing to cardiovascular diseases.



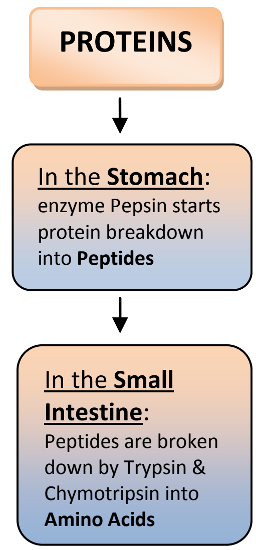


Protein

The Mechanisms of Protein Metabolism

The body has the life sustaining ability to transform ingested proteins into living body tissues through a series of metabolic processes.

When a protein is ingested, it moves to the stomach where it is acted on by the enzyme, pepsin. Pepsin breaks down proteins into smaller proteins (***peptides***). From the stomach, peptides are moved to the small intestine where they are broken down further by the proteases, trypsin, and chymotrypsin, into individual amino acids and absorbable peptides.



Complete proteins require ingestion every 3 to 4 hours to ensure the availability of all possible combinations of amino acids for cellular uptake. In this amount of time, 20 grams of protein can be assimilated. Since the body cannot store individual amino acids, they are collected and exchanged in the liver, blood, and interstitial spaces (spaces surrounding individual muscle fibers). Amino acids cannot be used for cellular protein synthesis until all of the right combinations are present at once. If the missing amino acids are not provided within 3 to 4 hours, the existing amino acids are deaminated and are no longer useful for protein synthesis. The limiting factor in oxidizing amino acids is the need to first remove the amino group (deamination).

The liver uses amino acids to build and store catabolic enzymes as well, for their release during times of physical stress. The liver also builds blood proteins using amino acids. When the diet is insufficient in carbohydrates, amino acids are deaminated by liver enzymes and used to produce glucose energy with a toxic by-product of ammonia. Ammonia is further broken down by the liver into urea, and excreted in the urine.

The amino acid deamination is identical to the gluconeogenesis process and usually occurs during strict dieting, over-exertion, and/or while on a very high protein diet. This process is obviously undesirable because amino acids should be spared to rebuild tissues and make structural repairs. The most effective way of sparing amino acids for this purpose is to ensure the ingestion of sufficient amounts of carbohydrates to provide for imposed energy needs. It is important to note that excessive protein intakes have been shown to be unhealthy for those people with existing kidney or liver disease. However, there is currently no evidence to indicate that liver and/or kidney disease will be the result in the apparently healthy strength training adult on a moderately high protein intake.

Protein catabolism

While the contribution of protein to the total energy supply is small under normal conditions (less than 5%), the importance is increased (up to 10%) during starvation or under low glycogen supplies. The acceptor of the amino group is usually a keto acid, which then becomes an amino acid. This process is known as transamination. An amino acid may enter the metabolic processes as either acetyl coenzyme (Acetyl CoA) or ***pyruvate***.

Cellular Uptake of Amino Acids

Once amino acids have been taken up into the muscle, there are two basic cellular functions that they are called upon to perform. The first, and most vital function, is to become cellular ***catalysts***. These catalysts perform cellular work, and the rate of their depletion is directly related to the amount and duration of cellular work performed. Without catalysts, the muscle fiber would no longer function. For this reason, catalyst replenishment takes precedence over repairing tissue. Once catalysts have been repleted, the second basic cellular function is performed, protein synthesis (repairing and building tissues).

If the duration of intense exercise is too great, catalysts are depleted and must be replaced immediately in order for them to perform survival functions. The absorbed amino acids intended for protein synthesis are the first to be converted into catalysts. If there are insufficient amino acids present, the muscle tissue itself is used for catalyst synthesis. This constitutes overtraining and is obviously undesirable. The simplest way for your client to avoid this type of "catalyst depletion" when overtraining is to consume meals rich in carbohydrates to include 20+ grams of protein every 3 to 4 hours.

Since the body prefers to use carbohydrates for energy, ensure that the client is consuming an adequate amount of carbohydrates. Always be sure to set up a routine for your client that is not over-exertive so that there will be sufficient post-workout recovery catalysts and energy present to immediately initiate anabolism (growth and tissue repair) and to avoid continued catabolism (tissue breakdown). It is interesting to note that the individual amino acids Leucine, Isoleucine, and Valine make up almost 60% of all muscle tissue volume. They are believed, therefore, to be the primary amino acids that are most readily taken up and converted into catalysts, sparing other amino acids for protein synthesis and energy production.

2 Basic Functions of Amino Acids once taken up by Muscle Cells

1. **Catalyst Formation**
   - Most vital function; takes precedence over tissue repair
   - Catalysts perform cellular work; without them the muscle fiber would no longer function
2. **Protein Synthesis**
   - Repairing and building new tissue

In the next chapter, protein requirements and energy production are examined in more detail.

CHAPTER 7

Metabolic Pathways and Energy Production

All body tissues have structural and energy needs. This is to say that tissues not only need to produce energy to perform activity, but they also need building blocks (protein) for recovery and tissue repair.

Metabolic pathways, the body's energy requirements and production, are examined more closely in this chapter.

Body Tissue Protein Measurement

There is a method of exacting the amount of protein required by the individual, though more clinical and expensive than is traditionally required. Known as the ***Urinary Urea Nitrogen (UUN) test***, it is a method by which nitrogen can be measured in the urine. Since the majority of commonly ingested proteins are 16% nitrogen, that means that for every 100 grams of ingested dietary protein, about 16 grams are nitrogen. The simplest way of explaining the significance of this realization is to determine the amount of your ingested nitrogen and then compare this to the amount of nitrogen excreted in the urine (through a UUN test). Most trainers, working with the general fitness population, will not go to the extent of the UUN test; but, it is still beneficial for you to understand what conclusions can be drawn from this comparison.

Lean tissue loss - If you are excreting more nitrogen than you are ingesting, you are losing lean weight and other body proteins (negative nitrogen balance).

Lean tissue maintenance - If you are excreting an amount of nitrogen comparable to the amount ingested, you are allowing for tissue maintenance but not growth (nitrogen balance or equilibrium).

Lean tissue increase - If you are excreting less nitrogen than you are ingesting, you are providing the materials with which to build lean tissue (positive nitrogen balance).

Now then, let's address whether or not a person's need for protein increases in the strength training athlete.

A note about *low* protein intake - As previously discussed, too little protein intake, in conjunction with the performance of adequate and proper strength training, will result in a detectable negative nitrogen balance. Slightly increasing dietary protein, while monitoring nitrogen balance, would allow one to arrive at his or her safe protein needs. Keep in mind, these needs vary based on changes in training intensity and resistance used. Heavy intense training causes more muscle damage than light, high rep training, therefore requiring more protein for repair.

A note about *high* protein intake - Too much protein intake may cause you problems, and even more so if you have an existing liver or kidney disorder. The excess ingested protein, over and above the body's needs, must be broken down by the liver to be used for energy (deamination). When deamination occurs, toxins derived from this excess ingested protein may compound any existing liver and/or kidney damage. On a high protein diet, excessive urea (the main nitrogen-containing compound) can be found in the urine. This indicates that protein ingestion is far too high.

In summary, everyone has differing genetic protein needs, and different training methods have differing protein demands. For the purpose of this manual, we will look at protein requirements strictly for the purpose of a broader understanding as well as for the purpose of establishing a reference point from which to make changes. The only way to nail down the specific protein requirement, or any related controversy thereof, is through a clinical nitrogen detection study, UUN test.

Body Tissue Energy Production

In this section let's look at how body tissues convert nutrients into energy. Adenosine Triphosphate (ATP) is the basic energy currency in most living organisms. It is an Adenosine molecule with 3 phosphate groups connected to each other. This molecule contains a very high energy bond between the second and third phosphates. An adenosine with 2 phosphates is known as an ***Adenosine Diphosphate (ADP)*** - the energy between the first and second is much less, thus an ADP is usually regenerated into an ATP.

It is important to know that muscle contraction requires that ATP be present, as it is the 'energy currency' of our body - but, the origin of ATP varies greatly. Breakdown of the macro-nutrients (catabolism) produces ATP. ATP is the only form of energy muscles can use. ATP is already synthesized and stored in the tissue cells so that you can perform immediate strenuous work (such as picking up a heavy object or walking up a flight of stairs). The following events occur in the cell to produce ATP energy:

First, there are about 4 seconds worth of ATP already stored in the working muscle cells. After this period of sustained muscle contractions, ATP in the working muscle is exhausted and the cells resort to the use of ***Creatine Phosphate*** and ADP to create more ATP, providing energy for about another 25-30 seconds. The cell has a total combined storage of energy available to last up to about 30-35 seconds during sustained muscle contraction before the cell must resort to the conversion and use of stored muscle glycogen.

When energy is needed for longer than 30-35 seconds, stored muscle glycogen is broken down into Pyruvate and Lactic Acid to produce new ATP. During slightly longer periods, oxygen acquired from the blood assists Pyruvate and Lactic Acid in creating ATP (sometimes referred to as ***metabolic oxidation***). These energy pathways are common in continuous tension resistance exercise and during the performance of strenuous work.

Muscle Glycogen: The chief carbohydrate storage form of glucose

Pyruvate: Converted form of intracellular glucose used for producing ATP energy with oxygen

Anaerobic Glycolysis:
The process of taking energy from storage (carbohydrates) and transforming it into an immediately usable energy form (ATP) when there is an absence of oxygen (i.e. oxygen is not available to 'accept' electrons). During anaerobic glycolysis, pyruvic acid is the electron receptor; once received, it converts to lactate. This process only provides an effective means of energy production during short, intense exercise, providing energy for a period ranging from 10 seconds to 2 minutes
****Lactic Acid build up occurs***

Also, in resistance exercise, oxygen transport into the working muscles during a set (continuous tension) is limited based on the amount of time the muscle is contracted compared to the amount of time the muscle is in a relaxed state. When the muscle is in a contracted state, nothing can get in or out of the cells, including oxygen. During these contractions, the muscle cell membrane is said to be impermeable. Therefore, the amount of work that can be performed during prolonged sustained contraction is limited in part by the amount of intracellular energy stored in the muscle at the onset of contraction. This production of ATP in the absence of oxygen is known as ***anaerobic glycolysis***. When contractions include brief periods of relaxation between them, oxygen can be taken up from outside the cell, assisting pyruvate in producing more ATP energy. This relaxation

period slightly increases the duration of the contractions because it allows for partial recovery. Also, both oxygen uptake and waste removal during relaxation act to convert or remove the unused accumulated fuel, lactic acid, that builds up quickly as a result of anaerobic glycolysis. Since lactic acid accumulation inhibits the contraction of a muscle fiber, the contractions are prolonged. This occurs because the muscle fails as it tires, causing the speed of the contraction to slow down. This prolongs the amount of time that the muscle isn't allowing fluids in or out, further exhausting it. That is why, when training to failure, the initial reps look easy and then, all of a sudden, the last reps are very slow and an immediate failure occurs.
Slower rep speed = more time under tension.

There are a variety of ways to apply the rest-pause method. If the goal is to move heavy weights for higher reps then you can actually put the weight down, count 10-15 seconds, do a few more reps, then repeat. For a set of curls, for example, use a weight that you can complete 6 hard, strict form reps (not to failure) then put the weight down in an easily accessible place (like a rack or bench). Rest 10-15 seconds, do 2-4 more, rest again and then continue until you perform 12-15 total reps. Once you can do 9 or more reps in the first segment, then raise the weight 3-5 pounds in the next workout. For squats or push-ups, perform 10-20 repetitions, full range, with a 2 second pause at the top. Perform another 10 reps at ¾ depth, with a slight pause, and finally, further shorten the range and lower or remove the weight for another 10 reps. There are limitless ways to apply this method and it can be done with any exercise.

With relaxation pauses, ATP is produced from pyruvate. Remember, pyruvate is the end product of glycolysis in the presence of oxygen. The process, in which chemical energy is made available for ATP synthesis, is known as metabolic oxidation. Since the heart and lungs are somewhat slow in delivering oxygen during the onset of aerobic activity, the pyruvate is used for energy until the heart and lungs catch up and can keep up with the oxygen demand. The rate of breathing is extremely labored at the onset of aerobic exercise because the heart is not yet beating fast enough nor are the blood vessels dilated sufficiently to provide an adequate volume of oxygenated blood to the working muscles. The lungs compensate until the heart and blood vessels catch up. Once the heart and cardiorespiratory system catch up and provides sufficient oxygenated blood, respiration decreases because needed oxygen is present. This occurrence is most commonly referred to as "catching your second wind". This occurrence indicates that the majority of energy provided to produce ATP is coming from an aerobic mix of oxygen, glucose, AND Fatty Acids. The simple logic is that fatty acids require large amounts of oxygen before they can be efficiently used for ATP energy production. These large amounts of oxygen are provided only through the increased cardiorespiratory activity accompanying aerobics. Simply put, during the performance of aerobic activity, increasing amounts of fatty acids and oxygen are used for ATP production. This form of ATP production is called Aerobic Metabolism and will rarely, if ever, occur during the proper performance of weight resistance exercise.

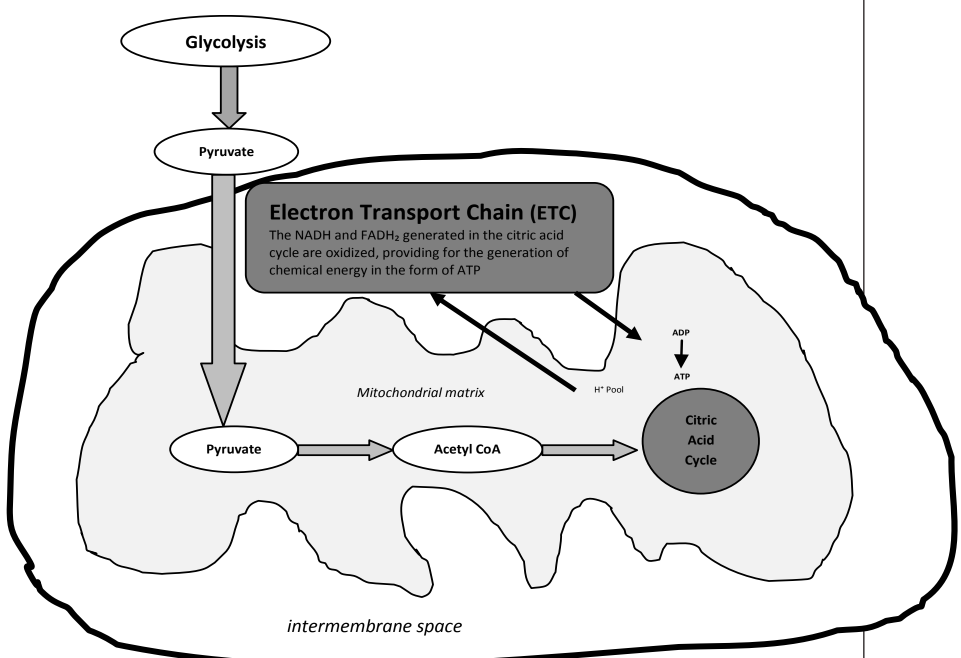
Metabolic Oxidation:
Chemical energy made available for synthesis of ATP as one atom becomes oxidized (by 'donating' electrons) and another atom becomes reduced (by accepting electrons)

Aerobic vs Anaerobic Pathways

While it is not the focus of this chapter to fully cover metabolic pathways, an overview is provided. The three macro-nutrients all contribute to muscle fuel; however, the main contributors of fuel are carbohydrates and fats. While glucose ***hydrolysis*** is strictly anaerobic, and fat metabolism is strictly aerobic, carbohydrates can be oxidized in aerobic metabolism, or used in anaerobic glycolysis with lactate being the byproduct. Glucose is converted into two different three carbon molecules that are involved in glycolysis, or the metabolic pathway that converts glucose to pyruvate. This three carbon molecule is known as the key intermediate because it can come from protein catabolism. After deamination, it comes from glucose, which may result in lactate production. Lactate is converted to pyruvate in the liver. Again remember that, pyruvate, the base of pyruvic acid, is a key intersection to metabolism - it can be made from glucose (through glycolysis) or converted back to carbohydrates, glucose (through gluconeogenesis). It is important to remember that glucose starts glycolysis but pyruvate ends it. Pyruvate can also be converted to fatty acids through acetyl coenzyme (Acetyl CoA). ***Pyruvic acid produces lactic acid when oxygen is lacking (anaerobic), and supplies energy to cells when oxygen is present (during aerobic metabolism)***. Its energy provision is accomplished during the citric acid cycle.

Aerobic Metabolism
Also called aerobic or cell respiration, this process extracts energy from carbohydrates, fats and proteins; unlike anaerobic glycolysis which only extracts from carbohydrates. Once the compound pyruvate has been broken down in glycolysis, it enters the mitochondria and is oxidized by the citric acid cycle. The products of this process are carbon dioxide and water, which creates an energy transfer that is used to break ADP bonds so that the third phosphate group can be used/added to form ATP.

Oxidative Phosphorylation: the metabolic pathway, occurring in the electron transport chain, where energy that is released by the oxidation of chemical compounds generated in the citric acid cycle are used to reform ATP

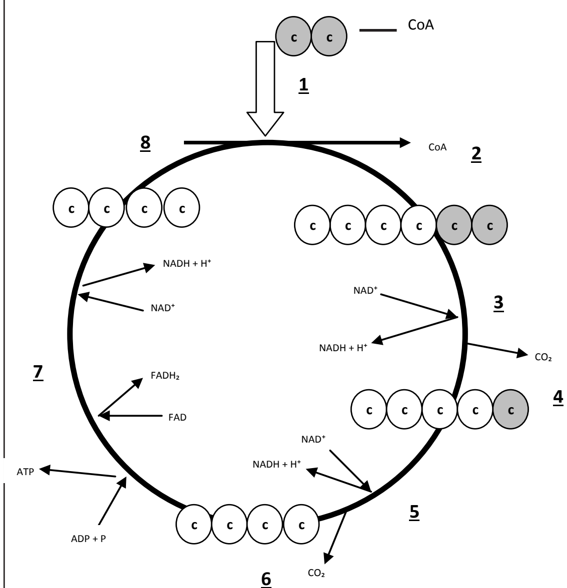


Mitochondria

The Cycle of Events: Citric Acid Cycle

The citric acid cycle makes up all the processes that are involved in the metabolic chain of chemical reactions to generate energy in all aerobic organisms. Occurring in the mitochondria as a specific energy production function of the cell, this process can only occur after Acetyl CoA is generated from glycolysis. The process begins with proteins, carbohydrates and fats converted into chemical energy in the form of ATP. This cycle is also known as the

Krebs Cycle, named after a British biochemist, Hans Krebs, who identified it in 1937. The diagram below is a simplistic rendition of one 'turn' of the Krebs cycle. It illustrates the removal of CO_2 (Carbon Dioxide) and the synthesis of 3 NADH (Nicotinamide Adenine Dinucleotide + Hydrogen), 1 $FADH_2$ (Flavin Adenine Dinucleotide + 2 Hydrogen) and 1 ATP. At this fundamental level it is not required to be familiar with these individual molecular elements and/or each step of the citric acid cycle. However, a basic understanding of this naturally occurring energy generating process is important.



<u>Citric Acid Cycle: an 8 step summary</u>:

<u>1</u>: The coenzyme Acetyl CoA enters the cycle in the mitochondrion, carrying the last 2 carbon (2C) molecules from the original glucose

<u>2</u>: Acetyl CoA looks for another 2C molecule coming from glycolysis and joins the 2C molecule to a 4C, making a 6C molecule

<u>3</u>: 2 Hydrogen and energized electrons are removed from the 2C molecule

<u>4</u>: 1 Carbon is removed as CO_2 - only 1 carbon from original glucose remains

<u>5</u>: 2 Hydrogen and energized electrons are removed from the 2C molecule

<u>6</u>: 1 Carbon is removed as CO_2 - none of the original glucose remains; ATP is produced by substrate level ATP synthesis

<u>7</u>: The 4C carrier molecule rearranges before it picks up the next Acetyl CoA; in doing so, it provides Hydrogen atoms and energized electrons to make 1 NADH and 1 $FADH_2$

<u>8</u>: Acetyl CoA gives the 2C molecule to a 4C molecule, making a 6C molecule

Fat Oxidation in Aerobic Metabolism

The most efficient fuel source in the body is fat. This is not necessarily a good thing since now days we are taking in much more 'fuel' than we are expending, thus storing it as fat. The body is capable of storing very, very large amounts of fat, a single pound of fat supplies about 3500 calories. The fat (triglyceride) is first broken down, through a process called ***lipolysis***, to mobilize the free fatty acids from the glycerol backbone. The fatty acids are then taken into the muscle through a transport agent, called an acyl-carnitine transferase. The acyl-cartine transferase and fatty acids are broken down by splitting them in the mitochondria into two carbon units, Acetyl CoA and Acyl CoA (fatty acid chain); this continues to occur repeatedly until no more splits can be made – it is the process known as ***beta oxidation***. Basically, beta oxidation is the use of oxygen to break down fat cells for producing ATP, energy, in aerobic conditioning. In a summary of events, fatty acids are converted into Acetyl CoA by beta oxidation and carbohydrates are converted into Acetyl CoA through glycolysis. In both cases, these molecules are converted for entry into the citric acid cycle.

Well trained endurance athletes can dramatically increase the mitochondrial enzyme quantity, thus increasing the amount of oxygen utilized. Since the objective of the endurance athlete is to go as fast as possible for as long as possible, the athlete should operate right on the edge of the anaerobic threshold and not accumulate too much lactic acid; sparing the all important carbohydrate sources.

Activation of Catabolism

Always remember that metabolism is controlled by enzymes. Catabolism is the stage of metabolism when activity is being performed that causes damage to cells that will later need repaired. Since enzymes are frequently controlled by hormones, our body's chemical messengers, they can initiate the activation of enzymes for the mobilization of fuels, catabolism. Usually hormones are released due to biofeedback from sensors (receptors) which monitor the physiological status. There are 3 means by which the mobilization of catabolism occur:

1) via intramuscular factors
2) from sympathetic nervous system activation
3) hormone activation of enzymes

This system is regulated by a negative feedback loop. Basically, if there is not enough of a certain substance, then things get turned on (e.g. the 'cannibalism' of amino acids, blood proteins, organ and muscle tissues for energy). If there is enough of a given substance, things get turned off.

Roles of Hormones in Energy Metabolism

The hormones that are important for metabolism are epinephrine, glucagon, ***cortisol***, insulin, and ***growth hormone***. Norepinephrine also has a role through nervous system activation. Norepinephrine and epinephrine, also known as noradrenaline and adrenaline because they are secreted by the adrenal gland, are among the most prominent of the catecholamines, along with dopamine, which are hormones and neurotransmitters that contain one amino group. These catecholamines, norepinephrine and epinephrine, are part of the "flight or fight" response. The hormones epinephrine, glucagon, cortisol and growth hormones act on Hormone Sensitive Lipase which causes the triacylglycerol to be split into glycerol and 3 fatty acids. The fatty acids then enter the blood stream and go through the beta oxidation process. These same hormones may also increase carbohydrate catabolic processes, but tend to be more specialized in their effect.

Remember, the body has several ways to deliver glucose, or pyruvate, to the muscle site:

1) Breakdown of Glycogen to Glucose
2) Protein breakdown and gluconeogenesis
3) Delivery of blood glucose to muscle site

Exercise plays a big part in both stimulating cortisol secretion, and glycogen breakdown in the liver, as well as lipolysis in adipose tissue. Growth hormone (GH), also called somatotropin or somatropin, raises the concentration of glucose and fatty acids and stimulates growth via cell reproduction. GH and cortisol are both stress hormones. Growth hormone is released from the anterior pituitary, and cortisol is released from the adrenal cortex. Thus, various central nervous system organs play key roles in energy production and the homeostasis of our metabolism.

The primary two hormones in normal metabolism (resting and light activity) are insulin and glucagon, both pancreatic hormones. Both of these hormones act on all three macro-nutrients, and affect the liver functions in several ways. Insulin serves to promote anabolism and inhibit catabolism. Insulin is released from the beta cells of the Islets of Langerhans in the pancreas. Glucagon, is the main catabolic hormone, and, when secreted, will inhibit anabolic processes.

Fuel Usage vs. Exercise Duration

As exercise intensity increases, the amount of fat being used for energy decreases. In fact, if you were to sit around the house and read this manual you would be using almost all fat for energy. But of course this does not mean that you will get skinny reading this manual several times over just because you are burning fat more than any other source for fuel/energy. The correlation between fuel source and fat loss is found in how long and hard you exercise (i.e. how many calories you burn during exercise and how long you keep your metabolism elevated afterward). The more intense the exercise the more carbohydrate (glucose) is used as a fuel source. Ultimately, with an increase in intensity, more calories are being burned (subsequently, more calories from fat) and the longer the body's metabolism is elevated during recovery (given a certain minimum duration, at least 30 minutes). Generally speaking, the fat loss client should not worry about a 'fat burning zone'; they should worry about the number of calories that they can burn with gradual increases in training intensity from a training program that is consistent. For the beginner fat loss client, lower intensity, longer duration is a good starting place for initial 'fat conversion', but increases in intensity should ultimately follow. Continuing to use low intensity activity (under 60% of max heart rate) consistently for 3 months, for example, won't continue to yield the fat loss effect in month 3 that it did in month 1. Steady state cardio produces fat loss in the beginning and is a training method that, for the beginner, provides the desired 'fat conversion' effect, and feels more comfortable and achievable; but the body will adapt and will require an increase in training intensity to achieve continuous results. Cardio conditioning is important, and it yields many benefits including initial fat loss and weight maintenance, improved aerobic fitness, improved endurance to maintain activities longer, and an overall benefit to mental and physical well being. However, for the fat loss client, it is important to also use resistance exercise with a focus on gradual increases in intensity, even more-so than a focus on duration (but this does not mean that it is okay to speed through an intense workout). The intensity level should be performed purposefully and with the ability to accomplish the exercise in strict form, for whatever the duration of the workout may be. The safe way is also the effective way.

The body actually has an "optimum duration" of about 90 minutes at 60% intensity; which is the body's window for burning calories from fat without burning muscle. Conversely, the shorter the workout (i.e. 15-30 min), even at a high intensity, the greater amount of muscle glycogen that is being utilized as fuel, because the fat metabolism has not been fully activated. Ultimately, especially for the beginner, performing a longer duration workout (60-90 minutes), at a 60-75% aerobic intensity level, results in a greater actual fat burning effect. Use the Karvonen formula to monitor Exercise Heart Rate at 60% intensity. This allows adjustments to be made as there are improvements to aerobic fitness.

VO_2Max Applied

The maximum amount of oxygen that the body can use during exercise is referred to as VO_2Max which stands for (V) Volume and (O_2Max) Oxygen Maximum. Specifically, VO_2 is the product of the a-VO_2 difference and maximal cardiac output, allowing for a quantified measurement of the ability to uptake oxygen and deliver it to muscles. Ultimately, it is indicative of the body's ability to generate ATP (the energy source that keeps your muscles working while you exercise) and, as such, acts as a measurable assessment of cardiorespiratory condition (aerobic fitness). It can be calculated in a number of different ways, with standard outcome values measured in milliliters of oxygen used in one minute per kilogram of body weight. The efficiency in our individual consumption and use of oxygen will fluctuate based on gender, age, fitness level (and even altitude). In this manual, we are looking at VO_2Max as a measure of aerobic fitness, but it is sometimes used to determine/ maintain an aerobic training intensity. **NOTE: VO_2Max is an advanced assessment for making these determinations. Only use VO_2Max to determine aerobic fitness/intensity for physically fit and/or athletic clients. For beginners and the general client population, use the standard *3 Minute Step Test***, it is a more practical method for establishing aerobic fitness that does not push your client to a max and lessens risk of injury. (*see page 227*).

As expected, a professional endurance athlete will have a high VO_2Max by comparison to the average person. This is demonstrated in the amount of energy that the elite marathon runner has, for example, to run the long distance race. They are able to use more oxygen and therefore able to produce more ATP (energy) to sustain the event. Though VO_2Max can vary greatly between the sedentary individual and the athlete, it is generally found that a sedentary client, with no health issues, will gain an approximate 10-15% improvement in VO_2Max, within about 2-3 months of regular endurance training. Note that VO_2Max effort can be measured using a treadmill with a specific protocol that correlates speed and intensity with the volume and concentration of oxygen inhaled and exhaled in specific time intervals. Here is one method for calculating VO_2Max for your fit and/or athletic clients:

Calculating VO_2Max

VO_2Max can be calculated using an equation that factors in body weight, heart rate and a one mile jog (George, J.D. et al. 1993). Here are 4 easy-to-apply steps for this calculation:

1- have your client do a 2 minute warm up and then jog, at a steady pace, for one mile. Record their time (e.g. 10 minutes and 34 seconds would be 10.57 when plugging into the equation)

2- take your client's heart rate (HR) at the end of the mile. Record their heart rate in BPM

3- determine your client's weight in kilograms (which is weight, in pounds, divided by 2.2)

4- enter the numbers into the equation for male or female (note: only the first variable is different: 108.844 (male) vs. 100.5 (female))

Male: 108.844 - (weight in kg x 0.1636) - (time for one mile x 1.438) - (HR at end of mile x 0.1928)

AGE	POOR	FAIR	GOOD	EXCELLENT	SUPERIOR
20-29	<42	42-45	46-50	51-55	>55
30-39	<41	41-43	44-47	48-53	>53
40-49	<38	38-41	42-45	46-52	>52
50-59	<35	35-37	38-42	43-49	>49
60-69	<31	31-34	35-38	39-45	>45
70-79	<28	28-30	31-35	36-41	>41

The Cooper Institute for Aerobics Research, 2005 *values in ml/kg/min

Female: 100.5- (weight in kg x 0.1636) - (time for one mile x 1.438) - (HR at end of mile x 0.1928)

AGE	POOR	FAIR	GOOD	EXCELLENT	SUPERIOR
20-29	<36	36-39	40-43	44-49	>49
30-39	<34	34-36	37-40	41-45	>45
40-49	<32	32-34	35-38	39-44	>44
50-59	<25	25-28	29-30	31-34	>34
60-69	<26	26-28	29-31	32-35	>35
70-79	<24	24-26	27-29	30-35	>35

The Cooper Institute for Aerobics Research, 2005 *values in ml/kg/min

EXAMPLE:

You have a healthy 32 year old male client who weighs 170 lbs, jogs the mile in 12 min 15 sec, and has a heart rate at the end of his jog of 165 BPM. Calculate his VO_2Max and assess his aerobic fitness using the respective data table. **For Male: 108.844 - (weight in kg x 0.1636) - (time for one mile x 1.438) - (HR at end of mile x 0.1928)*

Enter in Values and Calculate:
weight in kg = weight in pounds times .453592
= 170 x .453592
= 77.111

1 pound (lb) = .453592 kilograms
\# of lbs x .453592 = # of kg

Time for one mile = 12.25
Heart rate at the end of mile = 165 beats per minute (BPM)

His VO_2Max = 108.844 - (77.111 x 0.1636) - (12.25 x 1.438) - (165 x 0.1928)
= 108.844 - 12.615 - 17.616 - 31.812
= 46.801
His VO_2Max = 47 (rounded to nearest whole number)

AGE	POOR	FAIR	GOOD	EXCELLENT	SUPERIOR
30-39	<41	41-43	**44-47**	48-53	>53

Your client, in this example, displays 'good' aerobic fitness, based on the data table **for VO_2Max assessment**. The VO_2Max value provides a base aerobic fitness level. We will use the Karvonen formula to maintain an aerobic intensity.

The Karvonen formula is the standard method for determining Exercise Target Heart Rate <u>at any given intensity</u>. A start at an intensity of 60% is an effective base to build from for an apparently healthy, beginner client that is in average to good aerobic fitness condition. Of course, the intensity level variable may change depending on your client's aerobic fitness assessment and goals. Adjust the Karvonen calculation accordingly. For example, if your client is in poor or below average aerobic condition, then start out at 40-50% intensity, respectively, when calculating their Exercise Target Heart Rate with the Karvonen formula. As VO_2Max/aerobic fitness capacity improves, use the Karvonen formula to make adjustments for gradual increases in aerobic intensity. This formula allows you to monitor the intensity of the client in order to keep them at their respective intensity level and to systematically make adjustments as their aerobic fitness improves. Here is how to use the Karvonen formula to identify Target Exercise Heart Rate at a 60% aerobic intensity level:

<u>First</u>, find maximum heart rate (**MaxHR**) and resting heart rate (**RestHR**). When checking the pulse for heart rate, place your middle and index finger on the radial artery located on the inside of the wrist. The carotid artery can be used to check pulse, but the radial artery is best for the most consistently accurate reading. The best time for getting a resting heart rate is as soon as you wake up from a good sleep (ideally, without an alarm that startles you awake). As a trainer, unless your client is taking their own pulse in the morning, you will need to improvise by having your client get into as much of a resting state as possible. Have your client sit in a chair, feet on the floor and in a relaxed position for at least a couple of minutes before taking their pulse.

For RestHR, check pulse for 15 seconds and multiply by 4: **15 Second Pulse x 4 = RestHR**

The average adult heart beats about 60 to 100 times per minute, but this of course can fluctuate depending on factors like the client's current state of health or prescription drug use, such as a beta blocker. For example, the well conditioned athlete will have a resting heart rate of 40 to 60 beats per minute.

For MaxHR, use this formula: **208 - (0.7 x Age) = MaxHR**

In 2011, published in the Journal of the American College of Cardiology, research showed this equation (above) to be more accurate as compared to 220 - Age which was commonly used prior.

<u>Second</u>, use the <u>Karvonen Formula</u> to find the Target Exercise Heart Rate (ExHR):
RestHR + [Intensity Level x (MaxHR - RestHR)] = ExHR

At 60% intensity: **RestHR + [<u>0.60</u> x (MaxHR - RestHR)] = ExHR**

Adaptations in Energy Metabolism with Exercise Training

As someone gets into better aerobic condition, there are several changes that occur to promote fat utilization and minimize lactate accumulation. Mitochondrial numbers increase, as well as the enzyme content in them. The cross sectional area of red, slow twitch (Type I) fibers increase. This indicates the mitochondrial number, capillaries per muscle fiber and number of muscle fibers all increase. Additionally, intramuscular triacylglycerol content is enhanced in red, slow twitch fibers. At the same time, an attenuated (lower) hormonal response both decreases the amount of glycogen used and decreases blood glucose utilization. This is known as the "glycogen sparing effect".

Training for strength, power and speed doesn't affect the aerobic capacity but does cause specific adaptations in the ATP energy delivery systems. It increases the capacity to buffer against lactic acid, and provides for significant increases in strength or sprint performances. In addition, selective hypertrophy will occur in the white, fast twitch (Type IIb) fibers. The basics of this, if you want to go fast in the game, you need to go fast in training; if you want to go long in a race, you need to go long in your training.

Nutrient Review

Function of Nutrients:
Essential Nutrients for the Human Body
What determines the Recommended Amounts of Nutrients We Take?
Does the Quality of the Nutrient or Supplement Matter?
Supplements vs Real Food
What is a Balanced Diet and Why Worry about It?

A good place to always start is the beginning. So, when someone asks you, “what exactly is nutrition”?, it would be wise to have a correct definition on hand. Nutrition, basically, is the study of how food nourishes the body. This study includes components in the food that aid or alter our metabolic processes, the nature of absorption and utilization, and the effect of deficiencies of that nutrient on our state of health or in preventing a disease state.

The primary purpose of food is to provide energy, nutrients and water to the body. The two classes of nutrients are **macro-nutrients** and **micro-nutrients**. We need a lot of the macro-nutrients on a daily basis. These provide energy to our bodies. As previously discussed, Carbohydrates, Proteins, and Fats are the three types of macro-nutrients. Micro-nutrients are needed in small quantities and do not provide energy, but do provide essential nutrients. Vitamins, Minerals, and Water are the three types in this class. Phytochemicals occur naturally in plants (contributing to their color and smell) and have properties for disease prevention, immune system enhancement and defense mechanisms.

If a given nutrient is not synthesized by the body, and therefore has to come from a dietary source, and it is necessary for proper human function, that nutrient is called "essential". If the nutrient is missing from the diet and no adverse effects are noticed then it is "non-essential". Non-essential nutrients are just as important as essential nutrients, but they do not have to be part of the diet because they can be made by the body in sufficient amounts, and therefore do not require consumption. The table below provides a list of essential nutrients according to category. Note that all vitamins, and most minerals, are listed.

Essential Nutrients for the Human Body

Amino Acids	Fatty Acids	Electrolytes/ Minerals		Vitamins
Histidine	Linoleic acid	Sodium	Iodine	A,D,E & K
Isoleucine	α-Linolenic acid	Potassium	Iron	C (ascorbic acid)
Lysine		Chloride	Copper	B1 Thiamin
Methionine		Calcium	Chromium	B2 Riboflavin
Phenylalanine		Phosphorous	Selenium	B3 Niacin
Threonine		Magnesium	Zinc	B6 Pyridoxine
Tryptophan		Manganese		B12 Cobalamine
Valine		Molybdenum		Folic Acid
Leucine				Biotin
				Pantothenic Acid

What determines the recommended amounts of nutrients we take?

Many people do not realize how the dosage of a given vitamin or number of servings from each food group is determined. Nutritional science is relatively new and knowledge is gained from several types of studies including laboratory animals, epidemiological studies, intervention studies and even case studies. These studies basically examine the minimum amount of substance necessary to cause an adverse effect! This seems like a negative way to determine a proper dosage. However, it is the only way to determine if a nutrient is helpful to human health and how much is needed to prevent disease.

Now that nutritional science is maturing and the amount of public interest in it is HUGE, there are more guidelines and recommendations to obtain "optimal health", not just disease avoidance. The entire set of values for optimal health are known as the **Dietary Reference Intakes (DRI)**. This is used for planning and assessing diets and it consists of the following 4 values:

Recommended Daily Allowance (RDA): nutrient levels established by scientific studies for the recommended intake of vitamins and minerals, daily. It represents the amount needed to avoid disease or deficiency symptoms in 97.5% of the population.

Adequate Intakes (AI): basically the same as RDAs except less scientific studies have been done on the nutrients, so a slight amount of guesswork is used to establish recommendations.

Tolerable Upper Intake Levels (UL): suggested upper limits for potentially toxic nutrients. Intakes above recommendations are likely to cause illness from toxicity.

Estimated Average Requirements (EAR): population wide recommendations used in nutrition research and policy making, which are taken from the RDA. The EAR is the amount of a nutrient necessary to meet the need of 50% of the population, plus a margin of safety.

Two additional values are the **Daily Value (DV)** and the **Estimated Energy Requirement (EER)**. DVs are the nutrient standards used on food labels that describe nutrient levels. This value reflects the percentage of calories/nutrients the food provides based on daily requirements. Some labels will show both a 2000 Cal/day diet and a 2500 Cal/day diet. Estimated Energy Requirement is the portion of calories that the food provides for what someone needs in a day for maintaining an energy balance and level of physical activity consistent with good health.

Does the Quality of the Nutrient or Supplement Matter?

Many trainers will be connected to multi-level network marketing companies which all claim to have the "best quality products" which are "tested by our own scientific board" and the nutrients are "pharmaceutical grade". Though many manufacturers do test for quality, it is still important to be very careful of getting involved in selling supplements based on claims alone. Very generally speaking, your supplement company should be NSF GMP registered. This means the National Science Foundation (a government agency) has recognized the company as having "Good Manufacturing Practices".

"Good Manufacturing Practices are guidelines that provide a system of processes, procedures, and documentation to assure the product produced has the identity, strength, composition, quality, and purity that it is represented to possess."

- NSF, The Public Health and Safety Organization (www.nsf.org)

Another thing to determine in any supplement is the substance used ("vehicle") to bind the supplement for delivery and release in the body. The type of supplement varies greatly. There are those that are highly bio-available and readily enter the body's functioning system. Equally there are those that are not readily available and basically are eliminated with little to no absorption. Unfortunately, a strong background in biochemical nutrition is required to truly know which vehicle or formulation is better than another. When choosing a vitamin/mineral formulation it is usually best to choose one that is manufactured by a top NSF GMP registered company which consistently uses a particular formulation.

Watch out for nutritional companies that refer to their products as 'nutriceuticals'. The name nutriceutical was termed for the purpose of designating a given nutrient as being synergistically combined with other vitamins and minerals to perform a physiological function. In some cases, it may be a singular (stand alone) entity. While this term integrates the word pharmaceutical, and thus "medical drug", into its term, it in no way contains any known drug (it would need to be classified differently if it did)!

Supplements vs. Real Food

The old expression "It is not nice to fool with mother nature" was made famous by a margarine company which claimed its product to be so much like "natural butter" that it fooled even 'mother nature'. In the case of supplements, 'mother nature' isn't fooled. Getting your vitamins, minerals and phytochemicals from food sources wins out every time. NFPT officially supports the use of natural processes and advocates that you and your clients obtain nutrients from whole and, if possible, organic foods. NFPT does not advocate mega-doses of individual supplements and does not believe they advance athletic performance above and beyond what quality eating and training does. HOWEVER, we recognize the decline in the available nutritional value in 'real food'. This is the result of nutrient depletion in the soil, making whole foods less 'potent' than they ever have been before. Therefore, we cannot completely discount the value of good nutritional supplementation in these current times when nutrients are substituted and depreciated.

Often times, the most difficult thing for your client is trying to eat right. But, as you probably already know, a vitamin pill in a chocolate shake will NOT make everything okay, this is important for your clients to realize as well. Real fruits, vegetables, whole grains, beans, and lean meat, fish, or poultry is the way to go. Besides the obvious, vitamins and minerals in these foods also possess sugars, fiber, water, and phytochemicals - the value of which can't be substituted artificially.

NFPT recommends your client consult a Registered Dietitian (RD) to determine which supplement(s) can benefit them. Not all supplements are created equal; if recommended, look for supplements that have a third party purity certification.

What is a balanced diet, and why worry about It?

A balanced diet is one that has the right proportions of various macro- and micro-nutrients, and the variety is necessary to make sure no deficiencies exist for long. Each category has particular components that are necessary for certain bodily functions, and, by taking in a variety, one will ensure few to no deficiencies exist.

Carbohydrates - The brain requires glucose or ***ketones*** to function. Carbohydrate is the only fuel source that is catabolized without oxygen, and it is the fuel for fast action.

Protein - There are many things synthesized from proteins besides muscle tissue. Many bodily functions are coordinated by protein. Amino acids, which make up proteins, are the molecules of the three fuels containing nitrogen. Because nitrogen is critical for many molecules, protein or 9 different amino acids are also essential.

Fat - Not only do fats provide a significant portion of total calories, there are two fatty acids which are necessary for life processes, alpha-linolenic acid (an omega-3 fatty acid) and linoleic acid (an omega-6 fatty acid). Fats also perform many functions in the body and must be processed and transported differently due to their lipophilicity, or ability to dissolve in fats, oils and lipids.

Vitamins - Our bodies are able to perform the necessary functions for living because of the enzymes we possess. Enzymes are chemicals that have very specific functions, under specific physiological conditions, and only act on specific reactants to convert them into other substances. The enzymes can be uni- or bi-directional, and some enzymes are inducible, which means they are "turned on" because a certain reactant is present. Vitamins are often necessary for a certain enzyme to work effectively and are therefore known as cofactors or coenzymes. Thus, most vitamins are classified as "essential".

Minerals - Like vitamins, minerals are often necessary for proper enzyme functioning. In other cases, minerals may be key components in a given bodily material, like cartilage or finger nails.

A balanced diet is composed of all parts of the food pyramid, more recently dubbed the food 'plate', and in their proper ratios (see *Master Food List* and *Food Plate* guides). We strongly advice an emphasis on eating a good and healthy variety of foods that helps ensure that all vitamins and minerals are being taken in for the body's use where needed. It is important to note the body requires the moderation of a broad/balanced spectrum of nutrients as opposed to excessive doses of specific/individual nutrients. Finally, overindulgence can be combatted with proper portioning. The properties of a healthy diet are basically summed up as M.V.P.: Moderation, Variety, and Portion control. Remember the saying - "you can't out-exercise a bad diet"!

Nutrient Density vs Caloric Density: Getting the Good Stuff vs. Empty Calories
Two terms you should be familiar with to describe foods are **nutrient density** and **caloric density**. Density generally refers to something that is heavy for its size. Simply stated, it would sink in water quickly. Lead, and heavy metals have a high mass to volume ratio and are therefore quite dense. By the same token, foods with a high nutrient density indicates the food contains a high level of vitamins/minerals per caloric unit of that food. For example a piece of broccoli is loaded with vitamins and minerals and has very few calories. Thus, broccoli has a high nutrient density. A chocolate chip cookie has few vitamins and minerals and a high number of calories; thus it has a high caloric density.

Caloric density refers to the number of calories per weight of the food. The chocolate chip cookie, which does not weigh much and has a high number of calories, is high in caloric density. Some foods high in water, such as watermelon, are relatively heavy. They have few calories because the water contains no calories but contributes weight. Watermelon then has a low caloric density. Vegetables, in general, are one of the highest nutrient dense foods, with low caloric density. They are a good choice for any diet. The term "empty calories" refers to foods which have low nutrient density, and high caloric density. Generally, these foods contain processed carbohydrates and contain little or no nutritional value. A diet that is high in empty calorie foods, for an extended length of time, leads to nutrient deficiencies.

Vitamins and Minerals

The purpose and 'power' of vitamins and minerals is often very misunderstood. As mentioned, the purpose of vitamins and minerals is to aid enzyme function. Vitamins contain no calories. Thus, vitamins produce no energy (despite the claims of some manufacturers of energy drinks). Many vitamins and minerals actually act synergistically, both contributing a unique function which aids the other. Some vitamins are still under study as to the proper dosage for "optimum" function, but it is widely accepted that excess quantities do not enhance function. Think of pouring water into a glass. The proper amount of water fills the glass. An excess only spills over. The glass can't "accept" more water than it can hold. With some vitamins, excesses can cause toxicities. Minerals also act in this manner. Minerals must often share a particular transport system. If you "load up" on one type of mineral, another type may not "get a ride into the cell". This leads to mineral deficiency which leads to other health issues.

One of the unique things about vitamins is that they are all different chemical structures, and yet all are essential. As discussed, an "essential" nutrient is one that is not synthesized by the body, at least not in the quantities necessary to sustain life. They must be taken in through diet. Though there are instances in which an external stimulus, other than taking in food, also may initiate synthesis. For example, Vitamin D is also produced in the body as a result of skin contact with sunlight.

In general, our bodies must get the necessary vitamins and minerals through food. In our modern day, many people depend on supplements for an adequate supply of vitamins and minerals because of their poor dietary choices, lacking availability or both. The table to follow, "*Vitamins: An Overview*", is a quick reference for noting better ways that we can naturally receive what our body needs. This table provides a description of the role(s) that each vitamin plays in human physiology. It also describes the symptoms due to deficiency, as well as natural food sources.

Water and Fat Soluble Classifications

Remember, vitamins are known as micro-nutrients because they are not needed in large amounts. Vitamins are either complete organic compounds or contain carbon as part of their molecular structure. Vitamins are designated by alpha/numeric characters (e.g. Vitamin B-6) and by class. In general, vitamins serve multiple functions. Several, however, have highly specialized functions. Vitamins are classified as either water or fat soluble. They either combine with hydrophilic (water-based) environments or hydrophobic (fat-based) environments. Water soluble vitamins will not "last as long" in storage as fat soluble ones. Therefore, the risk of over-dose or toxic build up of water soluble vitamins is rare. Fat soluble vitamins are: A, D, E and K; water soluble are: B-complex and C.

VITAMINS: AN OVERVIEW

VITAMINS	CHIEF FUNCTIONS	DEFICIENCY SYMPTOMS	SOURCES
Fat Soluble			
Vitamin A - retinol (beta-carotene)	Eyesight, epithelial tissues (i.e. skin, linings)	Night blindness, xerophthalmia (dry eyes)	Orange foods, spinach, beef liver, milk
Vitamin D - calciferol (skin converts)	Bone Health, Calcium absorption	Bone softening: Rickets (in kids), osteomalacia (in adults)	Salmon, shrimp, milk
Vitamin E - alpha-tocopherol	Antioxidant, protects white blood cells, Vit A	Red blood cell hemolysis- cell breaks, liver & gallbladder complications, viral diseases	Safflower, canola oils, sunflower seeds, wheat germ
Vitamin K - menadione (bacterial produced)	Clotting	Uncontrolled bleeding	Mostly synthesized by colonic bacteria. Diet sources: leafy greens
Water Soluble			
Vitamin B1 - thiamin	Energy metabolism, nerve and muscle health	Beriberi (effects of the cardio and nervous systems, includes: weakness, weight loss, emotional and sensory impairment), ***Edema***	Spinach, peas, ham, pork, watermelon, black beans
Vitamin B2 - riboflavin	Energy metabolism	Lack of flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD)	Spinach, milk, yogurt, egg, liver, clams, mushrooms
Vitamin B3 - niacin (tryptophan)	Energy metabolism	Pellagra (diarrhea, dermatitis, dementia and/or death)	Shrimp, chicken breast, cod, tuna, spinach, mushrooms
Vitamin B6 (Pryridoxine)	Energy metabolism, hemoglobin, neurotransmitters, helps immune and steroid functions	irritability, neurological symptoms, seizures	Sweet/ baked potato, chicken, beef, banana
Vitamin B12 (cobalamin)	New cell, nerve cell health (needs intrinsic factor)	Anemia, fatigue	Cheeses, seafood, meats
Vitamin C (ascorbic acid)	Collagen synth, reduces colds, mild antioxidant, helps E & iron absorption	Scurvy, deficiencies with skin, nails, gums and hair (smokers need more)	Greens, citrus fruits, berries, bell peppers, tomatoes, kiwi
Folate (folic acid)	DNA synth, makes new cells, lower homocysteine	Neural tube defect (w/pregnancy), heart disease	Asparagus, beets, enriched cereal, pinto, lentils, avocado
Pantothenic Acid (Pantothenate)	Energy metabolism, many functions	Lack of energy, fatigue (deficiency is rare)	Most foods have small amounts. High amounts in: eggs, meat, yogurt, avocado, lentils and whole grains
Biotin	Energy metabolism, fat synth	Rash, fine/brittle hair, anemia (deficiency is rare)	Liver, berries, leafy vegetables
Choline	Makes acetylcholine (a neurotransmitter)	Fatty liver, kidney complications	Egg yolks, meats
Inositol	Cell membranes		Fruit (oranges, cantaloupe), produced from glucose
Carnitine	Cell actions, Fat transport		biosynthesized from amino acids

Vitamins and Metabolism
The B vitamins are necessary for metabolism. Each B vitamin plays a key role as cofactors in the metabolic pathways. For example, thiamine-B1, niacin- B3, and pyridoxine-B6, aid in carbohydrate metabolism. Riboflavin-B2 aids in fat metabolism, and pantothenic acid and biotin in protein metabolism. A lack of these vitamins may contribute to fatigue during exercise. This phenomenon leads to the false notion that vitamins “give energy”, but, in fact, this is not the case. The body does not benefit from elevated doses of vitamins. The efficient amount activates the needed function, an overabundance won’t create any added benefit for energy.

Other vitamins play key roles in our health and normal function. Vitamins A, C, and E have known anti-oxidant qualities. Folic acid and cobalamine-B12 have roles in the formation of red and white blood cells. Vitamins D and C contribute to the formation of bone, cartilage, and connective tissues. Vitamin K is required for sugar residues and proteins to form glycoproteins, which include several clotting factors. Extra attention is required by persons using anti-coagulant drugs when consuming foods that are high in Vitamin K.

This information is not intended for the purpose of ‘prescribing’ or otherwise recommending vitamins or minerals to your clients. This is for your personal education and understanding only.

Minerals
A mineral is an inorganic compound found in nature. Minerals are needed in the diet for normal functioning. Based on the amount of the mineral needed, they are categorized into macro-minerals or micro-minerals. The term “trace minerals” was used in the past to designate the micro-minerals, or minerals needed in small (trace) quantities. Minerals tend to fall into structural or regulatory roles. For example, structurally the body uses calcium and phosphorus in bone and teeth development. Sulfur is used in hair, joint, and tendon development. The regulatory role of minerals includes the use of sodium and potassium in neural conduction and blood pressure regulation. Zinc, magnesium and copper are essential for the function of many enzymes. Zinc and selenium serve in anti-oxidant functions. Iron and zinc have essential roles in immune cell functions. Iron is an essential element in the hemoglobin of red blood cells which enable them to carry oxygen. A lack of iron in some causes a form of ***anemia***. Flourine is well known for its capacity to reduce the bacteria which cause plaques in tooth decay. Bodybuilders have gravitated toward several minerals known to aid insulin function. Both chromium and vanadium have been shown to help insulin function. Chromium is part of the glucose tolerance factor, and vanadium helps insulin sensitivity - but, it is important to note that scientific studies have not proven these minerals to significantly enhance insulin’s function or muscle growth.

MINERALS: AN OVERVIEW

MACRO-MINERALS	CHIEF FUNCTION	DEFICIENCY SYMPTOMS	SOURCES
Sodium	Nerve transmission, muscle contraction, blood volume	Dizziness, muscle cramps, nausea	Sea salt, Himalayan pink salt, soy sauce
Chloride-Chlorine	acid-base balance	Convulsions	Sea salt, Himalayan pink salt, Soy sauce and unprocessed foods
Potassium	Blood pressure regulation, nerve transmission	Muscle cramps, irregular heart beat,	Almost all foods: meats, milk, coconut water, bananas, vegetables, grains, etc
Calcium	Bone growth/health, blood clotting, nerve impulse	Osteoporosis, nerve conduction impairments	Leafy greens, broccoli, cheese, greens, sardines, tofu
Phosphorus	Bones, teeth, DNA/RNA growth, ATP	Osteoporosis, brittle bones, muscle weakness, impaired growth	Milk, cottage cheese, steak, salmon, navy beans
Magnesium	Glucose metabolism, synthesis of fat, protein, nucleic acids, muscle contraction, blood clotting, transport proteins, blood pressure, lung function, & hundreds of enzymes	Muscle weakness, nerve problems, hallucinations	Nuts, legumes, dark green vegetables, seafoods, chocolate
Sulfur	Insulin, stabilizes proteins		Protein containing foods

MICRO-MINERALS	CHIEF FUNCTION	DEFICIENCY SYMPTOMS	SOURCES
Iron	Hemoglobin, myoglobin, need for energy	Anemia, weakness, impaired cognition	Protein containing foods-Red meats, fish, eggs, legumes
Zinc	Antioxidant, insulin, immune system, wound healing	Growth failure, sexual dysfunction	Protein containing foods
Iodine	Thyroid function	Goiter, cretinism	Iodized salt, seafood, seaweed, kelp, dulse
Selenium	Part of enzyme that defends against oxidation	Keeshan disease, skin rash, hair & nail damage, fatigue, irritability, nerve disorders	Seafoods, organ meats, whole grains, vegetables (depending on soil conditions)
Copper	Helps form Hemoglobin; part of several enzymes	Anemia, vomiting, diarrhea, liver damage	Seafood, nuts, legumes, whole grains
Manganese	Cofactor for several enzymes	Nerve symptoms/ disorders	Nuts, whole grains, leafy vegetables
Fluoride	Helps form bones and teeth: confers decay resistance on teeth	Susceptible to tooth decay, fluorosis, nausea, vomiting, diarrhea,	Drinking water (if fluoridated), tea, seafood
Chromium	Assoc w/ insulin; needed for energy release from glucose	Abnormal glucose metabolism	Meat, unrefined grains, vegetables, oils, beer.
Molybdenum	Cofactor for several enzymes		Legumes, cereal, organic meats

Water: The Most Essential Nutrient

In order to understand the importance of hydration in the body, it is important to first have a basic knowledge of the body's water 'components' and some of the uses of water in our metabolism, and in 'cooling our engine'. As is commonly known, water is critical to our body's ability to function, to stay cool, and even to stay warm. In adults, an estimated 50-65% of total body weight is water, depending on age and gender. In infants, this is much higher, up to 75%. Water helps to maintain body temperature and is responsible for more than 50% of all internally occurring chemical reactions. It is also responsible for the movement of nutrients, digestion, absorption, circulation, and the excretion of wastes. Water is also a vital component in synovial fluid (joint lubricant) and ***cerebrospinal fluid*** (brain and spine fluid) in the nervous system. Water is, in part, responsible for the transmission of light and sound in the eyes and ears as well. Yes, it is quite obvious, water is 'essential'.

The body's average daily loss of fluids, through excretion, respiration, chemical reactions and perspiration varies from about 1 to 3 quarts; and a high protein intake calls for an even greater amount of fluid intake - so, it's clear, we need it regularly and often. At even 2% dehydration, the body's work capacity decreases by 12-15%. Depending on the temperatures and activity, most people can only live a maximum of 2-3 days without water.

Water contains minerals which possess electrical charges. This does not mean that water is electric. What it does mean is that the minerals in it have either a positive or negative ion, and thus, water conducts electricity. These minerals are known as electrolytes, and the electrolytes are critical for everything from muscle contraction and brain function to appropriate distribution in the various components of the body.

When the body is deprived of fluids, it pulls water from any or all reserves in an effort to maintain critical blood volume and a safe body temperature. A prolonged low fluid intake, high sodium ingestion, or excessive prolonged use of diuretics (such as caffeine, alcohol, and others) may trigger a variety of hormonal responses resulting in the survival storage of surplus fluids. By increasing fluid intake, this survival storage response is effectively reversed and a loss of excess water weight occurs.

Fluid imbalances contribute to a host of metabolic disorders. All of these potential health threats are easily reduced by simply getting into the habit of drinking more water, at least 8 to 10, 8 ounce glasses daily.

Water is absorbed from the small intestine at a maximum rate of 8 to 10 ounces every 20 minutes. It should be ingested during and after exercise (especially in hot, humid conditions).

When preparing for exercise, and anticipating a profuse sweat, simply weigh in prior to and after. Then ingest 16 ounces of water per pound of weight lost, at the rate of 8 to 10 ounces every 20 minutes, until replenishment of 16 ounces per pound lost is restored.

Never consume large amounts of sodium during exercise. The temporary ***hypertonic*** concentration of sodium in the blood results in an osmotic shift of fluids out of the working muscles. This causes severe cramping and increased susceptibility to heat injuries (such as heat stroke and heat exhaustion). However, if activity is very intense and/or lasts longer than about 60 minutes, a sports drink containing no more than 6-8% sugar solution may be used (over 10% sugar solution may interfere with fluid absorption), and a sodium concentration of about 100mgs/8ozs of fluid. Perspiration rates vary and may increase the need for fluid and electrolyte replacement. Also, it is advised to drink between 16 and 24 ounces of fluids within 30 minutes after any event completion.

Avoid amino acid supplements produced by a process called "hydrolysis", or basically its decomposition with the addition of water. Some amino acids are compromised and rendered useless through hydrolysis. Moreover, these supplements could include toxic by-products formed during processing.

What Makes Us Thirsty?

Sodium, being the electrolyte responsible for fluid retention, holds the key to why we thirst. Throughout the day, active or not, there is a gradual reduction in fluids from chemical reactions. Of course, this occurs much more rapidly during exercise than at rest, but nevertheless it occurs constantly.

As mentioned, at 2% dehydration the body's work capacity decreases by 12-15%. Body temperature and heart rate increase during periods of dehydration. The body's prevention mechanism is osmoreceptor transmission to the brain, stimulating a sensation of thirst prior to the occurrence of dehydration.

The most common cause of dehydration occurs as a result of fluid loss through vomiting and diarrhea during illness. It is important then that electrolytes/minerals are replenished in addition to fluids.

As the body loses fluid, a steady increase occurs in the concentrations of sodium in the blood. When the concentration reaches a certain level, osmoreceptors trigger the thirst centers in the brain to create the sensation of thirst. Upon the ingestion of additional fluids, the sodium concentration is diluted down to acceptable levels, shutting down the thirst center in the brain.

Functions and Distribution of Water

Water content in the human body varies based on body composition. It is one of the factors used to estimate body fat percentage. Water content of muscle is about 74% of its total weight, and only about 20-30% in fat. By comparison to women, men generally have a greater percentage of water content contributed to weight because they tend to have a greater percentage of their overall body weight coming from muscle. By this same reasoning, a lean muscular man would have higher water content than an obese man; there would be a significant difference in the proportion of weight contributed to water versus weight contributed to fat, in this example.

Also, since water is a good conductor of electrical current, it makes sense that muscle would conduct electrical current better than fat. Electrical Body Mass Index (BMI) devices use resistance to electrical current in measuring BMI. An obese person, for example, has a higher BMI reading because fat resists the electrical current greater than water. This is also why the state of hydration can affect measurements. Height, overall body weight and athletic status are also factors in measuring BMI.

More Purposes of Water in the Human Body

Water in the human body serves several purposes. Water acts as a lubricant for both joint activity as well as transport mechanisms. The blood or lymph is composed of water and is responsible for almost all transportation in the body. Proper blood volume, with proper viscosity, is absolutely necessary in order for blood to course through the body (this is impossible without the right amount of water). Water is needed for several metabolic reactions to produce energy, and is produced as an end product in energy production in the electron transport chain reactions.

Water serves as a structural element in cells, muscle and fat, as well as glycogen and many other tissues. Finally, water is critical in temperature regulation, both hot and cold. Its role in heat protection is obvious, with sweating and evaporative cooling; but many don't realize that it is necessary to be hydrated for appropriate heating of the body as well.

Distribution of Water in the Body

The distribution of **Total Body Water (TBW)** is divided into <u>Extracellular</u> and <u>Intracellular</u> compartments. As previously discussed, the extracellular compartment includes plasma (intravascular water) and interstitial fluid (transcellular water), outside the cells. The intracellular compartment includes anything contained within the cell membrane, including red blood cells (RBCs).

The kidneys use water for blood regulation and for flushing toxins from the blood. After a long, hard workout in the heat, urine is concentrated and dark yellow or golden in color. This is because there is a high content of metabolized protein and other toxins in the urine. Clear urine results from the fact that there is a greater water to impurity ration (dilution) and more frequent elimination of metabolites.

Water Content » Blood (Plasma) Volume » Osmosis

Fluids flow between compartments, including the functional cells of the kidney, according to osmotic pressure. Osmosis is a simple process, yet it is often misunderstood. In osmosis, the larger the particle, the greater the fluid volume that follows or surrounds it. When two compartments are separated by a semi-permeable membrane, water will cross the membrane to equalize the concentrations. So, if we drank really salty water, we may actually become thirstier because there was no shift, or maybe even a negative shift, that has occurred in the osmotic concentration. This is the reason we can die of thirst, in the middle of the ocean!

In order for osmosis to occur, there must be a semi-permeable membrane that allows fluid to pass through. The membrane does not allow passage of suspended solids (metabolites or electrolytes) such as sodium, potassium, chloride, calcium or magnesium. Evidence of the osmotic process is readily observed after placing the hands in water for an extended period (such as dish washing). The fingers appear wrinkled because soapy dish water creates greater pressure to the skin surface thereby forcing fluid from within the skin cells. The fluid in your fingers pass through the skin into the water in order to equalize the osmotic pressure exerted by the soapy dish water. Thus, your fingers become wrinkled until you've stopped doing dishes and become rehydrated.

This same process occurs between the blood plasma and the red blood cells (RBCs). The RBCs can shrink or expand depending on the hydration state. As the body absorbs water in the small intestine, and eventually into the blood vessel, it will first move into the blood's fluid compartment, known as the plasma. The flow will then occur based on osmotic gradient, into the RBC or not. Fluid will move from low concentration compartments to high concentrations in order to dilute the high concentration and equalize the two compartments.

the term "***osmolality***" is often used instead of concentration to denote the osmotic effect

During exertion, it is important to drink a fluid that reestablish ions lost through sweating and breathing. The liquid should not be so concentrated that the small intestine won't absorb it and transport it to dehydrated cells. Notice that, when you eat food that is very salty, you feel thirsty after. This is due to the osmotic effect of the salty food pulling water from the cells into the gut. When a particle is big, and usually heavier, it will have a stronger osmotic effect than a small particle.

Sweat Production - the best cooling mechanism

The human body has several cooling mechanisms. None is more important than sweating. The following factors affect the sweat rate (volume of sweat/unit time):

- *Level of physical conditioning*: a well conditioned athlete sweats more and produces a more diluted sweat.
- *Acclimation to the environment*: someone used to the heat sweats sooner and more.
- *Environmental conditions*: when air temperature and humidity are higher, sweating is increased.
- *Exercise intensity*: greater exercise intensity results in more sweat production.
- *Clothing*: thinner and more 'breathable' clothing results in less sweating.

The contents of sweat can vary greatly between individuals depending on the time at which a sample is taken and from what part of the body it is taken. Both the level of conditioning and the amount of acclimatization will affect sweat rate. It should be recognized that the sweating mechanism works because there is a gradient for drying the sweat, which happens as the dry air passes over it. However, when the humidity is high (above 85%), there is not a sufficient gradient for drying and thus there is no cooling effect - the body temperature then increases and continues to sweat even more! Thus, there is a great deal of sweating in humid environments, so sports and exercise participants must be careful not to overheat since the sweating mechanism is rendered ineffective by this humid environment. Even though several electrolytes are lost in sweat, including sodium, potassium, iron, magnesium, chloride and calcium, the main losses come from sodium and potassium.

Assessing Hydration

At any given time, the body is in a state of hyperhydration (too much), dehydration (too little), or euhydration (normal hydration) depending on the balance of loss to intake and absorption. Assessing dehydration is actually an inexact science, partly due to the variation within each individual.

The degree to which performance is affected by hydration is based on several factors. They include individual tolerance or acclimatization, the type of physical event and ambient temperature. At 3% fluid loss, there is a "dry mouth" feeling and a decrease in urinary output. At 4-5% fluid loss, there is a 20-30% decreased work capacity, headaches, and difficulty in concentration. As dehydration increases to the 6-7% range there is strong impairment in temperature regulation, increased respiratory rate, tingling and numbness in extremities, and finally collapse (fainting) if exercise is continued.

Heat Cramps, Heat Exhaustion, and Heat Stroke

There are several progressive "reactions" to dehydration and overheating by the body. The body's core temperature is 98.6 degrees Fahrenheit. Even a fluctuation of a few degrees above or below may be an indication of some significant problems. One reaction is electrolyte loss. Electrolytes are necessary for muscle contraction. Profuse sweating along with inadequate electrolyte replacement results in inhibited muscle relaxation and exertional cramping. Some people are more prone than others to cramping. The solution? More sodium. Salt tablets or salty snacks may be helpful.

The phenomena of heat exhaustion and heat stroke can be viewed on a continuum, where heat exhaustion is less serious than heat stroke but both require an immediate response and treatment. Heat exhaustion can quickly turn to heat stroke if not responded to properly. Heat exhaustion can include symptoms like headache, dizziness, cramping and rapid, shallow breathing; whereas heat stroke is associated with a very high body temperature, no sweating and difficulty breathing. One distinction to be made, between heat exhaustion and heat stroke, is whether the condition was brought on by exertion. In general, exertional heat exhaustion is displayed by sweat soaked skin and paleness, rather than dry and flushed/red skin that is common with heat stroke. In most instances, the sweat mechanism has ceased to work with normal heat stroke, it is indicative of the internal body temperature rising to extremes with the inability to cool itself. Often, exertional heat stroke occurs in the unfit, unacclimatized, and obese participant, but not always. Risk of heat stroke is also common in athletes who use stimulants such as ephedra or synephrine. These substances tend to raise the metabolic rate, block pain, and increase heart rate, blood pressure and the overall intensity of exertion. All of these factors, especially coupled with environmental heat, level of activity and acclimatization factors, can lead to a possible episode of heat stroke.

If you see signs of heat exhaustion, immediately have your client stop the activity and find a cool spot to drink cold water, loosen tight clothing and apply a cool compress. If symptoms do not cease, or if it appears that the symptoms of heat stroke are present, seek medical attention right away. Heat exhaustion and heat stroke can often times be prevented with some common sense approaches to exercise - no vigorous activity in extreme heat and always remember proper hydration, using non-alcoholic and non-caffeinated beverages. Usually, water is always best; however, a sports drink may be better when it is used with extended vigorous activity in hot temperatures.

Fluid Intake

The Thirst Mechanism and Gastric Water Absorption

As mentioned, the only way for water to reach the cells, and all the places it is needed, is for it to be absorbed in the small intestine. This is actually a 3-step process: 1) fluid ingestion, 2) gastric emptying, and 3) intestinal fluid absorption. Therefore, the most effective rehydrating drink is one that: empties rapidly from the stomach, is easily absorbed by the small intestine and promotes fluid retention. Many factors influence the rate of gastric emptying:

- ***Environmental stress***: heat and dehydration
- ***Nutrient content of the drink***: carbohydrate concentration and type, protein and fat content
- ***Exercise Intensity and Mode***
- ***Drink properties***: volume, caloric density, osmolality, temperature, and pH

Generally speaking, the more you drink, the faster it leaves the stomach. However, the higher the osmolality, or content concentration, the lower the rate of gastric emptying. Isotonic sports drinks, or drinks that contain similar concentrations of salt and sugar to that of what the body contains, are well absorbed and usually have enough salts and carbohydrates to sustain energy and fluid retention - but note that the higher the carbohydrate concentration, the lower the rate of gastric emptying. However, if a solution is 2% or below in carbohydrate concentration, there is no significant difference; but, if the solution is above 2%, it will slow gastric emptying in proportion to the concentration. The "kicker" is that carbohydrate seems to enhance sodium and water absorption in the small intestine. This is due to a sodium-energy dependent transport system. Thus, drinks that contain between 2% and 6% carbohydrate concentrations of *simple* carbohydrate (glucose, sucrose, fructose or even maltodextrin), are usually emptied quickly and absorbed equal to or better than plain water.

Finally, exercising at low to moderate intensities has no effect on gastric emptying, but high intensities (>70% VO_2 peak) lower the rate. The type of activity also affects hydration, mostly due to the "inconvenience" and motions on the gut. Cyclists tend to stay better hydrated than runners for this reason. Ironically, the same movement that may cause discomfort in drinking certain amounts (intragastric pressure) will also aid emptying.

Sport Drink Composition Comparisons

There is a give-and-take relationship between putting carbohydrates and electrolytes (sodium and potassium) into the system and the rate of gastric emptying and absorption. There are some optimal levels in this give-and-take relationship, and having these components in the fluid does aid water retention - so then comes sports drinks. As you probably recognize, the sports drink market is a multi-billion dollar industry; and, though there is a place for sports drinks, it is important to understand why and when they are beneficial. The intended purpose of these sports drinks is to enhance performance in athletes by replacing water and electrolytes, giving the athlete more energy and endurance. Now days, sports drinks are even more focused on specific hydration or fuel absorption purpose for the specific phases of training or competition: Pre-, During-, and Post-Training/Competition are the three main areas. Some major brands have even broken up their products into drinks that are specific to these phases. For our general purpose, let's look at some of the leading products and their components.

Sports Drink Brand (8 oz)	CHO (%) / CHO (g)	CHO Type	Calories	Sodium (mg)	Potassium (%)	Protein (mg)
Gatorade (02 Perform)	6% / 18g	Sucrose, HFCS	50	110	1%	0
Clif Shot-Electrolyte	6% / 19g	Org brown rice syrup, org evap cane juice	80	200	2%	0
Powerade	5% / 14g	HFCS, Maltodextrin	50	100	1%	0
Accelerade	7% / 21g	Sugar, Trehalose	120	220	3%	5

CHO = carbohydrate / **HFCS** = high fructose corn syrup

Notice the variances in sodium to carbohydrate (sugar) between these brands. Sodium helps to retain water in the blood, so drinks higher in sodium may be best for athletes recovering from long periods of rigorous exercise. Sugar delivers carbohydrates (sugar) to the blood stream, providing calories of energy, however it slows the rate at which water enters the blood. According to the American College of Sports Medicine, beverages containing 4-8% carbohydrate (sugar) provide adequate replacement of carbohydrate used during exercise. Remember, sports drink intake varies with the goal of the athlete, individual tolerances and training conditions. A marathoner or long distance triathlete (>90 minutes of exercise), for example, should consider consuming calories, especially carbohydrate, to avoid depletion. A sports drink for this specific athlete should have 4-8% carbohydrate solution in multiple sugars including maltodextrin, and 500 to 700mg of sodium per liter (or 118 to 165mg per 8 ounces). Conversely, it is best that individuals who are not performing prolonged periods of strenuous activity drink 2 to 3, 8 ounce glasses of water an hour or two before exercise. Then consume enough to quench the thirst during exercise, followed by about 2 more 8 ounce glasses of water, after exercise.

The palatability of a sports drink is enhanced by the sugars and salts – and for good reason. Our bodies will actually "crave" missing or depleted substances, and many of our likes and dislikes are based on these often subconscious cravings (unfortunately, when it comes to food, it is often fat, sugar and salt that we crave, even when we are not low in these nutrients)! Sports drinks can have significant beneficial impact on athletic performance, *when knowing when and why to drink them*! However, sports drink consumption contributes to weight gain in persons using them in the absence of exercise. This is due to the high concentration of sugar in these products. NFPT does not endorse any particular brand of sports drink. Instead, NFPT recommends obtaining the food/fuel that is needed from more natural sources whenever possible (coconut water, for example). NFPT suggests that the trainer direct their client to a registered dietitian for specific individual hydration recommendations.

In conclusion, understanding the mechanisms of heat regulation, fluid ingestion, and the appropriate composition of fluids for rehydration are of critical importance for the personal trainer, and especially an athletic coach - in fact, it may be the most important!

CHAPTER 9

The Beginner Client

All that we do starts at the beginning. Whether you, as the trainer, are just starting your profession, or your client is just starting to work with you as their trainer, you both must know the basics of what kind of training will benefit them and what the difference is with all of the other types of training.

This chapter covers the basic principles and definitions for the types of training that you will use in your profession as well as the up-front effects that these types will have on your beginning client.

A Summary of Terms: Fitness Concepts and Training Principles

Let's start by looking at a quick snapshot of the identifiable aspects that define common fitness concepts and training principles. It is important to be very familiar with the following:

Muscular Strength vs. Muscular Endurance - Strength is the ability to exert tension on a single occurrence. The term "one repetition maximum" is used to describe the top weight that someone can lift. However, the real maximum would be found at a weight the person cannot move, or an isometric maximum. Muscular endurance is the amount of resistance people can repeatedly overcome or lift. This may take the form of body weight exercises such as dips, pull-ups, chin-ups, push-ups, sit-ups or crunches and planks. For many, these exercises are so difficult that they may qualify more as strength vs. endurance exercises. However, these exercises are often used to measure someone's muscular endurance. There are no set criteria for how many reps constitutes endurance vs. strength, but over 10 is a good gauge.

Muscle Size vs. Muscle Definition - These terms are quite subjective. The actual girth of a muscle is termed the size. The fine ridges and bumps, made visible by the muscle's close proximity to the skin with no subcutaneous fat in-between, is often referred to as muscle definition. Many think that muscle strength develops girth and that muscle endurance develops definition. This is not actually the case. Many bodybuilders entering competitive events must possess both.

Hypertrophy vs. Atrophy - "Trophy" literally means "growth". "Hyper" means "large", and the prefix "a-" is "not" or "an absence of something". Hypertrophy describes the size increase of muscle fibers after they have been trained and the proper nutrients and rest have allowed the body's natural anabolic processes to work. Atrophy is the natural decrease in size that occurs in a muscle that is unused or used less. Some athletes may experience muscle atrophy after leaving their competitive days. This occurs because, even though the retired athlete is currently more active and healthier than most, they are still less active than they once were. The term- "use it or lose it" describes atrophy well. Skills, coordination and endurance can be lost or decreased, but they do not actually atrophy.

Specificity of Training Principle vs. Overload Principle - These two terms actually work in concert. To achieve a "training effect", one must push a bodily system beyond what it can currently handle. Thus, someone "overloads" a given capacity when training. The exact way a person overloads a system will result in a change in modality only. Specificity may be for: a given intensity, frequency, range of motion, time of day, and even a specific workout location. For example, if someone is accustomed to training in the heat of the day, they would not be expected to perform as well in the cold of the night, compared to someone who does train under those conditions.

Plyometric vs. Ballistic Training - Both of these methods use fast movement but for different purposes. Ballistic training conditions both the neurologic system to react faster and the muscles to contract faster from a static position. Plyometric training utilizes the tension in the tendon to cause a more forceful muscle contraction and an increase in tendon strength. This also develops an increased capacity for transition between movements.

Cardiorespiratory (metabolic) Endurance vs. Muscular endurance - These two concepts are usually performed in coordination with each other. The heart and lungs are responsible for delivering oxygen to the muscle for aerobic metabolism. When a person runs or cycles, they develop cardiorespiratory endurance. However, the skeletal muscles used, and the endurance of those muscles, are specific to running or cycling. When conditioning in one sport trains muscles used in another, it is known as a "carryover" or "cross training" effect. Triathletes and duathletes would depend on this to some degree.

Concentric vs. Eccentric Contraction - Both of these terms apply to dynamic conditions (or when a limb is moving) versus static conditions (or when a limb is stationary). A concentric contraction is when a muscle shortens, pulls on the tendon, which pulls on the bone, to move in the direction of the shortening. An eccentric contraction is when the muscle lengthens under load, thereby pulling on the tendon but only to slow movement in the opposite direction. This is similar to the use of a retro-rocket to slow the descent of a rocket ship, or the reversal of thrust of a jet plane engine when landing.

Isometric vs. Isotonic - "Iso" means same, and "metric" means measure. In an isometric contraction, there is no movement, but there may be a maximal contraction. In an isotonic contraction, the resistance on the muscle is held constant. "Tonic" means tension. In reality, this is close to impossible. Since joint angle and leverage is constantly changing, the forces needed must also correspondingly change. With this in mind, the following previously covered concepts, DCER and DVER, are defined for clarification:

Dynamic Constant External Resistance (DCER) vs. Dynamic Variable External Resistance (DVER) - These terms are similar to each other but slightly different. If someone were to lift a dumbbell that was 20 lbs, someone may say the muscle was exposed to the same resistance throughout the motion. In reality, the joint angles, fulcrum points, and lever arms were adjusting throughout. To theoretically maximize resistance across an entire range of motion some weight machines are designed to purposefully alter resistance as the machine moves along its path of travel. The Nautilus "cam" or original Universal dynamic variable resistance machines are examples.

Functional vs. Standard or Traditional Training - There are no official definitions of these terms. Functional training is accurately described as training that is relative to a specific goal or goals which improve the ability to perform an individual's respective activities of daily living or chosen sport. Any movement is functional. It just depends on who and what it is for. What may be 'functional' for one person, may not be for another. Prescribing exercise based on individual needs and goals is what makes a program functional. Heavy explosive training for athletes is functional. Wall push-ups are functional for the elderly lady that has trouble holding herself up. Functional training value is measured by the amount of carryover that the actual training has in ones daily life or athletic performance. Many people think that the addition of a balance board, or some mechanical challenge, will mean that the exercise is functional. Balance exercises have value for most people and are functional when properly applied. However, not all balance exercises are functional. Conversely, not all functional exercises require balance devices. There is a limit to the benefit of using boards and other balance devices, the trainer must measure the value as the client progresses.

Standard, or traditional, resistance training is more of a cookie cutter approach that includes the use of barbells, dumbbells and machines in a balanced or even static environment. These programs are quite general and focus on one or two body parts at a time, with the goal to develop stronger, leaner muscles. Coaches also set up group programs for athletes to do on their own based on their sport. However, this is not always 'functional' because it may not account specifically for the needs of each athlete. If it is sport specific, and not individualized, then it is considered 'traditional'. If you are a bodybuilder, or someone just looking to do simple workouts to get into shape, then some form of traditional training is usually what you end up doing. The traditional method is less useful for sports, performance and time efficiency. The fact is, most people in the gym train this way because fitness evolves very slowly, and it's easier. But note that traditional exercises can be functional when applied to the right person in the right scenario.

Flexibility vs. Stretching – These terms work in unison. Stretching is a part of a flexibility program. However, most people do some sort of stretching, before or after a workout, with no real flexibility goal in mind. For athletes, especially, the impact of flexibility on performance should not be undervalued as it is a major part of achieving true movement efficiency. Therefore, flexibility is not just a part of the exercise program, but a program all unto itself. Tony Gummerson, Head of P.E. and Sports Coaching Program at York St. John University U.K., defines flexibility as, "the absolute range of movement in a joint or series of joints that is attainable in a momentary effort with the help of a partner or a piece of equipment". This means that flexibility is specific to each joint. There are several types of stretching, each with different benefits and applications, which improve flexibility when performed correctly. Within all the types of stretching, the stretch is basically either static (does not involve motion) or dynamic (involves motion). Like stretching, there are different kinds of flexibility modalities as well: static-active, static-passive, and dynamic flexibility. Static-active flexibility is the ability to maintain extended positions using only the agonist and synergists. Static-passive is maintaining an extended position using a limb or apparatus for support. Dynamic flexibility is the ability to move a limb through its full range of motion.

Calisthenics vs. Aerobics – Both terms are involved with conditioning. The difference in them is how they are performed. Calisthenics is systematic body weight exercises performed without an apparatus, such as push-ups and lunges, that promote strength, endurance and flexibility. Calisthenics can be incorporated into any exercise routines as it usually has a great deal of functional value. Aerobics is a system of conditioning for increasing the body's uptake of oxygen. Examples of aerobics are running, swimming, and jogging. Aerobic exercises require training at an individual's target heart rate for a period of 20 minutes or longer, 3 or more times per week, to have benefit.

The sections to follow focus most on resistance and aerobic training specifically. These types of training are fundamental to any program, beginner or athlete, and therefore require a high level of comprehension so that specific training principles are correctly interpreted. We will first review some basic training variables as they relate to resistance training (or lifting).

There are many things that can and "should" be altered in an effective resistance training program. We say "should" because the body becomes efficient at a given movement or contraction, after repeated experiences. This is how certain athletes can make a very difficult move look commonplace, but it is also why we hit plateaus in our training. Some of these variables include:

Repetitions: The number of lifts or motions per set
Sets: The number of batches of repetitions performed per workout
Speed of concentric phase, speed of eccentric phase: ballistic or slow sustained
Range of motion: partial, complete or combination thereof
Type of resistance: body weight, band, tube, kettlebell, weight, cable weight, etc.

Now, let's define some common training principles that are relevant to all clients and fitness enthusiasts. The four (4) main training principles are:

- **The F.I.T.T. Principle**
- **The Specificity of Training Principle**
- **The Progressive Adaptation Principle (Overload Principle)**
- **Ceiling Effect (or Law of Diminishing Returns)**

- **<u>The F.I.T.T. Principle</u>**: F.I.T.T. is an acronym used for remembering the measurable components of an exercise training program. No matter the training program, these components hold true:
(F) Frequency
(I) Intensity
(T) Time (duration)
(T) Type of exercise involved

Results are a reflection of the method or quantity by which each of the four variables are determined or trained. In a sense, the variables serve as the chisel to the program you sculpt; leading to the next principle.

- <u>The Specificity of Training Principle</u>: this is also referred to with the acronym "S.A.I.D.", or "Specific Adaptation to Imposed Demand". This principle basically states that the way you train according to the F.I.T.T. components will determine the improvements you gain. The training effect is specific to the activity being performed. If you wish to grow stronger, you have to lift heavier weights. If you wish to be more flexible, you have to practice stretching in that movement, not just in general. There is however some performance carry over. Developing speed, agility, and coordination in one sport that aids in another. The same holds true with cardiovascular capacity, but it is limited at best. There is only about 10% carry over between running to cycling and less the other way around. Specificity of training can apply to:
the mode (type) of exercise
the speed of movement (intensity)
the range of motion and strength in a given ROM
the energy system utilized (intensity and duration)
the environmental surroundings and time of day
muscle recruitment patterns and muscle fiber development

- **<u>The Progressive Adaptation (Overload) Principle</u>:** This principle states that in order to get an improvement in performance or conditioning you have to push the particular system beyond its current capacity. The overload should be significant enough in order to get a physiological adaptation, which occurs at a "training threshold". If too much overload is placed on the system, injury may occur. Thus, too much of a good thing is not a good thing. Again, the overload is the imposed demand, and it must be within the specific F.I.T.T. components to get the desired adaptation.

- **<u>Ceiling Effect, or Law of Diminishing Returns</u>:** The ceiling effect is seen in many different fields and natural systems. The "ceiling" represents the theoretical maximum that an individual is capable of reaching. Unfortunately, for many well conditioned people, the training threshold is really high, so they must exert quite hard to see even small improvements. For this reason, it is no surprise that there are so many elite level competitors who are very close in ability with only small differences, often in milliseconds. This is because everybody at that same competitive level has pushed themselves to their physiological maximum and, since they already have the genetic predisposition for that sport, they are considered to be the country's, or the world's, best athlete in their respective sport. In fact, their biggest competitive advantage may be their response to performance under pressure. In your clients, athletes or not, you will see a "plateau effect" when they have fully adapted to the imposed demand.

One of the biggest challenges anyone will face as a trainer of athletes is to motivate them to perform to their maximum without injury. The strategy behind this falls into two major concepts in training:
1) **progressive increases**; and
2) **periodization of training** to peak at a given time/event

If your client desires total fitness, or wants to increase their overall fitness, your fitness program should include each component at least a couple of times a week. Most workouts should have 4 distinct phases:
1. Warm Ups
2. Dynamic Flexibility
3. Endurance or Strength, or some combination there of (Muscular Endurance)
4. Cool Down and Static Stretching (especially when working the cardiorespiratory component in older individuals)

Some stretching after heavy lifting is also recommended to aid the recovery process. The specificity of training principle dictates that the more you work a given fitness component the more that component will improve. While there is some carryover in some activities, you should be looking to "spread the wealth" throughout the physical body by delivering a balanced program. This can be done in each workout or in an intentional periodic fashion.

THE BEGINNER AND…

...Mitochondrial "Re-Education"

There is a preliminary process that NFPT has labeled "mitochondrial re-education" which must occur before the beginner can be expected to recover appropriately from workout to workout. The mitochondria, in the beginner, are still not performing efficiently, resulting in incomplete replenishment of energy stores. This will be reflected in a drop in the number of repetitions that the beginner is able to perform to positive failure in each set of a given exercise.

...Eating

Suggest to the beginner that they ingest a few hundred calories of carbohydrates immediately after a workout. A whey protein shake with high Glycemic Index carbs (such as dextrose or maltodextrin) is a very good option. Getting carbohydrates (and protein) quickly to the muscle cells makes blood glucose available to the muscle tissue exactly when it needs it the most, immediately after the workout. These eating habits, along with the performance of as much post-workout low level activity as possible, will aid in the mitochondrial re-education process. The performance of activity forces adipose (fat) tissue to release energy through a triggered hormonal response, and it cannot release and store energy at the same time. This means that the primary destination for the newly ingested carbohydrates, while performing activity, is the muscles and their mitochondria. Hence, you are "force-feeding" the muscles while disallowing fat storage. Fairly inactive muscle tissue "receptor sites" will become "re-educated" as well through this process. With time, this methodology should result in the participant's ability to perform the same number of reps in follow-up sets in each particular exercise.

...Intensity

Even if the client has no exercise experience, the trainer still needs to determine if past exercise has been attempted and what type. The trainer must also determine the level of activity the client experiences as a result of Activities of Daily Life (ADL). This permits the trainer to more accurately determine the client's starting exercise intensity and duration.

In resistance training, once the beginner is getting the same reps to failure in each set, the re-education period is over. Encourage the client to attempt the use of greater and greater amounts of weight in their goal-related rep ranges. This effectively allows for a gradual increase in the intensity of the beginner's efforts, progressive adaptation, and positive progress evaluation.

If a client is allowed to level off and continue to use the same weight and the same rep range without applying the challenge of the overload principle, the body will quickly adapt. The client will at best maintain their current lean tissue and level of fitness. However, an increase in the intensity of effort will not only result in both greater tissue increase, but may also result in even greater fat loss. As a general rule of thumb, for fat loss and general fitness goals, start your beginner client off at 60-70% set intensity. However, each client may be different, so it is important to note that his or her current abilities and individual goals are factors for varying set intensities. A 60-70% set intensity is a good baseline to work from.

Be aware that during the performance of intense work, the adrenal glands are stimulated to release stress hormones which actually result in the catabolism of body tissues. Since these hormones are not immediately degraded, they remain present in the bloodstream for some time after the intense exercise is over. Therefore, the higher the intensity of a workout, the shorter the duration must be to reduce hormone-related post-workout catabolism.

The beginner must always be first instructed to monitor his or her between-set-recovery heart rate to ensure adequate recovery and to prevent overexertion. This target heart rate is usually 100 beats per minute (BPM) in cases where an aerobic effect is not desired. For an equal measure of aerobic and anaerobic effects, a recovery heart rate of 115 BPM is recommended. If an aerobic effect is desired, a recovery heart rate of 125 BPM is usually recommended.

As the beginner progresses and becomes more in tune with his or her general well-being, and considers contraindications, the need for checking their heart rate is no longer necessary. However, monitoring recovery heart rate between sets can be used to estimate energy expenditures (see *NFPT Charts and Tables*).

...The Nervous System

Another interesting note concerning the beginner – they will experience faster strength gains for the first few months after starting out. One reason for this phenomenon is that the nerve impulses being transmitted are, in the beginning, not very efficient. Once the neuromuscular function has been conditioned over a brief period of time, the impulse becomes more efficient. This results in improved synchronicity of motor unit activity, increased motor unit recruitment, and stronger muscular contractions.

It is also important to realize that since the nervous system is not yet efficient at signaling contractions, it is not likely that a beginner is able to work hard enough to cause significant injury while performing exercises using proper form. Of course, using improper form is the greatest contributor to injury in the beginner.

SAFETY

Safety first! Though we will get into more depth in the area of client safety, here are some beginning safety points to follow:

1. Use proper form and the proper weight. It can be said that there is no right way to lift weights, but there is a wrong way! One of the quickest ways to be injured is to lift with poor form. In addition, most incorrect lifting stems from using momentum or incorrect alignment to make up for a lack of strength. This does cause a premature overload on the muscle to be overloaded, thus it's really not being worked, and no growth or strength increases will result - though this person may get better at swinging weights!

2. Use a spotter. Lifting heavy weights is fine, when you're ready. Becoming stuck under them is not! There are several advantages to having a competent spotter. A good spotter grabs the weight that the client normally could not lift. Spotters encourage the client to get that last rep. Spotters may provide a partial reduction in resistance to allow the client to get further muscle overload. Remember, the term "competent" was used because many spotters do too much of the work and spot too early. The best spotter does the least.

3. Clear all paths of movement. Many gyms are hard pressed for space and crowd in equipment and people where they should not be. Make sure no one is in "your space" when lifting or when setting weights down. This is especially important for dumbbell bench work in which there is a need to set the weights down quickly. It is also vitally important to make sure there are no other dumbbells in the area. One of the worst injuries in a weight room results from someone setting their hand or fingers between two weights. Performing power or Olympic lifts require wide berths.

4. Use proper safety equipment. Some may want to use wrist straps to alleviate strain on their grip. Power and Olympic lifters may want to use lifting shoes with flat, wood soles.

5. Don't wear sandals, jewelry, or keys in the weight room. Sandals can easily get caught while altering foot positions, which is dangerous during a lift. Jewelry – especially the kind attached to a pierced body part – is an invitation for pain. Even a ring on a finger can press against a nerve. Keys can also puncture the skin when pressed on, not to mention scratch or rip the covering on pads. Watches are fine for the most part.

Eating Before Activity

It is not recommend to eat a meal right before training or right before an event. Depending on the size of your meal, you should wait 90 minutes to 2 hours, after you eat, before engaging in prolonged or intense physical activity. Though research does show that ingesting a *small* amount of easily absorbable complete protein and a natural source carbohydrate (i.e. apple, banana, carrots, whole wheat, etc.), 15 minutes before a workout, keeps the body more anabolic during the session. It is important to note the small, controlled and purposeful amount versus a full meal just before a workout. There is a big difference. A physiological change takes place relative to the cardiovascular system upon the ingestion of foods. The body has been engaged to work. This change during digestion acts to redirect blood flow from the muscles to digestion. Since the body's total blood volume desirably remains the same, the movement of additional blood to any one part of the body (i.e. for digestion) results in an enlargement (vasodilatation) of the vessels in that specific region. As a result, a reduction (vasoconstriction) occurs in the size of the vessels in all other regions. When eating, there is a greater need for blood in and around digestion for the purpose of carrying nutrients to the main vascular tree. When vessels dilate around digestion, they constrict in muscular areas.

If prolonged and/or intense exercise is performed during digestion, the central nervous system constricts vessels around digestion and dilates vessels in the working muscles. This nervous input and redirection of blood flow slows digestive processes and the motility of the digesting food in the gut. As a result, dizziness, nausea, and a general feeling of fatigue may be experienced.

On the 'flip side' of this, remember that not eating protein for more than 3-4 hours may promote catabolism. Choose pre workout meals wisely. Do not eat heavy foods or foods that may cause an insulin crash later in the day. Since the body cannot store essential proteins, we recommend that essential proteins be part of the last meal before your training session. If competing, it is essential to receive advice from an R.D. in this area. Many coaches instruct clients to "carb up" a few days before activity and events. But, the truth is, it's what you do *all* the time, not just for a few days before an event, that really makes the difference. Eating carbs, fats and proteins after exercise is what is most important for recovery.

5 COMPONENTS OF GENERAL FITNESS

Many of your clients will tell you they just want to get fit. Therefore, it is important to know just what constitutes a general state of physical fitness.

There are many definitions for "physically fit", but most point to the same basic requirement: "having the energy and strength to perform daily activities vigorously and alertly, with energy left over to enjoy leisure activities or to meet emergency demands." The heart, lungs, and muscles should be strong. Weight and body fat should be within a desirable range.

To determine a level of physical fitness, let's break up the fitness program into the standard five (5) measurable parts:

1) **Cardiorespiratory Conditioning**
2) **Muscular Endurance**
3) **Muscular Strength**
4) **Flexibility**
5) **Body Composition**

Within these five (5) parts is "endurance", or the ability to keep moving for long periods of time preferably in a rhythmic and steady state. Endurance is addressed through two (2) specific parts of physical fitness that make up the endurance component: Cardiorespiratory and Muscular.

1. Cardiorespiratory Conditioning

Cardiorespiratory endurance is the prolonged ability of the heart and lungs to supply muscles with nutrients and oxygen. Aerobic exercise (like biking, jogging, and swimming) enhances cardiorespiratory endurance; with performance that can be measured for speed, duration, and distance. Cardiorespiratory Conditioning is the first type of endurance one must develop to be physically fit. Building endurance promotes higher energy levels. Aerobic exercise also burns calories and fat to keep your weight under control. A fit cardiorespiratory system lowers the risk of death from heart attacks, strokes, and pulmonary disease.

Developing the Aerobic Phase

Apply the following principles when developing the aerobic phase of a general fitness exercise program to enhance cardiorespiratory fitness:

1 Type of Activity: The activity must use large muscle groups and must be maintained for a period of time at a steady state.

2 Intensity: The average conditioning intensity for healthy adults is 60-70% of their **functional capacity**, referred to as **maximum heart rate** (these terms are sometimes used interchangeably.) Monitoring a target heart rate training zone during exercise is a good way to measure intensity. In the case of the beginner, there is a brief preliminary phase of orientation training where new clients use lower intensity in their desired rep ranges. The purpose is to both learn the proper form and to minimize the initial Delayed Onset Muscle Soreness (DOMS). Once the client works through the initial muscle soreness, and has learned the proper form, they will be ready for the more intense overload training. As a personal fitness trainer, it is impossible to evaluate client progress when less than maximum effort is being applied in multiple rep sets. The client must strictly use the overload training principle to positive failure in order for a measurable evaluation of progress to take place. The principle of overload requires a greater than normal stress, or load, be placed on the body in order that an increased training adaptation take place. This concept is addressed at length in Chapter 12: *Resistance Training*. For now, understand that muscles adapt to certain levels of load. They will 'get used' to the amount of load and therefore must be additionally stressed by a greater load in order to increase in strength. Similarly, for an increase in endurance, the muscles must work longer than they are used to working.

3 Duration: The duration of the exercise depends on the intensity of the exercise. Usually activities of lower intensity, such as walking, will last longer than a high intensity exercise like running. Aerobic fitness is also accomplished by alternating high and low level activities. Walking in between brief periods of jogging for 15 to 60 minutes of discontinuous aerobic activity is an example.

4 Frequency of Conditioning: 3 to 5 days per week of aerobic activity is recommended for the general fitness client.

5 Rate of Progression: In the first 6-8 weeks of exercise, significant conditioning effects will occur. The trainer must adjust the intensity and duration of the activity if progress is to continue.

Progression and the Aerobic Phase
The American College of Sports Medicine has identified 3 stages of progression in the aerobic or endurance phase of the exercise training program:

1 The Initial Conditioning Stage: During the first 4 to 6 weeks, low level activities of 10-15 minutes, at 60-70% of maximum heart rate, are recommended for the average healthy individual. Include some stretching and light calisthenics, such as abdominal work, as well.

2 The Improvement Conditioning Stage: Initially, there is a slight increase in exercise intensity. Thereafter, duration of the activity is increased every 2 to 3 weeks. Older individuals may take longer to adapt to increases in conditioning.

3 The Maintenance Conditioning Stage: Usually after 6 months of aerobic training, the average individual has achieved their goal of general fitness and may just wish to maintain it. Aerobic Maintenance Condition can be accomplished, training at 60-70% of maximum heart rate, in as few as three 30 minute workouts a week.

2. Muscular Endurance

The second type of endurance that must be developed in order to be physically fit is Muscular Endurance. Muscular Endurance is defined as the ability of the muscles to perform contractions for long periods of time. The length of time that a plank can be held, for example, is a measure of abdominal endurance. If the client can hold a plank for 2 minutes then that is good endurance and they can be further challenged with pikes, for example.

Improving Muscular Endurance
Generally, the performance of high repetition resistance exercises (20-25 rep range) enhances the endurance of the muscles involved. The muscular endurance phase of a general exercise program may include the performance of a circuit routine consisting of multiple compound exercises targeting different muscle groups. The goal is to affect as much total muscle tissue as possible. To achieve this, perform 3 to 4 continuous circuits of these 3 suggested movements:
-Pushing
-Pulling
-Squatting/Lunging

3. Muscle Strength

Muscular Strength is another measure of fitness. It is identified by 2 types:
1 Static Strength: How much weight can be held in place
2 Dynamic Strength: How much weight can be moved

It is desirable to be strong in order to perform heavy work with less chance for injury. Maintaining strength is more difficult with age and the natural loss of lean weight. Considerations for Muscle Endurance training versus Muscle Strength training depends upon goals.

The development of speed, agility, and coordination will also enhance overall physical performance. ***Exercise is "sport specific" to the activity being performed.*** If you wish to grow stronger, you will have to lift heavier weights. If you wish to be more flexible, you will have to practice stretching, and so on

Increasing Strength

Strength is increased through static contractions, as in **isometric** exercise, or by low repetition isotonic exercises. For advanced applications, muscles are normally 30% stronger when practicing eccentric (negative) training. Since the resistance is greater, so is the amount of damage and resulting synthesized muscle tissue. Sets of an exercise in a 4-6 rep range will initiate optimal strength gains. When the target muscle is worked 1-2 times a week, compound movements that target the major muscle groups are required. Perform strength training less frequently as intensity is increased.

4. Flexibility

The final component of fitness is flexibility. Flexibility is defined as the ability to move muscles and joints through their full range of motion. One basic way to measure flexibility, from a standing position, is to determine the extent to which the client has the ability to touch their toes, with their legs straight and a neutral spine. Flexibility of the muscles and joints helps prevent injury and maintain mobility with aging. Of particular concern is flexibility in the posterior thigh and the low-back. A lack of flexibility in these areas, and particularly coupled with lacking hip mobility, increases the risk of chronic low back pain. As a trainer, it is important to understand how hip mobility effects the low back and knees.

Increasing Flexibility

Stretching increases flexibility. It is important that stretching is done slowly with gradual increases in the range-of-motion. When increased flexibility is the goal, NFPT suggests that a static stretch be sustained for 30 seconds, and should not cause pain.

Stretching exercises are to be performed at the beginning and end of every exercise session. It is recommended that a client start with a series of active stretches (stretches that actively contract the muscle in opposition to the one being stretched) followed by dynamic stretches that segue into the actual workout. Towards the end of the routine, using a foam roller is a good way to cool the client down and aid in increasing flexibility. Static stretching is to be done at the end of the workout, in most cases.

In the event that static stretching is performed without a preceding exercise routine, NFPT recommends an active warm up. It is safer and more effective to stretch muscles that are already warm.

On days that a client does cardio before resistance training, NFPT recommends an active and dynamic warm up before cardio. Once finished with the cardio, the client is to do a dynamic warm up that directly relates to the planned resistance exercises. Static stretching can be performed after the aerobic phase. However, static stretching should primarily be performed as the final phase of the general fitness exercise program.

5. Body Composition

Body composition is the ratio of lean body mass to fat body mass. Basically, when you take a body composition measurement, it is divided into two (2) parts: fat and non-fat.

> ***For women:*** fat should not exceed ***25%*** of body weight
>
> ***For men:*** fat should not exceed ***18%*** of body weight

Lean body tissue (the non-fat components) are bones, muscles, organs and water mass. Though small amounts of essential fats exist in organs and bones, they are still deemed lean mass, or 'non-fat', components. Generally speaking, when dieting *without* exercise, weight loss occurs as a result of lean body tissue, mostly water, and not loss of fat. A balance of healthy eating and exercise is the way to both lose the fat weight and build the lean body weight. It is important that your client know that 'thinness' doesn't always mean 'leanness'. Being lean is to be within a healthy weight range with adequate muscle to perform activity. Everyone knows that muscle is more dense, heavier per equal measure, than fat (i.e. a spoonful of muscle weighs more than a spoonful of fat). Thus, the traditional scale can be very misleading as it does not have the ability to differentiate between lean (muscle) and non-lean (fat) tissue - going simply by body weight alone isn't telling. As a trainer, you will conduct consistent body composition measurements to gauge progress. This is done with a scale that uses electrical impedance, calipers or underwater weighing. Though these devices are different in function, and should be used according to their specific instruction, they are similar in application. They all calculate body fat based on total weight, to determine lean body mass. Initial body composition measurements are conducted in the assessment phase of client programming.

The General Fitness Exercise Program

Now that we know the elements of general fitness, let's translate what we have learned into an appropriate exercise training program. NFPT recommends a well balanced exercise session that is aimed at maintaining overall fitness for the average individual. This could consist of the following programming models. Also include a 5 to 10 minute warm up and a 5 to 10 minute cool down consisting of a low level aerobic activity (such as walking or slow cycling). Program design for specific types of training is examined in-depth, progressively throughout the text. However, at this point, the initial development of a fitness program addressed.

After 5 to 10 minutes of a low level aerobic warm up:

1 Perform active and dynamic stretching to warm up the entire body. Pay particular attention to hamstrings, lower back, calves, and, most importantly, the muscles that are to be targeted in the resistance training part of the exercise program. Foam rolling can be considered for tight areas as well.

Active Stretching (examples): Cat/Camel, Yoga Twist, Bent Knee Twist, Shoulder Clocks, Supine Bridge, Side Lying Trunk Twist, Quadraped Arm-Leg Raise, Fire Hydrants, Calf Stretch, Single Leg Supine Bridge, Supine Leg Whips, Glute Med Hip Hikes, Overhead Broomstick Dislocations

Dynamic Stretching (examples): Toy Soldier, Single Leg Hip Hinge, Reverse Warrior Lunge w/Twist, Warrior Lunge Hip Flexor, Walking Spiderman, Alternating Lateral Lunge, Squat to Stand, Crossover Overhead Reverse Lunge, Running Butt Kicks, High Knee Skips, Sumo Squat

2 25 minutes of resistance/weight training. Perform 3 sets in the 20-25 rep range of the following exercises in a circuit fashion: Pushing, Pulling, Squatting/Lunging, for a total of 9 sets (3 sets per exercise). This improves muscle endurance and fat loss. If muscle strength is the goal, perform a split routine using sets of 4-6 reps (see *NFPT Charts and Tables* for program design). Some active stretching between sets may be helpful. Performing traditional floor exercises on a foam roller or physio ball is sometimes preferred, but only as the client progresses and becomes stronger. *Replace this part of the program with functional training if desired.*

3 5 to 10 minutes of abdominal work and core exercises. Use medicine balls, balance boards and physio balls.

4 10 to 20 minutes of aerobic activity performed at 60-70% of maximum heart rate; such as jogging, running on a treadmill, or a combination of both followed by some mild stretching.

Reminder: Upon reaching the *Maintenance Conditioning Stage* (stage #3, Progression on the Aerobic Phase, page 141), the above exercise program, performed 3 times a week, will maintain an average level of overall fitness, for most people. The NFPT recommended routines, as outlined in the *Charts and Tables* section of this manual, are geared toward one of these three goals specifically: **optimizing fat loss; maintaining lean muscle weight; or increasing lean muscle weight**.

Alternative Resistance Progamming

While there is no one resistance training program that stands above others for general fitness, the following could be considered more of a "non-athletic" program, preparing the client to better perform daily activities. This is especially applicable among special populations.

Note: NFPT does not recommend the performance of intense aerobic activity and intense anaerobic activity in the same exercise session.

Full Body Resistance Program

It is recommended to use the following sample resistance program two (2) times per week, consisting of between 8-10 separate exercises performed in a circuit fashion, with sets of 12-15 repetitions. When using this type of program design, it is important that multi-joint (Compound) exercises are performed first before moving on to single-joint (Simple) exercises, as suggested in this sample routine:

1. **Squat:** quadriceps, glutes
2. **Lunge:** quadriceps, glutes, hamstring
3. **Supine ball tuck:** hamstrings
4. **Chest press:** pectoralis major
5. **Wide grip pull-downs (slightly wider than shoulder):** latissimus dorsi
6. **Seated rows:** upper back
7. **Military press:** deltoids
8. **Biceps curls:** biceps
9. **Triceps extensions:** triceps

Generally speaking, training muscles that perform primarily single joint (simple) movements prior to training muscles that are primarily associated with multi-joint (compound) movement may be counter productive.

For example: performing sets of triceps presses exhausts the triceps. Following this triceps training with chest presses places the pectoralis major at a disadvantage being the prime mover; the triceps muscles that assist the pectoralis major will contribute to failure of the triceps before the pectoralis major reaches complete exhaustion.

Some experienced resistance trainees actually find it desirable to train a “lagging” or “rehabilitating” single-joint muscle just prior to a compound exercise in which it assists. This is done to intentionally exhaust the usually smaller, “lagging” body-part prior to exhausting the prime mover (usually larger). This type of training is referred to as “pre-exhaustion”.

Flexibility, Stability and Core Strength

A quality trainer will focus on flexibility, stability, and core strength while working towards a specific goal. Flexibility is one of the most important parts of a fitness program. Unfortunately, it is often over-looked by most trainers. Lack of flexibility is the root of most injuries and range-of-motion limitations. When a muscle is tight it limits the muscle’s ability to contract properly, causing inefficient movement.

Muscles that are tight are more likely to be injured and cause the opposing muscle to contract improperly. When more focus is placed on stretching and performing moderate exercise, many health problems/injuries, (including the need for certain medications) will dramatically decrease. Flexibility and stability are the foundation of exercise. Without these, the body’s movement becomes limited and results are difficult to achieve. Stability is a key element. This is an area where many trainers lack knowledge.

Stability exercises should be implemented into every exercise program. Exercising with free weights and challenged environments (e.g., training on a physio ball) promotes balance and stability. These are essential for the exercise program, especially when working with an older population. Training primarily with machines, without integrating free weights into the program, is inefficient because the client is moving resistance along a fixed axis, and not in free space. Stability is critical for everyone. Without stability, even the strongest person can not effectively move a resistant force. Stability training starts with an effective core routine. A weak core contributes to poor stability and inhibits proper limb movement.

Training the core ('mid section') involves more than just sit-ups and hyperextensions. An efficient core routine consists of dynamic movements, challenges to the center of gravity, as well as isometric (static) exercises. Medicine balls, balance boards and physio balls are great tools for core training and should be integrated whenever possible and applicable. Training on a physio ball is superior to traditional floor exercises for engaging the core. If the core is weak, the extremities cannot function properly. This causes muscle imbalances in the kinetic chain. As a person ages, balance and stability are compromised. If balance and stability are not addressed, they will consistently degrade. Many back and hip injuries are related to weak core muscles. There are many small muscles in the core that the general population knows little about, and therefore does not address during exercise. MRI images show **atrophy** in these small muscles in most spinal injuries. These small muscles need training in order to maintain a healthy spine. When it comes to general fitness clients, and especially athletes, a good trainer understands that the fitness program is not about using fancy equipment or the latest trends. It is about teaching them to maintain a braced and stable core and to understand how to transfer force across their core while performing movement. Functional training that relates to every day activities and focuses on core stability will improve a person's quality of life.

When the goal is lean muscle maintenance and loss of body fat, circuit training is the best choice. Performing circuit training is a sure way to burn maximum calories. Do not target or isolate specific muscles. Engage as many body parts as possible, while keeping strict form. This type of training ensures an efficient and balanced session. For the general population, the benefits of this type of training surpass the traditional style of single muscle sessions. Circuit training is geared toward increasing the heart rate while using some form of resistance or environmental challenge. When circuit training, it is crucial to keep moving and maintain the target heart rate.

When sport specific training, the exercises selected are ones related to the specific movements required by that athletic activity. The exercises used should relate as closely as possible to the sport's required movements. Training in this fashion ensures maximum performance while actually engaged in the sport. It is imperative to focus on the muscles involved in the particular activity, and be mindful of any muscular imbalances. It is important to include drills that enhance muscular control to avoid inadequate response by the central nervous system which may result in injury. A qualified trainer can emulate the challenges faced on the playing field during the session through functional training.

A Good Balance

Remember that the widely accepted general fitness program consists of both aerobic and resistance exercise. However, what about the fitness enthusiast who wishes to be more specific concerning the application of their sport specific program? The pursuit or enhancement of athletic ability by means of the application of aerobic and/or resistance conditioning is commonplace among personal trainer clients. The personal trainer encounters all varieties of recreational and competitive athletes. Those competitive athletes range from the marathon runner to the power-lifter. In these situations, the personal trainer must understand the difference between the general fitness program and an athletic conditioning program. Athletes, such as marathon runners and power lifters, require an individually tailored conditioning program. On one end of the continuum, the marathon runner needs to almost completely focus on aerobic conditioning, with less emphasis on resistance training. Somewhere in the center of the continuum, the boxer, basketball, and football player need a mix of aerobics and resistance conditioning. On the other end of the continuum, the bodybuilder and power-lifter need to focus almost completely on resistance conditioning, with less emphasis on aerobic conditioning.

It is within a personal trainer's role to make the determination regarding the timing, proportion, volume, and intensity of aerobic and resistance exercise conditioning. Please keep in mind that no client should ever completely exclude aerobic or resistance training from their overall exercise program. Both are necessary to achieve the universal goal of good health. It is also important to have a complete understanding of the need for functional core training and a flexibility program at varying levels for your individual clients.

Fundamental Core Routine

The common myth is that training the core simply involves sit-ups and back extensions. An efficient core routine consists of multiplanar movements, or training in all planes of motion. As the body moves, its center of gravity changes. Additionally, forces that are exerted by and on the body's tissues are constantly changing.

Stability of the trunk, and the entire body, starts with an understanding of ***dynamic stabilization***, which relates to strengthening core muscle stabilizers of the spine (transverses, abdominis, and multifidus) while keeping in a 'neutral spine' position, and ***proprioception***, or the sense of the relative position/s/ of neighboring parts of the body. This allows each muscle group to react efficiently to external forces and stresses. These stresses include gravity, changes in terrain, carrying loads, and internal forces exerted by other muscles.

A proper core routine consists of dynamic movements (challenges to the center of gravity) and includes isometric exercises. To completely train the core, dynamic stabilization, isometric and proprioceptive movements must all be included, not just for the mid- section, but for the entire trunk. Medicine balls, balance boards, foam rollers and physio balls are great tools for core training and should be integrated whenever possible and applicable.

Training on the physio ball (challenged environment) is superior to traditional floor exercises, especially for improving stability. As a person ages, balance and stability are compromised. If balance and stability are not addressed they will consistently degrade.

Dynamic stability is best achieved through training in practical positions that mimic activities or movements of a particular sport or daily activity. Most people perform core training while sitting or lying down. This style limits pelvic movement and thus has little functional value.

A weak core contributes to poor stability, inhibits proper limb movement and causes muscle imbalance in the kinetic chain. Many back and hip injuries are related to weak core muscles. Many falls among the elderly are attributed to this as well.

The goal of core training is to develop the core as an efficient automatic system. The developed core is trained to work as a stable base from which to generate optimal force and motion. Again, without stability, even the strongest person cannot propel a force effectively. Remember the key terms and concepts for achieving core stability, proprioception and dynamic stabilization.

Core stability testing (to evaluate client's core strength) is crucial when creating a solid exercise program. The following section contains a list of movements that serve to assess the client's stability and mobility. These same movements may also be used as part of a workout routine. Motor control, mobility and stability must be established to train the core effectively.

Core Progression

It is important to understand progression when training your client. Progression is about challenging the person further, *once they have mastered a particular movement*. It is important, as a trainer, that you do not memorize training programs, you must understand them. Correct any postural distortions, faulty motor patterns or balance issues first. Start with basic stability exercises and stretching on the floor. Focus on holding a neutral spine. Great exercises to start with are: quadruped arm raise, knee planks, upper back only cat camels, and glute bridging. Once the client proves that they can maintain a neutral spine with these exercises in a static position, add some perturbations (small, challenging changes). Don't be so quick to change the exercises themselves. Simply increase the level of difficulty. The following are some basic progression examples broken down by level:

1. Start with quadruped arm raise; to
   quadruped leg raise; to
   quadruped arm and leg raise; to
   quadruped arm raise with knees on a ½ foam roller; to
   quadruped leg raise with knees on a ½ foam roller; to
   quadruped leg raise with knees on a ½ foam roller & hands on dyna disc; to
   knee planks
   knee plank with foam roller; to
   full plank; to
   plank with leg raise; to
   plank on roller; to
   plank on ball with airex pad under feet

2. Start with upper back only cat/camels; to
   low back only cat/camel; to
   cat/camel; to
   cat/camel with eyes closed; to
   cat/camel on half foam roller

3. Start with static glute bridge; to
   two leg glute bridge; to
   two leg glute bridge with band around knees; to
   two leg glute bridges with feet on airex pad; to
   1 leg glute bridge; to
   1 leg glute bridge on dyna disc

Once the client shows proficiency while performing basic floor movements, add basic standing balance exercises. Spend less time on the floor as they improve. The following are basic standing balance exercises in order of difficulty/progression:

1) one leg stand holding neutral spine
2) one leg stand holding neutral spine with perturbations
3) one leg stand with eyes closed
4) one leg stand on airex pad
5) one leg stand with eyes closed on airex pad

STRETCHING

We've briefly covered the topic of stretching, but it's time now to take a closer look at how, what and why to incorporate stretching into your client's routine. Lack of flexibility, improved with stretching, is at the root of many problems. When a muscle is hypertonic, or is abnormally rigid with an increase of tension that impairs proper movement, it is limited in its ability to contract and lengthen properly; this causes inefficient movements and joint stress. Muscles that are hypertonic are more likely to contribute to faulty biomechanics. Appropriate stretching and moderate exercise may prevent many prevalent musculoskeletal injuries. Stretching and strengthening, when implemented appropriately, produce a solid foundation for healthy biomechanics. Without this foundation, biomechanics and movement patterns will become inefficient, leaving you not only performing at a less-than-optimal level, but with a possible increased risk of injury. In some instances, decreased range of motion of the body will enhance performance. An example would be the torso of a sprinter. Energy derived from the ground is transferred to the trunk by the lower extremities. Some of this energy can be lost to excessive lengthening of the trunk musculature. Therefore, it is important to understand specific motion patterns in order to develop a training program that will improve upon the desired results. Furthermore, there is no evidence that stretching decreases the risk of injury. In fact, research by Dr. Stuart McGill, well-known author and professor of spine biomechanics at the University of Waterloo, Ontario, Canada, has shown that low back range of motion in injured workers had little correlation with their return to work. The findings actually show a negative correlation between low back flexibility and back injury. Muscle injury (tear, strain, etc.) rarely occurs at end ranges, discrediting the notion that stretching decreases the risk of soft tissue injury. Therefore, a training/stretching program must be tailored for each individual/athlete that is specific to the individual tasks that they need to, or do, perform.

Arbitrarily increasing joint range of motion, without considering the individual and the tasks they need to perform, may be detrimental. Studies have shown a decrease in muscle power output and increased muscle reaction time following a stretch. When strength and/or power are required of certain muscle groups during the activity, stretching them may be contraindicated.

Precautions: As with all training programs, it is highly recommended that you consult a health care professional, the client's general physician, before initiating a stretch program. Stretching can be dangerous in the presence of musculoskeletal injury or disease. It is also important to warm up muscles before stretching them. Stretching a cold muscle can result in injury.

Goals for the Warm-up Period

- *Improved elasticity and contractibility of muscles*
- *Greater efficiency of the respiratory and cardiovascular systems*
- *Shorter reaction time*
- *Improved perception*
- *Better concentration*
- *Improved coordination*
- *Regulation of emotional states*

TERMS TO NOTE:

Anterior pelvic tilt – Position of pelvis is determined by the anterior superior iliac spine (or ASIS), which is pointed anterior (forward). This is usually associated with hyperlordosis, or hyperextension, of the lumbar spine; this can be usually noticed visually by the glutes "sticking out".

Posterior Pelvic tilt – Position of pelvis is determined by the ASIS, which is shifted posteriorly (toward the back). This is usually associated with hypolordosis, or flexion of the lumbar spine; this can sometimes be noticed visually if the belt buckle is up towards belly button.

Neutral spine – a.k.a. 'good posture', is achieved when the joints are not bent and the spine is aligned, not twisted. This is the midway balanced point of the spine that requires the least amount of muscular contractions, or least amount of energy, to maintain the desired postural alignment.

Stretching Principles and Types

There are several principles that every trainer should be familiar with. Having an understanding of some basic science and principle concepts, you will be able to create the appropriate flexibility and stretching routines that are specific to the person and situation. Let's start with an overview of important concept terminology:

The Stretch Reflex

The stretch reflex is the neurological process where the body responds to a sudden change in the length of a muscle. This pathway includes the muscle fibers, receptors, sensory and motor neurons of the spinal cord.

Golgi Tendon Organ

The golgi tendon organ is a proprioceptive sensory nerve ending, embedded among the fibers of a tendon, often near the musculotendinous junction. This sensory nerve shuts down muscle contraction just short of serious acute muscle injury related to extreme overload.

Stretch receptors

Stretch receptors (also known as muscle spindles) are located within the sarcomere, or muscle cell, and, when lengthened, send a signal to the spinal cord through sensory neurons. When a muscle is in danger of tearing from over-stretch, these neurons synapse, or transfer, the signal to motor neurons that control the muscle that is being stretched. This causes a protective contraction of the muscle from the muscle spindle fibers, called a 'myotatic reflex', in order to maintain its resting length. The controlled use of this stretch/shorten cycle is the basis of plyometric training.

Autogenic Inhibition

Autogenic inhibition is the neurological process whereby proprioceptors (golgi tendon organs), located at the musculotendinous junction, detect an increase in tension in that muscle. When a certain amount of tension is detected, the muscle is then inhibited in the spinal cord, preventing it from contracting. As a result, the muscle will relax.

Reciprocal Inhibition

Reciprocal inhibition occurs upon the contraction of an agonist muscle neurologically inhibits the contraction of the antagonist muscle. This occurs as a motor neuron that causes contraction in the agonist muscle synapses, or transfers its signal to an inhibitory neuron. This inhibits the antagonist muscle. In other words, the antagonist muscle relaxes and is prevented from contracting.

Reciprocal inhibition may also contribute to muscle imbalances. When an agonist muscle is hypertonic, or overactive, its antagonist will be inhibited. This results in lengthening and a decrease in functional control. This allows the agonist to further contract, or shorten, creating a cyclical pattern of dysfunction.

Static Stretching

Static stretching is slow, and involves holding the end point of tension for 30 seconds. This type of stretch targets the passive elastic component of the muscles. An example is holding a toe touch for 30 seconds. There is controversy on static stretching and when to apply it. Throughout the text, more information is given into common misconceptions so you will understand when to apply static stretching.

Problems with Static Stretching

Through experience in the industry, our team of professionals find that most fitness enthusiasts, and even trainers, insist that 3-5 minutes on the stationary bicycle and static stretching are a proper warm up. What some fail to realize is that increasing body temperature alone has benefit, but, it is not enough. Improvement and optimization are not one and the same. Although the body may be warm, the muscle groups need to be specifically warmed up through active and dynamic movements, not by static stretching. Once your warm up is completed properly, then move into the event or routine.

Static Stretching: Good to Know

Static stretching is a great way to increase flexibility for almost any client, when done correctly. NFPT recommends static stretching *after* every resistance training and aerobic workout, as long as the client has no injury limitation. The amount of time spent at the end of each session depends on the need of the client. For clients who consistently stretch on their own and have normal ranges of motion you should spend about 10 minutes and focus on tight areas. For clients who are very tight and/or have a more limited range of motion, spend 20 minutes, with a focus on slow, safe and simple on the tight areas, at the end of the workout. Clients should be taught how to do simple and safe static stretches and encouraged to do them at home for increasing range of motion as well as for relaxation. The importance of stretching is often overlooked and its benefits under estimated.

• Scientific evidence demonstrates that static stretching of muscle decreases isometric and dynamic muscle strengths at different velocities. This means that you will be slower and weaker on tasks that are fundamental to high-level performance.

• Isometric strength is important for stability during complex movements.

• Dynamic strength is inherently important as it relates to physical movement.

There are two factors that are sometimes overlooked regarding static stretching:

1. Muscle/Tendon

2. Neuromuscular

1. Muscle/Tendon

• Prolonged stretching can actually make the muscle and tendon overly compliant.

• It is important to have optimal stiffness when developing force in a muscle. Stiffness allows for better use of stored, elastic energy in the muscle and tendon. It also ensures proper alignment at the muscle fiber level.

2. Neuromuscular

Due to motor control and reflex sensitivity, static stretching makes it more difficult for the nervous system to tell the muscle when to fire.

Static Stretching Acutely Impairs

• Static stretching acutely impairs the muscle and nervous system's ability to perform slow-speed, high force movements, such as power lifting.

• Static stretching acutely impairs the muscular and nervous systems' ability to perform high-speed, lower force movements, such as jumping & sprinting.

Research reveals that balance, reaction time and overall movement time are negatively affected. Overall muscular endurance is affected as well (very important for an endurance athlete).

Static Stretching has its Benefits

As mentioned earlier, static stretching reduces contractibility of the muscles and can impair reaction time, balance and coordination. Static stretching minimally affects the respiratory and cardiovascular systems. This type of muscular stretch may even relax you to the point of impairing concentration, mellowing you out when you need to be firing up. Be aware that there are situations where static stretching is needed before activity. For example, if the client is extremely tight, after a dynamic warm up, you can static stretch those muscles. A good trainer knows how to personalize stretches for each individual.

Static stretching is used for:

- Relaxation
- Increasing or maintaining a particular range of motion
- Post workout: resistance training and aerobic activity

Static stretching specific muscles, before activity, may be required if they are so tight that they impede movement. Usually falling into this category are the:

- Psoas Major muscle: a hip flexor originating from the lumbar region of the spine, L1-L4, inserting into a small protuberance at the posterior medial region of the femur; and the
- Scalene muscles: these act to laterally bend the neck, they originate from the cervical spine, C2-C7 (the neck) and pass through the sides of the neck, inserting into the first and second ribs

There are always exceptions to the rule, so be aware of client needs.

Passive Stretching

A passive stretch is achieved by having an external force applied, such as a partner's push, wall, floor, machine, and so on, in order to attain and hold the end position. Using a well-trained partner can help to achieve greater ROM, and target specific muscle groups.

Active Stretching

Active stretching uses agonist muscle contraction in order to stretch antagonist muscles. This type of stretching uses the principle of reciprocal inhibition. An example is a calf raise through a slow range of motion. This type of stretching is a good way to start as you progress into a dynamic warm up.

Dynamic Stretching

Dynamic stretching uses "controlled movement through the active range of motion for each joint" (Fletcher & Jones, 2004), which improves ROM, loosens muscles, and increases heart rate, blood flow and body temperature in order to prepare the body for physical activity and athletic performance. Dynamic stretching uses active contraction of the antagonist muscle, creating motion, in order to produce a stretch to the agonist muscle.

Example: Transitioning from a body squat to a walking lunge. All sessions should begin with easy active movements and progressively become more dynamic and difficult.

A study of dynamic stretching, performed on recreationally active men (not athletes), showed an increase in power during leg extensions following dynamic stretching. This may be due to the rhythmic contraction of antagonist muscles raising the temperature, and to post activation potentiation or improvement in muscular performance following contraction.

Dynamic Stretching: Good to Know

- Improves performance in sprints, jumping tasks and agility tests
- Increases dynamic range of motion
- Reduces injury rates, when compared with a static stretching program
- Exercises are grouped into three simple categories based on difficulty: Easy, Medium and Difficult
- 8-10 drills per session are sufficient in a single session
- Dynamic flexibility drills serve as a fantastic way to transition from rest to high intensity exercise that is performed through full ranges of motion

Ballistic Stretching

Ballistic stretching involves active motion within a joint while creating a bouncing motion at the end range of the stretching muscle. The goal is for the bouncing to result in an increase in motion past the typical end range on every repetition. This type of stretching can be detrimental to the target or surrounding tissues. It is not recommended to repeatedly force a joint, or a soft tissue, beyond its end range. This can cause irreversible laxity and instability in the non-contractile tissues of the joint (ligaments, joint capsule).

Example: Performing toe touches while bouncing repeatedly to the floor.

This could also activate the stretch reflex, which would in turn cause the target muscle to respond by contracting, or tightening. This type of stretching is not recommended in most cases due to risk of injury. In the event that this type of stretching is required, you should first consult with the client's physician. Similarly, in the information to follow, we look at various stretching techniques at an introductory level for fundamental understanding; but NFPT recommends hands-on specialized training before implementing these or other advanced level stretching techniques.

Facilitated Stretching

This type of stretching requires an assistant. The assistant/trainer manipulates the limbs for the client by pushing the limb to its end range and holds for 20-60 seconds. Assistant/trainer may repeat this 2-3 times per body part. It is simply an assisted static stretch.

Proprioceptive Neuromuscular Facilitation (PNF) Stretching

Proprioceptive Neuromuscular Facilitation (PNF) is a method of 25 facilitated stretches that incorporates four different types of stretching techniques described below. These combine muscle contraction and relaxation in order to relax an overactive muscle and/or enhance the flexibility of a shortened muscle. PNF was developed by Herman Kabat MD, PhD, Margaret Knott PT and Dorothy Voss PT in the 1940s to treat paralysis patients. Over the years, other forms of PNF were developed for the treatment of orthopedic, as well as neurologic, disorders.

A simple variation of Proprioceptive Neuromuscular Facilitation (PNF) is a type of stretching used to optimize motor performance through the enhancement of passive and active ranges of motion. The result can be enhanced by the use of an assistant/trainer. Find your partner's first barrier, then have them slightly push for 10-12 seconds and relax into a deeper stretch for 10-20 seconds. Repeat this 2-3 times on each muscle group.

Post Facilitation Stretch

1. Target muscle is placed in mid-position
- Midrange of the muscle's full contraction

2. Client contracts isometrically for 10-12 seconds using maximum strength
- do not allow muscle to bounce – positioning and leverage are key

3. Relaxation phase
- Client is instructed to let go of the stretch
- Trainer immediately stretches muscle
- Client may have to practice how to let go immediately

4. Stretch
- Muscle is held at new barrier for 15 seconds

5. Repeat at new barrier
- If no increase in ROM was achieved, start at mid-position
- Increase in ROM due to autogenic inhibition

Post Isometric Relaxation (PIR)

1. Engage barrier

- This is done by lengthening the muscle until slight resistance is met

2. Isometric contraction

- Client is told to exert slight resistance (10-20% muscle contraction force) in the opposite direction
- This is held for 10-12 seconds
- It is important that the contraction is isometric, therefore, no movement must take place

3. Relaxation phase

- Client is instructed to relax
- Wait at barrier for muscle to release and then initiate stretch

4. Stretch

- Stretch until the next barrier is met and hold for 15 seconds

5. Repeat at new barrier

- Increase in ROM due to autogenic inhibition

PIR with Agonist Contraction

1. Same as PIR (Post Isometric Relaxation): Engage barrier

- This is done by lengthening the muscle until slight resistance is met

2. Same as PIR: Isometric contraction

- Client is told to exert slight resistance (10-20% muscle contraction force) in the opposite direction
- This is held for 10-12 seconds
- It is important that the contraction is isometric, therefore, no movement must take place

3. Agonist contraction

- Following the isometric contraction, the agonist muscle is contracted as the target muscle is taken to its new barrier.

4. Repeat at new barrier

- Increase in ROM due to reciprocal and autogenic inhibition

Contract-relax

1. Same as PIR (Post Isometric Relaxation)

2. Concentric contraction
- Target muscle is contracted through its full ROM against resistance

3. Relaxation phase
- Client is instructed to relax and let go

4. Stretch
- Stretch until next barrier is met and hold for 15 seconds

5. Repeat at new barrier
- Increase in ROM due to autogenic inhibition

Note: At the time of this initial study, researchers assumed that the increased ROM of the muscle was based on muscle fatigue, reciprocal inhibition, muscle spindles, golgi tendon organs, and so on. However, EMG studies have shown significant activity in stretched muscles after their contraction in PNF-type techniques. Therefore, this increased ROM cannot be solely attributed to relaxation. It has been theorized that actively stretching allows the subject to feel as if they have more control, and as a result are more willing to extend their tissues into greater ranges.

Cramps

Muscle cramps are involuntary and often painful contractions of the muscles, resulting in shortening. It is a common misconception that cramps originate in the muscle itself, and that the muscle fires randomly. In actuality, cramps are found to be a primarily neurological activity in which the motor neuron that controls a muscle fiber fires at a high frequency, causing this involuntary contraction.

Some Causes of Cramps May Be:
• Heavy exercise
• Pregnancy
• Hypothyroidism
• Depleted magnesium or calcium stores or other metabolic abnormalities
• Alcohol consumption
• Kidney failure leading to uremia
• Medications
• Muscle fatigue
• Dehydration

Although cramps may be benign, it is important to note that they may also be red flags of serious neurological, endocrine or metabolic disorders. Persistent cramping should always be evaluated by a professional.

Fasciculations

Fasciculations are single, involuntary firings of motor neurons that will cause brief twitches in the muscle fibers that they innervate. These twitches usually are low in intensity, and will usually not produce motion at a joint.

Like cramps, many fasciculations are benign and do not indicate pathology. It is very common for healthy people to experience benign fasciculations. Common areas of fasciculations are eyelids and thumbs.

More serious causes of fasciculations; such as motor neuron disease, or denervation due to radiculopathy, are usually accompanied by weakness and atrophy of the affected muscle group. These pathological fasciculations generally tend to occur randomly, whereas benign fasciculations tend to occur repetitively at the same sight. As with cramping, it is suggested that regularly occurring fasciculations are evaluated by a professional to determine whether or not they are benign.

**Stretching techniques should not be overlooked as a key element to reaching goals! In order to develop appropriate training programs that are in line with desired results, it is important to understand specific motion patterns. Stretching and strengthening, when implemented appropriately, produce a solid foundation for healthy biomechanics. Biomechanics and movement patterns become inefficient without this foundation. This chapter provided an introduction to learning the various types of stretching techniques, but you are encouraged to seek additional education on this subject. Consider NFPT's *Stretching Principles* continuing education course, or find others available that teach the techniques required to achieve optimal performance and minimize injury through appropriate stretching.

CHAPTER 10

Aerobic and Low Level Activity

All exercise program designs for apparently healthy clients should include components of both resistance exercise (anaerobic) and also cardio (aerobic) exercise. The recommended amount of each form of exercise is entirely dependent on the client's current condition and their fitness-related goals.

REVIEW:

Aerobic exercise: *uses oxygen* to adequately meet the energy demands required by the exercise. Also known as 'cardio'/cardiovascular exercise, aerobic exercise is low to moderate intensity, such as walking, jogging, swimming, cycling.

Anaerobic exercise: uses energy systems to produce ATP in the *absence of oxygen*, a process known as anaerobic glycolosis, to meet energy demands of the exercise. Anaerobic exercise is generally brief, high intensity exercise, such as bodybuilding/weight training, jumping, sprinting.

Recommendations must be precise and objective to assure consistent progression toward client goals whether the client is interested in competitive athletics, fat reduction, or general fitness.

The purpose of this chapter is to provide the fitness professional with a system of objective measures. This allows for proper aerobic training recommendations as they apply to apparently healthy clients, ranging from sedentary individuals to world-class athletes.

Safety First

Each prospective client must be appropriately screened for any major health concerns prior to beginning an exercise program, regardless of the type of activity that will be performed. No big surprise here, but it is necessary to reiterate this point to protect both trainer and client from any unforeseen maladies. If a small risk factor is missed, then there is potential risk to the client's life and the trainer's livelihood. Always recommend the client undergo a physical examination prior to initiating any new physical activity; and, if the client has ANY cardiovascular risk factors, REQUIRE A PHYSICAL!

The Metabolic Continuum

Glycogen is converted to glucose and used for energy during average to high intensity aerobic exercise, just as it is for resistance exercise. Regardless of conditioning level or the duration, intensity, etc., a small portion of energy used during aerobic exercise is always derived from glucose. The bulk of this glucose originates at a different place during aerobic activity than it does during resistance activity. During aerobic-based exercise, glucose is taken directly from the liver and blood (a small amount of glucose will always be obtained from inter-cellular "glycogen" stores in the working muscles). The liver stores, with the right pre-workout meal, can provide 300 - 400 calories of glycogen for conversion to glucose and gradual release into the bloodstream during aerobic activity. Through the body's use of oxygen (liver glycogen or muscle glycogen [during intense segments]) along with circulating blood born fatty acids and adipose tissue, the muscle energy needs are met during aerobic activity.

The contribution of the primary energy substrates, glucose and fatty acids, changes significantly depending on the effort necessary to meet the imposed demands of that activity. The higher the intensity (at the start) of an activity, the more the body depends on stored carbohydrate sources for energy (glucose). The lower the intensity (at the start) of an activity, the more the body depends on greater percentages of stored fat sources for energy (fatty acids and glycerol). Keep in mind, at any given time, energy is in fact provided from both primary energy sources and some proteins (amino acids). For now, only concern yourself with the primary energy sources, glucose and fatty acids.

When beginning any activity over and above resting metabolism, the energy required to perform that activity is first supplied by anaerobic (carbohydrate) metabolism. This occurs because it takes several minutes to mobilize fat in sufficient quantities to sustain an activity. As activity is continued for a sufficient amount of time, the body "catches up" as oxygen uptake increases to allow greater, more efficient utilization of oxidized carbohydrate and fat for energy. This transition from an anaerobic metabolism to an aerobically dominated metabolism is dependent on two major factors, the *intensity* and *duration* of the activity. If an exercise requires near maximal, immediate effort (such as weight training which cannot be sustained for long periods of time) the exercise metabolism remains primarily dependent on glucose sources without need for significantly increased oxygen uptake to perform the activity (anaerobic). As aerobic intensity increases, there is a relative percentage/need of energy coming from glucose sources.

Performing an activity which is of low intensity (a fast walk or a slow jog) and is maintained for long periods of time facilitates the increase in oxygen uptake necessary to utilize fat stores as the primary energy sources (aerobic). These long, low intensity aerobic workouts access fat storage for fuel, however, a weight loss goal requires that the calories burned during and after the workout (while the metabolism is high) <u>exceed</u> the daily caloric intake.

Monitoring Aerobic Exercise Intensity

Based on the preceding explanation and review of VO_2max, evaluating and controlling aerobic exercise intensity is very important in assuring progress toward a desired goal. While there are many methods by which a personal trainer can estimate aerobic exercise intensity, the standard and easiest method for both trainer and client is to simply monitor heart rate. At submaximal workloads there is a linear relationship between heart rate and oxygen uptake. Therefore, as aerobic exercise intensity increases, heart rate increases in direct proportion making it the ideal method of monitoring aerobic intensity. Aerobic exercise intensity for the typical symptom-free fitness client will fall in the range of 60 - 70% of their maximum heart rate. The following equation is based on 60% intensity. As previously discussed, the Karvonen is probably the most common method for calculating exercise heart rate (ExHR). The exercise heart rate should be at least the sum of the resting heart rate (RestHR) plus a percentage of the difference between the age predicted maximum (MaxHR) and resting heart rates (RestHR). Remember, the calculation for finding the target exercise heart rate for the client, exercising at 60% intensity, is:

208 - (0.7 x Age (in years)) = MaxHR

Check Pulse for 15 Seconds (non-exercising, seated rest) x 4 = RestHR

RestHR + [0.60 x (MaxHR - RestHR)] = ExHR

Obviously, as the client's aerobic conditioning improves, their exercise heart rate will decrease proportionately. However, there are situations in which the calculated estimations exceed a client's ability to perform without excessive discomfort. This may be due to poor conditioning or non-apparent risk factors. When this situation occurs, it is helpful to utilize a tool called a *Rating of Perceived Exertion Scale* (RPE), or the *Borg Scales*. These scales can be used to identify both aerobic and resistance training intensities, which are based on how the client feels with regard to strain, effort, and fatigue. Of course, this is a subjective measure that is based on the client's perception of effort, but it is helpful for monitoring and adjusting the intensity level accordingly.

The Borg Scales contain both numeric and physically descriptive categorizations by which the client can describe the difficulty of the activity. Difficulty is most apparent by their shortness of breath and struggle to perform the activity. It is important that both trainer and client understand the range of perceived exertion on both the high and low ends of the scale in order that the feelings be communicated accurately (0 being the feeling you have at rest, and 10 being the feeling at absolute maximal effort where no more effort can be given to the activity). Use this information as a gauge for reassessing the load/activity as it correlates to their current intensity level (adjusting as needed based on the client's feelings of strain, effort, fatigue or discomfort).

Borg Scales (Modified RPE)	Exertion Description
0	No Exertion at All
0.5	Extremely Light
1	Very Light
2	Light (able to hold conversation)
3	Moderate (60% intensity)
4	Somewhat Heavy (Hard) (starting to get difficult to hold conversation)
5	Heavy (Hard)
6	(breathing is labored, getting harder to hold conversation) (80% intensity)
7	Very Heavy (Hard)
8	(deep and forceful breathing, not able/not wanting to hold conversation)
9	Extremely Hard (90% intensity)
10	Maximal Exertion

Aerobic Training Program

With the preceding information in mind, the aerobic training program then becomes a matter of manipulating the variables of frequency, intensity, duration, and type of exercise. The following examples describe the ways in which the variables are adjusted and applied to specific training goals.

Aerobics and the fat reduction client

The primary concern with a fat reduction client is just that...reducing fat. Due to periods of prolonged inactivity, this type of client typically has very inefficient fat mobilization and utilization mechanisms. Unfortunately, when it comes time to be active, they are very efficient at using carbohydrates for energy, which does very little for reducing their fat stores. Therefore, it is of the utmost importance that this client's aerobic exercise program is designed to emphasize fat metabolism while at the same time de-emphasize the influence of glucose metabolism. The resistance exercise facilitates glucose metabolism.

Any energy requirement, rising rapidly over and above resting metabolism, is initiated via carbohydrate metabolism. Therefore, the intensity for the beginning client's aerobic training program should be low. If heart rate is monitored, a slow, progressive increase over a period of several minutes will be observed. Monitor the client's exercise heart rate until it reaches between 60 and 70% intensity. The client's actual target heart rate is determined by use of the Karvonen formula. A progressive increase in the client's respiration is also observed. Respirations should not be so labored that the client is unable to speak comfortably while working within the (60-70%) intensity range. Consider clients age, cardiorespiratory function and aerobic conditioning when establishing the intensity range. Obviously, as the client's cardiorespiratory function improves, exercise intensity may be increased as tolerated.

With practice, the client is able to effectively utilize the Borg Scales to assist in monitoring their aerobic exercise intensity. This reduces the necessity of taking frequent heart rate readings. Using the Borg Scales, a fat reduction client will want to remain at a Modified RPE of level 2 plus or minus one level (fairly light). This level protects against exceeding the capacity of the body to provide sufficient fat for energy while minimizing glycogen conversion and use.

The typical recommendation duration for aerobic activity ranges in duration from 15 to 60 minutes per session. The duration of aerobic exercise sessions for the fat reduction client should fall toward the latter and even longer. The duration may extend longer, but only if the exercise intensity is maintained at the lower end of the recommended heart rate intensity range. This recommendation is also applicable to strength training athletes and to the elderly; basically, anyone who is interested in fat reduction and the moderate cardiorespiratory benefits associated with this type of activity.

An additional advantage to lower exercise intensity with fat reduction clients is that it can be performed much more frequently and for longer periods than more intense aerobic activity (which is directed primarily at improving cardiorespiratory benefit). In fact, at such low intensities, this type of exercise can be performed on a daily basis (assuming your client is not on a sub maintenance caloric intake).

Recommended types of exercise for low levels of activity include walking, cycling, and/or stationary bike riding. The intensity levels of these forms of exercise are easy to control. They are progressed without difficulty, are low impact, and do not require development of new skills.

REVIEW: Low Level and Aerobic Activity for the Beginner, Fat Reduction Client

1 Low to moderate intensity (< 60 to 70%, depending on fitness level)
2 High frequency (fat reduction clients can exercise more often)
3 Long duration (60 - 90 minutes at low intensity levels)
4 Choose exercises that are performed with: low impact, low intensity, long duration, requiring minimal coordination and are rhythmic in nature (e.g. a long walk)

Aerobics and the General Fitness Client

Many clients may already be involved in some sort of fitness program. These clients may seek the services of a trainer for guidance and direction in further improving their fitness levels. Perhaps they have progressed from their beginner, fat reduction stages to a point where they are still working on weight loss goals but at a higher level of fitness. In this case, the general categories of intensity, duration, frequency, and type of exercise are modified to fulfill the client's fitness goals.

To 'kick off' fat reduction, for the beginner, exercise intensity remained low to de-emphasize anaerobic systems. As the client moves from strictly fat loss to a more generalized goal for weight maintenance and improved overall fitness (a.k.a. the 'General Fitness Client'), a new and more demanding goal, using increased intensities, will inevitably stress the anaerobic systems to some degree. This is due to the fact that the energy requirement of the more intense aerobic exercise performed exceeds the cardiorespiratory system's current ability to supply as much of the energy aerobically. In order for the desired adaptation to a higher level of aerobic fitness to occur, more glucose energy will be required. With time, anaerobic systems will once again become less and less stressed. With this progression, and when further adaptation is desired, it will then be time to make changes that will again result in more intensity and a greater dependence on the anaerobic systems. Progression of this type is always dependant upon client goals. Basically speaking, the difference in total energy expended and the aerobic energy supplied by the cardiorespiratory system, will be supplied by carbohydrate based anaerobic systems. This correlation is strictly based on exercise intensity. Low intensity emphasizes the aerobic systems while higher intensity emphasizes the anaerobic systems.

Exercise intensities for a client interested in improving their existing fitness level are within the range of 70 to 85% of maximum heart rate (use the Karvonen formula). Intensity is adjusted according to the client's current fitness level, as well as their tolerance based on the Borg Scales. The RPE for this type of client ranges from 4 (somewhat hard) to 7 (very hard). Again, adjustments should be made to accommodate each client's current fitness level.

Ever-increasing exercise intensities dictate a necessary decrease in the frequency of aerobic training. For the general fitness client, aerobic exercise may be performed between 3 and 5 times per week. As the client progresses to higher intensity exercise sessions, reduce the number of total sessions per week to allow adequate recovery between workouts. This will prevent "burn out" due to overtraining, and reduce the likelihood of injuries.

An inverse relationship also exists between the duration of an exercise session and its intensity. The stress applied to anaerobic systems during too frequent, long duration, higher intensity, energy draining aerobic training sessions, results in a decreased ability to maintain the desired exercise intensity. This difficulty occurs because of the progressive depletion of carbohydrate sources that supply the necessary energy to challenge current fitness levels. Increased recovery duration is generally necessary.

Depending on current fitness levels and applied exercise intensity, the above exhaustive level of exercise may also be too uncomfortable to continue for extended periods of time. Typical aerobic training sessions for the general fitness client should be no less than 15 minutes and should not exceed 60 minutes. Frequency is 3 to 5 times per week *depending upon current fitness levels*, with the average duration falling between 20 and 30 minutes (not including warm-ups).

Note: Although a progressive increase in aerobic exercise intensity is beneficial, an eventual "burning sensation" in localized working muscles is experienced. This occurs because of localized lactic acid build up and is not usually experienced by the general fitness/fat loss client. If this burning is experienced it is a clear indicator that anaerobic systems are being overemphasized and exercise intensity may be too high for your beginner client. Conversely, however, if the goal is to increase muscle endurance through the muscles' improved ability to tolerate lactic acid then this "burning sensation" is desirable. Increases in intensity are necessary for continued progression, but the 'jumps' in intensity are controlled by the client's progressive fitness level and goals.

A well-rounded exercise program provides for greater variety in the client's training. Aerobic activity in this case may be more directed toward a sports or recreational related activity such as brisk walking, running, roller blading, cross-country skiing, and biking. Exercise can also be performed on any of these pieces of aerobic equipment: treadmills, ski machines, stair climbers, rowing machines, etc. This variety plays an important role in client motivation also. It is good to mix things up so that progressive higher intensity exercise is made more enjoyable for the client.

REVIEW: Aerobics and the General Fitness, Advancing Client

1 Moderate to high aerobic intensity (70 to 85%)
2 Moderate frequency of aerobic exercise (3 to 5 times per week)
3 Moderate duration of aerobic exercise (average 20-30 minutes per session)
4 Choose any variety of sport or exercise activities which are continuous/sustained in nature

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Aerobic Activity and Cellular Catalyst Function

Aerobics performed at greater than 70% intensity, and/or for a duration of more than 30 minutes, accelerates catalyst (enzyme) function in the muscle cells. When this occurs, catalysts and available amino acids are depleted. Amino acids, ordinarily spared for protein synthesis (building tissue), are used by the body to produce more catalysts. Since catalysts provide for survival functions, their maintenance and repletion takes precedence even over the maintenance of muscle tissue. It is important to note that the greater the intensity of aerobic exercise, the greater the cellular catalysts' depletion.

Aerobics and the Endurance Athlete

The endurance athlete presents a special challenge for personal trainers. Chances are, these athletes have already endured the rigorous workouts necessary to achieve an extremely high level of aerobic fitness. Their purpose in seeking trainer services is typically to improve their specific endurance event performance. Essentially, the cooperative goal, when working with such an athlete, is to maximize their ability to utilize oxygen (maximal oxygen uptake, increased VO_2max %) and to perform at that maximum level for a longer period of time.

This type of training not only stresses the aerobic energy systems to their maximum but also requires a major contribution from the anaerobic energy systems as well. However, great care must be taken to control this anaerobic contribution as it can inhibit performance due to high levels of lactic acid and exhaustion of energy systems. Extending the athlete's ability to perform at near maximum levels, for extended periods, forces adaptation and enhances performance.

To achieve improvements in performance, through increased VO_2max, it is important to note that it is not always necessary to train at maximal intensity to place sufficient stress on the aerobic and anaerobic systems. Research indicates that maximal oxygen uptake is reached at 80% of maximal performance speed for a given training distance. 80% performance speed equals approximately 95% of the athlete's maximum heart rate. Therefore, two simple calculations provide you with sufficient information to recommend training intensities that elicit an effect equivalent to maximum effort.

These simple calculations are based on either training time over a particular distance, or training heart rate. Examples:

Suzy Swimmer swims 200 meters in 120 seconds. To calculate the training interval for this activity, divide the time by 80%:
120 seconds / 0.80 = 150 second training interval

Randy Runner is a one mile run specialist. He performs repeated half mile runs. During his best timed half mile run his maximum heart rate was 200 beats per minute. To calculate Randy's training target heart rate, multiply the maximum heart rate by 95%:
200 BPM x 0.95 = 190 BPM Target Heart Rate

Keep in mind that exercising at these intensities will improve maximal oxygen uptake while preventing a maximal contribution from the anaerobic energy sources.

All recovery from maximal effort clearly takes longer than recovery from near maximal effort. Training at intensities higher than 80% for time or 95% of heart rate, contributes to further increases in maximal oxygen uptake. Additionally, this comes at the expense of the ability to perform a greater number of repeat intervals due to a near total exhaustion of anaerobic systems. Performance at high intensity requires a decrease in frequency and duration in order to achieve optimal recovery and maintenance or ability to complete the next workout routine. The greater the exercise intensity, the less frequently training at that level can be performed. For example, if it takes Randy Runner 3 days to recover from a 95% intensity workout, it may take only 1 or 2 days to recover from a workout at 75% intensity. Adequate recovery time (between higher intensity training sessions) is determined by noting the client's ability to repeat and maintain training performance over a number of progressively more intense training sessions. Inclusion of several less intense "recovery sessions" (based on the following information) is most helpful.

First: A well-trained endurance athlete's cardiorespiratory system recovers from exercise very quickly and is rarely a determinate of this athlete's ability to recover from a training session.

Second: lower intensity "recovery" workouts (75%) place less stress on the anaerobic systems because aerobic systems provide the primary sources of energy at these lower levels of intensity and with very little needed recovery. Inadequate recovery of the anaerobic systems is generally responsible for overtraining and lagging performance. Inclusion of lower intensity "recovery" throughout near maximum intensity sessions (95%) does not significantly deter the ongoing recovery between near maximum intensity sessions. For these reasons, the aerobic systems (utilizing oxidized carbohydrate, fatty acids, and slow twitch muscle fibers) can be trained more frequently by the conditioned athlete to maximize aerobic capacity development. Randy Runner's training log, for example, may look something like the Day/Intensity log provided here:

Day	*Intensity %*
1	90%
2	75%
3	80%
4	85%
5	75%
6	95%
7	OFF
8	75%

Note this is simply an example. Individual client performance varies depending on current fitness levels, performance goals, and recovery ability. Most of the endurance athletes training sessions are directed toward performing their respective activity. (Runners will run, swimmers will swim, etc.) However, it may be necessary at times to provide alternative activities to the athlete to prevent injuries, allow for healing of old injuries, prevent mental or physical stagnation, or to emphasize improvement in one particular aspect of their performance (i.e. strength, glycogen storage, explosive power, finishing kick, lactic acid tolerance). Sport/Activity specific high repetition resistance exercises are valuable in improving anaerobic systems through improvement in the body's ability to store energy. It is also important to cross train the endurance athlete in accordance with functional training recommendations.

Keep in mind, athletes who require muscular strength and stamina may be adversely effected by the intensity and frequency of the above recommendations. These suggestions are for the serious endurance athlete.

REVIEW: the Endurance Athlete

1 Moderate to very high intensity (70% to maximal effort)
2 Moderate to high frequency (depending on exercise intensity, level of conditioning, and event demands)
3 Moderate to long duration (depending on exercise intensity, level of conditioning, and event demands)
4 Primarily event specific activity
5 Resistance exercises designed to improve muscle energy storage and production
6 Implement appropriate cross training methods (See Chapter 11: *Cross Training and Enhancing Sports Skills*)

Hitting the Wall

When an endurance athlete "hits the wall," it is primarily due to the exhaustion of glucose reserves in the liver and muscles. The abrupt loss of energy and sudden onset of fatigue are observable measures of "hitting the wall." The performance and recovery from resistance activity increases glycogen stores and, in turn, enhances and prolongs the aerobic performance of endurance athletes, inhibiting the "hitting the wall."

To maximize the duration of aerobic performance, a client must perform regular resistance exercise in the higher rep ranges (20-25) to failure, targeting the muscles to be used in the chosen event. Through consistency in proper diet and resistance training, endurance athletes can actually duplicate and improve the ability to tolerate the "muscle burning" sensation. This improves their ability to perform in the stage of an event where there is increased aerobic intensity (running up an inclined surface, approaching near maximum effort, during a sprinting phase, etc.). Performing recommended resistance training in high rep ranges, while focusing on the musculature involved in the specific activity, effectively trains the muscles to store more energy. The occurrence of the burning sensation is offset, thus delaying the "hitting the wall" phenomenon. DO NOT use this type of resistance training within 2-3 days of an event. The client's muscles may not have time to totally recover and they will fail sooner from the lack of energy replacement. The 2-3 day period prior to the event would be better spent having the client load up on carbohydrates.

Maintenance of Aerobic Fitness

What happens if your client discontinues their recommended conditioning program? Upon cessation of exercise, improvements in cardiorespiratory conditioning progressively return to pre-training levels over a period of a few months. Improvements in aerobic fitness are not permanent and require some form of regular training to be maintained.

Intensity may vary to accommodate those who wish to maintain a higher, but not competitive, level of fitness.

Aerobics and Muscle Tissue 'Cannibalism'

Remember (as described in Chapter 6: *Physiology of Nutrient Metabolism)*, glucose depletes during aerobic activity, and stress hormones are released by the adrenal glands to trigger the liver to release enzymes into the bloodstream. These enzymes deaminate and cannibalize amino acids, blood proteins, organ tissue, and muscle tissue. In the absence of glucose, during intense aerobic activity, energy needs exceed the body's supply of oxygen and fatty acids. Therefore, muscle tissue will 'eat away at itself', essentially being cannibalized, to provide for the balance of the energy needed to keep up with this continued demand.

CHAPTER 11

Cross Training and Sport Enhancing Skills for the Athlete

Before getting into the 'art' of cross training, athletes should understand that their body will adapt only to those activities that are performed regularly. With this in mind, the only way to obtain optimum "functional fitness" is to apply cross training. Cross training is like multi-tasking, in the sense that two or more tasks are performed at once, but with one generally focused goal. Cross training provides for an improved overall state of performance and fitness by training in multiple modalities. The athlete may train as if they are training for two or more sports. However, their focus is on maximizing their performance in one of them. The manner in which most athletes prepare for a specific event or sport is generally specific to the sport itself. All sport activities have unique conditioning needs and the S.A.I.D. (Specific Adaptation to Imposed Demands) principle applies here. For example, if a triathlon athlete trains using only techniques specific to that sport they will most likely perform poorly in another sport, since its demands are completely different than those demands imposed during triathlon preparation. For instance, an extremely well conditioned bodybuilder plays a serious game of football over the weekend. To everyone's surprise he performs terribly. Moreover, he has to take a rain check on the next day's "playoff" game because he could hardly get out of bed that morning. What can be learned from this? There is a need for cross training in order to achieve peak general functional fitness (ability to perform well in activities across the board). This requires equal measures of cardio, multi-directional exercises, varied sport activity, strength training, and flexibility exercise. It is important to understand that cross training techniques (properly applied with a focus primarily on sport specific activity) enhances the athlete's performance in that sport.

In many cases the avid fitness enthusiast slips into a rut by choosing a fitness program comprised of exercises that seems appropriate for their initial needs and goals. After a period of time, this fitness buff becomes attached to their program and often times resists change. Use the components of cross training to get out of the rut. The four (4) commonly known components of a cross training program for the athlete, or for those wishing to maintain functional fitness, are as follows:

1 **Strength and Power –** Building strong muscles is an asset to anyone whether an athlete or someone seeking general functional fitness. There are varying strength demands in any sport or physical activity. The greater the strength requirement in the respective sport or activity, the more strength training should be highlighted in the fitness plan. Even if the client's fitness goal is functional fitness, the addition of a strength training component results in lean weight gain, fat loss, joint stability, and the prevention of muscle imbalances.

2 **Cardio –** Cardiorespiratory training makes the heart, cardiovascular, and respiratory systems more efficient and stronger. The duration and intensity of cardio should vary based on goals.

3 **Flexibility –** Include Functional Range of Motion (F-ROM) exercises. This includes stretching to enhance flexibility and prevent injury. Yoga and Pilates can be used as alternatives as well. Flexibility enhances sports performance.

4 **Sport Activity –** this refers to the multi-directional exercises specific to a given sport. Hence, they are "sport-specific". Study the movement of a sport to determine multi-directional (plyometric) exercises of choice.

Attend to ALL of the above four (4) components of cross training so that the client's performance is maximized and injury less likely. Developmental imbalances will occur as a result of not applying all four components. This means the athlete may never reach their true potential.

The next section is a closer look at cross training, one component at a time. The common mistakes that often keep serious people from reaching their fitness potential are examined as well.

Strength and Power

Exclusively Training for Strength and Power

Avoiding cardiorespiratory, flexibility, and multi-directional training while developing strength and power, is not a good idea. Over a prolonged period, a fitness program of this type results in an extremely de-conditioned, inflexible, unbalanced, yet potentially very large individual. The sacrifice of cardio, stretching and multi-directional training by the strength athlete results in poor performance and an increased potential for injury during events (whether related or unrelated to the sport of choice). It is acceptable for the strength athlete to place more emphasis on the strength component than the other three. However, the others must never be completely absent. Past beliefs maintained that the performance of cardio, flexibility and sports specific training inhibits gains in strength and power. However, true professional strength-based athletes train vigorously in these other three areas and not only perform at exceptional skill levels but outperform those who do not effectively cross train.

Exercise Selection

Some beginning and intermediate resistance athletes do not train for ***symmetrical*** development. In other words, many people train their "show muscles". NFPT resistance exercise methodologies focus on all major muscle groups. As a result a more symmetrical and balanced physique. Do not rely on any one exercise or on any unbalanced combination of exercises. Consider the following advice to minimize imbalances.

- Use multi-joint, compound exercises when possible that are in no way isolated
- Train each muscle group at least 1 time per week in some form of cycle
- Never train specific muscle groups on back-to-back days
- Pay attention to muscles that stabilize the joints such as the hips and rotator cuff

Use Variety in Programming

The body adapts to a strength training program in as little as three to four weeks. Most people don't realize this and stay with the same program for years. Training variation comes in many forms and does not always require drastic changes. Even subtle changes make a huge difference. Interchanging machine use for free weight use is a good example.

1 **Vary Exercises:**
For functional improvement, use interchangeable exercises that work the same body part. Exercises that work muscles (prime movers) at different angles stress different neuro-pathways and revitalize muscle tissues. The use of varied leverage is a refreshing change for the target muscles and keeps them in an adaptive state. Do not focus (for extended periods) on exercises that are considered "isolated". The reality is that muscle specific isolation is physiologically impossible.

2 **Vary the Number of Repetitions:**
When deciding upon the best possible way to achieve functional fitness, it is important to first understand that variation of weights and reps trigger different motor units. For example, a client's sport-specific conditioning program requires the set performance in the 4-6 rep range. However, it is equally important to include lighter sets in higher rep ranges occasionally to achieve variation and strengthen bones and joints. If a sport-specific workout routine requires training in the 20-25 rep range, the inclusion of intermittent heavy, 4-6 rep sets results in a wider range of effect on muscle tissue and keeps things fresh. Rarely (if ever) is it acceptable to maintain training at the 1-3 rep range for periods beyond one week. Power training produces the greatest amount of muscle tearing. Training beyond one week at the 1-3 rep range results in too much tissue damage and recovery is more difficult, especially in the inexperienced athlete.

Fat Loss / Endurance	20 to 25 reps
General Fitness / Stamina	12 to 15 reps
Strength / Size	4 to 6 reps
Power	1 to 3 reps

> ***Note:*** Be certain that you have spent considerable time building a Muscular Endurance or Strength/Stamina base before moving on to Muscular Strength or Power rep ranges.

3 **Vary Speed:**

A fast muscle contraction results in the development of power. In contrast, the slower contractile speed results in size and strength increase. Compensatory acceleration produces the speed and power common to ballistic training. There is an inherent risk of injury associated with ballistic training as the load used increases. This is especially the case among young athletes with unqualified instruction. Ballistic lifts, over time, produces more equal neuromuscular efficiency, resulting in increased power and speed of movement. However, ballistics (e.g. power cleans) does little to increase muscle size. The duration of the stimulus is too brief to produce tissue damage that is sufficient enough to require repair and growth. Multi-directional exercises and drills (plyometrics) results in speed and power improvement among young athletes without the risk associated with applied loads.

Functional fitness is achieved through cross training (e.g. multi-directional movement), whether your client is an athlete or an avid fitness enthusiast.

Incorporating different movement speed ranging from slow continuous tension to "compensatory acceleration" (maximum effort against a submaximal resistance), without resorting to Olympic weightlifting techniques, is an example of a method for altering resistance training performance. Remember that strength and power training are just one component to optimally enhancing sport and functional fitness performance. Some sports require heavy intense resistance training while others require light weight resistance training. The personal fitness trainer needs to study the sport activity to determine the specific weights and reps that are most effective in the client's specific resistance training component.

Cardiorespiratory Training

Exclusively Cardio with No Weight Training

There is a common misconception that weight training always results in large muscles, inflexibility, poor athletic performance, etc. This misconception is most common among women who do not desire a bodybuilder's physique and therefore avoid weight training. It is important to note the lost advantages in not performing weight training, while exclusively doing only cardio. They include an increased risk of injury, weak muscles, lost lean weight, probable long-range fat accumulation, and poor muscle tone.

The fact is that cardio training alone, while on a strict diet, results in muscle cannibalization. The body cannibalizes muscle tissue for energy before it burns fat for energy. This occurs in order that the body maintains fat for survival during periods of low caloric intake (e.g. during a low calorie diet). Unfortunately then, the structural muscle tissue is used for energy, rather than stored fat. If muscles are not required to work, they will be viewed as 'expendable' by the body.

Different Modes of Aerobic Activity

Duration and intensity of aerobic activity are the two primary variables that dictate the training result. If the participant continues to perform aerobic activity for the same duration and at the same level of effort and intensity, the body soon adapts and therefore further increased adaptation at that same intensity is impossible (i.e. you can only adapt once to something). Keep in mind, there is still value in this type of exercise for general, but not peak, functional fitness.

For peak functional fitness, (desirable by the cross training athlete) aerobics are to be performed in cycles of varying levels of intensity. Depending upon the athlete and the desired result, a particular level of intensity may be more productive than others. Consider the 4 primary modes of cardiorespiratory activity:

1 **Low Intensity/Long Duration:**

It is generally recommended that this mode of aerobic work is sustained for at least 40-45 minutes per session. A larger percentage of energy during low intensity activity comes from mobilized fat. The long duration of this activity allows fatty acids to perfuse even more extensively into the smallest capillary beds, feeding the working muscles, thus optimizing oxygenation and fat loss (in the beginning). The muscle cellular furnaces, mitochondria, become more efficient at burning fatty acids for ATP. But, remember, this is not a method for optimizing fat loss because the body will quickly adapt and requires increases in intensity for sustaining a fat loss benefit. Instead, this is a mode of aerobic work that targets improvements in cardiovascular condition.

2 **Alternating High and Low Intensities Over Equal Durations:**

This aerobic training modality requires the athlete to perform at an intensity that is barely maintained for periods of no longer than 5-10 minutes. The high intensity work is followed by 5-10 minutes of low intensity work. Aerobic power and lactate thresholds increase as a result of performing this alternating form of aerobic training. Translated, this means that the duration of a participant's ability to work at maximum effort increases.

Maximum effort is of tremendous value for athletes needing to perform repeated short bursts of near maximum effort. Increasing the lactate threshold results in the athlete being able to perform high intensity work longer during endurance events. This result is consistent across the board regardless of the sport event.

Since this higher intensity activity requires more glucose energy, the muscles adapt by building more glucose energy burning mitochondria. In addition, the muscles become more efficient at transporting and utilizing insulin-carried glucose from the bloodstream.

Generally speaking, since each multiple intensity level has its own unique benefit, this type of training mode enables the muscle to utilize all related aerobic and anaerobic energy fuels and pathways more efficiently. This training mode could be considered to offer the most comprehensive approach to total cardiorespiratory conditioning.

3 **Short Recovery Between Bursts of Maximum Intensity:**

This aerobic training modality differs from the above described modality in two ways. The first difference is that the athlete stops working completely for the 5-10 minute period that follows the maximal work (5 minutes or more depending on how the participant feels) for complete rest. The second difference is that this modality requires an aerobic intensity barely maintained for 1.5 to 3 minutes, reaching near complete failure. This aerobic training modality produces adaptations to the cardiovascular system such as increased VO_2max and an increase in volume of pumped blood per contraction (because the heart muscle itself becomes stronger and can pump more blood per contraction). Additionally, the muscle's anaerobic energy producing sources become more efficient and the body's ability to remove and tolerate lactic acid improves.

<u>This type of cross training is not for the faint-of-heart!</u> Pay close attention to the contra-indications to exercise and don't over do it. Athletes required to perform short bursts at maximal effort benefit from this mode of cardio (an NFL lineman perhaps).

The above aerobic training modes clearly take the participant well into the realm of peak functional fitness. However, do not forget that performing aerobic exercise exclusively is NOT a good idea if the athlete desires to reach peak level of functional or athletic fitness. In order to increase intensity, either increase speed or incline. This shifts the energy source to muscle stores.

How would you structure this aerobic program? It is recommended that the athlete target modes 1 through 3 progressively. Train in each of these first three modes for a period of 4-6 weeks before progressing. It is also recommended that the participant include a long duration, low intensity, component at least once a week.

Over-use injuries occur even in the best planned aerobic component of the functional cross training routine. Additionally, there is tremendous value in mixing up cross training activities alternating cycling, running, skiing, swimming, etc., especially if there is not commitment to a specific sport. However, when committed to a specific sport, one of the best ways to improve skills is to engage primarily in that activity. In other words, to be a better basketball player, put the greatest emphasis on playing basketball. To be a better football player, put more emphasis on position-based training. Occasional variety in sport activity is always helpful even if committed to a given sport.

4. **Steady State Target Heart Rate Aerobics:**

Steady state target heart rate aerobics is currently the most popular and commonly used aerobic training mode. This type of aerobic training is not to be used if preparing a client for a progressive cardio program described above in training modes 1 through 3. This aerobic training methodology produces the least adaptive results as it relates to development of athletic enhancement.

Use the Karvonen formula to determine individual client Target ExHR:

RestHR + [% intensity x (MaxHR - RestHR)] = Target ExHR

Use of the Karvonen formula does not produce an exact target number. It does, however, allow a trainer to begin training a client in such a way that at least minimal adaptation occurs. As a client increases their fitness level the Karvonen formula may again be used to recalculate the Target ExHR. As the human body becomes more fit the RestHR slows requiring the use of the Karvonen formula to recalculate.

This approach to aerobic fitness is not practical because no person truly maintains a fixed or steady heart rate during their daily activities. The Target Heart Rate (THR), method of training lacks the intensity to improve the anaerobic sources and lacks the duration to result in optimum fat loss.

Flexibility Training

Research has shed an entirely new light of disapproval concerning the age old practice of intense stretching prior to exercise. Training for a Functional Range of Motion (F-ROM) encompasses all forms of stretching exercises, as we have previously reviewed. While it is agreed upon by *some* experts that flexibility is the most vital component of a functional fitness routine, we can *all* agree that timing and type of flexibility training is everything. For flexibility and the general fitness client, refer back to Chapter 9: *The Beginner Client*, for an example of the correct way to implement flexibility into the general fitness routine. Intensive stretching prior to either an endurance or resistance activity will have a negative effect on performance. F-ROM exercises such as Pilates and Yoga can be performed on their own for optimum F-ROM conditioning. A general rule of thumb - the more intense the stretching activities, the more disassociated they should be from any events requiring optimum performance. Keep in mind that if stretching exercises are to be performed both before and after the event or activity, they should be performed mildly and while muscles are warm.

Sport Activity

There is little doubt that every sport poses its own unique demands. Multi-directional movement, lateral quickness, strength and endurance requirements, explosive power, vertical leap, eye–hand coordination, etc. With this said, the more variety in sport performance the more well-rounded your motor skill development and neuromuscular conditioning. This will help to bring you to the highest level of fitness. Keep in mind that in order to improve skills unique to your sport of choice, as stated earlier, the sport needs to be consistently performed - practice makes perfect!

Performing Solo-Sport Activity

Overuse injuries abound in sports today. This is a direct result of repetitive activity without change. Ignoring F-ROM, strength, and cardio cross training activities, will minimize the athlete's ability to continue adapting and improving physically. Athletes must continue to challenge themselves using the cross training techniques discussed in this chapter in order to keep up or, better yet, set the pace at game time. When face-to-face with an equally skilled opponent, it may very well boil down to the level of functional conditioning that will ultimately mean the difference between winning and losing.

A Little About Steroids

We think that this topic is important to cover here because so many athletes are faced with the choice to use, or not to use, steroids. Anabolic substances accelerate, or contribute to the acceleration of, cellular catalyst function and tissue recovery from damage. In addition, steroid use may lead to the shut down of hormone production, as well as liver and kidney damage. It is important to have an understanding about what steroids do to the body and to also know that they are not a miracle supplement, they are quite harmful and there are alternatives to this kind of drug use that will yield much greater long term benefit.

Proper diet and exercise constitutes 99% of the effectiveness of an overall fitness program, and, sadly enough, many drug users have no concept of the basic diet and training principles; it is like skipping over the concepts of adding and subtracting and going straight to multiplying and dividing - which, as we know, can't be done effectively because you have to understand the first to understand the second. If the correct training methodologies were understood and put to practice, the need for discussion and consideration of ***exogenous*** hormonal stimulation would be significantly diminished.

Steroids and Cell Function

It is a physiological fact that if the cell is not being provided with its basic needs, all the testosterone in the world (synthetic or otherwise) will result in only limited progress, which is short-lived at best, with a host of potential problems.

Testosterone has its effect on the RNA in the nucleolus. It accelerates the rate that RNA delivers instructions to the ribosomes, that now will more quickly build actin and myosin in the myofibrils as the result of steroid use. Whenever there is an increase in the size of an intracellular component, such as the myofibril, there is an equal increase in the sarcoplasmic fluid. This fluid increase, in combination with the increase in circulating estrogen, lends to the retention of extracellular and intracellular water, causing the "steroid trademark" of a very puffy and smooth appearance.

Common Adverse Effects with Steroid Use

The liver is charged with the task of degrading more testosterone (synthetic) than it is capable of degrading. This is quite taxing to the liver, and could easily lead to liver damage.

The kidneys act to try to filter and excrete wastes that accumulate more rapidly due to the increase in muscle tissue breakdown during steroid use. This can lead to kidney damage.

Androgenic Effects

Increased levels of testosterone result in increased levels of estrogen. Increased estrogen can lead to ***Gynecomastia***, which is an activation and enlargement of the mammary glands in the male. Other female characteristics in the male, like a more feminine distribution of body fat, will take place as well.

In the female drug user, these ***androgenic*** effects result in the formation of several male characteristics, such as a deeper voice, facial hair and a more masculine change in fat distribution.

The endocrine system functions, in this case, by way of a negative feedback mechanism. The Pituitary will release the ***gonadotrophic hormones*** Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH) when the circulating testosterone level gets too low. These ***tropic*** hormones then trigger the natural release of testosterone from the testes and the adrenal glands. During a drug cycle, the levels of circulating testosterone are never low enough to stimulate the release of these tropic hormones from the pituitary. There is a chance that these tropic hormones may never be released again. Thus, the testes and adrenal glands will never be stimulated to release testosterone naturally again either. The end result? Paying for a lifetime for short-lived instant gratification.

Proper diet and exercise are the only way to experience long term progress in your training goals; when necessary, remind your clients of this as well. Stay clear of this illegal, damaging, and unethical hormonal manipulation. The consequences of steroid use on health and overall well being of the user and those around him or her are too great to get involved in this type of activity.

CHAPTER 12

Resistance Training

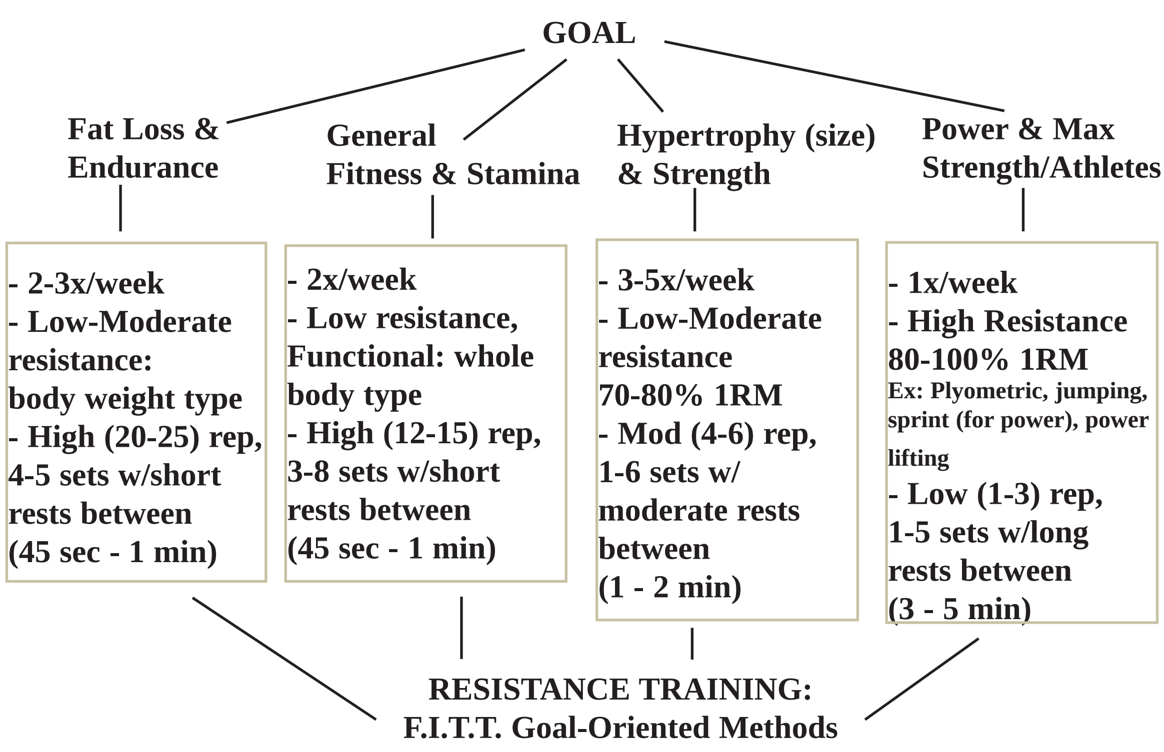
This may be the chapter that you've been waiting for. Resistance training and literal body building are generally the focus of any personal training program. We'll call it 'resistance training', as opposed to 'weight training' because there is such a wide variety of modalities and fitness products that can be used to place strain on a muscle for a physiological effect; of course the use of weights for this purpose is the most known and common form of resistance training. Just note that, when you limit yourself to resistance training alone (whether using weights or a bodyweight suspension device), you are leaving too much other knowledge and skill on the table that should be picked up and used along side it. Often times, many people have the mind-set of resistance training as being intense weight lifting that is strictly for the elite bodybuilder with chiseled abs and cut-up pecs. Not often do people think of resistance training for the average person wanting to trim down and get fit. In fact, some people, more often women, will shy away from it as if they are going to sprout enormous biceps overnight. As a trainer, you know better. You know that resistance training has its place in almost all modalities of fitness training. And, if the goal was to sculpt the body in a way that you see in a popular health & fitness magazine, then you better be committed with the drive and will for the long haul because there's no sprouting enormous biceps overnight! Know first that the best resistance trainer is the one who delivers the results that their client desires, and keeps them injury free and excited about working out. Simply forcing someone to do more than they are currently capable of doing, making them sore and risking injury, takes no skill or education and is not what proper resistance training is all about.

When determining the origin of energy relative to resistance exercise, one needs to remember that the muscle's nutrient uptake from the bloodstream is very gradual during rest, recovery, and during the performance of work.

A study of pre- and post-workout blood sugar readings taken from six (6), 12-hour fasted, strength training athletes (using proper training techniques) showed no significant reduction in post-workout blood glucose levels. This shows that very little energy is taken up into the cells from the blood during properly performed size and strength training. Since this is the case, muscle glycogen, and/or muscle glycogen and oxygen (in the case of prolonged, high rep, training), must account for most of the energy produced in the cell during the performance of immediate, heavy, and intense work; such as resistance exercise.

The bulk of the energy used, during the proper performance of resistance exercise, comes from what has already been stored inside the working muscles as a result of recovery from past resistance exercise workouts. Since the muscles rebuild damaged tissue and/or refill muscle glycogen stores slowly, an insufficient number of days between training specific body parts may not allow for adequate repair of tissue or total glycogen replenishment. Also, a low protein, and/or low total caloric intake, will not allow amino acids to be spared for structural repair, nor allow sufficient glucose availability for cellular uptake recovery.

WHY RESISTANCE TRAINING?



Whenever you are about to contract your muscles in a vigorous manner, multiple times, you risk injury. Injury most often occurs in the form of muscle strain or pull, but tendon damage is also quite common. Here are two ways to minimize this risk of injury:

1- Warm up the entire system. Performing some active and dynamic stretching for about 5-8 minutes. This is a great way to increase blood flow to the muscles that are about to be worked, and to increase the temperature of that muscle. Some find that light activity actually "wakes up" the mental processes, metabolism, and even their balance and coordination skills. A light cardio activity may be appropriate for deconditioned clients that need a warm up before the *active* warm up.

2 - Do a warm-up set. Warm up sets can vary greatly in design but the overall purpose is to get blood flow, and thus heat, to the working joints to prepare for activity. Sources vary from recommending that you lift 50% of your first set for about 10-15 reps, to just lifting the bar or a very small weight, quickly for 15-25 reps - either way, the benefit of this is the same. Research suggests many different ways to warm up. NFPT recommends that set #1 be done at about 40% of training weight, and set #2 be done at about 50% of training weight for best warm up results.

Safety

Don't dismiss this very important aspect of resistance training, or any type of training for that matter. As we have covered in Chapter 9: *The Beginner Client*, there are specific safety 'rules' that you should adhere to for the best interest of your client, and your future as a personal trainer. A quick recap to emphasize these safety rules:
- be aware of your clients form and alignment
- be a good spotter
- be on the lookout for obstructions in the training space (including jewelry)
- be prepared with proper equipment and proper attire (i.e. closed toed shoes)

Resistance Exercise Guidelines

While there a lot of different methodologies out there, and if you pick up a health magazine this month you're sure to see some "new and exciting" way to get ripped abs, let us start by saying that there is no magic workout and no way around hard work, to get a hard body! Genetics help, but in the long run it is all about consistent effort, at the proper intensity, with the proper mix of strength, power, hypertrophy, or endurance for your client's needs. Yes, some people could be described as "hard gainers" which basically means they tend toward ectomorphic qualities; while others are "hard losers", meaning they tend toward endomorphic qualities, not losing weight easily, but often gain strength and mass easily. And then there's the mesomorph individuals who are those you often find in a bodybuilding contest or athletic field; they may have more "gifts" in terms of natural body contours and composition, but most often, they work harder than others too.

The somatotype theory, derived from the work of American psychologist William Sheldon and first published in his book "Atlas of Men" in 1954, makes a distinction between three (3) categories of physical body type: ***Endomorph***, ***Mesomorph*** and ***Ectomorph***. Now, since this is a theory that is early 20th century, it comes with a bit of debate - but, nonetheless, it is a good benchmark and offers some general insight that is helpful for developing training programs. Somatotype identification is also quite commonly understood among trainers, and you should be no exception.

SOMATOTYPE	CHARACTERISTICS
Endomorph	Increased capacity for fat storage, viewed as 'overweight' or 'big boned', wide waist and shoulders, larger bone structure
Mesomorph	Increased capacity for muscle gain, viewed as 'muscular' and 'healthy', narrow waist and solid torso, medium bone structure
Ectomorph	Difficulty storing fat and muscle, viewed as 'thin' or 'skinny', narrow limbs and thin bone structure

Sheldon went on further to classify these types by parts within the types. Though, for our purposes, we will not delve into the degree to which these can be broken down, it is important to note that most people are actually a combination of the differing somatotypes. Understand, however, that there is much variation in body types, shapes, abilities which can be attributed to a large number of factors. There will always be variances contributed to nature versus nurture, which may have scientist debating until the end of time. Though the identification of a somatotype, or other physiological or psychological generalities, will help you as a starting place with your clients, they are still just that, 'generalities'. You may be surprised by what an endomporh can accomplish when he or she trains hard to reach their goals, for example.

The Basics: Resistance Training

Establish some quantifying intensity

Just like the endurance exercise, the resistance exercise must be done with the proper intensity. Instead of the HRmax value, we use the 1 repetition max (1RM) value or %1RM. This is the total or highest amount of weight that can be lifted in a given position. This is to be subjectively assessed based on the individual client, because injury avoidance is always the first priority. Understand that different exercises for different muscle groups will have different 1RM values. For example, the bench press weight will be different than the squat weight because of the different muscles and joints being used in the body. In general, the more muscle mass you are recruiting the stronger you will be for a given lift.

Injury avoidance is the primary focus and is especially relevant when working with a sedentary or general fitness client. It is first prudent to review the proper way to find 1RM without causing injury. A sedentary or general fitness client lacks the neural control, balance, and core and joint stability to be exposed to the traditional 1RM protocol. A traditional 1RM protocol is generally used with elite athletes and those who have achieved an advanced level of fitness. For sedentary and general fitness clients, this method is modified to avoid injury.

There is no better way to get to know a client than to simply train them over a period of time using the principles of slow progressions. Simply stated, when starting to train a new client, who is a beginner and otherwise sedentary, the best method is one that targets the red, slow motor units and their internal components for a period of four to six weeks. Use a common sense approach, know that a beginner is not at a level where 100% intensity is possible, even with a weight that they can move, lift, push or pull 20 times. Asking a beginner to apply 100% intensity is asking for injury. Positive adaptation is the goal. For the beginner client, a good place to start that does not require calculations for 1RM is to have the client perform the elected exercise a total of 29 times. The exercise that you elect them to perform should be one that will be incorporated into their regular routine. After you have seen that they can perform this exercise 29 times, then add a reasonable amount of weight and have them perform the same exercise 20 times. This will give you instant feedback as to your individual client's weight and intensity threshold.

Following the principles of slow progressions, use the 20-25 rep range for your beginner client at a 50-60% resistance intensity. By or before week six, the client should be ready to proceed to the next level of intensity where repetitions stay the same and the load is gradually increased over the next 4 to six weeks. The same principle holds true when using the 12-15 or 4-6 rep range protocols.

Consider also, depending on your client, it may be in both of your best interest to recommend that they take a yoga, pilates, or some other class that is focused on stretching and alignment to help compliment the hard lifting and aerobic activity. Also, for all client types, encourage them to use their workout as a way of removing stress. Remind them that a good workout is a way of getting stress out of the system - it is not meant to generate it!

Muscle Strength and Muscle Endurance: calculating the intersection

Now, on to numbers and calculations. At the end of the day, personal training encompasses a lot of common sense approaches to finding what fits for your individual client; but it also requires an understanding of exercise science and the aspects of program design. Many aspects of fitness program design can be found by using specific calculations. However, regardless of the number of equations that you may be able to memorize, these calculations can never compare to the impact of the term 'personal' in 'personal training'. Each client is different. They will have different needs, goals, physical and mental limitations, personalities and different things that motivate them. Therefore, you must go beyond exclusively using calculations to design training programs.

In this section, we dive deeper into the calculation for 1RM. The result establishes a baseline to work from and also gives more insight into what you should know as you grow in the profession of personal fitness training. However, whether you are a new trainer or a seasoned trainer, always view the result of these equations within the context of the client, and then use common sense approaches to what the individual client needs and is able to do.

There is an interesting inverse relationship between a client's strength and their endurance, which can be estimated. Obviously, as something gets heavier, it cannot be lifted as fast or as often. On the endurance end, you get the lactic acid build up due to continued efforts above the anaerobic threshold. The heaviness in the muscles and difficulty breathing, and very rapid heart beat, are classic signs of cardiorespiratory fatigue. On the strength end, the power athlete has the pain of trying to get the muscles to contract maximally, or several muscles to simultaneously contract, with a certain timing and speed. They must do this until they can't move it anymore. This is neuromuscular fatigue and red, fast (Type IIa) muscle recruitment deficiency. It seems that a seasoned athlete will gravitate toward one end or the other in their preferences to withstand the "pain" associated with each.

So, what exactly is the relationship between repetitions (muscular endurance) and strength (amount of tension on the muscle or weight that can be lifted)? It all boils down to how much weight someone can lift one time - the one-repetition max (1RM), as discussed. If your client is at a fitness level that allows for this assessment, the safest way to implement is to first know how much weight your client can lift 10 times. Your client's 10 rep max is the maximum amount of weight that they can lift, push, pull or move 10 times with decent form and reaching complete failure. In other words, they would not be able to do 11 repetitions without either breaking form or needing your assistance to lift it. It is important to remember that "complete failure" in a beginner will most likely be neural and not truly due to mitochondrial or myofibril failure. Eventually, once the beginner learns form, technique, and wakes up the nervous system, a greater number of fibers will be recruited for contractile strength which will lead to mitochondrial and myofibril failure. (See Chapter 4: *Skeletal Muscle: Structure and Function*)

There are several formulas for calculating 1RM, we'll look at the Brzycki formula which states:

$$\mathbf{1RM = w \div [(1.0278) - (0.0278 \times r)]}$$

w = weight in pounds (sustained for at least 10 repetitions)
r = repetitions *performed* (of the given exercise)

Before conducting this test for 1RM, conduct a warm up by having your client lift a light weight for 5-10 reps (light weight = 40-60% of perceived max), followed by a one minute rest. Then, increase the weight slightly for 12-15 reps (moderate weight = 60-80% of perceived max), followed by a one minute rest. Increase the load by approximately 5-10% and have your client perform repetitions with a goal of 10, using proper technique for the respective exercise. Weight per client will vary, but technique should always stay consistently proper in order to assure accurate measure and prevent injury. If the client can get 10 or more repetitions, then allow for another one minute rest and subjectively add more weight (additional weight depends on your visual interpretation of RPE and feedback from the client).

Here's an example. After conducting a warm up with gradual weight increase, your client is able to bench press 55 pounds 10 times. Plug these numbers into the equation:

$1RM = w \div [(1.0278) - (0.0278 \times r)]$ $w = 55$
$r = 10$

$$\begin{aligned} 1RM &= 55 \div [(1.0278) - (0.0278 \times 10)] = \\ &55 \div [1.0278 - .278] = \\ &55 \div .75 = 73.333 \end{aligned}$$

73 pounds is the estimated 1RM

This can now be used as an upper limit and turned into a percentage to provide for the load on the client with that respective exercise. If it were the bench press, for example, and your client was doing reps of 40 pounds, then you can find their %1RM using the equation $w \div 1RM = \%1RM$. From this example, $w = 40$ and 1RM = 73, so: $40 \div 73 = .55$ Your client, in this example, is at 55% of their 1RM

The table below shows NFPT recommended repetition ranges and the relative training weight depending on your client's training goal:

CLIENT GOAL TYPE	%1RM	REP RANGE
Strength	70-100%	4-6
General Fitness	60-70%	12-15
Fat Loss/Endurance	55-80%	20-25

Use the 20-25 rep range with 55-80% of their 1RM, with slow progressions, for sedentary and beginner clients

There are other tests, like the Muscle Balance Test, that will look at the relative strength of antagonistic muscle groups, which may also be to your benefit as well. The point is, the more you know the better - don't stop learning the methods that are available to you. Your training reputation and career will be enhanced by the more that you learn about various protocols and methodologies for advanced and/or specialty fitness training. It is clear that using scientific calculations, like the Brzycki formula (though sometimes yielding only close estimates), is one area that can really assist you in your fitness program preparations. It doesn't have to be guess work. This will allow you to put a quantified measure on your client's existing performance and future progress.

Progressive increases will vary with your client's capacity to handle overload and to adapt to the stresses imposed - increasing at a volume no more than 10% in a given *week* with endurance athletes, and not more than 10% in resistance in a given *month* (depending on the phase of their training), is a general rule of thumb.

Resistance Training Guide

This will be a very simple guide to some general lifts which most people should be able to do. The objective is to exercise the major muscle groups in the body, as many of the muscles in that group as possible with each exercise. Keep a focus on big muscles doing big work, to get big results - contrary to what your general weight loss client may think, this will be the way he or she will get 'smaller'.

Lower Body

Major Muscle groups: Hip flexors, Hip Extensors (Glutes), Abductors (outer thigh/hip), Adductors (inner thigh/hip), Knee Flexors (hamstrings), Knee Extensors (quads), Ankle Plantarflexors (calves), Ankle Dorsiflexors (shins)

Main Exercises: Squat, Dead lift- Roman, Dead lift- Straight Leg, Leg Press, Lunge-Straight Trail Leg, Bent Trail Leg, Sumo Squat, Steps, Reverse Lunges, Calf Raises, Side Lunges, Side Lying Clams, Supine Ball Tuck, Side Step Up

Upper Body

Major Muscle groups: Chest, Shoulders, Trapezius, Upper Back, Scapular Retractors, Internal Rotators of the Scapula, Shoulder Adductors, Spinal Erectors, Elbow flexors, Elbow extensors, Wrist flexors, Wrist Extensors

Main Exercises: Rear Fly, Standing Cable Press, Push-ups, Pull-ups, Stiff Arm Push-down, Seated Row or Bent over Row, Lat Pull-down, Lateral Raises, Frontal Raises, Hyperextensions

Core Area

Major Muscle groups: Abdominal- Rectus and Transverse, Obliques- Internal and External, Intercostals, and Erector Spinae Group

Main Exercises: Planks, Side Planks, Ball Crunch, Chops, Pikes, Ab Wheel, Low Back Body Weight Extension, Dead Bug, Suspension Training

The amount of exercises that you do for a particular muscle group should be based on the size of the group, the amount of sets and the needs of the client. In addition, the trainer must keep postural balance in mind and not over work one area. For example, if you perform 3 chest exercises, as a rule you should do at least 4-5 back exercises. Smaller groups may need 2-3 exercises, where larger groups may require 3-6 exercises. A knowledgeable trainer will pay careful attention to the program design, and plan accordingly. For example, if you are doing a vigorous leg routine, 4 sets of front squats, dead lifts, leg press and calf raises, it doesn't make sense to do the same exercises in the next leg workout, you risk overloading that client and inhibiting progress. The next leg session can be more focused on stability and more complex movements, like 3 sets of balance board squats, 3 sets of reverse lunges, 2 sets of side band walks and glute bridging. Changing up the routine of your workouts is highly advisable.

Overload Training Principle

Consistently apply the overload training principle, in all rep ranges, to establish objectivity in monitoring the client's performance. Your understanding of how to use and teach the overload training principle is very important and extremely applicable when administering quality fitness training services. Remember, muscles adapt to certain stimuli over time (i.e. weight bearing load or duration of aerobic activity); therefore, the need for a continual increase in the stimulus is necessary in order that an exponentially beneficial adaptation occur. Once the muscles 'get used to' lifting a certain load, they must be gradually stressed with a greater load in order to increase in strength; and, similarly, once the muscles 'get used to' a certain duration of time with aerobic activity then an increase in the duration of time must occur in order to increase endurance.

How It Works: for the strength training client

Help your client select a weight that they can control through the entire range of motion, in strict form, and barely complete 12 repetitions (reps) on their own, with absolutely no "***forced reps***" (assistance). The set is finished when they realize that they would not be able to complete another rep in strict form, through the entire range of motion, without de-stabilization or needing assistance. Sufficient "between set" recovery will allow for the same number of reps to be performed in all of the remaining sets of this particular movement.

In a future workout, when your client is able to perform 15 reps, with this same weight and in strict form through all the required sets of this same movement, they will be ready to increase the weight used in this exercise, and in this “rep range”, in their next workout. The increase in weight should be just enough to once again allow the client to be able to perform only 12 reps in strict form, through the entire range of motion, to unassisted failure. This progressive training principle applies to all rep ranges including (4 to 6), as well as the (20 to 25) rep ranges, all having a different effect on the target muscle. Keep in mind that, for you to effectively apply the overload training principle for your strength training client, each set must be an attempt at a “personal best”. Through the continued recorded use of the overload training principle, in all rep ranges, you have a progress evaluation method built right in.

Applications to Rep Range Training

4 to 6 Rep Sets

In preparation for a set of 4 to 6 reps in a particular movement, have your client perform a 5 to 8 minute warm-up involving the muscle group about to be trained, that includes some sort of mild stretching for the target muscle group(s). Also, after warm-up, have your client use a moderate (not light) weight and only for as many reps as is necessary to re-establish the concentration and strict form used the last time they performed the movement. The warm-up weight used should be heavy enough to place the client’s body in the same position of leverage that it will be in during the performance of the 4 to 6 rep “working-sets”. Keep in mind that fibers stressed during heavy training have low energy reserves. Expending too much of this already limited muscle energy warming up may take away from the productiveness of those strict adaptive reps performed during your client’s size and strength workout (e.g. 4 to 6 rep “working sets”). Have your client perform fewer preliminary sets, fewer than is commonly recommended, when preparing for heavy overload training. Concentration, control, and continuous tension will act to prevent injury.

Remember that, while training heavy, it is the intense, individual contraction of the actin and myosin during one repetition that optimizes growth stimulating damage - not a group of less than intense contractions in a less than intense set! The effect of intensity on the muscle tissue can be likened to breaking and repairing a pencil; by constantly training beyond failure and/or by performing too many heavy sets, you are taking a hammer and smashing the actin and myosin making it very difficult, if not impossible, to repair. This results in very little, if any, size and strength increase. If you correctly use the overload training principle in heavy rep ranges, however, you are in effect, “breaking the pencil cleanly” once in each set. You’re able to ‘fix’ a cleanly broken/snapped pencil (just put it back into the sharpener and correct the lead tip); but, with a smashed up pencil that you took a hammer to, you can’t cleanly ‘fix’ it. So, essentially, you have to be able to control and repair the damage in order to get the desired result. By doing fewer total heavy sets, your body can effectively repair the controlled damage that was incurred prior to that muscle’s next workout. This will result in size and strength increase. Through the continued recorded use of the overload training principle, in all rep ranges, you have a progress evaluation method built in.

This approach to strength training will help to prevent the unnecessary wasting of energy during submaximal effort, and also prevent the pre-exhaustion of target muscles that commonly occurs with periodization. By doing fewer total heavy sets, your body can effectively repair the controlled damage incurred prior to your next workout.

While training heavy, always convey to your client, “slow down, conserve energy, and rest longer. Learn to concentrate more on putting everything you’ve got into every rep you do - remember, quality, not quantity”! It will be difficult to convince your clients, who have resistance training experience, that less work equals better gains. However, regular strength tests and body composition measurements will be convincing enough. If your client has been taking the advice of anyone and everyone who is bigger than he or she is, and your client is not using anabolic steroids, then he or she is not getting the advice that they need. The only way that the human body can recover from ridiculous marathon-length workouts is to accelerate the rate of recovery through the use of anabolic steroids, a terribly unhealthy approach - the long-term health risks of steroid use by far out-weigh the short-term benefits.

Using the overload principle exclusively in the 4 to 6 rep range will optimize the natural growth of tissue, but it is not without risks. The low rep warm-up method, which is designed to prevent the wasted depletion of the already low levels of energy stored in the target “white fibers,” may increase the likelihood of joint injury. Therefore, the heavier the resistance, the greater the need to maintain the continuous contraction of the prime movers for safety purposes as discussed earlier in this chapter. This will reduce the risk of soft tissue damage.

If the client is exclusively performing sets of 4 to 6 reps, instruct him or her to inform you of any joint pain, in which case you should recommend the replacement of some of the client’s sets of 4 to 6 reps with sets of 12 to 15 reps in movements involving the injured joints and/or soft tissue (active rest). Use the remaining sets of 4 to 6 to monitor his or her size and strength maintenance. Performing the sets of 12 to 15 will reduce soft tissue stress, and provide for the perfusion of nutrient dense fluids in and around the aggravated joints.

Strength tests during these “active rest” recovery periods will allow for an objective method of insuring that no muscle tissue is being lost and at the same time allow for the healing of the effected soft tissue and joints.

Emphasis on warm-ups. There is a tremendous need to prepare target muscles in two regards; blood flow and increased muscle temperature. Both can be achieved with a gradual increase in demand for blood, starting with the brief 5 to 8 minute warm up activity, which will cause blood to move into collateral circulation. ***Collateral circulation*** refers to circulation in tissue (or an organ) where numerous paths exist for blood to reach it - in many cases, an alternate route of blood supply within the tissue is the result of small, normally closed, arteries that open up and connect to larger arteries, or different parts of the same artery, increasing blood flow. Increased blood flow and muscle temperature, for any target muscle group(s), can be best accomplished through the preliminary performance of limited exercise involving target muscles, using little or minimal resistance. This will desirably have little effect on target muscle energy stores that are stressed during strength training.

12 to 15 Rep Sets

Training in the 12 to 15 rep range offers, in theory, an option for optimizing the building of greater energy stores and/or new myofibrils. By performing a standard overload set in this rep range, energy depletion, contraction-inhibiting substances and contractile stresses (fiber damage) are occurring equally. However, by performing the sets with continuous tension, eliminating relaxation, more energy is depleted (energy depletes in proportion to the duration of muscle tension), thus resulting in super-compensation (increase) of energy storage during recovery.

On the other hand, by incorporating a one second pause between every rep (in a position of relaxation), the working muscle is able to take up oxygen and release wastes, to some degree, allowing for the delay of failure. This delay approach permits an increase in the number of damaging repetitions. This type of stress on muscle fibers in the 12 to 15 rep range induces adaptation through the production of more *new* myofibrils.

20 to 25 Rep Sets

It is important to understand that the reason for doing 20 to 25 rep sets is to:
1) build new mitochondria; improving the endurance capability of the working muscles by increased energy storage capacity (high intensity)
2) purposely expend as much stored glycogen as possible; in order to maximize fat mobilization during recovery (low intensity)

Glycogen rapidly depletes during a continuous tension set. This is an additional purpose of this high rep range. Consequently, it is important to always use continuous tension in this rep range. As a reminder, this rep range is not recommended for significant growth stimulation. It offers adaptation of the muscle by increasing future energy stores and increasing recovery fat release. The performance of 20 to 25 rep sets is of tremendous value for everyone from the beginner to the competitive athlete. Increased muscle energy is good for everyone.

Evaluating Recovery Based on Performance

Regardless of what rep range the client is using, less energy is available for future workouts if the client:

- trains beyond failure
- fails to eat adequate protein
- fails to eat enough total calories
- fails to adequately recover between workouts

Therefore, clients may not be able to perform the same number of strict repetitions in the first set of each movement. Personal trainers are typically able to tell if their client is adhering to recommendations because of continued performance monitoring. For example, if a client, who has typically been performing 15 reps with a given weight in their first set of bench presses each chest day, is then suddenly able to perform only 13 reps, then they may not be adhering to trainer recovery recommendations. Express how this impacts progress and make appropriate modifications to their program based on the client's response.

Between Set Recovery Considerations

Achieving the same number of reps from set to set is another story altogether. As long as the overload training principle is strictly adhered to (and the appropriate recovery methods are used) clients should always be able to complete the same number of reps in all of the sets for each movement. *Massage* between *light* sets is beneficial in the removal of lactic acid, and *mild stretching* between *heavy* sets will allow for more complete contractions in the following sets.

Extending rest time between sets is the most effective method of getting the same total reps in each set (regardless of the rep range used). Lactic acid inhibits contractions. Its removal through massage and adequate recovery (to include short term energy stores) allows for the performance of the same number of reps in all sets of a given movement. The replenishment of exhausted short term energy stores occurs during this recovery to include lactic acid's conversion back into energy and re-introduction back into the cell.

Reminder: clients must not be training beyond failure or performing forced reps. This may not allow the performance of the same number of reps from set to set. The application of these principles allows for a degree of objectivity and a rationale approach to recovery and resistance exercise performance. It is important to note that all resistance exercises for size and strength, geared exclusively to maximizing adaptation of muscle tissue, are performed at maximal intensity. The following table reflects what is known as the "Big Four R's": **Routine, Rep Range, Recovery** and **Rate of Perceived Exertion**

PERFORMANCE GOAL	*MUSCLE OUTCOME*	*ROUTINE*	*REP RANGE (TARGET)*	*RPE*	*%1RM*	*# OF SETS*	*RECOVERY BETWEEN SETS (in BPM)*
SIZE/STRENGTH	Hypertrophy/Power	3 day split	4-6 (4)	Very hard to Maximal	85-100%	1-6	100 RHR
GENERAL FITNESS	Wellness/Stamina	2 day split	12-15 (13)	Moderate	60-70%	3-8	115 RHR
FAT LOSS/ENDURANCE	Longevity/Definition	Circuit (3/week)	20-25 (22)	Moderate to Hard	55-80%	4-5	125 RHR

When a Client is Not Progressing

In the event that a client fails to progress within a reasonable time (while adhering to recommendations) trainers may consider the following:

1. Decrease the number of total sets for the specific movement (if the problem is specific to one movement).
2. Increase the number of days between workouts involving the particular muscle group(s) for improved recovery.
3. Increase the total caloric intake to ensure muscle energy stores are adequately replaced.
4. For clients working in the 4 to 6 rep range, consider increasing protein intake. Low protein intake is *not usually* responsible in these cases, however, it should not be ruled out.
5. Ensure that the client has not consistently overtrained. Overtraining may result in a level of tissue damage and stresses to the energy and nervous systems that require even more recovery than the trainer currently recommends.

6 Assess level of client stress. Stress diminishes recovery ability and is a common factor among those not progressing for otherwise undetermined reasons. Trainers are quite limited in how they may help to alleviate client stress. However, trainers may help clients to simply identify that stress is hindering progress and recommending the appropriate counseling.

7 As a last resort, have the client take a UUN test (as previously discussed). This is a scientific method of determining the individual body's specific protein (nitrogen) needs and imbalances. This test may uncover a hidden negative nitrogen balance.

Identifying and addressing any or all of the above alternative issues (as they apply to the different rep ranges) should result in the client's ability to again achieve the same number of reps (or more) in the first set of every movement, in every workout. Additionally, changing exercises and rep ranges from time to time may hold the key to getting past plateaus that cannot be otherwise overcome with these suggested revisions.

Antagonistic Multi-Set Training Principle

Along with the overload training principle, there is a scientific training principle that is complementary and very effective. It is called the ***Antagonistic Multi-Set Training Principle***. Antagonistic muscles are muscles, or groups of muscles, whose contractions provide for movement in opposing directions.

Extended Rest and Lactic Acid Removal

Lactic acid released into the blood is converted back into energy by the liver for transport and immediate use by the body, to include muscles. Though the topic of lactic acid and muscle fatigue/failure is sometimes questioned, with validity on both sides of the 'argument', we will stick to foundational research and understandings of the effects of lactic acid build up; ultimately, the training techniques designed to reduce such fatigue are still effective.

Removal of unused lactic acid from the muscle tissue cells between sets is the most effective method of ensuring that a minimal number of repetitions are lost in the following sets. Extending between-set-recovery periods is the most effective way to reach this goal. Training antagonistic muscle tissue, back-to-back in the same workout, offers one solution to this problem of optimizing lactic acid removal. Suppose you find that your client needs 3 minutes between sets to allow for the performance of the same number of reps in the following set. What would happen if your client, after completing a set and waiting for these 3 minutes, went to a different movement for a totally different antagonistic muscle group; then, after completing this set, the client waited 3 more minutes and again returned to the original movement? *The answer:* the workout would last the same amount of time, only each muscle group would spend twice the amount of time (6 minutes) in recovery between sets, allowing for the greatest amount of lactic acid removal possible. Now, imagine a client moving directly from one exercise to the next "antagonistic" exercise, without rest. If 3 minutes are required to perform each movement, the same amount of work would be performed in half the time, still allowing the muscles to recover adequately (3 minutes). If this seems too demanding for the client, there is no harm done in resting for a short time between these antagonistic exercises. While administering this technique, remember that the ultimate goal is the ability to perform the same number of reps in all sets of a movement. If this cannot be accomplished, recovery times will need to be adjusted accordingly.

Nervous Relaxation and Lactic Acid Removal

When nervous signals are transmitted to antagonistic muscles in an alternating fashion, unlike any other muscle combinations, the resting muscle group(s) experience no residual impulses. By ensuring that the muscle group(s) being trained together are antagonistic, as earlier mentioned, there will, in effect, be a *forced* relaxation (due primarily to this nervous inactivity) in the resting muscle while its antagonist is contracting. This will allow for optimal collateral blood flow in the recovering muscle, lactic acid removal and conversion, and oxygen re-supply.

Blood Flow and Lactic Acid Removal

Since the cardiovascular system re-routes blood flow back and forth during antagonistic muscle functioning, the performance of a set for the second body part will actually draw interstitial fluid back into the vessels, along with the removed lactic acid, from the areas around the first (antagonistic) body part that was just contracting, allowing maximum recovery.

Incorporating Antagonistic Training

When applying Antagonistic Training, variety in exercise selection is good as long as alternative exercises stress the same muscle groups' "prime movers". NFPT suggests the following muscle group combinations:

***3 Day Split Routine* -** This antagonistic multi-set training method requires the need to arrange muscle groups in the 3 day split routine for size & strength as follows:

Day 1- Back and Chest
Day 2- Shoulders, Biceps, Triceps
Day 3- Quadriceps, Hamstrings, Rotator Cuff
Perform calves, core, and forearms intermittently as desired

2 Day Split Routine - To adapt the antagonistic training method to a 2 day split routine, consider the following muscle group combinations:

Day 1- Back, Chest, and Arms
Day 2- Shoulders, Legs, and Rotator Cuff
Perform calves, core, and forearms intermittently as desired

Circuit Routine - A circuit routine should always be designed to include a compound pushing movement (such as bench presses) alternated with a compound pulling movement (such as rowing movements) and a compound lower body movement (such as squats or leg presses). Another example is to complete a push-up, immediately followed by a pull-up and then into a squat. There are many ways to design a circuit program, and the benefits are proven over and over. For example, on day one, do chest, back and legs and then, on day 2, do core, triceps, biceps and shoulders. Be creative and mix it up by varying intensities and muscle training combinations. For beginners, choose simple exercises mixed in with therapeutic and active rest exercises.

Note: these routines are suggested as recommendations by NFPT for being the most effective combinations.

TRAINING TIPS

Regardless of the principle that is the most effective for your client, there are 'rules of thumb' that remain constant when resistance training. The following are some of those most common questions and considerations:

Dumbbells or Barbells?
The use of dumbbells in any compound movement is not a recommended first choice for the beginning strength trainee due to the additional challenge of trying to maintain balance and stability. Remember, the goal for strength and power gains is to move the most amount of weight possible for a specific number of reps, while maintaining proper form. Keep in mind that beginners should start with light weights in order to learn proper form, no matter if it's a dumbbell or barbell. We find that it is safer for a beginner, whose goals are size and strength increase, to use a barbell in every compound movement. This is because dumbbells are more difficult to handle and it is easier to spot/assist when using a bar. If the client's goals are not specific to maximal size and strength increase, then dumbbells may be a better choice; beginning with very light weight. If the client's goal is to improve activities of daily life, then dumbbells and exercise devices are certainly warranted. However, these should be used only based on the client's needs. To compliment a beginner's routine, NFPT suggest the implementation of dumbbells only ***after*** all heavy compound movements are completed. This will help them improve neural control and will give the trainer a true picture of muscle imbalances and the chance to work directly on the weaker side of the body (without compromising strength or power gains). In the event that a new client is completely unbalanced (one side of the body is much stronger than the other) NFPT recommends a corrective training cycle using light dumbbells, bands and cables before starting heavy training with straight bars. The goal of the corrective cycle is to first strengthen the weaker side so as to avoid enabling weakness upon commencing the use of barbells. Most importantly, avoid stressing one side of the body and creating further imbalance. It is the position of NFPT (in the case of strength training) that compound movements be selected that allow the prime movers to be stressed in the prime mover's strongest position of leverage (i.e. flat bench press preferred over incline bench flies for chest). This is most effective for growth and strength, especially in the early stages of a strength training program.

It is not uncommon for general fitness clients to present with many muscular imbalances. In this case, it is recommended that basic movement patterns are addressed first rather than focusing on compound movements. If it is observed that the client is much stronger on one side than the other, a barbell will greatly exaggerate that deficit. Training with bands, cables, body weight and light dumbbells in a stable environment is usually the best way to start with these types of clients.

Setting Up for a Heavy Set

In any free weight movement, the distance the bar travels from the time it leaves the rack to the starting position should be minimal. This is especially the case when engaging in heavy sets, because valuable time and energy is spent simply moving the weight from rack to workout spot. This wasted energy exertion may take away from the total number of reps that can be performed. When the client “sets up” for a free weight movement, such as the squat, bench press, barbell rows, etc., time is definitely of the essence.

Bar Gripping

Arrange a client’s grip, paying close attention to centering (or getting an “even grip”). The exact hand position depends on the exercise and, to some degree, the client’s height and flexibility. To stay safe, in general, make sure that the client has a full grip with the thumbs and fingers tightly wrapped around the bar; as opposed to a grip in which the thumb and fingers do not come all the way around, or encircle, the bar. Instruct the client to use the same grip each time the lift is performed.

Training Straps

Instruction concerning the proper use of training straps is a must. Training straps assist the forearms in maintaining grip when lifting or pulling extreme weight. The forearms, being the “weak-link” in the chain, may be in need of support during strength training. When training heavy, straps help to avoid interference with achieving complete exhaustion of the large target muscles. This practice is not necessary to functional and general fitness clients because the resistance used is not as great.

Locking Out In Pressing Movements

When the client is performing pressing movements in the 4 to 6 rep range, the joints involved should remain bent through the entire range of motion. Most weight-lifters finish a motion in full extension, not a locked position. This will prevent the potential dangers of allowing for a relaxation of muscle in a locked-out position, during the application of heavy resistance. The problem with relaxing muscle tissue during heavy pressing movements is that the amount of resistance obviously remains constant and, since the muscles are not supporting the weight, then the weight is being supported by non-contractile tissue such as the tendons, ligaments and bones in the involved joint. The joints and surrounding tissue are very susceptible to serious, chronic, and acute injury. Relaxation during less than maximum effort and/or during higher repetition sets is acceptable. These pauses may prolong performance of activity since more wastes are being removed and more oxygen is taken up during relaxation.

Control and Concentration

The client must realize the need and importance of concentration and strict form when performing heavy sets. Every set must be performed exactly the same as the one before it. This means continuous tension and control. Never be too anxious to accept excuses when a *conditioned* client fails to get the same number of reps in all of their heavy sets. As long as they are eating and recovering correctly, training with proper form and concentration, there are few real excuses.

Heavy Extension Movements

Attempting to apply maximum contraction to a muscle group, against heavy resistance in its stretched position, can easily result in tendon of insertion damage. For this reason, be cautious of heavy extension movements. Do not recommend sets of 4 to 6 reps for any extension exercises (i.e. triceps extensions, leg extensions).

Breathing Correctly

A consistent breathing pattern must be maintained during each rep. Inhale on the negative, exhale on the positive. A more relaxed breathing pattern is applicable and effective during lighter sets. However, during sets using weights greater than 80% of maximum, temporary breath holding at the point of greatest effort is unavoidable. This action, done intentionally, is referred to as the ***Valsalva Maneuver***. The Valsalva Maneuver is, basically, forcing air against a closed airway (like when you keep your mouth closed and pinch your nose shut while ascending and descending on an airplane to 'pop your ears' - which, in effect, will balance out the pressure between the ears and sinuses). Interestingly, the technique was described first in the early 18th century by a physician whose primary practice was that of the ears and sinus cavities, Antonio Valsalva, who the technique is named after. It is used today, primarily, as a method for medical assessment of cardiac function. In terms of resistance training, many authorities advise against the Valsalva Maneuver because it increases blood pressure and consequently deprives the brain of oxygen. The increase in blood pressure subsequently also increases the pressure of the cerebrospinal fluid (which surrounds the brain), which offsets the increase in blood pressure in the brain. It should still be handled with caution. Yes, the Vasalva Maneuver can promote stabilization of the trunk, thereby improving leverage and preventing injury. However, breath holding is NOT acceptable beyond a few short seconds.

Using a Weight Training Belt

There is much controversy regarding the use of weight training belts. The use of a weight belt provides support to the area just below the thoracic region and just above the pelvic girdle. They are very effective for stabilizing this abdominal core area when applying maximum load in very low rep ranges. *However,* it is so effective that the core muscles aren't challenged and so don't develop effectively. This leaves those muscles weak and your core unstable; fostering a reliance on the belt. A belt should only be used for near-maximal lifting when using very heavy weights. This is usually for competition purposes or when practicing with competition lifts. If a belt is used to do bench presses or barbells curls, then good form and core strength should be re-examined. A belt stabilizes the core by making the abs push outward against it.

Tip: Ease off the belt if currently using one. *Slowly* work back up to the current desired weight load to avoid injury. Clients will develop far greater core strength, stability and tighter, flatter abs by simply sucking in the stomach and contracting the abs during a lift. No belt needed.

Regarding the functional fitness client, there is no need for the use of a training belt. The use of a training belt during functional fitness training defeats the purpose, since core development is a primary goal of functional training. The use of a training belt will weaken the core and muscle imbalance will result.

Using Knee Wraps

Knee wraps should only be used when performing extremely heavy lower body exercise, such as the squat. They should only be used on an infrequent basis. To most industry professionals, the use of wraps is considered to be "artificially supporting" the hard tissue; and the continued repetitive use of knee wraps may result in disproportionate strengthening of soft tissue. Consequently, this may result in weakening of tissue in and around the joint (risking an acute knee injury). As long as heavy squatting is not exclusively performed, and phases of higher repetition squatting (12 to 15 rep range or higher) are performed to improve fluid movement and strengthen the knee joints, then there should be little risk of injury associated with the infrequent use of knee wraps. NFPT reiterates the caution: though knee wraps are useful for maximizing the load-bearing strength of the major muscles in the lower body, they should only be used during temporary extreme overload training, when the absolute strength of a movement is the *temporary* goal. For example: single lift, maximum strength (power lifting events).

More on Warming Up for Resistance Training: The Not-So-Beginner

There are a few exercises that can be performed prior to every resistance training workout (in which the resistance exercise program is recommended as the entire training session). These exercises act to maintain flexibility, range of motion, a strong healthy back, reduce long and short term likelihood of injury, increase muscle temperature, and prepare the body for resistance exercises.

Traditionally, most trainers have a client ride an exercise bike or perform some other sort of moderate level activity for about 5 to 8 minutes. When a client is new, this is fine. However, once they become proficient at exercise, NFPT suggests that the trainer teach the client an active warm up circuit such us cat camel, quadraped cross-crawl and glute bridges. Take care not to overexert the client. There is no need to increase the exercise heart rate any higher than the recovery heart rate will be during the resistance exercise session. The purpose of this warm up activity is to prepare the "support systems" for resistance exercise by first constricting blood flow to the organs and digestion while re-routing and directing blood flow to the muscles that are about to be trained. This provides the muscles with oxygen and nutrients from the onset of the workout. If the client does not warm up in this manner, the heart rate during the first few minutes of the workout will be unnecessarily high. This is due to the muscle's sudden demand for oxygen and nutrients, and the heart's desperate attempt to comply. Inadequate preliminary activity can result in not only an extremely rapid pulse, but also increased respiration and nausea.

After an initial warm-up, a good first fundamental core exercise is the plank. Be sure to have the client engage their core and maintain a neutral spine. Trainers may elect to have the client hold this position as long as possible. A sustained isometric contraction results in a more rapid energy depletion than if the client were to perform a long exhaustive high rep set of conventional sit-ups.

Another fundamental follow-up core exercise is the antagonistic movement to the plank, the gym ball hyperextension or reverse hyperextension. It is important to note, that when a muscle contracts, its antagonistic muscle group is forced to stretch and relax optimally. These benefits explain why training antagonistic muscles in the same workout (in an alternating fashion) is recommended. Select core exercises on a case-by-case basis and use a wide variety of these exercises.

Back Conditioning Considerations

There are three major considerations to maintaining a healthy back: strength, flexibility/mobility and posture. It is the appropriate combination of the three which provides the client the necessary agility to avoid injuries while progressing toward fitness related goals.

Back Strength

While increases in absolute back strength are desirable for lifting heavy loads, it is the balance of all the trunk musculature which is the most important aspect of strength and preventing back injuries during activity. Posteriorly, the spinal erectors directly supporting the spinal column are very active during back extension movements, and function isometrically while lifting heavy loads in unsupported postures.

Antagonistic to the spinal erector muscles are the rectus abdominus muscles which, when well developed, give the stomach that "washboard" look, so frequently desired by most clients. The rectus abdominus muscles are most active during trunk flexion activities.

Finally, the external obliques, internal obliques, and transversus abdominus provide rotation and stability as they wrap around the entire trunk in three separate muscular layers like a "built-in back brace". The contraction of these muscles compresses the abdominal contents, thus increasing the intra-abdominal and intrathoracic pressure. this increased pressure stabilizes the spine against postural stresses as well as during heavy lifting. These muscles are all best strengthened through the use of a variety of extension, isometric, flexion, and trunk rotation and stabilization exercises, such as straight-leg dead-lifts, planks, pikes, hyperextensions, cable chops, medicine ball use, etc.

Back Flexibility and Hip Mobility

Spinal flexibility is important in that it allows the trunk to adapt posturally to the positions and activities imposed upon it. Remember, the spine is able to move in six general motions, bending forward (flexion), bending backward (extension), bending to either side (lateral flexion), and twisting to either side (rotation). NFPT recommends avoiding the use of flexion exercises with new clients or with clients who have any history of low back injury or concern. Flexion exercise programs should only be designed by an advanced level trainer when the circumstance warrants it.

The goal for spinal flexibility should be a balance between all the muscles of the trunk and mobility at the hips. Muscles need to be trained based on weaknesses and movement deficits, not based on vanity. Too much stretching in the back will compromise its ability to stabilize during activity. It is important to teach clients how to maintain a neutral spine throughout the core routine, and to be sure to engage the hips during rotation exercises. A trainer must introduce low back stabilization exercises and glute work before graduating to advanced, unsupported exercises.

Posture, Posture, Posture

The single most important step to maintaining a healthy back, beyond the realm of exercise, is to always maintain good posture. Proper posture balances the forces along the spine, rather than overloading one area which can easily lead to injury. It also prevents injuries associated with prolonged use of stressful "relaxed" postures, like slouching. Over time these postures can be as debilitating as an automobile accident.

To achieve the appropriate posture, simply sit or stand "tall", maintaining the natural curve of your spine as you 'brace', or tighten, the abdominals. To help a client understand how to 'brace' their abdominals, first tell them to prepare for a punch to the stomach. Then, tap their stomach to demonstrate the feeling of 'bracing' the abs. This properly aligns the spine and ensures support from the abdominals. Fatigue may onset quickly in this position, however, it takes only a short time to adapt to this new posture.

When sitting for long periods, it is important to move around, about every 30 minutes, to avoid kyphotic posture. The spine is in its most vulnerable position when seated because the hips are fixed. This is why it is so important that the spine be neutral and clients avoid flexion movements while seated, especially lateral flexion.

Back Injuries

If a client sustains a back injury, discontinue exercise and immediately apply ice to the injured area for 20 minutes and recommend repeated ice application every two hours as needed. If pain does not significantly subside soon after the initial pain occurs, they must see their physician immediately.

Upon the client's return to their exercise program, and after a written physician's clearance has been provided, have them begin with lighter exercise and progress as tolerated (progressively increase exercise intensity as long as the client's pain does not return). Avoid core exercises other than mobility, foam rolling and light stretching for a couple of sessions to avoid aggravating the condition. Consult the appropriate health professional with any questions.

Remember, proper care of the back involves a balance of thoracic mobility, lumbar stability and hip mobility. Ignoring these key elements will put your clients at a much higher risk for injury.

Contraindications to Exercise: The Basics

Personal trainers must inform their clients of the contraindications to exercise, which are any symptoms of overexertion or injury that may indicate an underlying problem. Trainers must fully understand and have the ability to explain the differences between expected exercise discomfort versus discomfort that is beyond a normal level and may, in fact, be indicative of a medical concern. Conversely, if there is awareness of an existing medical concern, such as significant cardiovascular disease/concern (e.g. history of severe hypertension, stroke, pacemaker, etc) or the client is currently taking medications for these or other serious medical issues, it is prudent to consult their physician and also discuss appropriate limitations/guidelines for their exercise program. Some trainers reach out to their client's physician by providing a list of questions to the client with a request for those to be answered with the physician's signature/statement regarding the client's condition and ability to perform exercise (include trainer contact information as well). Most physician's will appreciate this and will respect the fact that you are thorough and care enough for your client's well-being to consult with them. This is also a great way to establish professional relationships in the medical community that will give you a networking leg up!

Contraindications to exercise include:

- blurred vision
- joint pain
- dizziness
- light headedness
- nausea
- rapid pulse
- excessive sweating
- extreme muscle soreness
- cramping
- chest pain

It is always good to err on the side of caution, slight discomfort and a little sweat are a lot different than extreme soreness, cramping or chest pains - keep the lines of communication open with your clients, remind them that you need to know how they feel before, during and after their workout.

CHAPTER 13

Program Design: Charts & Tables

The program design charts and tables in this chapter will be a beneficial reference as you apply them to your work as a personal fitness trainer. However, more than just using them, it is of even greater value that you understand their context. We will cover the fundamentals in this chapter, using the charts and tables as our guide, but understand that your work as a personal trainer can vary a great deal depending on the goals, abilities and limitations of your clients. We will cover *Client Screening and Consultation* in the chapter to follow - but, for now, let's look at the basic recommendations for an easily applied resistance training program for your apparently healthy client. Generally speaking, your clients will seek out your services for one of the following main goals: fat loss and toning, strength and size increases or stamina and endurance.

The following methodologies are recommended by NFPT, primarily to provide a starting point for improving body composition using a resistance training program.

Functional routines, for those wishing to improve their ability to more safely and effectively perform specific activities of daily living, are not factored into these charts and tables.

General Exercise Recommendations

GOAL	REP RANGE	ROUTINE	SET INTENSITY	DURATION	RECOVERY HR
Strength/Size	4-6	3 Day Split	90-100 %	30-60 min	100 BPM
General Fitness/Stamina	12-15	2 Day Split	85-95%	45-70 min	115 BPM
Fat Loss/Endurance	20-25	Total Body Circuit	60-90%	45-90 min	125 BPM

After you have effectively performed the client screening process, use this table to establish a baseline for your exercise programming. Even as you become more experienced, and are able to be more detailed and specific with your client, this table will continue to serve as a guide. Here is a quick and basic breakdown of the its components:

Goal

Notice first that your recommendations are always based upon the client's goal. Look at the far left column; the first goal listed is Strength/Size. If this is the client's goal, you simply follow the basic program parameters for a size and strength client. General Fitness/Stamina is the next possible client goal; this would be the category in which an incremental athlete would fall under (i.e. boxer, basketball player, linebacker, etc.) - it could also be for those desiring general fitness, firming up, and lean weight maintenance. The third and final goal listed is Fat Loss/Endurance. If your client is interested in fat loss, cardiorespiratory enhancement, or is an endurance athlete (long-distance runner, free-safety, etc.), use the recommendations for this respective category.

Rep Range

The second column in this table indicates the appropriate "Rep Range" to be used to achieve the selected goal. These differing rep ranges have been determined to be ideal in causing the type of adaptation required to achieve the relative listed goals.

Routine

The third column in this table lists the most effective routine to be used to optimize the client's results, relative to his/her selected goal. You should have an understanding of what the 3 day split, 2 day split, and circuit routines are. We have discussed these concepts, but let's have a brief recap:

On a 3 day split routine: divide all of the major muscle groups up into 3 separate workouts. Muscle groups should be stressed with heavy weights in the 4-6 rep range, and then given several days of recovery before being directly stressed again. For example, muscles worked on day 1 are recovering on day 2 and day 3. Take additional days off from time to time when extreme intensity is applied.

On a 2 day split routine: divide all of the major muscle groups up into 2 separate workouts and use moderate weight in the 12-15 rep range. Since less actual damage is caused to the muscles in this rep range, less recovery time is required prior to directly stressing these muscles again. Muscles worked on day 1 are recovering on day 2. Take additional days off from time to time when extreme intensity is applied.

On a total-body circuit routine: performance of resistance exercises using light weight, in the 20-25 rep range, using 3 or 4 compound movements involving all the major muscle groups - training every other day, 3 to 4 times per week. Since there is less damage done in this higher rep range than in either of the other two, this allows for the performance of the total-body circuit routine on an every-other-day basis. Take additional days off from time to time when extreme intensity is applied.

Set Intensity

The next column identifies set intensity, it offers you the option of varying the client's set intensity from 60 to 100%. It is important to note that this is 'set intensity' not 'average intensity'. We'll look at set intensity in more detail in the following section; for now, know that, if your client is a beginner, 60-75% set intensity is usually suggested for at least as long as it takes to work through the initial muscle soreness. Explain to your client that the initial sessions will be easier than he or she may expect because you, as their trainer, need to get an understanding of their recovery period. If a client is already a resistance trainee then, in most cases, you can start them at 100% set intensity. You will use information that you gather in your client screening consultation to determine if this is suitable.

Duration

The next column in the table deals with determining the duration of the workout, specific to the resistance part of the program. Generally speaking, the greater the set intensity, the shorter the workout can and should be. Conversely, the lower the set intensity, the longer the workout can and should be.

Note - It is important to point out that if the set intensity is 100% at 4-6 reps and the duration is 90 minutes or longer (high volume, heavy training), the 3 day split routine should only be performed five (5) days a week. For example, train on Day 1 (Monday), Day 2 (Tuesday), Day 3 (Wednesday), Day 1 (Thursday), and Day 2 (Friday); so, only Monday through Friday, then start with Day 3 on the following Monday, and so on. This offers more recovery time for those fibers involved in a very damaging, high volume workout. A caloric increase should be considered as well.

Recovery Heart Rate

The final column in this table reflects what the client's heart rate should be prior to performing the next set. The higher the recovery heart rate, the greater the cardio effect. Have your client palpate his or her pulse at the wrist or neck between sets, in a seated position. Upon completion of a set, the client, in a seated position, should count the number of beats in a 15 second time period and then multiply this number times 4 to end up with the number of beats per minute. The client should repeat this process until he or she is at, or below, the recommended recovery heart rate for that rep range. At this point, the client is ready to perform the next set. Once clients have a 'feel' for where their heart beat should be, and they are not troubled by any contraindications, they will no longer need to constantly monitor their heart rate. They can move from one exercise to the next based solely on the way they feel.

All things considered, if a client wants to gain size and strength, the recovery heart rate should remain as low as possible (100 BPM). The client who is interested in general fitness, or is an incremental athlete requiring stamina, needs a degree of lean tissue increase blended with a cardio effect - his or her recovery heart rate should be slightly higher (115 BPM). Lastly, the client who is most interested in achieving muscle endurance, achieving a cardio effect while maintaining lean muscle tissue, or is an endurance athlete, etc., needs to perform at an even higher recovery heart rate (125 BPM). Since all clients are performing resistance movements, muscle tissue maintenance is always emphasized.

In your client's first several appointments with you, the recovery heart rate method should be strictly followed to familiarize the experienced versus the beginner client of just how fast they should be moving from exercise to exercise. Remind the client repeatedly, for the first several sessions, of the contraindications of exercise and ask whether or not they are experiencing symptoms. If a client experiences mild contraindications at the recommended recovery heart rate, lower this recovery heart rate temporarily and pick up the pace as the client's condition improves. Do not alarm the client when these mild symptoms occur, simply emphasize the importance of consistency and discipline in reconditioning. After an extended length of time, using the recovery heart rate, the client will be able to distinguish his or her readiness to continue on to the following sets, based on their level of comfort. This will allow clients to alter their future resistance training efforts as they see fit. However, instruct the client that cellular energy and catalysts depletion, during resistance exercise, increases with the increased duration of intense effort. Thus, the higher the client's recovery heart rate, the greater the risk of muscle tissue loss.

2 Key Elements to Optimizing Your Movement Selection

Key Element Number 1- In the case of your client wanting general fitness and/or fat loss, movements should be selected that involve the greatest amount of muscle mass so that the greatest amount of muscle energy is depleted. This allows for the greatest amount of fat mobilization and uptake into the muscle for energy replacement purposes between workouts. Therefore, in setting up a circuit routine for a client who is concerned about general fitness and/or fat loss, use multiple sets of movements that involve the most muscle mass possible.

Simply put, in establishing a circuit routine, recommend several sets of each a pushing movement, a pulling movement, and a leg press or squatting movement. Your client should perform these movements consecutively until completing 4 to 5 circuits. This will be far more efficient than setting the client up on a conventional circuit routine where small muscle groups are exercised individually and that will deplete very little energy per set.

Exercise selection is imperative in order to challenge the heart rate as well. There has been much attention on the High Intensity Interval Training (HIIT) principle, and for good reason, it may elicit better weight loss benefits in most clients. Grouping full body tri-planar movements with endurance drills can get your client to his or her max training heart rate, sustained for 30-45 seconds. Then, the less intense single joint and postural exercises that follow, for about 90-120 seconds, act as a rest period before the next bout of intensity. The duration of high intensity bouts vs recovery time is based on the client level and the client goals. New clients need shorter bursts of intensity with longer rests. HIIT principle can be applied to any phase of training such as power, strength and endurance. The above example is a way to integrate the HIIT principle into a simple circuit style routine. Learning and exploring the in-depth principles of HIIT, and/or any of the specific training areas that we will cover, are specialty education courses in and of themselves; for the purposes of this manual we will cover the basic foundation for these and we encourage you to seek further knowledge on this and other subjects. As for HIIT, understand that the general goal is to include short, high bursts of exercise followed by slightly longer 'recover' periods. As your level of fitness and stamina increases, then you begin to increase either the duration or the intensity of the intervals.

Key Element Number 2- For your client whose goal is size and strength increase, your movement selection should be based on the principles of leverage and innervation. Muscles will grow more quickly using movements that allow for the target muscle to be stressed by the greatest amount of weight possible in the muscle's strongest position of leverage. If your client, seeking increased size and strength, can use more weight with strict form while performing barbell curls than dumbbell curls, then he or she should be performing barbell curls. This simply means, for example, that for chest, a bench press movement using heavy weights will result in more effective size and strength increase than would result from performing dumbbell flies using lighter weights. It is imperative that you factor in the client's goals, limitations and needs. If a client is much stronger on their left side, for example, then doing straight bar exercises may further exaggerate their weakness and lead to repetitive stress injuries. In the case of this example, it makes more sense to correct the imbalance by independently training each side of the body using bands, dumbbells or cables. Before you load your client up with heavy weight and low reps, you must make sure that they have proper muscle coordination and are able to keep good form. New clients need to learn proper movement before throwing around heavy weights.

It is physiologically impossible to shape a muscle. Pain experienced in specific locations within a target muscle group can be misleading. Muscle fibers will grow along their entire length, not just where the most pain is experienced. Furthermore, the isolation of a muscle is not possible. No muscle can contract on its own without the assistance of at least one totally separate muscle group (synergist or secondary). In light of this, there is little benefit in trying to isolate a muscle.

Suggested Movements and Total Sets

Now that you are familiar with the *General Exercise Recommendations* table, it is time to move on to the *Suggested Movements and Total Sets* table. This table lists the major muscle groups, the recommended total sets to be performed for each muscle group, circuit routine information, and the NFPT's suggested movements based on client goals. As you can see in reviewing the table, it is fairly self explanatory and easily applied.

Let's look at total sets, for example; you will notice that the greater the intensity, the fewer the recommended sets. For example, if the client is targeting the chest in the 12-15 rep range, at high intensity, he or she should only perform 8 total sets of the suggested movements. With this same client, at lower set intensity, 10 total sets are recommended. The reason for allowing your client to perform more total sets at low intensity than at high intensity is because there is not as much damage being done to the muscle at low intensity. Therefore, it is safe and effective to perform more low intensity sets. Prolonged intense work in all rep ranges causes more damage/energy depletion than the body can effectively recover from. Too many heavy intense sets means overtraining. Therefore, the number of total sets per body part, as outlined in this table, should be relatively low.

Suggested Movements and Total Sets

MUSCLE GROUP	TOTAL SETS 4 TO 6 REPS (HIGH INTENSITY)	TOTAL SET 12-15 REPS (LOW INTENSITY)	CIRCUIT 20-25 REPS	SUGGESTED MOVEMENTS
Chest	6 to 8 sets	8 to 10 sets	4 to 5 sets	Flat/Incline Bench Press/Push-Ups/Cable Pressing
Back (upper)	8 to 10 sets	10 to 12 sets	4 to 5 sets	Pull-Ups/Cable Rows/Pull-Downs
Back (lower)	4 to 6 sets	6 to 8 sets	4 to 5 sets	Hyperextensions
Shoulders	4 to 6 sets	6 to 8 sets		Rear Fly, Dumbbell Side Raises*
Triceps	4 to 6 sets	6 to 8 sets		Shoulder Press/Tricep Extensions/Close Grip Bench
Biceps	3 to 5 sets	5 to 7 sets		Curl w/Dumbbells or Bar
Traps**	3 sets	3 sets		High Pull and Hang Cleans
Quads	8 to 10 sets	10 to 12 sets	4 to 5 sets	Squat/Leg Press/Deadlift/Lunges
Hams	3 to 4 sets	3 to 4 sets		Stiff Leg Deadlifts/Supine Leg Ball Curl
Calves	3 to 4 sets	3 to 4 sets		Standing/Seated Toe Raise
Abs	1 to 2 sets	1 to 2 sets		Ball Crunch/Chop/Ab Wheel
Forearms	2 to 4 sets	2 to 4 sets		Wrist Curl/Reverse Wrist Curl

*Side raises, as with all exercises, are contraindicated when improperly performed. There is no need to raise the dumbbell past shoulder height.

**Traps are best trained with some basic Olympic style lifts. NFPT does not recommend these exercises for most general fitness clients, do not use these lifts without proper training. In most cases, there is no need to perform elevation exercises for traps with the general fitness client, depression and posture exercises are usually best suited.

NOTE: NFPT does not recommend the barbell upright row because of the risk of shoulder injury. This exercise internally rotates and abducts the shoulder which impinges the joint space and, over time, will irritate the soft tissue. In situations where its necessary, a High Pull is acceptable as long as the client has proper mobility and motor control; however, an entry level trainer should not determine if a client is clear to do High Pulls, and, in most cases, it is unnecessary and actually harmful

When planning total sets for different muscle groups, the size of the muscle group is a determinant in the number of sets performed. As a general rule of thumb, a smaller muscle group will require fewer total sets than a larger muscle group.

NFPT Range Chart

A brief overview of the Range Chart will reveal to you the significance of the application of its principles. This chart also provides you with a means by which to define and convert general recommendations concerning rep ranges and intensity levels into specific numbers of repetitions and exact weights to be used based on client goals and experience. Use the Range Chart to find the exact number of repetitions a client should perform in a chosen rep range and at every level of intensity in that rep range. For example, when referring to the chart, if you wish for your client to train with 80% set intensity in the 12 to 15 rep range, then the client will be doing 12 repetitions with a weight that could be used to failure at 16 repetitions. This amounts to what is called '4 reps short of failure'. Another example, when selecting the right starting weight for training at 70% set intensity in the 4 to 6 rep range, would be to look for the weight that a client can get 7 repetitions to concentric (positive) failure. Later, require that client to perform only 4 reps with that weight. As a rule, 100% intensity is safe for apparently healthy individuals, who can use proper form.

Range Chart

Chart is only effective with proper diet and recovery

Intensity during set and effect on tissues

	(4-6) REP RANGE	(12-15) REP RANGE	(20-25) REP RANGE
Effect on Tissue at 70% Intensity	Maintain Strength	Maintain Stamina	Some Fat Conversion
Effect on Tissue at 80% Intensity	Increase Strength	Increase Stamina	Moderate Fat Conversion
Effect on Tissue at 90% Intensity	Maximize Strength	Maximize Stamina	Maximum Fat Conversion
Effect on Tissue at 100% Intensity	Build White Tissue	Build Red Fast Tissue	Build Red Slow Tissue
Effect on Tissue at 110% Intensity	Tissue Damage	Tissue Damage	Tissue Damage

Rep Ranges: Relative to % Intensity and Point of Contraction Failure

RPE*	(4-6) REP RANGE/STRENGTH	(12-15) REP RANGE/STAMINA	(20-25) REP RANGE/ENDURANCE
Somewhat Hard (Borg 4) 70% Intensity	3 reps short of failure	6 reps short of failure	9 reps short of failure
Hard (Borg 6) 80% Intensity	2 reps short of failure	4 reps short of failure	6 reps short of failure
Very hard (Borg 7-8) 90% Intensity	1 rep short of failure	2 rep short of failure	3 rep short of failure
Very, very hard (Borg 9) 100% Intensity	Max; Unassisted failure (Good)	Max; Unassisted failure (Good)	Max; Unassisted failure (Good)
Exhaustion 110% Intensity	Past failure; Forced reps (Bad)	Past failure; Forced reps (Bad)	Past failure; Forced reps (Bad)

*Rate-of-Perceived-Exertion

Total Activity Expenditure and Calorie Needs

As a NFPT Certified Personal Fitness Trainer, you need to have some understanding of how much and what type of foods your client is eating. You can set up the perfect exercise program for a client, but if he or she is not following fundamental diet principles, then the program will not be optimally effective. In order to determine dietary needs, it is essential to first estimate the number of calories that one will expend during the exercise program you recommend.

Before we discuss metabolic equations, for Basal Metabolic Rate (BMR) and/or Resting Metabolic Rate (RMR), which are often used interchangeably, we will first look at the basic averages for those who are at least somewhat active. Here is an *Activity Expenditure Chart* that you can quickly and easily use to estimate your client's training expenditures.

Activity Expenditure Chart

ADD TRAINING EXPENDITURE TO DAILY ACTIVITY EXPENDITURE

100 BPM = Recovery Heart Rate (between sets)	500 Calories per Hour Training (Expenditure)
115 BPM = Recovery Heart Rate (between sets)	750 Calories per Hour Training (Expenditure)
125 BPM = Recovery Heart Rate (between sets)	1,000 Calories per Hour Training (Expenditure)
Average person's day-to-day activity requirement	500 Calories For Daily Activity (Approximate)

For example: 115 BPM Recovery Heart Rate = 750 calories per hour of training. If the duration of the workout is 30 minutes, then the training expenditure is 375 calories. Now that you have established a training expenditure, add the approximate 500 calories, reflecting the average person's daily activity expenditures. The resulting figure will return a general estimate of your client's total daily expenditure.

Now then, take into account the client's metabolic category as being **Ectomorph**, **Mesomorph**, or **Endomorph**. If the client is an Ectomorph (very fast metabolism) consider adding 500 more calories; if Mesomorph (normal metabolism) you should leave the total expenditures alone. If the client is an Endomorph (difficulty losing weight) take away 500 Calories. This will give you an *estimated* "Total Caloric Expenditure", which is an estimate of your client's daily need in calories. Now, factor in the RMR as well as the thermic effect of food in order to find an even more precise figure for caloric expenditure, because:

Total Caloric Expenditure = RMR + Activity Expenditure + Thermic Effect of Food

At this stage in your studies, we will estimate at a basic level for an average client and will provide you with a couple of different methods for calculating these figures.

General Dietary Advice

NFPT Charts and Tables in this section are goal-oriented; for example, this *General Dietary Advice Chart.* Let's explore the application of the chart prior to expounding on its principles. First is simple - what is the goal? In all of these charts and tables, the single most important thing in determining recommendations is the goal of the client.

You'll notice that the general goals include: ***weight loss, weight maintenance and weight gain***. Each of the goals has its own set of recommendations for diet. Note also that the recommended protein, carbohydrate, and fat percentages refer to calories, not grams. You will need to teach your client how to convert grams into calories and vice versa.

ENERGY SOURCE	CALORIES PER GRAM
Fat	**9**
Proteins	**4**
Carbohydrates	**4**

This *General Dietary Advice Chart* will provide basic dietary parameters that are simple to understand and easily applied.

General Dietary Advice Chart

GOAL =	WEIGHT LOSS	WEIGHT MAINTENANCE	WEIGHT GAIN
TOTAL CALORIES =	TOTAL EXPENDITURE - 500 CALORIES	TOTAL EXPENDITURE	TOTAL EXPENDITURE + 500 CALORIES
% Protein =	25%	20%	15%
% Carbs =	50%	55%	60%
% Fats =	25%	25%	25%
# of Meals/Day	4-5 Meals	4-5 Meals	5-6 Meals

Now, let's start to pinpoint the 'Total Caloric Expenditure' number so that you can come even closer to exacting that figure, and reaching the goal. One of the most important determining factors in calculating a more precise expenditure and, subsequently, your client's diet recommendation, is to have the capacity to determine lean body weight (LBW), also known as lean body mass (LBM). We suggest that you purchase a skin fold caliper (this device, for measuring body composition, and other similar devices, can generally be purchased through a medical supply company). Once you have measured the client's LBW, by using the body composition measuring device and respective instructions, you will then be ready to determine his or her specific caloric intake need. The LBW allows you to establish a caloric base to work from. If you were to recommend a calorie intake based on total weight, then you would be providing calories to support fat weight, and that is obviously discouraged. For each of the respective goals, weight loss, weight maintenance or weight gain, the closer that you can come to true total caloric need, the closer that you will be to accurate calculations per food source for the respective goal. Finding LBW can help you to estimate your client's Resting Metabolic Rate. It is essential that you have a clear understand of RMR. If your client were to lie around doing nothing physical all day, then their Resting Metabolic Rate, in calories, would provide for all necessary body functions. For our purposes, we will look at RMR as opposed to BMR, because both are very similar and RMR calculations can be more generally stated, while the BMR calculation requires a more scientific approach. Always keep in mind that, *for client safety, never, under any circumstances, consume a diet that is below Resting Metabolic Rate.* A medical professional may prescribe diets that are below RMR, or BMR, to fat loss clients/patients; but, this is not an entirely safe process, especially for a personal fitness trainer. To err on the side of caution, though health professionals may consider it safe to suggest a weight loss rate of up to 2 pounds per week, NFPT recommends a weight loss caloric reduction rate of only 500 calories per day, and this reduction should be based on total caloric expenditure, not on RMR alone. As a general rule, rather than dropping 500 calories from a weight loss client's diet, you should always opt to increase activity expenditures in the amount of 500 calories. Generally, it is healthier for your client to perform more activity than to diet in the form of less calories (especially if your client tends to take dieting to extremes).

The most common method for calculating RMR is through the Mifflin-St. Jeor formula (known simply as the "Mifflin formula"). Many online calculators are available for this and other formulas which will provide quick and accurate results (however, it is beneficial to understand the method/formula that is used to find the resulting figure; not for memorization purposes, but for a personal understanding and benefit of knowledge). The Mifflin formula states that:

For Men: RMR = (10 x weight, in kg) + (6.25 x height, in cm) - (5 x age, years) + 5

For Women: RMR = (10 x weight, in kg) + (6.25 x height, in cm) - (5 x age, years) - 161

Note that these figures are in kilograms and centimeters, remember to convert:

1 pound (lb) = .453592 kilograms
# of lbs x .453592 = # of kg

1 inch = 2.54 centimeters (cm)
# of inches x 2.54 = # of cm

Once you have solved for RMR, this number can be plugged into the equation for Total Caloric Expenditure. Remember:

Total Caloric Expenditure = RMR + Activity Expenditure + Thermic Effect of Food

We have changed this equation up a bit by using RMR instead of BMR (which is virtually the same thing), and we will only use general estimations of the Thermic Effect of Food. The Thermic Effect of Food is, basically, the amount of caloric energy needed, above RMR, to digest the food you eat and to absorb and distribute those nutrients. We're going to use a basic 10% of caloric intake as the Thermic Effect of Food; of course this will vary depending on the types of food ingested and the energy sources present.

Let's look at an example based on the Mifflin formula and estimations for variables that contribute to the Total Caloric Expenditure. You have a 36 year old female client who weighs 135 pounds (lbs) and is 5'6" tall, find her RMR.

1) convert to kilograms and centimeters
lbs to kg = # of pounds x .453592
kg = 135 x .453592
kg = 61.23492

inches to centimeters = # of inches x 2.54
5'6" = 66 in
66 x 2.54 = 167.64 cm

2) Plug in to Mifflin formula, for women
RMR = (10 x weight, in kg) + (6.25 x height, in cm) - (5 x age, years) - 161
RMR = (10 x 61.23492) + (6.25 x 167.64) - (5 x 36) - 161
RMR = 612.3492 + 1047.75 - 180 - 161
RMR = 1319 calories (rounded to nearest whole number)

3) Plug into the equation for Total Caloric Expenditure - with Activity Expenditure and Thermic Effect of Food estimates factored in. For this example, let's say she is working out for 30 minutes a day and has a recovery heart rate of 115 BPM; therefore, her activity expenditure is 375 calories. Also, since the average person's day-to-day activity expenditure (without training) is 500 calories, see *Activity Expenditures Chart*, *page 209*, we will add that to the total as well.

Total Caloric Expenditure = RMR + Activity Expenditure + Thermic Effect of Food
= 1319 + (375 + 500) + (1319 x 10%)
= 1319 + 875 + 131.9
Total Caloric Expenditure = 2326 (rounded to nearest whole number)

As discussed, there are several methods for calculating, or estimating, the average client's resting metabolic needs. The Mifflin formula gives us a great place to start in order to get a more accurate reflection of the Total Caloric Expenditure that a client uses each day, given their activity level. From this example, you will notice a 1000+ calorie difference between RMR and Total Caloric Expenditure. This is because one of these, RMR, looks at a steady resting state (doing absolutely nothing), while the other, Total Caloric Expenditure, factors in the activity level and even the energy needed to break down food. We could go into further calculations with even more specific variables, which would also effect both of these numbers, i.e. age, genetics, supplementation, even altitude; but, for our purposes, we want to keep this as easily applied as possible based on tried and true averages that will establish a working baseline.

Now, as an alternative to conversions and equating to get to RMR, NFPT independent research has established a 'broken down' method to use as an alterative to these formulas. As a trainer, it is good to understand that RMR can be found by using more than one method. NFPT's alternative method may be easier for you to apply as it offers a simplified equation for an estimated RMR that will yield very similar results compared to the Mifflin formula. The NFPT simplified equation states that: **LBW x 11 = RMR**. Let's try it for an estimated RMR. Except, this time, we need to find the client's LBW - if you know the Body Fat%, just plug it into the LBW formula:

LBW = Body Weight - (Body Weight x Body Fat%)

Using our same example, in order to find RMR using the simplified LBW x 11 equa-tion, you need to first know her LBW. This can be found by first finding body fat%, using the body composition measuring device of your choice. Per the specific instructions for the device that you use, the most common of which is the skin fold caliper, you will find a body fat % (*see page 236-241*). Note that, according to the American Journal of Clinical Nutrition, an average 'healthy' body fat %, in an age range of 20-40 years old, is 8-19% for men, and 21-33% for women. NFPT suggests a healthy target of no more than 25% of body fat for women, and no more than 18% for men. Obviously, you would expect this body fat %to exponentially increase or decrease given the inactivity or athleticism of your client, respectively. A female athlete, for example, may have only 15% body fat and that would be considered healthy based on her fitness level.

Knowing the body fat % will yield you a quick and easy LBW as well, which will then allow you to find LBW in pounds, because: **LBW = Body Weight - (Body Weight x Body Fat%)**. And, yet, there are still several ways to find LBW, it is a matter of which works best for you. We suggest calculating for RMR, Total Caloric Expenditure and LBW using more than one method to see how closely they compare. You can expect to find differ-ences, but they should be relatively small differences. Let's see what our difference is when we compare the resulting RMR from the Mifflin equation with the simplified NFPT equation: **RMR = LBW x 11**. We'll find LBW using the popular, and industry standard, Hume formula (but, keep in mind, the LBW can be found by using other body composi-tion methods, e.g. the skin-fold caliper method):

For Men: LBW = (0.32810 x weight, in kg) + (0.33929 x height, in cm) - 29.5336

For Women: LBW = (0.29569 x weight, in kg) + (0.41813 x height, in cm) - 43.2933

Again, we'll use the same example: our female client, weighing 135 pounds and who is 5'6" tall. We have already converted pounds to kilograms and feet/inches to centime-ters, so let's start plugging into the Hume formula to find her LBW (in kg).

LBW (for Women) = (0.29569 x 61.23492) + (0.41813 x 167.64) - 43.2933
= 18.1065535 + 70.0953132 - 43.2933
= 44.9085667 kg

To convert Kilograms to Pounds:
1 kg = 2.20462 lbs
44.9085667 kg x 2.20462 lbs = 99 pounds (rounded to nearest whole number)

Now, take the resulting LBW to find the estimated RMR, using the simplified NFPT for-mula:
RMR = LBW x 11
RMR = 99 x 11
RMR = 1089 calories

You will notice that the difference between the result of the Mifflin formula, which gave us 1,319 calories, and the NFPT formula, which gives us 1,089 calories, is only 230 calo-ries. Again, remember that this is an estimation and you should consider, at least, the client's activity expenditure as well, when using RMR to estimate a total caloric intake need for your client. Err on the side of caution, add calories needed for daily expendi-ture to RMR so that you do not recommend a lower than true RMR caloric intake.

We have discussed the activity expenditure variable for finding Total Caloric Expenditure using both a training expenditure, based on recovery heart rate, as well as an average day-to-day expenditure of 500 calories. But another way to find this estimate is by using the activity factors as provided for by an activity sub-set of the Mifflin equation. Choose an applicable factor for your client from one of the following:

ACTIVITY DESCRIPTION	ACTIVITY FACTOR
Sedentary: little or no exercise	1.2
Lightly Active: light exercise/sports 1-3 days/week	1.375
Moderately Active: moderate exercise/sports 3-5 days/week	1.55
Very Active: hard exercise/sports 6-7 days/week	1.725
Extremely Active: hard daily exercise/sports w/physical job demands	1.9

If you were to use this Activity Factor for an estimate that provides RMR + an activity expenditure, then find RMR and multiply the Activity Factor. For example, using the same female client who we have calculated RMR for, let's say that she is moderately active. "Moderately Active" would have an Activity Factor of 1.55, according to the chart. So, where RMR equals 1,319 calories (per Mifflin equation), we can find the RMR that includes an activity factor:
RMR x 1.55 =
1319 x 1.55 = 2044 (rounded to nearest whole number)

As you can see, there are many ways to get to the daily caloric intake need, derived from Total Caloric Expenditure, for your clients. You will also notice that there will be differences between the results of the various equations, but note that there are also differences in true values for your client's daily caloric intake need based on their activity from one day to the next. These formulas will offer you a baseline for RMR and, subsequently, Total Caloric Expenditure. Unless you use more advanced scientific devices and protocol for calculating these figures, a baseline is the best way to start and is a means for understanding the context of your recommendations. Remember, ***never recommend a daily caloric intake that is below RMR***. Your client's RMR may be 2000 calories per day, for example, but if they are ingesting 4000 calories per day and remaining completely sedentary then, by calculating for RMR, you can better show the reason for unwanted weight gain and also reinforce a need for a caloric intake adjustment. But, you are not using RMR alone to make this caloric adjustment, you will use the figure for *Total Caloric Expenditure* (RMR + factors for activity, at least 500 calories, and thermic effect of food, which should be at least 10% of RMR, added in) to make recommendations and to educate the client on the reasons for your recommendations.

Weight Loss, Weight Maintenance and Weight Gain

Let's look at each of these general, yet common, client goals in relation to the general dietary advice recommendations.

General Dietary Advice Chart

GOAL =	WEIGHT LOSS	WEIGHT MAINTENANCE	WEIGHT GAIN
TOTAL CALORIES =	TOTAL EXPENDITURE - 500 CALORIES	TOTAL EXPENDITURE	TOTAL EXPENDITURE + 500 CALORIES
% Protein =	25%	20%	15%
% Carbs =	50%	55%	60%
% Fats =	25%	25%	25%
# of Meals/Day	4-5 Meals	4-5 Meals	5-6 Meals

FOR ANY CLIENT - FIND RMR:

After finding your client's RMR, add in the activity expenditure to find your client's total daily caloric intake need. As discussed, you can do this by using the *Activity Expenditure Chart* provided, (RMR + Total Training Expenditures + Daily Average Expenditure (500 calories)); or, you can do this by finding RMR and multiplying the Activity Factor, per the Mifflin equation.

FOR WEIGHT LOSS CLIENT:

Take away approximately 500 calories from your client's Total Caloric Expenditure need. The result is an estimation of the weight loss client's suggested total calorie intake. These total calories should be broken down further into appropriate %s of macro-nutrients. You may find this to be a conservative approach to weight loss, however, it is a reliable starting place that will provide for the maintenance of enough total calories to prevent lean muscle loss, which typically occurs in most prolonged starvation diets. As there are approximately 3,500 calories in a pound of fat, a reduction of 500 calories per day below the client's Total Caloric Expenditure will result in weight loss of approximately 1 pound per week.

FOR WEIGHT MAINTENANCE CLIENT:

The caloric estimate that you find when calculating RMR and total activity expenditure is generally sufficient for an average client's goal of weight maintenance. In short, you are now providing replacement energy in the amount needed to maintain the client's current lean weight. At this caloric intake, the average person would not experience a long term loss or gain in total lean weight.

FOR WEIGHT GAIN CLIENT:

Add 500 calories per day to the weight maintenance needs, in other words the client's Total Caloric Expenditure + 500 calories. This extra 500 calories assures sufficient nutrition to support muscular growth. Using regular body composition testing will allow you to make further caloric adjustments while assuring increases in weight are due to lean weight gain versus fat weight accumulation. A weight gain client should increase calories at the same rate that a fat loss client is decreasing calories (500 Calories/day); ideally this will assist in the goal of gaining weight at a rate of 1 pound per week. Again the use of body composition testing is needed to assure the maintenance or increase of lean body weight and the loss of fat weight. This method of weight management, in addition to using skin fold calipers, is considered optimal in assuring muscle tissue maintenance during low calorie dieting, and/or minimizing body fat accumulation while weight gain dieting.

Metabolic Rate - the hidden factor

As previously discussed, the *General Dietary Advice Chart* can be objectively applied to the average healthy individual. However, when determining total caloric intake based on client goals, there are some hidden factors for the individual that will make or break the effectiveness of a seemingly perfect diet; the client's individual metabolic rate and variances which effect it. For example, somatotypes, discussed previously, will play a somewhat impactful role in the number of calories that you might otherwise suggest. There are also metabolic disorders that you should be aware of prior to training your client. We will not look at metabolic disorders within the scope of this text, but it is important for you, as a trainer, to understand that these conditions exist and can effect your client's training goals. As for making generalities regarding caloric intake and somatotypes, you can assume that, since the ectomorph struggles to gain weight, he or she may need additional calories to do so; and the endomorph, who struggles to lose weight, will need fewer calories than the average recommendation in order to lose weight. The *General Dietary Advice Chart*, as presented, applies to most apparently healthy individuals. We suggested a 500 calorie per day adjustment as a baseline; however, note that this is simply a general baseline as there are varying degrees to these categories. You will need to make the daily caloric adjustment decision on a case-by-case basis. Monitoring body composition will allow you to make future adjustments quite accurately. You can even make basic comparisons between a client's somatotype against the client's eating habits and overall body shape/appearance. For example, the client who consumes a large number of calories and still appears extremely thin is ectomorphic; if he or she is trying to gain weight, then this would need to be taken into account because more calories than is the general recommendation may be needed in this case to reach the goal.

Percentages of Nutrients

In looking closely at the suggested percentages of total calories to come from protein, carbs, and fats, relative to the desired goals, it should be noted that the absolute amount of protein intake (in grams) remains similar. Additions and/or reductions in total calories come almost exclusively from changes in carbohydrate intake.

As stated earlier in this chapter, make sure your client knows that there are 4 calories in a single gram of carbohydrates, as well as in a single gram of protein, but there are 9 calories in a single gram of fat. Therefore, 1 gram of fat has more than twice the calories as a single gram of carbohydrates or protein. The suggested percentages of nutrients in the chart were compiled based on the body's need for a balanced ingestion of nutrients from all three groups (protein, carbohydrates, and fats) to ensure optimum assimilation and cellular uptake.

REMEMBER:

General Dietary Advice Chart

GOAL =	WEIGHT LOSS	WEIGHT MAINTENANCE	WEIGHT GAIN
TOTAL CALORIES =	TOTAL EXPENDITURE - 500 CALORIES	TOTAL EXPENDITURE	TOTAL EXPENDITURE + 500 CALORIES
% Protein =	25%	20%	15%
% Carbs =	50%	55%	60%
% Fats =	25%	25%	25%
# of Meals/Day	4-5 Meals	4-5 Meals	5-6 Meals

Number of Meals Per Day

The value of eating more small meals throughout the day, as indicated in the *General Dietary Advice Chart*, instead of fewer large meals, cannot be overstated. To the body, digestion is considered work, and the more work you make the body do the more energy it expends, even during weight loss dieting. Equally break down the total calories into the suggested number of meals and attempt to maintain the same nutrient percentages in all meals. Also, keep in mind that, if your client has a bad habit of eating infrequently large meals, especially while sedentary, then, every day for several hours a day, the body is literally doing nothing significant and metabolism slows because it is being starved long-term. When calories ARE introduced, the body (in a survival mode) thinks it is starving and will store these calories as fat and not use them for body processes.

Conversely, in the case of eating more frequent smaller meals throughout the day, the body does not think it is starving and will release its fat around the clock for body functions, also working at the same time to digest food that assists in increasing metabolism as well. Frequent small meals are also great for maintaining a more steady blood sugar level.

Supplements

While NFPT does not recommend the use of concentrated, individual, nutrient supplementation for the typical personal training client; we realize that there will be those clients who use these supplements regardless of your recommendations.

With this in mind, the following information has been included to provide basic knowledge of those supplements which have been determined to be of some value dependent upon the client's goals. The supplement table in this section provides goal oriented recommendations for weight gain, general fitness, weight loss, size and strength, intermediate athletics, and endurance. Each row of this table provides the appropriate supplement, most commonly used, for the respective fitness goal.

Supplement Table

GOALS	WEIGHT GAIN	GENERAL FITNESS	WEIGHT LOSS	SIZE AND STRENGTH	INTERMEDIATE	ENDURANCE
BCAAs	■	■	■	■	■	■
FREE FORM AMINOS	■	■	■	■	■	■
PROTEIN DRINK	■	■	■	■	■	■
B-COMPLEX	■	■	■	■	■	■
MULTI-VITAMIN	■	■	■	■	■	■
CARB LOAD DRINK	■			■	■	■
HCL (PEPSIN)	■			■		

We will discuss the purpose of each supplement at its basic level; this does not mean that we suggest that you recommend supplementation to your clients, but it is important that you understand their implications to training. Simply make the client aware of the beneficial effects of different supplements, and let them decide whether or not they wish to incorporate them.

It is assumed that natural healthy foods contain bio-chemical substances that contain vitamins in just the right quantities to provide the average person's body with the enzymes needed to effectively assimilate that particular food's nutrients. Sadly, not only is the average person's diet rarely all-natural, there are pesticides and preservatives used that destroy some of these natural bio-chemicals (vitamins and minerals). Food today is not what it was 100 years ago, sometimes it's not even 'food' as we know it; therefore, supplementation has become more and more a part of our regular intake habits. Here are some good things to know about certain supplements as they relate to your clients' training goals.

BCAAs

Branched Chain Amino Acids (BCAAs) are the individual amino acids Leucine, Isoleucine, and Valine. These three amino acids are found to comprise about 50 to 60% of all muscle tissue, they are the most abundant amino acids incorporated into muscle protein. They are not broken down significantly by the liver, as is the case with most other amino acids. They are released into circulation by the liver and then taken up into skeletal muscle tissue to be broken down. This break down occurs during physical exertion/exercise in order to create cellular enzymes (catalysts) for energy production and to promote the sparing of nitrogen in muscle cells.

BCAAs could be supplemented within one hour prior to, and during, prolonged, intense exercise, to replenish depleted catalysts. When sufficient BCAAs are present in the cell fiber for catalyst formation, other amino acids in the cell can be used for the more desirable purpose of protein synthesis (building and repairing muscle) and energy production.

Free Form Amino Acids

Taking free form amino acids with meals that are 3 to 4 hours apart and include incomplete protein food sources, will assure that all of the unique "genetically required" combinations of amino acids are present at once (often a requirement for cellular uptake).

In theory, this will assure continued uptake, tissue repair, and anabolism. Diets that are deficient in protein or are high/low in total calories can be complemented by the supplementation of these free form amino acids. These situations should be avoidable (by properly using the *General Dietary Advice Chart*), as a substantial portion of each meal is comprised of protein. It is also important to note that the heavier the training, the greater the tissue damage. Consequently, the greater the damage, the greater the need for protein.

Protein Drink

A quality weight gain protein drink consists of an acceptable balance of carbs, proteins, and fats. When and if your client is ever faced with missing a meal, this type of protein drink can be used as a replacement. However, do not make this a habit, there isn't enough fiber in these types of drinks and there is no substitute for sound nutritional eating habits.

Infrequent "meal replacement" application will obviously be of value to all of your clients regardless of goals. The need for client discipline in the areas of meal timing, total caloric intake, and nutrient composition, can be satisfied through the replacement use of a quality high calorie protein drink.

On the other hand, another effective application of the high calorie protein drink is relevant to those weight gain clients who have an incredibly high metabolism from inherited hormonal reasons. These clients will claim that they absolutely cannot eat enough to gain weight; which is not valid reasoning due to the availability of extremely high calorie foods. Nonetheless, a high calorie protein drink is more easily digested and should be added to the weight gain client's existing high calorie diet. It is important to note that the amino acid breakdown and the calorie comparison between expensive weight gain supplements (protein drinks) and regular nonfat powdered milk are very similar. The serving sizes of course differ, but using powdered milk offers a more affordable means by which to supplement your client's needed calories and amino acids.

B-Complex

These vitamins are co-enzymes that are used in proportion to energy expenditure. Their replacement should be considered by everyone who is relatively active.

Multi-Vitamin

The next supplement is the ever present under-rated Multi-Vitamin. This supplement's value is by far greater than most, if not all, other supplements. It is commonly overlooked because the money spent on Multi-Vitamins would take away from the amount of money that could have gone to buying a mega-dose supplement. The Multi-Vitamin is simply a form of insurance because it provides the body with at least some of everything it needs.

Carbohydrate Loading Drinks

Last are the carb load drinks that can be found in any health food store. Remember that most of the glucose used in resistance training comes from sources already inside the muscle cell fibers. The source of glucose for aerobic activity comes mainly from the liver. This understanding should shed a whole new light on the use of carb load drinks. For the endurance athlete, maintaining blood sugar levels during aerobic activity is of the utmost importance. So, these slowly absorbed carbohydrates, which act to maintain blood sugar levels, come in very handy just prior to an event in loading the liver stores. For the resistance athlete, taking a carb load drink just prior to a workout would be unnecessary from the standpoint of supplying energy to fuel the workout, since energy comes primarily from inside the cells in resistance exercise.

However, there is a very useful purpose for carb load drinks in all types of activity; energy replacement. Simply put, regardless of the type of exercise, post workout carbohydrate intake is necessary to initiate replenishment of all glycogen stores and to prevent muscles from feeding on themselves for immediate post-workout recovery energy (catabolism). The immediate uptake of blood glucose, after an energy depleting resistance exercise session, will mean the difference between continued catabolism (break down) and the initiation of anabolism (rebuilding).

“One Hand Washes the Other”

Maybe this is an idiom that you are already familiar with...it means, in a nut shell, that it takes a cooperative effort in order to get the job done. You can use supplementation, for example, but it will only get you so far if the other end of the equation, physical fitness, isn’t being taken into account. There will always be a powerful balance between healthy eating and keeping active, it will never not be the case that these things do not go hand-in-hand to get the overall job done effectively, and well. We will assume that most of your clients will be those whom have tried dieting, maybe fasting, or other methods for weight loss or maintenance, so let’s look at a few of the most common reasons for dieting ‘fails’, and also some related ‘fixes’ for success.

1) STICKING TO THE PLAN

FAIL: 90-95% of people who lose weight will gain it back in 3 to 5 years. There tends to be a very low adherence to dieting, more than 20% of dieters will drop off their plan in the first 2 months, and more than half will quit before the end of a year.

FIX: Make a commitment that is truly attainable. Long term weight loss requires focus and a life-long commitment. This means making changes gradually versus the radical changes that people make and can’t stick to. Help your client to be realistic about their goals and what changes that they can really implement long term into their daily routines. Remind them that it took a long time to develop bad habits and to be affected physically by them, so a fix can’t happen overnight, or even within months, it’s a long haul commitment that will take some re-training of old habits.

2) UNDERSTANDING METABOLISM

FAIL: Most diets restrict your caloric intake so much that metabolism slows down. The weight loss process can be seriously affected by too much caloric restriction and very low calorie diets, causing significant decreases in metabolic rate, part of which is the result of the body resorting to using fat-free mass (muscle). This rapid decrease in caloric intake also activates the "set point" mechanism in the body (likely hypothalamic) which again causes the body to lower metabolic rate and lipid oxidation. Weight regain and constant fluctuation in weight is the result of this type of 'yo-yo dieting', which actually puts the client at more risk for additional medical concerns.

FIX: Be familiar with the client's Total Daily Caloric Intake need and be sure that there is only a 500 calorie deficit per day (750 calories at most, depending on the client and their training goals). Also, if the exercise volume is increased, the caloric consumption should be as well to cover the additional activity expenditure; this will help to raise the metabolic rate, even if the exercise is aerobic in nature. You, as the personal trainer, should emphasize the need for properly 'feeding' the body and the implications of not doing so. This may be a mind shift for your client, as they may feel like less food and calories equals a thinner body, but that's where you come in to dispel that myth. There is a threshold by which less calories is a good thing; too few daily calories will be counter productive to the fitness goal.

3) ENCOURAGE ATTAINABLE LIFESTYLE CHANGE

FAIL: Diets that have a lot of 'phases', or that require big changes to what is routine for your client, tend to fail. Also, those diets that depend on a certain shake or prepackaged drink/meal can be equally hard to hold onto, long term, because they're not as easily accessible or they are hard to follow. The dieter will often give up because they are lost in all of the rules, or because it's just too hard to keep up.

FIX: Learn to eat the right foods that are easy to get a hold of; adapt your eating habits to match your lifestyle. Encourage control and power over food - if managed properly, your client won't have to cut out everything that they enjoy eating, it could be a simple matter of portion control or choosing something comparable, but better, than what they are used to. Also, be encouraging about the overall feeling of working out - it doesn't have to be "something that *needs* to be done" but, rather, it can be "something you *get* to do". Exercise can be enjoyable, not a drag; so, express feelings of fun and excitement during your client's workout. Before long, your client will feed off of your energy and we'll feel great accomplishment with their healthier lifestyle; they will even start to feel "off" when missing a workout or eating junk food.

Exercise is not just part of the program, it IS the program. In fact, as stated and recognized by the American College of Sports Medicine, "exercise is the single greatest predictor of maintaining weight loss". People who try to diet without the exercise component will fall significantly short of their long term goals. In fact, a lack of exercise coupled with a very low calorie diet will start the yo-yo cycle that leads to frustration, over-compensation (i.e. "filling the void" with binge eating and/or other more extreme indulgences) and even depression. It is important to recognize that the quicker your client can get a handle on *how* to reach their weight loss goals, then the less up and down cycles that they will have to go through - this makes it worth your while, as their trainer, to teach them, show them, how and why the principles of your training methods will work for them, today and tomorrow!

CHAPTER 14

Client Screening & Consultation

There is no better way to begin offering client services than by learning how to perform client screening and knowing what questions should be asked during the first client consultation appointment. As a general rule for safety, you should always suggest that your client see his or her personal physician prior to starting or increasing the intensity of an existing exercise program. It is also both professional and appropriate that you maintain a current CPR (Cardiopulmonary Resuscitation) & AED (Automated External Defibrillator) certification. As a qualified and conscientious trainer, the services that you offer should reflect your awareness and approach to the safety of your clients.

The reason many people get a personal trainer is because they have not exercised in a long time, or ever, and want to learn how to do it the correct way. Therefore, much of the time, you may be working with a highly untrained individual, and it is likely that some may fall into health risk categories. This is why you do a pre-participation health screen. You need to first identify any 'red flags' that may be a warning to you and your client which indicate the need for seeking medical evaluation and/or further advice elsewhere. In this chapter we will look at the order in which you should screen your clients, and what you should be looking for during this assessment.

Understanding the Order of Operations

No, we're not going back to pre-algebra, but we are going to emphasize the order in which you screen and consult with your clients. Identifying any 'red flags' should always come first. This means that you will be doing the following:

- Discovering who may have medical conditions which will contraindicate exercise at this time
- Identifying individuals who may be at risk for certain diseases due to their age, symptoms, and reported physical conditions who should first be seen by a physician
- Identifying individuals who currently possess a condition which warrants participation in a medically-supervised program
- Revealing individuals with special conditions or needs that may require your attention or referral to another health care specialist

The diagram to follow is a visual representation of the order in which you should proceed for proper screening, assessment and programming of your client. We will even give an overview here of the kinds of business practices that should be in place as well. One process should not take priority over another, each step is equally valuable for you and your client's success. And note, it all starts with "proving" yourself as a valuable asset to achieving their fitness goals – you will need a personal biography or CV (curriculum vitae) or resume, something to show your client that demonstrates that you are capable of working with them and that you have the skill set required to do so; this description of your experience and education/certification/s/ may come in the form your marketing literature as well (a brochure or pamphlet). Never under-estimate the value of information - less is not more in this case. The more education and experience that you have, and can demonstrate, the better for your long term success as a personal fitness trainer. Don't assume that your client doesn't need to know more about you, or that they know all they need to already, it is your job to sell yourself and your services, not just once, but over and over again. Here's what you do *after* you have shown your potential client that you are in fact the right person for the job - NFPT's version of the "Order of Operations" for your personal training success.

ORDER OF OPERATIONS:
for personal trainer success

Client's Fitness Goals: discuss what they wish to accomplish

Business polices: discuss and agree

Expectations of both parties: written, outlined from both perspectives, signed agreement

Training packages: monthly, weekly, per session

Payment policies: monthly, weekly, per session

Refunds/Cancellations: loss of session when missed, gain if you cancel, etc.

Termination conditions

Tardiness/Make-up policies

Scheduling factors: frequency of training, AM or PM, set time (weekly slot), by appointment or no

Time commitment: explain the length of time each session will take

Goals vs. Limitations

GOALS for: Cardiovascular, Stamina, Strength

Discuss realistic time periods to obtain goals (short, intermediate, long)

Discuss (tour, if applicable) the facility where you will be training: gym, client's home, outdoors, ect.

Consider travel expense (additional fee) if travel to client's home is required

If Yes, agreement to train has been met

Medical/Health Risk Assessment:

assess current conditions

Major risk factor identification: Cardiovascular (CVD) Risk Profile

Personal medical history: PAR-Q

Physician contraindications

Current medications (Physician's clearance is required if your client is on blood pressure, cardiac, or blood glucose altering medications)

Chronic illnesses or biomechanical problems

If Yes, passes health risk screen

Client General Screening:

gather applicable information about your client

Demographic Info: Age, Gender, Height, Weight

Circumference: (optional, but recommended)

Addtnl information: Sleeping habits, Water intake, Occupation

Client Fitness Assessment: (Main 5 Components)

Client goals: short term, mid-range, long term

Previous activity/history: recent and past (sedentary, athlete, etc)

Client imitations: time, biomechanical or physiological, and facilities available.

Identify contraindications to exercise: (refer to Consultation Guidelines)

Program Design and Training

Consistent Re-assessment

Pre-exercise Screening and Risk Classification

So what tests can you run to screen for these potential risk factors? The first, well recognized and common standard, is the pre-exercise screening offered by the Physical Activity Readiness Questionnaire (PAR-Q), *see page 317*. This is a very fast and simple survey with seven (7), one-line questions that will assist in identifying 'red flags' – it includes a sub-section, a "YES to one or more questions", or "NO to all questions" section, that tells you and the potential client what the general next steps would be, given the answers provided by the potential client. This questionnaire has stood the test of time and has been used throughout the world by health and fitness professionals as a benchmark for assessing physical activity readiness.

There is also the Cardiovascular Risk Profile, or CVD Risk Profile, *see page 318*, that will help you to determine, based on an overall score, if your potential client is a low or high risk for physical training. These questionnaires are important for the initial assessment, and we will cover these in more detail as we move through the text. Generally speaking, your initial assessment will allow you to group your client into a low, moderate or high risk category.

Low Risk: may perform moderate or vigorous exercise and no physician is needed for submaximal or maximal tests
Moderate Risk: may perform moderate exercise but not vigorous without physician approval, and may take a submaximal, but not maximal, VO_2 test
High Risk: should have a physician's approval for all exercise and tests

In any case, regardless the risk category, NFPT recommends that you establish a relationship, or at least communication, with your clients' primary care physician.

Why?...
...is a good rule of thumb to make your client's physician know that you will be implementing an exercise program, this way, if there is a medical concern, you have been proactive in notifying the physician so that the physician may communicate this as a concern to their patient

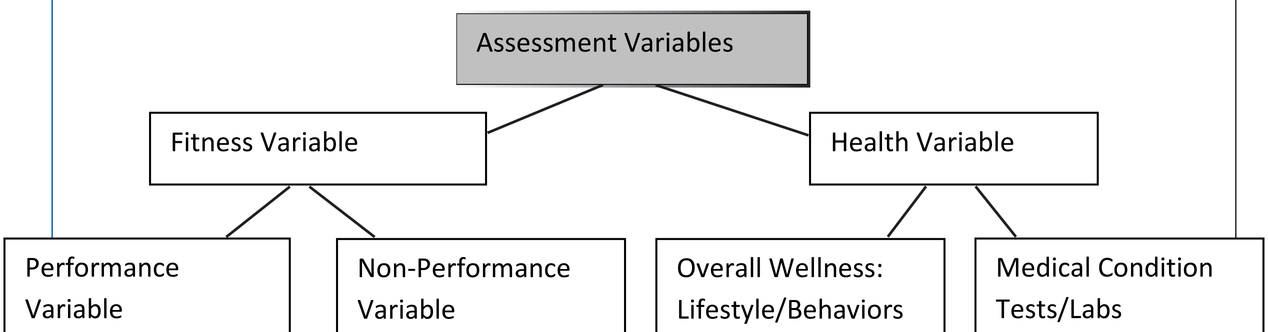
...your client's physician would know that you care enough about your client to inform them, and that you respect their role in your client's health, which communicates your desire to work *with* them, not *around* them

...you may establish a good enough working relationship with the physician that he or she may refer patients to you whose health condition would benefit from physical fitness in their lives.

General Client Information and Risk Assessment

This may sound a bit cliché, but a quality personal fitness trainer will need to get somewhat 'personal'. You have to be able to look at and evaluate a client's total lifestyle, not just their exercise needs. There is more to health than just exercise alone; and there are many types of surveys and/or tests to assist you with gauging someone's overall health condition. In this manual, we will provide you with the CVD Risk Profile and the PAR-Q & You questionnaires; but, keep in mind, that there are additional forms, readily available, which you may want to consider adding to your assessment protocol - such as a Medical Health Questionnaire and/or Medical Status Questionnaire, which include additional variables to your assessment. A typical Medical Status Questionnaire will include sections that ask about the following: medical history, cardiopulmonary and metabolic symptoms or presence of disease, coronary risk factors, current and past fitness level and overall lifestyle and behaviors.

Understanding Assessment Variables and How to Test for Them



PERFORMANCE VARIABLES

For our purposes, we will concentrate on performance and non-performance variables of fitness. Performance variables will include the following:

- **Cardiorespiratory Condition**
- **Muscular Endurance**
- **Muscular Strength**
- **Flexibility**
- **Power**
- **Speed**
- **Agility**

For each of these performance variables, an assessment can be done to determine the readiness and current fitness level of your client. Of course, there are many methods for determining your client's capacity for each of the variables; the section to follow will suggest a place to start for these respective assessments.

*Use *Client Measurement Information* form, *page 315/316*, as a data recording reference of the performance tests to follow. This should be used for initial assessment and re-assessments

Cardiorespiratory Condition: The predicted maximum aerobic capacity of an individual can be estimated very easily by having them run or walk either 1 or 1.5 miles, record their finishing time and heart rate at the finish. However, for otherwise sedentary clients and/or for a more easily implemented and well established assessment, a 3 Minute Step Test will work well and may be best. When using either of the following assessments, a heart rate monitor and stopwatch are needed:

Predicted VO_2 Max test - using standardized protocol, *as described on page 110*, use a treadmill or a field test (an outdoor jog on flat terrain; a field test allows for the testing of several individuals at one time) this is a 1 mile steady jog and uses heart rate with workload, gender, weight and age for predictions.

3 Minute Step Test - the following is a well-established and easily implemented assessment based on the YMCA test for cardiovascular fitness. This test looks at how quickly your heart recovers following a short exercise bout. When testing your client, you will notice that the fitter your client is, the quicker their heart rate will return to normal after exercise. For this test, you will need a 12 inch step, bench or box, a stopwatch and heart rate monitor. Instruct your client to face the step and be ready to step on and off to a marching rhythm of up, up, down, down (a metronome is a great tool to use here. Set it to 96 beats per minute and loud enough that your client can hear each beat and step to its cadence). Start the stopwatch and instruct your client to start stepping in time, at a consistent pace, for 3 minutes. At the end of the 3 minutes, instruct the client to stop and remain still (they may sit down on their step). Within 5 seconds or less of them stopping the exercise, perform a manual pulse reading at the wrist or neck, and count the number of beats for an entire 1 minute (if wearing a heart rate monitor, record the heart rate 1 minute from the time they sat down). Record their pulse when you have reached 1 minute, and compare to norms (in BPM):

MEN	Age 18-25	Age 26-35	Age 36-45	Age 46-55	Age 56-65
Excellent	50-76	51-76	49-76	56-82	60-77
Good	79-84	79-85	80-88	87-93	86-94
Above Avg	88-93	88-94	92-88	95-101	97-100
Average	95-100	96-102	100-105	103-111	103-109
Below Avg	102-107	104-110	108-113	113-119	111-117
Poor	111-119	114-121	116-124	121-126	119-128
Very Poor	124-157	126-161	130-163	131-159	131-154

WOMEN	Age 18-25	Age 26-35	Age 36-45	Age 46-55	Age 56-65
Excellent	52-81	58-80	51-84	63-91	60-92
Good	85-93	85-92	89-96	95-101	97-103
Above Avg	96-102	95-101	100-104	104-110	106-111
Average	104-110	104-110	107-112	113-118	116-121
Below Avg	113-120	113-119	115-120	120-124	119-127
Poor	122-131	122-129	124-132	126-132	129-135
Very Poor	135-169	134-171	137-169	137-171	141-174

Muscular Endurance: There are a variety of different tests that can be performed to measure muscular endurance. Your client's muscular endurance should be tested for their upper body, lower body and their core. The following are tests that NFPT recommends for each; though most of these will only require the use of body weight, some tests will require the use of standard gym equipment - always follow safety and accuracy protocols when performing any performance variable testing. Demonstrate proper form and explain expectations and purpose for the tests as each is conducted. Proper form and full range of motion are required to successfully test the following:

UPPER BODY

Push-up test - assesses muscular endurance of the chest, shoulder and triceps. Hands are placed shoulder-width apart (or just outside), with feet 12 inches apart. Bend at the elbows until arms are at least parallel to the ground. The arms should be fully extended at the top of this motion. Have your client perform this test to exhaustion, with no rest/break, and record how many he or she can perform. According to the American College of Sports Medicine (ACSM), the following table can be used to assess this performance:

MEN	Age 20-29	Age 30-39	Age 40-49	Age 50-59	Age 60+
Excellent	36	30	25	21	18
Very Good	29 - 35	22 - 29	17 - 24	13 - 20	11 - 17
Good	22 - 28	17 - 21	13 - 16	10 - 12	8 - 10
Fair	17 - 21	12 - 16	10 - 12	7 - 9	5 - 7
Poor	16	11	9	6	4

WOMEN	Age 20-29	Age 30-39	Age 40-49	Age 50-59	Age 60+
Excellent	30	27	24	21	17
Very Good	21 - 29	20 - 26	15 - 23	11 - 20	12 - 16
Good	15 - 20	13 - 19	11 - 14	7 - 10	5 - 11
Fair	10 - 14	8 - 12	5 - 10	2 - 6	2 - 4
Poor	9	7	4	1	1

Chin-up test - assesses muscular endurance of the biceps and shoulder, a chin-up bar is required. Have your client grip the bar with his or her palms facing them (underhand/supinated grip); placement of hands should be no wider than shoulder width apart. Your client, using his or her arms, pulls up until the chin is above the bar and then lowers until arms are straightened/returned to the starting position. The client should repeat these, with no rest/breaks, until they are unable to continue. The number of chin-ups that he or she is able to perform will establish a baseline for progressions. Very generally speaking, for men, 8-10 chin-ups would be considered 'good'; for women, 4-6 would be considered 'good'. Of course, someone with a shorter, lighter frame would result in the ability to perform more chin-ups as opposed to the individual with a taller, heavier frame.

A pull-up is very much like a chin-up except that your palms are facing away from the body (overhand/pronated grip); chin-ups are often easier to perform due to the grip position. Generally speaking, chin-ups focus on strengthening the biceps, while pull-ups focus on strengthening the back (lats).

LOWER BODY

Squat test - assesses muscular endurance of the lower body and back; like all exercise, it is important to keep proper form in order to avoid injury; it is *not* recommended that a deep squat be performed, this movement should only be performed by trained athletes as the risk to injury is much greater. During the assessment of the squat for lower body muscular endurance, have your client take a shoulder width stance, maintain an erect spine and descend until the tops of the thighs are parallel to the floor (like sitting in a chair). The feet should remain flat on the floor. Once the knees have made a 90 degree angle, have the client stand up into the starting position. This squat test should be performed until fatigue does not allow your client to perform any more.

According to the ACSM squat test protocol, use the following ratings for number of squats performed:

MEN	Age 18-25	Age 26-35	Age 36-45	Age 46-55	Age 56-65
Good	44 - 49	40 - 45	35 - 41	29 - 35	25 - 31
Above Avg	39 - 43	35 - 39	30 - 34	25 - 28	19 - 21
Average	35 - 38	31 - 34	27 - 29	22 - 24	17 - 20
Below Avg	31 - 34	29 - 30	23 - 26	18 - 21	13 - 16
Poor	25 - 30	22 - 28	17 - 22	13 - 17	9 - 12

WOMEN	Age 18-25	Age 26-35	Age 36-45	Age 46-55	Age 56-65
Good	37 - 43	33 - 39	27 - 33	22 - 27	18 - 24
Above Avg	33 - 36	29 - 32	23 - 26	18 - 21	13 - 17
Average	29 - 32	25 - 28	19 - 22	14 - 17	10 - 12
Below Avg	25 - 28	21 - 24	15 - 18	10 - 13	7 - 9
Poor	18 - 24	13 - 20	7 - 14	5 - 9	3 - 6

CORE

Understand that using floor exercises to test core strength is not an exact measure of how weak or strong the core actually is during daily activities. How your client stabilizes on the floor is completely different than when they are standing or are in an athletic position. There are a large number of floor exercises that are used to test overall core strength but the truth is that no floor exercise can accurately measure true core strength; you get more of a general idea rather than hard facts. NFPT recommends simple safe tests for trainers who are working with beginners and general fitness clients. These tests are consistent ways to identify weaknesses, compare to peers and measure progress. Floor tests do have value when properly applied and even more when used in conjunction with advanced standing tests and sports specific tests. We recommend learning more advanced methods as you gain experience and work with more challenging populations.

Plank test - assesses the muscular endurance of the back and abdominals (erector spinae and rectus abdominis); the plank starts by getting into a press up position with elbows and forearms on the floor, shoulder width apart, and hands flat on the floor (resting the weight of the upper body onto the forearms). With the body in a straight line from heels to shoulders, feet spaced hip width apart and body weight brought up on toes and forearms, instruct the client to maintain a neutral spine. Engage the gluteal and abdominal muscles (as if a stomach punch is expected), these should be held tight. The upper arms should keep an approximate 90 degree angle relative to the floor. When your client is no longer able to keep proper form (neutral spine), the test ends and the results are recorded. Set a goal for the client of 2 minutes, this may take some time to achieve; anything over 1 minute is satisfactory, 2 or more minutes indicates a strong core.

Dead Bug test - assesses the muscular endurance of the core*, use a supine foam roller for assessment.* Client lies supine on a roller that is placed lengthwise for support along the entire trunk from head to tailbone. They will get into a neutral spine position and place both hands across their chest. Once in position, have the client pick up one leg, holding it straight out at a comfortable height off the floor, keeping the other leg bent with foot planted on the floor for stability. Have your client try and remain in this position with neutral spine for 30 seconds. If the client is able to complete this, then you would progress the client by having them bring the hip and knee to 90 degrees and touch the opposite hand to the knee then fully extend the arm and leg, while maintaining balance on the roller and a neutral spine. If the client can perform 15 reps on each side, then you may progress the test even further by having the client take both feet off of the floor and perform opposite arm and leg extension while maintaining a neutral spine. A great way to demonstrate a neutral spine is to put your finger between the client's lumbar spine and the roller. Tell the client to pretend that your finger is a grape; instruct them to not drop or break the grape. When they feel the abdominals activate as they try to keep the 'grape' in place and intact, that is their neutral spine.

Bent Knee Crunch test - assesses the muscular endurance of the abdominals and core muscles (primarily the rectus abdominis and also the obliques). Starting in a supine position, on a mat/floor, have the client bend at the knees with their feet together and raise the legs up to make a 90 degree angle relative to the floor. With arms relaxed and placed straight down at sides, measure and mark the spot that is 3 inches farther down from their fingertips (using tape or small object as a marker); this is the spot that they should reach to each time, only an approximate 3 inch movement as to not exaggerate spinal flexion. Instruct the client to concentrate on using only their abdominals and core muscles and to keep their lower back on the mat throughout the entire exercise. Exhale and curl up (rib cage to pelvis) until the upper back is off the mat and the fingertips have extend to at least the marker point. Hold this position very briefly and inhale on the return of upper torso to the mat. Keep proper form and alignment of the head with the spine throughout the exercise. Have the client do this exercise for one minute without rest. Record total number of reps without pause, compare to comparative norms:

MEN	Age 20-29	Age 30-39	Age 40-49	Age 50-59	Age 60-69
Excellent	75-93	65-81	63-79	61-77	58-74
Good	64-74	56-60	54-62	52-60	49-57
Average	55-63	48-55	46-53	44-51	41-48
Below Avg	46-54	40-47	38-45	36-43	44-51
Poor	<46	<40	<38	<36	<33

WOMEN	Age 20-29	Age 30-39	Age 40-49	Age 50-59	Age 60-69
Excellent	67-83	67-85	65-83	63-81	60-78
Good	58-66	57-66	55-64	53-62	50-59
Average	52-57	48-56	46-54	44-52	41-49
Below Avg	41-51	38-47	36-45	34-43	31-40
Poor	<41	<38	<36	<34	<31

**NOTE about Crunch Test: Spinal flexion exercises, especially on the floor, are proven to exaggerate most low back conditions and provides little carry over to athletic performance or daily activities. The crunch test is commonly used for mass data purposes (e.g. schools, military, and civil service assessments) because they can more easily compare results against a group of peers/candidates. DO NOT use this assessment test for those with low back history. For a client with no low back history there are generally no issues with this test, however keep in mind that excessive flexion exercises over time can cause damage to the spine. Therefore, NFPT recommends that the entry level to intermediate trainer first be sure that no low back issues exist before using or training a client to pass this test; and then, if implemented, do not overuse.*

Muscular Strength: A muscle strength test will be useful for determining initial strength/lean tissue of both the fat loss client and the weight gain client. In either case, select a weight to be used in the bench press movement that will allow for client performance of between 4 to 6 repetitions, in strict form, to concentric (positive) failure without the need of assistance. *Keep record of the weight and reps performed for future re-evaluation*. It may be desirable, in the case of the resistance trainee beginner, to incorporate the use of a machine for this test, as poor balance and/or form with the use of free weights may put the client at risk of injury. The strength test is easily applied and extremely useful in continued lean weight monitoring in all client situations. Periodic muscle strength tests will effectively monitor the associated loss/maintenance of strength/lean tissue in the weight loss client. Periodic tests will also effectively monitor the associated maintenance/gain in strength/lean tissue associated with the weight gain client. It is always ideal to improve upon the volume of lean weight whenever possible.

Metabolism increases with lean weight volume increase. Lean weight loss is frequently indicated when strength levels drop, which is obviously undesirable and must be corrected through dietary and training changes. A strength test can include:

Dynamic Strength Determination - assesses overall upper body strength using 1 repetition maximum (1RM) bench press and body weight to determine relative strength (this test can be performed using other compound exercises as well; though the bench press is commonly used to assess overall strength). Do not use the traditional 1RM method for the beginner, general fitness, weight loss, or sedentary client. As previously stated, *on pages 184-185*, the traditional 1RM method is only used for advanced and athletic level clients. It is more applicable to use a 10 rep method to find 1RM, using the Brzycki formula. **1RM = w ÷ [(1.0278) - (0.0278 x r)]**. A general scoring estimate, for demonstrating average strength, would be the ability to press weight between 1.15 - 1.29 pounds for every pound of body weight. After you find your client's 1RM, divide that number by their body weight. For example, if the resulting 1RM for the bench press is 144 pounds, and your client weighs 150 pounds, the percentage would be .96 (144 ÷ 150 = .96), which would demonstrate poor muscular strength.

SCORE	<.90	.91 - .99	1.00 - 1.14	1.15 - 1.29	1.30 - 1.60	>1.60
DETERMINATION	Very Poor	Poor	Fair	Average	Good	Excellent

Flexibility: This is a very important component in a fitness routine. Improving flexibility will reduce the risk of injury, associated not only with exercise but also in the performance of daily activity, especially in older adults. Muscles and connective tissues need to be supple and have elasticity; without these, there will be tension in the muscle and shortened range of motion. Nerve impulses affect tense muscles more dramatically, and predispose hard and soft tissues to injury.

Modified Sit and Reach test - assesses lower body, specifically hip and hamstring, flexibility. The modified sit and reach allows for the adjustment of the zero mark based on your client's limb length. A box, adhesive tape and metric ruler are needed for this test. Have your client perform a 10 minute dynamic stretch warm up and then sit on the floor with their back and head against the wall; with legs fully extended, place the box against the bottom of their feet. Instruct your client to place one hand on top of the other and extend their arms forward, keeping their head and back against the wall. Tape the ruler to the top of the box with the zero mark at the client's fingertips. Client then slowly bends forward (head and shoulders come away from the wall) with legs flat against the floor. Have the client attempt the reach twice and then on the third attempt hold for 2 seconds, with no bouncing; the distance is recorded, in inches.

MEN (AGE)	Very Poor - Poor	Average	Above Average	Good - Excellent
Under 25	<11 - 13 inches	14 - 17 inches	18 - 19 inches	20 - >22 inches
26-35	<10 - 12	13 - 16	17 - 18	19 - >20
36-45	<8 - 11	12 - 15	16 - 17	18 - >20
46-55+	<6 - 8	9 - 11	12 - 13	14 - >17

WOMEN (AGE)	Very Poor - Poor	Average	Above Average	Good - Excellent
Under 25	<15 - 16 inches	17 - 19 inches	20 - 21 inches	22 - >23 inches
26-35	<14 - 17	18 - 19	20 - 21	22 - >23
36-45	<13 - 16	17 - 18	19 - 20	21 - >22
46-55+	<11 - 14	15 - 16	17 - 18	19 - >20

Keep in mind, the sit and reach test can place undue stress on the discs and therefore is not recommended for those with disc concerns - consider performing this test in a standing position, making sure that a neutral spine is maintained. Once they are at the end range, you can measure the distance that their fingertips are from the floor. Using a hip hinge here, to visualize any poor bending mechanics, is a good addition to this test.

Reach Over (or, "Back Scratch") test*, for older adults* - assesses shoulder girdle ROM. The client takes one hand over the shoulder toward the back of the neck and reaches as far as possible down the middle of the back, while placing the other arm behind the back with palm facing outward and fingers pointing upward. Attempt to touch or overlap the middle fingers of both hands. A zero measure is when the middle fingers touch each other. The overlap, if any, is recorded as a negative score (conversely, the gap between the middle fingers is a positive number). Have your client practice this 2-3 times before the test measure. Record in inches.

MEN (AGE)	Below Average	Average	Above Average
Under 64	> 6.5 inches	6.5 - 0 inches	< 0 inches
65 - 69	> 7.5	7.5 to -1	< -1.0
70 - 74	> 8.0	8.0 to -1	< -1.0
75+	> 9.5	9.5 to -2.5	< -2.5

WOMEN (AGE)	Below Average	Average	Above Average
Under 64	> 3 inches	3 - 1.5 inches	< 1.5 inches
65 - 69	> 3.5	3.5 to 1.5	< 1.5
70 - 74	> 4.0	4.0 to 1.0	< 1.0
75+	> 5.5	5.5 to 0	< 0

Power: is a combination of how fast and how much resistance is moved. A vertical jump, for example, lifts the body weight. The faster the take off, the higher the jump.

Vertical Jump test - assesses how high the client is able to elevate himself or herself off of the ground, using their muscles to raise their center of gravity. This test is generally more applicable to the athletic client, but it can also be a good determinant of the lower body power in any healthy, youth to young adult, client type. The jump can be measured by a pressure sensitive mat, or by using a simple measuring method against a flat wall. To measure without the use of additional devices (other than a tape measurer), have your client reach up against a flat wall, with feet kept flat-footed on a flat surface, and mark the highest point of his or her standing reach. Then, have your client take several jumps from a standstill position (no running jump) and mark the highest point that he or she can reach from their standing jump. Measure the difference, in centimeters or inches, between the flat-footed reach point and the highest vertical jump to determine your client's vertical jump measurement.

MEN	Centimeters	Inches
Excellent	> 70cm	> 28in
Very Good	61 - 70	24 - 28
Above Avg	51 - 60	20 - 24
Average	41 - 50	16 - 20
Below Avg	31 - 40	12 - 16
Poor	< 21 - 30	< 8 - 12

WOMEN	Centimeters	Inches
Excellent	> 60cm	> 24in
Very Good	51 - 60	20 - 24
Above Avg	41 - 50	16 - 20
Average	31 - 40	12 - 16
Below Avg	21 - 30	8 - 12
Poor	< 11 - 20	< 4 - 8

Speed: Speed tests are as much about acceleration as they are speed. As a general rule, the fastest individuals in short sprints (< 100 m) are those who can accelerate the fastest. Thus, moving one's body weight up to the maximum velocity as fast as possible is a power variable. This test is most applicable to sports specific clients, and therefore should not be used in all cases where general fitness is the goal.

40 Yard Dash test - assesses acceleration, is an indicator of your client's speed. After a thorough warm up, the client's time to sprint 40 yards is recorded; generally speaking, an above average time for performing this sprint is for the young athlete is between 4 to 4.3 seconds for men and 4.5 to 4.7 seconds for women.

Agility: This is a very important skill in many sports. Agility is, basically, the capacity to move the body in different directions in rapid succession. This skill involves slowing rapidly and stopping, changing momentum directions and accelerating again. Someone who is agile often is not heavy in body weight, is often strong for their body weight, has good balance, good coordination, a well-conditioned core, and strong joints. When an athlete is moving at high rates of speed they often have to shift to either catch their opponent, or to not be caught by their opponent. Agility testing applies to the client who is an athlete or has athletic physical fitness goals, this is not a recommended test for clients who do not have sport specific goals:

Zig Zag test - assesses agility of the athlete to run a zig zag course in the shortest possible time. A standard zig zag course uses four cones placed on the corners of a rectangle, 10 by 16 feet, with a fifth cone placed in the center (at 5 by 8 feet). Label the 4 corner cones 1 to 4 around the rectangle, going wide, or counter-clockwise, and label the center cone "C". The test will begin at 1, and then go in the pattern of 1 to C, 2, 3, C, 4, then back to 1. The distance between cones, and number of circuits performed, may be altered; but the total run distance should not be so great that fatigue becomes a limiting factor. The test is timed and scoring is based on individual progression over a period of time and/or comparative times of group/team members.

*NOTE: Power, Speed and Agility testing are advanced level assessments which are not used with a beginner or general fitness client. All tests described in this section, referring to the assessment of performance variables, are examples of commonly used tests which establish a baseline for assessing fitness level and general physical ability. This is not a comprehensive list or illustrative demonstration of all applicable assessment tests. The tests, that have been summarized here, are examples of those which are commonly used by fitness professionals. Consider acquiring additional skills, through further assessment training and education, that enable you to implement additional performance-based and diagnostic tests into your client assessments. This additional training will lend to the overall quality, effectiveness and marketability of your personal training skills.

Blood Pressure (BP): because blood pressure is a determinant that can identify a cause by which all performance variables will be effected, it is important that you know how to take it, and how to read it. A dysfunction in blood pressure can be a ‘silent killer’. Many people with hypertension feel fine and never realize they have it. Many, who do realize that they have it, will stop taking their medications because they feel fine, which can unfortunately be a fatal mistake. Blood pressure is measured in millimeters of mercury (mmHg). In general, someone with a systolic over 150 and diastolic over 100 should not be trained without their physician’s consent.

Your ability to offer blood pressure screening will help you determine the ‘at-risk’; consider a BP training workshop at a local hospital/clinic, or other training specific resources for honing in on the skill of proper BP testing. BP testing can be done completely manually, or with a manual cuff and stethoscope, or with automatic BP devices. BP testing calls for the client to perform aerobic activity, usually in the form of ergometer cycling. At three (3) separate stages, blood pressure measurements are taken. Ideally, the systolic (above) reading should rise slightly while the diastolic (below) reading should not change dramatically. If either result is not the case, the client should gradually slow to a stop, and a physician notified for the scheduling of a medically supervised “maximal” pre-exercise test.

With the influx of hypertensive persons needing to monitor blood pressures away from the doctor’s office, the medical supply industry now provides battery operated, digital display, blood pressure testing kits for self-testing. These kits can easily be applied by the personal fitness trainer in taking supine, seated, and standing blood pressure readings as he or she sees fit. However, without proper certification or training in blood pressure screening, you are not qualified to perform submaximal pre-exercise testing. Should you be interested in performing submaximal exercise testing, we encourage you to seek out the proper certification, it is a worth while investment of time and is usually not a very complicated process.

It has been shown that regular resistance training will lower blood pressure during lifting activities in comparison to lifting activities of the same absolute weight prior to training. In other words, Joe Client initially lifts 100 pounds, which is 80% of his one repetition maximum (1RM). After several weeks of resistance training, Joe Client improves his strength such that 100 pounds is now only 70% of his 1RM. By monitoring blood pressure, during his initial training, and then comparing it to BP during his current/improved training ability, you will see a favorable decrease in both systolic and diastolic pressures, because lifting 100 pounds is now easier for Joe. This training effect may carry over to other activities and, therefore, reduce overall resting blood pressure. This further supports the use of resistance exercise with your clients to help reduce their blood pressure during activities of daily living.

Commonly, a potential error in blood pressure measurement can be made because of the posture of the client. Even nurses, who take BP readings on a daily basis, allow for measurement errors. When you take a BP reading, using a cuff, your client should be sitting down with their back supported, feet on the floor, small bend in the knees, legs not crossed, and the cuff and monitor should be at the heart level. The individual should not have eaten recently and should be relaxed and well rested. The environment should be quiet and well lit. Note that automatic cuffs do tend to over estimate BP because of their sensitivity; properly conducted, manual BP readings are more accurate.

NON-PERFORMANCE VARIABLES

Non-Performance variables are viewed as those things that are not a measurement of the physical fitness level, or specifically performance, of your client. For example, the circumference of the client's waist or hips is not a measurement of performance. Anthropometrics, or, basically, the measurement of the human frame, falls into the category of non-performance variables. The following are non-performance variables and suggested methods for taking the respective measurements or readings.

Body Composition: The measure of body composition (body fat vs. lean muscle) requires 1) knowing the total body weight, and 2) knowing how to use the proper body composition measuring device (generally a skin fold caliper, manual or electronic). There are many different ways to measure the size and composition of the body. Lengths, girths, and breadths as well as volume and mass are all components in body measurements. All measures must use anatomical landmarks and standardized protocols. Lengths are usually measuring body segments or multiple segments, like arm span or hand span. Girths are another term for circumferences, and breadths are another term for widths. The best way to measure breadths is with calipers.

Because body fat measurements are the most applicable to our purpose in this text, we'll have a quick overview of several of the methods used for fat analysis. The incorporation of any one or the other of these methods into your assessment is not required, but it is good for you to be familiar with what is available.

1) *Hydrostatic (Underwater) Weighing*: because fat has a lower density than water (0.901 g/cc), and muscle has a higher density (1.10 g/cc), and, of course, water weight is equal to the actual density of water (1.0 g/cc), then the ratio of the 'on land' weight to the underwater weight can be used to calculate body density, which can then be used to calculate body fat. Based on Archimedes Principle, when someone is totally submerged in water, the weight underwater is equal to the water displaced by the body volume. In other words, if two people both weigh 200 lbs but one has more fat and the other is more muscular, the one with more body fat would have a larger body volume and thus displace more water (e.g. this person displaced 195 pounds of water and thus weighs 5 lbs underwater). The muscular person would displace less (e.g. this person displaced 185 lbs of water and thus weighs 15 lbs underwater). When performed correctly this test is the most accurate type of body composition testing; but keep in mind that several factors such as age, gender, ethnicity and physical activity level can alter the composition of the fat free body component. Unfortunately, this method is expensive and troublesome to store and maintain, and the procedure can be difficult to perform correctly; e.g. many individuals will not stay still or blow out all their air prior to weighing.

2) *Body Plethymethography, or 'Bod Pod'*: like the hydrostatic weighing technique, the Bod Pod also uses body density. Instead of water displacement, it uses air displacement. When the body mass is known from a weigh in, the body volume is determined from the Bod Pod using pressure differences with an empty capsule, versus a person inside it. Although the Bod Pod has been around for awhile, the amount of research is limited. Again, accurate measurement of lung capacity is necessary for valid measures. The Bod Pod test is very easy to perform, but very expensive.

3) *Bio-electrical Impedance Analysis (BIA)/Anthro-Impedance*: BIA devices use a low-level electric current that passes through the body and the impedance or opposition to current flow is then measured. Because muscle possess much more water than fat, and because water is an excellent conductor of current, the estimate of both body water and body fat can be made. Impedance machines have been greatly improved since first coming out. The impedance scales are now highly affordable and easy to administer. However, what they possess in ease, they lack in accuracy. Improvements in analysis include some questions such as age, gender, hydration state, and athletic background.

Anthro-Impedance offers enhancements to the BIA method that result in more accuracy. Anthro-Impedance combines the anthropometric measures of 5 (men) or 6 (women) with analog impedance measure (supine dual electrodes on hands and feet). The use of dual frequencies to estimate both intracellular water and extracellular water volume offer more specific readings. In general electrodes are more accurate than feet contact, and feet are more accurate than hand.

These measurements are more accurate, and consistent, when the client:
-Does not eat or drink within 4 hours of the test
-Does not engage in vigorous exercise within 12 hours of the test
-Empties bowel/bladder completely within 30 minutes of the test
-Does not consume alcohol, caffeine, or diuretics prior to assessment
-For female, is not retaining water due to menstrual cycle

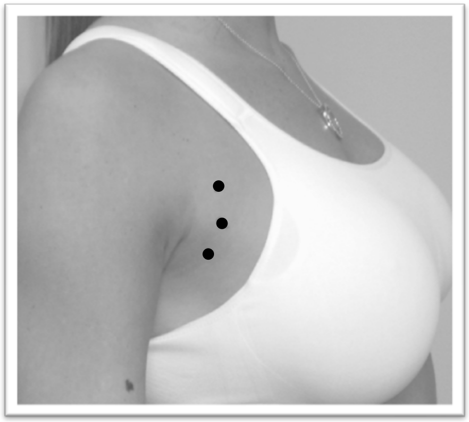
4) *Skin-Fold Caliper:* this method is by far the most popular and most commonly used by personal fitness trainers. But, remember, like the other methods, there can be a lot of variance between measurement instruments and operator error. Many inexperienced measurers either don’t use the correct location, angle of pinch, pressure of manual pinch or caliper pinch. It is crucial that you use the device specifically per the instructions provided. Though research has found only small differences between the metal calipers and plastic calipers, you should take into consideration the quality of the device that you choose - it is an investment worth making, especially considering the frequency in which you will be using it. One advantage, for example, of the higher cost device, is that the spring is calibrated to give consistent pressures across different widths, and can be calibrated with a “kit”. Remember, more measurement sites does not necessarily improve accuracy. It can be an additional source of error as well. A re-evaluation over time is a must; just remember that taking multiple measurements (across time) should be done by the same person (you, the trainer) using the same caliper at the same sites, to minimize errors.

The number of sites measured may vary based on the comfort level and experience of the trainer and client. However, make sure that measurements of the upper body, mid body, and lower body locations are included. Here are the most common:

- **3 Site (women):** tricep, supra-iliac, thigh (re: Jackson/Pollock et al, 1980)
- **3 Site (men):** chest, abs, thigh (re: Jackson/Pollock)
- **4 Site** (both men and women): tricep, supra-iliac, abs, thigh (re: Jackson/Pollock)
- **7 Site** (both men and women): chest, mid-axillary, tricep, abs, sub-scapular, supra-iliac, thigh (re: Jackson/Pollock)
- **9 Site** (both men and women): chest, bicep, tricep, sub-scapular, mid-axillary, abs, supra-iliac, thigh, calf (re: Parrillo 9-site formula, 1993)

SKIN-FOLD MEASUREMENT SITES

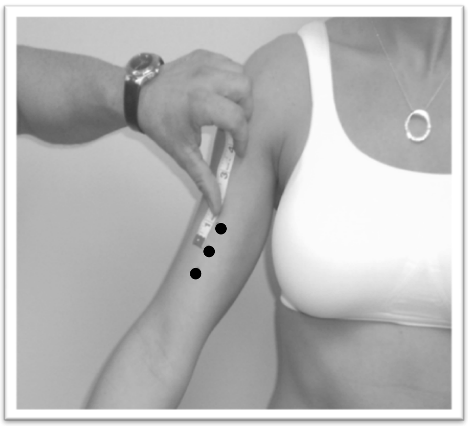
Chest



Location: at the point between the axilla (armpit) and the nipple, as high as possible on the anterior axillary fold.
For women, take the measurement at 1/3 the distance between the fold and the nipple, modesty is very important.
For men, this measurement can be taken at 1/2 distance.

Pinch Orientation: a diagonal pinch, lateral to the nipple

Bicep



Location: at the mid-point between the acromion process and the proximal and lateral border of the radius bone on the mid-line of the anterior surface of the arm, over the biceps muscle.

Pinch Orientation: with palm of hand facing forward, a vertical pinch parallel to the length of the arm at landmark

Tricep

Location: at the mid-point between the acromion process and proximal and lateral border of the radius bone (the halfway point between the shoulder joint and elbow joint, directly over tricep, on the posterior surface of the arm)

Pinch Orientation: with palm of hand facing forward, a vertical pinch parallel to the length of the arm at landmark

Sub-Scapular

Location: at the lower angle/bottom point of the scapula. Instruct the client to reach behind their back with their right arm, or raise and lower their arms,while feeling for the movement of the scapula

Pinch Orientation: lateral, diagonal pinch along the natural fold of the skin, 1-2 cm below inferior angle of scapula

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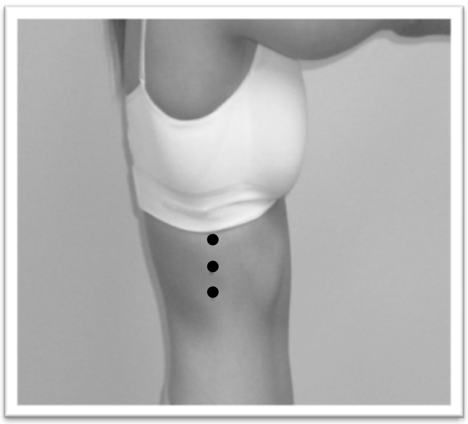
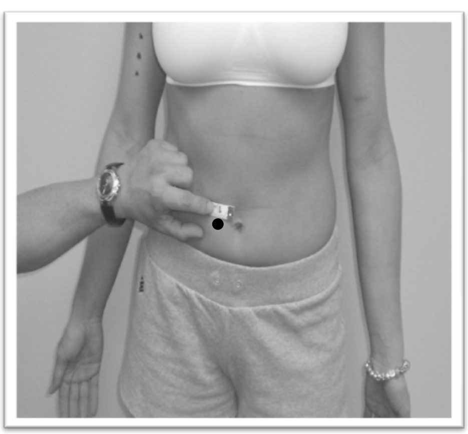
Mid-Axillary



Location: at the point of lower angle/bottom point of the scapula. Instruct the client to reach behind their back with their right arm, or raise and lower their arms,while feeling for the movement of the scapula

Pinch Orientation: vertical pinch following the natural fold/line of the skin (horizontal pinch method may also be used)

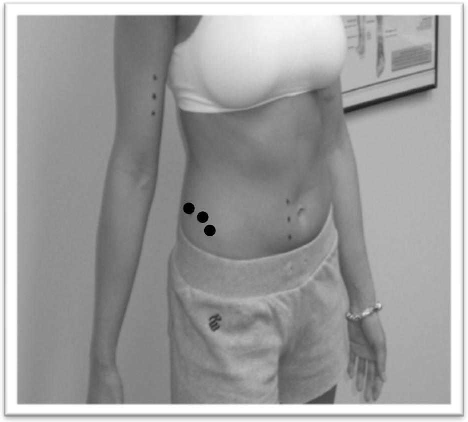
Abdominals

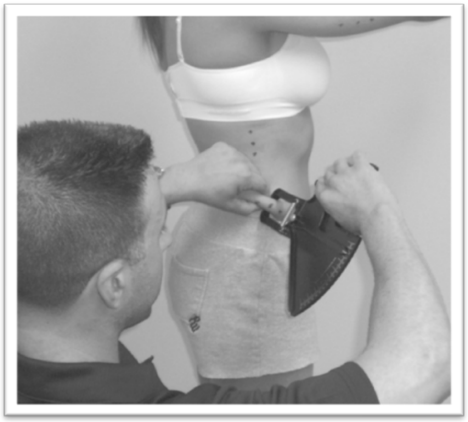


Location: 5 cm (2 in) adjacent to the umbilicus (belly-button), to the right side

Pinch Orientation: vertical pinch (horizontal pinch method may also be used)

Supra-Iliac (Crest)





Location: just above the iliac crest (top of hip bone), on the most lateral side

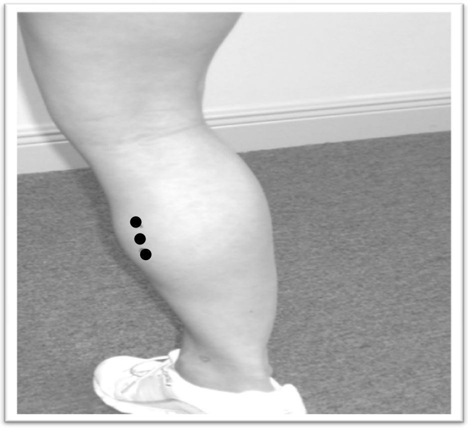
Pinch Orientation: oblique, anteriorly and downward in line with the natural fold

Quadricep (Thigh)

Location: mid-point between patella (knee cap) and crease at the top of the thigh. A mid-point between greater trochanter (hip prominence) and lateral femoral epicondyle can also be used

Pinch Orientation: vertical, making sure to get enough skinfold. In obese subjects, the muscle and subcutaneous fat will often be hard to separate. Shaking the skinfold sometimes helps, or angling the calipers may help, but this may disrupt the accuracy of the measure, thus the total body composition determination. Taking this measurement with subject seated is also commonly performed

Calf



Location: at the medial (inside) surface of the calf, at the point of the largest circumference

Pinch Orientation: vertical pinch parallel to the length of the leg

SKIN-FOLD MEASUREMENT STEPS

NFPT recommends using the Parrillo 9-Site formula for finding body fat percentage. Generally speaking, the more sites measured the more precise the test outcome will be; however, the 3, 4, and 7 site methods may also be used to provide an accurate estimation of body fat percentage (BF%). Whichever method is used, continue that same method when re-assessing. You may also utilize an online calculator for any of the various skin-fold measure methods/formulas. Many reputable software and independent fitness-based internet companies provide these resources.

Parrillo 9-Site formula *(uses body weight in pounds)***:**

Body Fat % = [27 x (Sum of all sites)] ÷ Body Weight

HOW TO:

1. Pinch the skin and fat in line with the underlying muscle, using the right side of the body. (see pinch orientations in the previous section). Do not perform this test after a workout or while the skin is wet.

2. Have the client flex their muscle for two seconds to ensure that you are not pinching it along with the fat and skin (make sure they relax before you record the measurement).

3. Place the calipers in the middle of the skinfold, below where the fingers are pinching. It is a common mistake to place calipers too close to where the skin is being pulled, resulting in a larger number than what is accurate.

4. Hold the pinch for a few seconds to let the calipers sink into the skin. Open the calipers completely so not to scratch the client (gently remove the calipers).

5. Measure to the nearest millimeter. Measure each site twice and a third time if the first two numbers are more than 2mm different. Add the measurements together and divide by the number of times measured.

Example Tricep: 2,5,5 becomes 2 + 5 + 5 = 12. Divide 12 by 3 = 4mm. (4mm is the average number for the Tricep)

6. When you have the average number for each site (chest, abs, thigh, bicep, tricep, subscapular, supra-iliac, low back, calf), add them up.

Example Tricep 4, Supra-Iliac 10 and Thigh 15 becomes 4 + 10 + 15 = 29mm total.
Don't divide this number by three! You have already averaged each site in step 5. For this step, you are looking at the sum/total of all sites measured.

7. Use the Parrillo 9-Site formula, enter in figures for:
Body Fat % = [27 x (Sum of all sites)] ÷ Body Weight

Example: you have a 25 year old female client whose body weight is 148 pounds and the sum total of all sites measured equals 103. Therefore, BF% = [27 x 103] ÷ 148. BF% = 18.8%

Upon performing the pinch measurements and calculating BF% per the formula, refer to *Body Fat % Composition Ratings* chart *(page 241)* for comparison to norms.

8. Mark the results with the date and re-measure every 3-6 weeks. Use the right side of the body each time you repeat the test. *(See page 313-314 for Parrillo 9-Site form for Body Fat%)*

Skin fold testing tells the client how much fat they have compared to muscle on their body. If they lose fat and gain muscle, the skin fold test will show this. This is far more effective encouragement to your client than strictly using weight to determine progress. This is also the reason for continual re-assessment, it is important to demonstrate progress in cycles of approximately every 3-6 weeks (depending on the rigor of the training program). According to body fat guidelines established by the American College of Sports Medicine, the following are standards for comparison of the client's BF% (found from the BF% equation used, with client's skin-fold measurements and body weight; in this example, we are using the Parrillo 9-Site formula) to make a general determination of their body fat rating.

Body Fat % Composition Ratings

Rating (MEN)	Age 20-39	Age 40-59	Age 60-79	Rating (WOMEN)	Age 20-39	Age 40-59	Age 60-79
Underfat	< 8%	< 11%	< 13%	**Underfat**	< 21%	< 23%	< 24%
Healthy	8.1 - 20%	11.1 - 22%	13.1 - 25%	**Healthy**	21.1 - 33%	23.1 - 34%	24.1 - 36%
Overfat	20.1 - 25%	22.1 - 28%	25.1% - 30%	**Overfat**	33.1 - 39%	34.1 - 40%	36.1 - 42%
Obese	> 25%	> 28%	> 30%	**Obese**	> 39%	> 40%	> 42%

Whatever tool used to find body composition, it is important to follow the specific instructions for the device and to re-assess under the same testing conditions. As a personal trainer, a skin-fold caliper can be one of the most valuable tools at your disposal. Regardless of the device used, the resulting information should be the same, or similar. When the body fat percentage is determined, then you can start to make subsequent determinations as well. Take the client's total weight and multiply this times the calculated percentage of body fat, to arrive at the client's total fat weight:

Body Weight x BF% = Fat Weight

From Example: 148lbs x 18.8% = Fat Weight
148 x .188 = 27.8 pounds, Fat Weight

Subtract the resulting fat weight from the total weight and you will have arrived at the client's lean weight:

Body Weight - Fat Weight = Lean Weight

From Example: 148lbs - 27.8 = 120.2 pounds, Lean Weight

Now that lean weight has been found, using the client's BF% and body weight, their Resting Metabolic Rate (RMR), in calories, can be found using the NFPT simplified equation for RMR (*see pages 209-213*).

RMR = LBW x 11
RMR = 120.2 x 11
RMR = 1322 calories

Use this information to appropriately recommend training methods for client goals. For example, if the goal is weight loss, then through proper diet and an individually designed exercise program, the Fat Weight figure will decrease with the decrease of their BF%. Their Total Caloric Expenditure, derived using RMR as a factor, is also a baseline which can be used for implementing caloric intake recommendations for individual client goals.

Anthropometric Measures

Simple circumference measures of the neck, waist and hips (for women); and neck and waist (for men), along with the height, weight and age, will also provide a relatively accurate estimation of body fat. The U.S. Military uses anthropometric measurements for body composition inferences due to the ease and low measurement error.

Waist to Hip Ratio (WHR): The ratio of the waist to hips has been used for a long time to describe the body shape of someone. This measure is now used to predict obesity-based diseases such as Metabolic Syndrome, Diabetes, and CAD, which are related to visceral obesity. To find this ratio, you would perform proper waist and hip measurements, under clothing, using a measuring tape and measuring parallel to the floor (while reminding your client to breathe normally, and no sucking in the waist-line!):

Waist: measure slimmest part of natural waist, just above the belly button (about 1 inch)
Hip: measure the widest part of the hip, at the widest part of the buttocks

After finding the waist and hip measurements, in inches, divide the waist measurement by the hip measurement to get your ratio. For example, a 27 inch waist and a 32 inch hip measurement will give you a waist to hip ratio of 27 ÷ 32 = 0.84.
According to the Mayo Clinic chart for WHR, use the resulting figure (0.84 from our example) to identifying the risk for disease and other health problems:

FOR WOMEN

Little/No Risk	Moderate Risk	At Risk	Very High Risk
< 0.75	0.75 - 0.79	0.80 - 0.86	> 0.86

FOR MEN

Little/No Risk	Moderate Risk	At Risk	Very High Risk
< 0.85	0.85 - 0.89	0.90 - 0.95	> 0.95

Circumferences (Girths): Many circumferences are used to track both muscular development as well as fat loss. In some fitness programs, both factors may happen simultaneously, and thus body composition changes may be masked. Research has even shown greater accuracy in circumference equations over skin fold measurements. Some formulas include variables like the abdomen (two sites, averaged), waist, hip, height, weight, age, and even knee. Circumference measurement formulas can be relatively complex and the measurement points are not usually typical, and sometimes have to be averaged.

Clients desiring lean weight increase may or may not initially show significantly increased circumference. The possible loss of fat tissue in the areas of measurement may even reflect a reduction in circumference depending upon the current diet and exercise program used. If circumference does not enlarge in the client desiring size increase for an initial temporary period, the measured reduction in body fat and increased strength will have to be used as the indicators of progress. As for the client wishing to lose weight, circumference should begin to decrease within the first month of adherence to the NFPT guidelines concerning fat loss diet & exercise principles.

Commonly measured sites include:
Neck: at base or just inferior to laryngeal prominence, above trapezius
Shoulders: at mid deltoid, rotational point, just inferior to acromion process
Chest: closely fit under arm pit, 4th costo-sternal joint
Abdomen: at maximum anterior point, often umbilicus
Waist: narrowest part of torso between ribs and iliac crest, about one inch above naval
Iliac: across bony point on both ilium (bi-iliac)
Hip: at widest point, usually even with greater trochanter
Thigh: proximal, at gluteal fold, mid- midway between inguinal crease and patella; distal, just proximal to the femoral epicondyles
Calf: at widest girth
Biceps: at mid arm, mid-point between acromion and olecranon processes
Forearm: maximum girth of forearm
Wrist: styloid process of radius and ulna

All circumference measures should be taken with a soft tape, which has been periodically calibrated against a ruler to check for excess stretching. Like in all anthropometric measurements, the tape should be firm, but not tight, around the body part, and you should be careful not to measure the clothing as well. The specific locations of these measurement sites should be chosen in such a manner as to allow for exact and consistent placement of the measuring tape for future re-evaluation. Some trainers use ink stain markings to indicate these sites, but this should depend on what the client is comfortable with, i.e. will he or she appreciate an ink stain on their thigh when they're at the beach next weekend? Use your best judgement and some common sense here, you may just find a place that is naturally 'landmarked', such as a scar or mole that you can use to remember the exact location of your prior measurements.

The most common sites tested are the waist and thigh. For people trying to slim down you may want to pay special attention to the measurements of the neck, abdomen, waist, hip and thigh (proximal). For people trying to gain muscle mass you may want to pay special attention to the measurements of the neck, waist, hip and thigh (proximal); and calf, biceps and forearm (mid). Some bodybuilders find the flexed versus relaxed measurement contrasts of interest. Unfortunately, standardized flexed positions do not exist. A front double bicep pose and a fully flexed wrist, and a standing, fully extended thigh contraction are commonly used for "contracted girths".

Weight: Total body weight must be accurately determined for client goal setting, lean body weight measurement, and overall client progress evaluation. Client weight can most accurately be determined through the use of a well calibrated "hospital" scale. For accuracy in future re-evaluations, take written notes of the time of day, and clothing worn by the client at weigh-in.

A client's weight change is too often considered one of the most valuable factors in determining the success or failure of a fitness program. The application of resistance exercise in weight management brings with it changes in body composition that need to be discussed briefly here, and may already been known at this stage in your personal fitness experience. Since fat (light) is lost, and muscle energy stores (heavy) increase through resistance training, total weight will most likely increase, temporarily. This may occur even while weight loss is the goal. Therefore, being able to calculate the changes in fat weight separate from the changes in muscle weight is the real indicator of a fitness program's success.

Body Mass Index (BMI): While this is perhaps the most popular measure for someone's "body fat" status, it is also perhaps the most inaccurate when not observed in context. The BMI will be inappropriate for anyone engaging in vigorous resistance exercise routines, or is 'heavily muscled'. The muscle mass will distort the weight, and the result will be an overweight or even obese reading on paper, when, in fact, he or she may actually be very lean. It is important to look at the client's BMI in context according to their build and current fitness level. The BMI is the person's body weight in kilograms divided by their height in meters, squared. These metric conversions can add some difficulty to the equation, so here is an equation that has been converted to pounds and inches:

$$\textbf{BMI = [(Weight (lbs)} \div \textbf{(Height (in)}^2\textbf{] x 703}$$

For example, to find the BMI of a female client who is 5'7" and 166 pounds, we would first find the height in inches (67 in) and then square that number, so: $67^2 = 4489$.

Plug this into the equation: BMI = (166 ÷ 4489) x 703

= 0.03697928 x 703

BMI = 25.99

Identify the weight classification and risk:

BMI Value	CLASSIFICATION	Risk to Health
< 18.5	Underweight	The lower the BMI, the greater risk
18.5 - 24.9	Normal Weight	Very low risk
25.0 - 29.9	Overweight	Increased/high risk
30.0 - 34.9	Obese - Class I	High to very high risk
35.0 - 39.9	Obese - Class II	Very high risk
> 40.0	Obese - Class III	Extreme high risk

**World Health Organization, 1998 Report*

General/basic reference for ideal weight based on gender, height & frame/build (for age 25-59):

MEN (Height, in)	Small Frame (lbs)	Medium Frame	Large Frame
62	128 - 134	131 - 141	138 - 150
63	130 - 136	133 - 143	140 - 153
64	132 - 138	135 - 145	142 - 156
65	134 - 140	137 - 148	144 - 160
66	136 - 142	139 - 151	146 - 164
67	138 - 145	142 - 154	149 - 168
68	140 - 148	145 - 157	152 - 172
69	142 - 151	156 - 160	155 - 176
70	144 - 154	151 - 163	158 - 180
71	146 - 157	154 - 166	161 - 184
72	149 - 160	157 - 170	164 - 188
73	152 - 164	160 - 174	168 - 192
74	155 - 168	165 - 178	172 - 197
75	158 - 172	167 - 182	176 - 202
76	162 - 176	171 - 187	181 - 207

WOMEN (Height, in)	Small Frame (lbs)	Medium Frame	Large Frame
58	102 -111	109 - 121	118 - 131
59	103 - 113	111 - 123	120 - 134
60	104 - 115	113 - 126	122 - 137
61	106 - 118	115 - 129	125 - 140
62	108 - 121	118 - 132	128 - 143
63	111 - 124	124 - 138	134 - 151
64	114 - 127	124 - 138	134 - 151
65	117 - 130	127 - 141	137 - 155
66	120 - 133	130 - 144	140 - 159
67	123 - 136	133 - 144	143 - 163
68	126 - 139	136 - 150	146 - 167
69	129 - 142	139 - 153	149 - 170
70	132 - 145	142 - 156	152 - 173
71	135 - 148	145 - 159	155 - 176
72	138 - 151	148 - 162	158 - 176

Blood Chemistry: We'll start this section by reminding you that it is very important to not overstep your boundaries as a personal fitness trainer - there are certain things that you will need to leave up to a medical professional. One of those things is blood work, which can only be ordered by the client's physician. NFPT recommends that these tests be performed by the appropriate health professional to assure the use of universal precautions in the handling and disposal of blood products or body fluids. However, more recently available are finger prick sample kits that you can use and that can be very helpful. You must make sure that your kit is 'CLIA Approved' (Clinical Laboratory Improvement Amendments, information can be found from the Center of Disease Control website, www.cdc.gov). These blood sample kits can provide many different blood elements, including a complete cholesterol-lipoprotein profile. Glucose and ketones can also be measured rapidly and easily with this method.

1) Blood Sugar Analysis

The 12-hour fasted use of "Glucostix" or a "Glucometer" will effectively reveal to you any abnormality in blood sugar. The average adult's normal 12-hour fasted blood sugar ranges from 70-110 mg/dcl. A low reading may indicate Hypoglycemia, where a high reading may indicate Hyperglycemia/Diabetes. Pre- and post-exercise blood sugar monitoring may also prove valuable in adjusting dietary intake around training.

2) Ketone Testing

Initial client Ketone testing is usually unnecessary in the apparently healthy individual. It is during periods of starvation dieting and/or extreme overexertion that this test should be applied on a re-evaluation basis. When a client is on a fat loss diet and chooses to lose weight at a more rapid rate than is safe, by NFPT and other professional standards, then your necessary and logical course of action would be to safeguard the client's health. During starvation dieting, muscle is rapidly lost alongside the fat, leading to long-term metabolic problems. The use of Keto-Stix will indicate when too much body tissue (muscle) is being cannibalized for energy which can lead to metabolic acidosis, coma, and even death. Evaluate Ketone levels on frequent dates during unsafe dieting practices; and, be aware of the warning signs of Keto-Acidosis which include confusion, loss of balance and extreme dizziness. The use of Keto-Stix to test for this is a self-test with label directions, and qualifications are not required of the user.

3) *Lipid Profile*

The typical lipid profile will look at lipid abnormalities, specifically unhealthy variances in total cholesterol, the ratio of total cholesterol to HDL and the LDL cholesterol, as well a triglyceride levels - measured in milligrams per deciliter of blood (mg/dL). HDL, or high density lipoprotein, is the 'good' cholesterol; while LDL, or low density lipoprotein, is the 'bad' cholesterol. Your total serum (i.e. blood) cholesterol is calculated using this equation: HDL + LDL + 20% of triglyceride level. According to The American Heart Association, a total cholesterol level of less than 180 mg/dL is optimal; and these levels should be tested every 4 to 6 years, in adults over 20 years of age. This blood profile can be ordered by the client's physician, generally as a routine examination, but more frequent observations of lipid levels would need to be drawn in those with risk of cardiovascular disease or other potential genetic conditions.

Periodic Re-Evaluation

On predetermined dates, the appropriate diagnostic tests should be repeated for the purpose of result comparisons, and consequent client progress. Dependent upon client progress, desired goals and/or training programs may change; but this cannot be known unless you periodically review, re-test and re-assess.

SPECIFIC VARIABLES EMPHASIZED FOR SPECIFIC CLIENT TYPE:

VARIABLE and ***Client Type***	***General Fitness Client***	***Size Increase Client (bodybuilders)***	***Client w/CVD Risk Factors Present***
ANTHROPOMETRICS	Body Weight/BMI	Circumferences	Body Fat (impedance/calipers)
PERFORMANCE	Blood Pressure	Strength Tests	Aerobic
BLOOD CHEMISTRY	Blood Sugar	Ketone (optional)	Lipids

MAJOR RISK FACTOR IDENTIFICATION

The most valuable service you can offer your client is the identification of his or her specific health risk factors. Understand that your NFPT Certification will not qualify you to administer exercise to persons with one or more major health risk factor(s) present without the direct involvement of a medical physician/approval (example template provided in the NFPT *Consultation Guidelines* section of this manual). Now that you understand which variables will play a part in identifying the ability and overall capability of your clients, let's look at the questions to ask for these possible health risk factors. Remember our steps in risk assessment:

- Major Risk Factor Identification: use CVD RIsk Profile *(see page 318)*
- Personal Medical History: use PAR-Q & You form *(see page 317)*
- Physician Contraindications
- Current Medications (physician's clearance required if client is on blood pressure, cardiac or blood glucose altering meds)
- Chronic Illness or Biomechanical Impairment

Here are the following major risk factors that need to be identified up front. These questions are part of the *NFPT Consultation Guidelines* section:

1. Do you have Diabetes?
2. Does your weight/body composition or general state of health interfere with the performance of activities of daily living?
3. Do you know your total serum (i.e. blood) cholesterol level? (should be less than 180 mg/dcl, or LDL less than 130mg/dcl)
4. Do you have an irregular heartbeat? Have you ever had an electrocardiogram (ECG) to test the regularity and rate of your heartbeat?

There are several other questions that must also be asked to obtain more specific medical background information. Ask the following:

Have you ever had or experienced...

- cardiac surgery including bypass?
- extreme chest discomfort?
- high blood pressure, over 140/90?
- smoke and over 35?
- serum cholesterol > 180 mg/dcl?
- irregular heart beats?
- heart murmurs?
- rheumatic fever?
- ankle swelling?
- any vascular disease?
- phlebitis?
- unusual shortness of breath?
- fainting?
- asthma, emphysema, or bronchitis?
- abnormal blood fat levels?
- stroke?
- emotional disorders?
- recent illness or hospitalization?
- drug allergies?
- orthopedic problems or arthritis?
- heart attack?

**If your prospective client answers 'yes' to any of these questions, you cannot train him or her without a complete physical, or signed Physician's Release form (refer to forms available in Consultation Guidelines).*

Has Client Been Advised Against Exercise?

If the client has ever been instructed by a physician not to exercise for any reason that is not already covered in the Client Screening Questionnaire, you may need to consult with their physician accordingly.

Family History of Illness or Disease

Ask if your client has ever had an immediate family member die prior to the age of 50, and, if so, what was the cause of death. With the exception of accidental death, parental and sibling illnesses/diseases, especially cardiorespiratory diseases and blood sugar abnormalities, are often times inherited. Inform the client of his or her increased susceptibility to these specific disorders and recommend relative lifestyle changes that will help offset the likelihood of your client suffering these family specific disorders.

Cardiovascular Risk Profile

The completion of a Cardiovascular (CVD) Risk Profile Questionnaire is a very important step in the process of risk factor identification. Your sample questionnaire is relatively self-explanatory and objective, as to make the determination of risk clear. A client score of over 32 on this questionnaire would be a strong reason not to train this individual without a complete physical and/or the client's physician's approval.

Current Client Medication

If the client is on prescription medication, require that the client contact his or her physician or qualified pharmacist to ensure that there are no risks involved in starting the exercise program while on this medication.

Chronic Illness, Injury, or Limitations

If the client is currently ill, put off starting his or her exercise program until they are over the illness. If the client suffers from a chronic or recurring illness, care should be taken that the illness is not complicated by exercise. If a client has a chronic injury or a range-of-motion limitation, it should always be advised that he or she see their personal physician, a licensed physical therapist, or an orthopedic physician prior to implementing your recommendations. In the case of range-of-motion limitations, this therapeutic referral only needs to be made if recommendations involve the articulation (movement) of the injured site(s). You must also avoid recommending movements that aggravate above conditions. Inform the client to stop exercising if he or she experiences relative symptoms or undue pain of any kind; express the need to consult immediately with you, and if necessary consult with their physician.

Contraindications to Exercise

As a personal fitness trainer, you must inform your client of the contraindications (symptoms of overexertion or injury) to exercise so that the client will be able to distinguish the difference between expected discomfort and discomfort that could indicate an underlying problem. As previously discussed, contraindications to exercise include joint pain, dizziness, nausea, rapid pulse, excessive sweating, extreme muscle soreness, cramping, or chest pain. If symptoms occur, your client would need to immediately consult with you, and, if necessary, with their physician.

Summary of Physician Assistance

A physician must be directly involved if a major risk factor is present. A physician's consent and/or a complete physical must be obtained when there exists any one or more of the following:

1) adverse personal medical history symptoms
2) the client's cardiovascular risk profile score is over 32
3) a significant and restrictive chronic illness or range-of-motion limitation
4) persisting contraindication(s)

As initially stated, all clients, even apparently healthy individuals, should be advised up front to visit with a physician prior to starting or increasing the intensity of his or her existing exercise program. You are not, however, obligated to require the apparently healthy client to do so.

General Client Information

A quality personal fitness trainer will evaluate a client's total lifestyle, not just their exercise needs. There is more to health than exercise alone. The following is a brief overview of each of the general client information topics to be included in the assessment phase with your clients (see your *NFPT Client Screening Questionnaire):*

Age

Knowledge of client age is useful in determining health risks, exercise intensity and duration, as well as for computing maximum heart rate. The once popular equation stating 220 - age = MaxHR has since been modified with several versions that attempt to decrease standard deviations. We have introduced an equation that can be used to more closely estimate MaxHR, which also incorporates age but offers a more accurate result: **MaxHR = 208 - (0.7 x Age)**

Sleeping Habits

Poor sleeping habits can reduce recovery effectiveness, lower growth hormone release, and cause an inability to concentrate. Sleep is the body's built-in recovery mechanism. A toxic protein builds up in the cerebrospinal fluid during waking hours that can be broken down only during sleep. Moreover, sleeping abnormalities can usually be directly linked to stress and improper diet.

Water Intake

Persons taking in too little fluids are more susceptible to dehydration during exercise. Prolonged low fluid intake can lead to survival water retention in the body. It is also important to note that, even though the drink may contain water (i.e. tea, coffee, sports drinks, etc), the benefits of drinking the appropriate amount of water will not cross over into other beverages, you *need* good old fashioned water!

Gender

This information is usually needed for demographic reasons. Gender also is a consideration in determining health risks as is indicated as part of the *Cardiovascular Risk Profile Questionnaire*; and it is also a variable in certain applicable calculations, like RMR.

Weight
Weight is generally a determining factor in first establishing your client's goals, it is of obvious importance for things like body composition measurement and re-evaluations. Don't simply ask the client for their weight. Accurately weigh the client yourself to be sure of the accuracy of this variable.

Height
Height is a determining factor in setting client goals based on national height and weight standards. These standards have been established by professional health/medical institutions as well as major health insurance companies to provide a very general indicator of physical condition. It is NFPT's position that the determination and comparison of lean and fat weight are better indicators of health and body composition than general height and weight numbers alone.

Occupation
Knowing what type of daily activities your client performs will assist you in determining total caloric intake, meal timing, exercise scheduling, and possible lifestyle change recommendations. Occupational stress should also be considered while making recommendations.

Stress
As a personal fitness trainer, you can determine, (to some extent) the degree of stress that your client is under. While questioning the client, solicit answers to questions such as… "Do you feel like you are under a lot of stress at work? Are you easily upset? Would you say you are always trying to do two or three things at once? Do you enjoy an active social life"? Answers to these types of questions, along with the answers to occupational, sleeping habits, and dietary questions, may point towards a need for special attention to one or more areas. Make arrangements for referrals to a stress management professional in those cases of extreme anxiety, depression and other stress related conditions. On a smaller scale, stress can sometimes be effectively controlled through proper dietary consideration, increased physical activity, improved sleeping habits, etc., thereby contributing to an all around healthier lifestyle.

Most Recent Exercise Program
In order for you to optimize the results of your client's new resistance exercise program, you must learn as much as possible about their past resistance exercise program. Question your client concerning past resistance exercise. Pay special attention to responses regarding the following, and understand basic concepts of each:

<u>*Type of routine*</u>
- ***A circuit routine*** is for general wellness, endurance and fat loss
- ***2 day split routine*** is designed for building stamina and promoting general fitness
- ***3 day split routine*** is used for weight gain and muscle building, size and strength

<u>*Total sets per muscle group*</u>
- A large target muscle group requires more total sets
- A smaller muscle may need fewer total sets

Typical number of reps per set

- Fewer, heavier reps for lean weight gain
- More, light reps for fat reduction and aerobic conditioning

Recovery between sets and workouts

- Longer recovery is for lean weight increase
- Shorter recovery is for fat reduction and aerobic conditioning

Movements used

Compound (multi-joint) movements are preferred over simple (single-joint) movements for both lean weight increase and for fat reduction/aerobic conditioning. Selection is dependant on the client's ability and fitness level. Trainers need to understand how to modify movements for new clients. For example, if a new client needs to do a deadlift, do it from the hang and not the floor. Focus on progressing movements and increasing ROM rather than loading up weights for inexperienced clients. Pull-ups are great, but most people have a hard time with them; so, modify the pull-up by having a client do them in a squat cage. Set up the bar so it's far enough from the floor that the client can hang under it and dig their heels into the floor.

Length of workouts

- Short, high intensity workouts should be performed for lean weight increase
- Long, low intensity workouts should be performed for fat reduction and aerobic conditioning

Time of daily exercise

- Train later in the day for lean weight increase
- Train earlier in the day for fat reduction and aerobic conditioning

Long and Short-Term Goals

The client's long and short-term goals are quite valuable. In order for you to effectively implement the exercise program, you must have a clear understanding of your client's goals.

Client Eating Habits

Ask the client to give you a detailed list of his or her typical daily food selection, number of meals, meal timing, size of meals, hunger between meals, and current supplements being taken. The significance of these dietary factors should be clear to you, especially when you see it all on paper. Only dietitians are qualified to make actual food selections and detailed meal planning; but, it is incumbent on you to make your client aware of the effects that their eating habits will have on their training program - proper eating and training go hand-in-hand. When your client sees a log of what and when they eat every day and/or other sources for dietary facts about the foods that they are eating, this should have a tremendous impact on their understanding of how these eating habits are affecting their health and fitness goals overall.

When educating your clients regarding dietary health risk habits, refer to your *NFPT Master Food List* and *Consultation Guidelines* for review and emphasis regarding the ill effects of specific health risk foods.

Acquiring Informed Consent

After you have had the initial screening and consultation appointment with your client, he or she must give you informed consent prior to the performance of pre-exercise tests and/or the administration of the exercise program itself. Be sure that the client understands the contraindications to exercise and encourage them to ask questions concerning the possibility of injuries that may occur with resistance training, or anything at all that they are unclear about. It is important to be on the same page with your client before you get started. It is also important that, prior to requiring physical activity, you request that they sign an informed consent waiver. An example of this waiver is provided in the *NFPT Consultation Guidelines* section.

Also note the value in the "Par-Q & You". This form reflects a typically standard document for the collection of agreement and consent by your client. NFPT encourages you to use both the Par-Q and, in addition, a more specifically stated informed consent waiver.

Re-Evaluate

We will emphasize this message because it is extremely valuable for both demonstrating your client's progress and for altering the program due to lack of progress - both are equally important. If, for example, you have a client who meets with you 4-5 times per week, consider conducting performance-based tests, e.g. sit and reach, push-up/pull-ups, reach over, etc., as often as every 2 weeks; and non-performance measurements every 4-6 weeks. Of course, this re-evaluation time frame depends on the frequency in which you meet with your client, and it can also depend on how well the client is doing with sticking to your recommendations on their own accord. Generally speaking, irregardless of the exact number of weeks in-between evaluations, it should be understood that:

- even a small increase in performance and/or decrease in circumference around the waist, for example, should be celebrated and encouraged
- performance variables will likely yield more noticeable gains in the short run, so these can be tested more frequently to show progress
- non-performance variable differences, like body fat and circumferences, tend to be more characteristic of progress, from the client's perspective. Often times, weight and circumference measurements are the only things seen by the client to be indicators of reaching their goals. Because you know that change for the better, especially as indicated by these measurements, takes hard work over time, you should emphasize this fact and refrain from taking measurements too often (you and your client are both better off to wait it out until the positive differences are more demonstrable).

Client Programming, Stretches and Exercises

The purpose of this chapter is to provide insight into the knowledge, skills, and application abilities that a trainer must possess before he or she can deliver a safe and effective program to any given client. In general, the trainer should be educated and competent in 10 areas:

1. **Screening and Risk Factor Determination:** *evaluates if the potential client can be physically trained*
2. **Programming Aspects:** *includes initial data collection and explanation of your business policies*
3. **Physiological Assessment:** *crucial for program design*
4. **Training Principles and Applications**
5. **Aerobic/Cardiorespiratory Training**
6. **Nutrition Principles:** *(i.e. total calories recommended, nutrient percentages, meal timing)*
7. **Building Client/Trainer Relationships:** *what to encourage and what to avoid*
8. **Recommended Stretches**
9. **Recommended Resistance Exercises**
10. **Post Workout Considerations**

In the last chapter, we looked at the relevant variables and risk factors that are important for you to understand, and why they are important. Now, we will put those to practice in a step-by-step way that will give you an easy to follow system for implementation into your training practice. The *NFPT Consultation Guidelines* section will provide you with a summary of this information and all charts and tables as well.

1. SCREENING AND RISK FACTOR DETERMINATION

This first step will be the determining factor for your potential trainer/client relationship. Based on this initial consultation, you will know whether or not it is safe to train your potential client. This initial consultation appointment will include, but does not have to be limited to, the following:

- Major risk factor identification
- Personal medical history
- Physician contraindications
- Cardiovascular risk profile
- Current medications
- Chronic illnesses or biomechanical impairments
- The provision of waivers and other professional documents

When you have determined that your potential client is “apparently healthy”, as the result of your initial consultation, and/or if you have received physician’s consent/medical clearance, you may begin programming aspects. It is only through your appropriate due diligence that you will be able to determine the risk category for your potential client. If your style of training does not pose a risk to them, then you can start explaining your business policies and mutual expectations. These ‘programming aspects’ require that you and your client be on the same page about how you run your business and how you intend to train them. Because of the wide variance in the methods and procedures of business practices, only general guidelines will be presented here. We simply emphasize that your business policies be:

- in writing
- comprehensive, complete and thorough
- clear and in plain language: don’t make it hard to understand
- signed off on by client, after they have been given the chance to ask questions

NOTE – (forms provided) Prior to the performance of any activity the client must have provided you with what is known as “**Informed Consent**" as well as their completion of the industry accepted Par-Q & You form. ‘Informed’ means that you have discussed with them the possibility of injuries relating to the fitness program they will be undertaking, even the possibility of injury or death. This is, of course, a precautionary measure with the intent to minimize your liability.

The way you conduct your business is literally ‘your business’. A large aspect in conducting your business is that your policies be well stated and comprehensive enough to anticipate most situations, whether likely or unlikely to occur. It is important that the client know in advance and has actually been explained the policies in a person-to-person fashion. This seems unnecessary to many trainers, but the client will appreciate the fact that you are running a business and that you have guidelines for conduct and expectations of them. A decent amount of front-end work (laying out ground rules) on the programming and policy delivery can save you a lot of time and money on the back end. Consider the below suggested programming aspects.

2. PROGRAMMING ASPECTS

Before getting 'down to business' you need to make sure that your client agrees with your style of doing business. Otherwise, you could very well waste a lot of both of your time. Now that you have determined that he or she is not a risk in terms of health, you should do your part to make sure that he or she is not a risk to your business - that all starts with you. It is important to find a good balance between policies that are thorough but not scary and overwhelming. There are many great sources for legal advice and even template agreements that can help you tremendously in this area. The following includes some, not all, business policies that are a must when it comes to your client's understanding and consent:

Payment polices

- Monthly fees, contract based, special service packages, hourly rates, etc.
- Advance payment, loss of session when missed, refund if you cancel, etc.

Expectations

- What the client can expect from you
- What you expect from the client
- Termination conditions, refund policies, etc.
- Tardiness policies, vacation plans (interruptions), bonuses, etc.

Scheduling Factors

- Preference for AM or PM
- Can they train at a set time (weekly slot)
- How often can they, or do they want to, train
- Does training them require your travel time (additional fees)
- Inform them on the duration of a typical session and/or contract period

Client General Information

Record the following for the individual 'file' of each client:

- Age
- Gender
- Height
- Weight
- Circumference (optional, but recommended)
- Additional information: sleeping habits, water intake, occupation, etc.
- Consultation Questionnaires (e.g. Par-Q & You, CVD Risk Profile)

Training Factors

- Determine client goals, limitations, and exercise facilities available to them
- Goal 'Category': Cardiorespiratory, Fat Loss, Endurance, Stamina, Strength
- Realistic time periods to obtain goals (short, intermediate, long)
- Previous Activity: recent and previous exercise program/activity
- Identify Limitations: time, biomechanical or physiological impairment, availability of facility and coordinating schedules
- Review of Contraindications: client should understand what these are and that they are to inform you if they experience any of these concerns

3. PHYSIOLOGICAL ASSESSMENT

Here, we will be looking at the 5 components of fitness and how the client performs for each:

1) Cardiorespiratory Conditioning: *VO_2 Max test*
2) Muscle Endurance: (test light) Upper Body, Lower Body, Core
3) Muscle Strength: (test heavy) 1RM test
4) Flexibility: sit and reach, hip hinge with bent knee to teach proper squat
5) Body Composition: skin-fold caliper or other preferred device

- Find RMR: number of calories needed to maintain lean body weight at rest
- Find blood pressure: at rest
- Biochemical values (*optional tests, usually via lab/physician*): such as blood and nutrient levels
    - Cholesterols (LDL, HDL, Total)
    - Triglycerides
    - Glucose
    - Ketones
    - Nutrients: vitamin and mineral levels (via blood test, not urine or hair)

REMINDERS:

Movement Tests: After health screening indicates that your client is safe to perform these tests - have your client take off their shoes and squat, hip hinge and lunge. If your client has an easy time with doing these movements correctly, increase the difficulty. For example, if they easily squat, with no dysfunction, then have them do a one legged squat, to gauge their ability. Conversely, if your client can't do a basic body weight movement correctly against gravity, then do not load that dysfunctional motor pattern. Your number one priority as a personal trainer is to teach proper form and the ability to get into the positions necessary to maintain proper form throughout the full range of motion.

Muscular Strength Test

-Experienced Athlete: heavy compound movements, such as bench press, deadlift, squat and pull-up

-Beginner and general fitness client: start with body weight and cable machines. Push-ups are recommended because they will also show you shoulder dysfunction and core weakness. If someone can't do a push-up correctly, start from a push-up on the knees and progress from there.

Additional components for assessment may include core and balance:
Core Strength: Side Plank, Supine Cross Crawl (Dead Bug), Crossover test
Balance: One Legged Stand

4. TRAINING PRINCIPLES AND APPLICATIONS

This section focuses on suggested resistance training principles which require the application of provided NFPT Charts and Tables

Basic routines based on client goals:
Three General Categories

1. Size/Strength
2. Stamina/General Fitness
3. Endurance/Fat Loss

General Exercise Recommendations Chart
Integrating overload:
Define intensity requirements for continued adaptation
Overload Training Principle
Resistance exercise:
Repetition ranges based on goals
(4 to 6) Size/Strength
(12 to 15) Stamina/General Fitness
(20 to 25) Endurance/Fat Loss

Wellness Circuit Workout: applies to all ranges of 8 and above; intensity is easily adjusted by allowing rest between exercises.

Specificity training:
Depending on any sports specific goals, you may emphasize a given musculature or types of exercise

Balancing workouts and regimes:
Body-part
Total Sets
Fundamental Exercises
See *Suggested Movements and Total Sets Table*

Intensity and rep ranges:
Identify the desired effect on tissue based on intensity and rep ranges
Rep Range Chart

Progressing your clients:

1. Re-assessment of performance and non-performance variables
2. Re-evaluate the client's goals and progress

<u>5. AEROBIC AND CARDIORESPIRATORY TRAINING</u>

Applying the "F.I.T.T." principle to aerobic training:

- ***<u>Frequency</u>:*** how often are they working out? Rule of Thumb: less frequent at high intensity; more frequent at low intensity
- ***<u>Intensity</u>:*** how hard are they working out? Use heart rate and RPE scales as a monitor of this. Explain how heart rate indicates measurable work output or intensity level in a studio setting. Explain that maximum aerobic capacity and maximum heart rate are, in some cases, interchangeable. Use the Karvonen formula to calculate your clients target heart rate range.
- ***<u>Time</u>:*** how long are they working out? Rule of Thumb: shorter amount of time at high intensity, and longer amount of time at low intensity
- ***<u>Type</u>:*** what type of workout are they getting? Explain how intervals work the anaerobic systems. High intensity = anaerobic energy production

Emphasize the importance of <u>Recovery</u> Principles:

- Appropriate Amounts of Sleep
- Nutritional Needs: e.g. endurance athletes need higher caloric intake and may consider supplementation
- Rest Between Training Sessions: the harder the session, the longer the recovery

<u>6. NUTRITION PRINCIPLES</u>

Acceptable Practices:

Apply the commonly known interrelationships between nutrition and exercise. Includes physical fitness, weight control, physiology of nutrient metabolism as it relates to exercise and athletic performance in the apparently healthy individual.

Not Acceptable Practices:

Registered Dietitians plan and manage a patient's diet in a clinical setting and provide dietary treatment to diseased individuals, this is not in your scope of practice as a NFPT - CPT. Dietitians diagnose and treat disease using nutrition, to include a physiological and biochemical basis for nutritional care. Managing effects of disease on nutrient metabolism, diet therapy, nutritional assessment, and nutrition counseling is not within your scope of practice as a NFPT - CPT. It is recommended that you establish a professional relationship with a local R.D. in order that you may refer your clients when needed, and vise versa.

Eating Regimen

- for muscle gain
- for fat loss
- for overall health maintenance

Recommended Strategies

Resting Metabolic Rate (RMR) requirement

Daily Caloric Expenditure Needs = RMR + Activity Factors

1. Apply to Goals
- Weight Gain: Daily Caloric Expenditure Needs + 500 Calories/Day
- Weight Loss: Daily Caloric Expenditure Needs – 500 Calories/Day
- Weight Maintenance: Daily Caloric Expenditure Needs

2. Eat smaller meals more often

3. Wait 60-90 minutes after eating before engaging in vigorous activity

General Diet Information

1. **Hydration**: at least 8 to 10, 8 ounce glasses of fluid daily. Do not include caffeinated drinks in this total

2. **Proper Protein**: approximately 20-25% of total calories = about 0.75g/lb of body weight. Intense resistance training will necessitate higher protein requirements.

3. **Fiber**: soluble and insoluble fiber are essential in any healthy diet.
Soluble fiber assists in the regulation of blood sugar and insoluble fiber assists in the regulation of digestion and waste excretion.

4. **Vitamin and Mineral Rich Foods**: if not normally consumed, then supplement with multi-vitamin/mineral complex, and possibly additional antioxidant vitamins

5. **Avoid**: saturated and/or partially hydrogenated (trans) fats and simple carbohydrates (such as sugars, corn syrup, cured meats, and high sodium or pickled foods)

6. **Choose**: Linolenic and Omega 3 fats, high fiber, high nutrient dense foods. Fruits and vegetables with more color and smell tend to be vitamin rich

7. **Food Plate** (formerly "Pyramid"): this illustration can be found in the *NFPT Consultation Guidelines* section. Following these daily recommendations will ensures a full complement of necessary vitamins and minerals

General Caloric Composition
For all scenarios listed below, break caloric intake down into 4-5 small meals per day, with nutrient percentages varying 2.5% above or below the stated guidelines.

1. <u>Weight maintenance</u>: 20% protein, 55% carbs, 25% fat
2. <u>Weight gain</u>: 15% protein, 60% carbs, 25% fat
3. <u>Weight loss</u>: 25% protein, 50% carbs, 25% fat

NFPT does not advocate any particular diet, especially those high in fats and low in fruits and vegetables. NFPT does not advocate the use of any particular supplement, though some athletes, and those seeking to avoid or retard the progression of disease, may find beneficial effects from many types of supplements. If extreme dietary risk habits exist, even in the case of the apparently healthy individual, it is recommended that a client get dietary counseling from a Registered Dietitian (R.D.) and/or a health care professional specializing and educated in nutritional biochemistry.

7. BUILDING CLIENT/TRAINER RELATIONSHIPS

Frequent encouragement is a good start to a great relationship. It may be annoying to clients for you to say something in between every repetition, but encouragement at least once or twice per set is recommended.

Let the fearful client know that you are working with them and that you understand their apprehension. Many clients feel uneasy regarding safety and/or the possibility of injury, you must reassure your client where this is concerned.

When dealing with frustrated (or frustrating) clients it is necessary to "preach patience". Tell them about other cases, maybe your own, where someone who is much like them was able to overcome the difficulty or plateau.

Establishing self-efficacy means letting the client know that they are doing well and are very capable of making/reaching their intended goals.

Establish external support by giving your client a call outside of their appointment time and let them know that they did well; and, if they have any questions at that time, you are there for them.

It is important that the client feel your worth as well as their own. Let your client know what kind of changes they have made with you and how their progress shows.

Avoid overtraining and burnout by giving your highly consistent clients short breaks, making sure to take one yourself. Burnout and overtraining can cause a lack of effort, boredom and even emotional exhaustion - switch things up (e.g. routines, music, settings - with their preferences and comfort in mind, of course) to make your client have as much of an enjoyable experience as possible.

Professionalism is the key. Be very, very careful not to overstep your boundaries as a *professional* personal trainer. NEVER make sexual comments or innuendoes, NEVER speak out of line or in jest in a way that is offensive to someone else and NEVER speak with a foul mouth or think that your behavior and/or speech is not being registered mentally with the client. Even when you think that you can 'push the envelope' a bit, with one client or another, don't assume that it is not offensive or even annoying to your client. Just because your client isn't verbalizing their distaste for your comments or actions, does not mean that they care for it or that they aren't verbalizing it to someone else. There is a professional expectation of you, irregardless of your assumption of the client's level of tolerance.

Take caution not to 'get involved' with a client in a personal way. Of course, it is at the discretion of you and your client to engage in a social relationship outside of your practice, but it is not recommended to be-friend your client on a social or personal level, especially if you do not already know him or her in that way.

Professionalism does not mean that you have to be stern or dull, but it does mean that you take great care in maintaining your position as a teacher, consultant and supportive friend in fitness.

8. RECOMMENDED STRETCHES

Stretching is a very important aspect of a training program. Also, the more that stretching is integrated into the training program, the more that the client values the trainer's service. In addition, the more flexible someone is, the more they can lift, and the less likely they are to become injured at a given intensity. Stretches should follow some basic guidelines, and be area specific.

- All static stretches should be held for *at least* 15 seconds, but **30 seconds** is ideal and recommended, at the end of the workout. Though there may be no extra benefit to holding the stretch for longer than 30 seconds, and there is added risk for injury if held for too long, some people like to hold for 60 seconds (maybe because of the feeling that the stretch gives), and this is okay.
- All stretches should target a specific muscle.
- It is recommended to perform active and dynamic stretches as a warm-up, and during exercise. Do not perform static stretching until *after* the main training activity.

Be mindful of factors that can impact your client's ability to stretch:
- dehydration
- medical history (i.e. diabetes, connective tissue impairment, scar tissue, smoking)
- age/elasticity
- level/type of activity prior to the stretch (i.e. muscle fatigue)

Mild static stretching can be done after only 5-10 minutes of light cardiorespiratory work that warms the muscle. Here are some examples:

Upper Body and Low Back Stretches

Forehand: Shoulder horizontal extension
Backhand: Shoulder horizontal flexion
Rotator cuff stretch: (Pitcher stretch): Using a towel or band, grab the object such that your hands are about 45 degrees to the vertical. Gradually roll your hands backwards so that your shoulders and elbows are at 90 degrees and a stretch is felt in the anterior shoulder.
Hook shot stretch: Stand sideways to a vertical bar. Grab the vertical bar with the hand on the other side of the body (make sure to keep your head under the arm.) Have the hand that is over the head on the bar so that you can gently push away from the bar for an additional stretch.
Grab elbow above head: triceps and shoulder stretch
Human Pretzel: seated twist with one knee bent
Twister stretch: lower back stretch

Lower Body Stretches

The following stretches have lying or seated and standing options. Either option is fine, client preferences should dictate the option used.

Hamstring stretch: seated

Quad stretch: standing

Hip flexor stretch: lunge stretch

Adductor stretch: feet together and knees out: seated

Adductor (Groin) stretch: standing

Glute stretch: standing

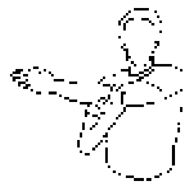
Glute stretch: seated

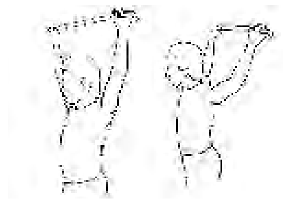
Calf stretch: standing

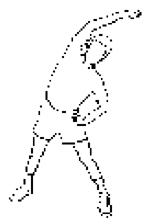
Hamstring stretch: standing

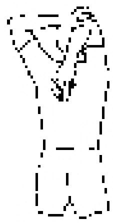
Upper Body, Lower Back & Hip Stretches


Forehand Stretch

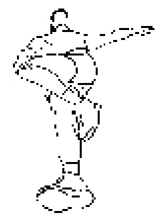

Backhand Stretch


Rotator Cuff Stretch


Hook Shot Stretch

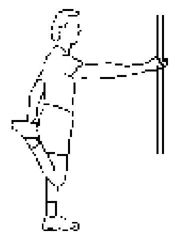

Grab Elbow Above Head

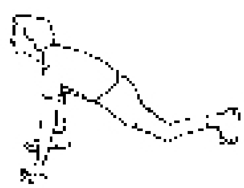

Human Pretzel

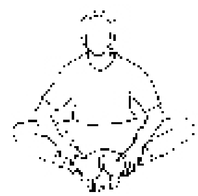

Twister Stretch

Lower Body Stretches

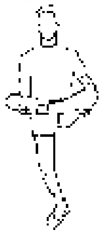

Hamstring Seated


Quad Stretch Standing


Lunge Stretch


Seated Adductor


Standing Adductor Stretch


Standing Glute Stretch


Seated Glute Stretch


Calf Stretch


Standing Hamstring Stretch

9. RECOMMENDED RESISTANCE EXERCISES

The Beginner and General Fitness Client

Many of your clients may be beginners, or possibly have no interest in progressing their development beyond the general health and functional benefits of exercise. In these cases, exercises primarily using lighter weights, with less intensity, present less risk. As your client progresses and becomes more interested in further improvement, closely work with him or her to implement the more effective, NFPT recommended, exercises and routines. You should always encourage your clients to progress beyond their current level of fitness.

The Experienced Client

NFPT recommends the exercises as listed in the *Suggested Movements and Total Sets Chart* to be the most effective for physical adaptation (rep range training) and fat loss (circuit training). These exercises are not without risk. However, even the safest of exercises performed improperly are contraindicated. As a personal trainer you should monitor the performance of these exercises through the use of proper spotting techniques. If possible, consider "shadowing" an experienced and successful trainer quality trainer to learn proper form and spotting techniques.

Upper Body (Overview)

Chest (Pectoralis Major): Flat, Incline and Decline Bench Press, Push-up, and Cable Press

Back (Scapular Retractors: Rhomboids, Teres, Upper Lats): Seated Cable Row and Standing High Rope Face Pull

Back (Latissimus Dorsi): Front Lat Pull-down - wide, overhand grip acceptable - Pull-Up, Bent Row

Shoulders (Trapezius, Rhomboids, Deltoids): Dumbbell Press, Rear Fly and Side Raises

Arms (Biceps, Brachialis): Biceps Curl - barbell or dumbbell

Arms (Triceps): Rope Push-downs, Close Grip Push-up and Overhead Dumbbell Extension

Forearms (Wrist Flexors/Wrist Extensors): Wrist Curl/Reverse Wrist Curl

Lower Body (Overview)

Butt, Legs (Glutes, Quads, Adductors, Hip Extensors): Squat, Deadlift, Lunges and Leg Press

Rear Legs (Hamstrings): Lying or Seated Leg Curl and Stiff Leg Deadlifts

Calves (Gastrocnemius/Soleus): Standing/Seated Toe Raises

Abs (Rectus Abdominis): Ball Crunch, Cable Chop, Plank and Supine Cross Crawl (Dead Bug)

10. POST WORKOUT CONSIDERATIONS

After each workout, it would be beneficial to again include 5 to 10 minutes of stationary cycling (or some other type of low level activity) for even more important reasons than before the workout. After a resistance workout, regardless of its intensity or duration, there has been energy depletion in the muscle tissue cells. As we have already discussed, the value of having cellular energy after a workout for recovery purposes is invaluable if you are to reduce continued catabolism and quicken the recovery process.

Post-Workout Activity and Fat Loss
Aside from exclusive high rep training with a high recovery heart rate for aerobic stimulation, there is little fatty acid use for energy during the resistance workout.

The majority of energy used during resistance exercise comes from glucose and/or stored sugar (glycogen) in the muscles. However, during recovery immediately after (and between) workouts, fatty acids provide a greater proportion of the energy required by the muscle to function during less intense post workout activity while it takes up nutrients such as blood glucose and amino acids for cellular repairs, or anabolism. With this in mind, the performance of post-workout low level activity will require your fat cells to release greater amounts of fatty acids; that will in turn be used by the muscles while they take up recovery nutrients in carbohydrate rich post-workout meals. Low level activity can effectively be maintained for prolonged periods, and for a suggested minimum time period of 5 to 10 minutes after your client's resistance workout.

Post-Workout Stretching
After the workout is an excellent time for the client to perform proper stretching movements. You will find a few recommended stretches in this manual. However, there are literally hundreds of effective stretching techniques you can perform that accomplish the same goal.

After a workout, it is most important to stretch the just previously trained muscles. Post-workout stretching is performed for the purpose of improving in-between workout recovery through increased relaxation, resulting in enhanced blood flow. This improved collateral circulation will provide for greater waste removal, as well as healing nutrient provision.

CHAPTER 16

Special Populations

Youth
Older Adults
Pregnancy
Diabetes
Hypertension
Arthritis
Coronary Heart Disease

The purpose of this chapter is not to prepare you to work with these specific special populations, as they each come with inherently greater risk. This chapter, which will be an overview of each of the listed groups, is intended to point out unique considerations for training, which may encourage you to seek a specialty education/certification that will provide you with the knowledge and appropriate credential for working with these groups. Your willingness to work with a potentially 'at risk' client comes with risk of your own. With any potential client, a good rule of thumb is to ask yourself if you feel qualified to work with him or her - if you don't, then don't. If you do feel qualified, then err on the side of caution and compile your recommendations for your client's physician to review and sign-off on. It is within the physician's scope of practice to permit their patient to start a fitness training program; it is not within the trainer's scope. As always, NFPT strongly encourages that you pursue individual continuing education courses that prepare you in greater detail to work with a specific special population and/or specific fitness training modality.

Youth

Using chronological ages to classify youth into groups is not applicable as growth rates differ from child to child at various ages. Two children of the same age may be at different stages of physical development. The following terms apply to the development of our youth along with a subjective age range for each group. Pre-pubescent refers to the youngest and smallest of children (4-12). Pubescent refers to the next developmental stage (12-18). Post-pubescent refers to the young adult (18+), and this group can generally be treated as adults. As a trainer, you must use your best judgment on a case-by-case basis when determining chronological versus biological age as it applies to age ranges and the design of a safe and effective exercise program. Just remember, like with adults, **the biggest priority when training a young person is using proper form.** The below considerations apply to both Pre-pubescent and Pubescent youth (4-18)., these are general statements for understanding:

- *Brief* intense exercise is safe
- Children need more oxygen during exercise than adults
- Children store less glycogen than adults
- Aerobic energy pathways are more efficient in youth
- Children require less recovery than adults
- Children do not adjust as well to extreme climates as do adults
- Children should be screened and tested in much the same way as adults
- A child's motor skills are significantly more enhanced with a variety of activity/sports; children have greater capacity for muscle memory and adaptability than adults
- Children should have at least 60 minutes of some level of physical activity per day
- Parents should always be involved in the fitness programming of their children

Resistance training is good for pubescent youth with the below considerations:

- Extremely close supervision
- Slow and controlled movement with proper form
- Slightly higher repetition ranges are suggested (12-15)
- Scaled down equipment may be desirable

Older Adults

The older adult population is the fastest growing segment in America. With advances in modern medicine and health research, Americans are living longer than ever before. The current issue now has become the quality of life. Who are 'older adults'? How do we define 'old age'? As a fitness professional, be aware that there is a difference between chronological and biological age. By the age of 65 years, 1 in 3 people report at least one disability preventing them from being able to independently perform "Activities of Daily Living" (ADLs). For our purpose, we won't distinguish between an 'older adult' and an 'elderly' adult, other than to say that a common standard, chronologically speaking, could be to identify the older adult as being between the ages of 50-65, and the elderly adult as being 65+; the social norm for retirement age can be noted here as a distinguisher between 'older' and 'elderly'. But, again, chronological age can be deceiving when you look at it and nothing else; biological, and even mental, age can be more of a determinant in overall health after 50. And, also note, that an elderly person is an 'older adult', while an 'older adult' isn't necessarily elderly. Irregardless of chronological age, or the semantics of these distinguishers, it is recommended that, if working with an older adult, to strongly encourage the following behaviors and activities for the betterment of overall health and well-being:

- Remain physically active: regular exercise will reduce both the risk of injury and the impact of illness. Exercise is good for the brain and for the body, it will improve memory and mental function as well as mobility and structural functions.
- Remain socially active: maintaining good relationships with peers is important for self-assurance, overall mood and energy levels.
- Maintain self-reliance: the ability to perform ADLs (even if these activities need to be modified and/or limited) is important for both the mental and physical aspects of aging.
- Manage medical conditions independently: do not discount the need for a physician and/or medical treatment based on participation in a fitness program. It is increasingly necessary to have consistent check-ups and regular visits with a medical professional as we grow older.
- Pay very close attention to contraindications: the presence of these risk factors could indicate even greater health concerns and should be taken very seriously. Be diligent in your questioning of these signs of potential danger, ask often "how are you feeling"? and make sure that your client knows why you are asking and what things you are specifically looking for.

If or when training the older adult population, perform resistance training activities 2-3 times per week using the full body resistance workout program, paying careful attention to the amount of resistance being applied. It is crucial that you incorporate functional training at low intensities, and with little or no resistance, especially if multi-directional movement is performed (exercises should emulate daily activities).

Your primary goal when working with the older adult demographic is to enhance their overall quality of life, primarily and specifically as it relates to the ability to independently perform "Activities of Daily Living" (ADL).

Pregnancy

Though exercise, during pregnancy, is generally very beneficial for most women, it is still like every special population consideration, whereby there is a need for preliminary medical evaluation and clearance prior to starting an exercise program. Under normal conditions, some level of exercise is beneficial to everyone, especially the pregnant woman. Exercise during pregnancy will, generally, result in higher energy levels, increased self-efficacy, increased ability to lose and maintain weight after birth and even a decrease in risk and discomfort during childbirth. During pregnancy, the fitness program should consist of low to moderate levels of intensity. Here are some things to note about exercise during pregnancy:

- An increase in sweat production is normal
- Body temperature may increase slightly
- Less oxygen and nutrients are provided to working muscles

Program Design Considerations:

- Avoid contact sports, ballistics, and multi-directional activity
- As fetus develops, avoid supine exercises (lying flat on the back)
- Avoid extreme temperatures and dress appropriately as to not overheat
- Do not perform the Valsalva Maneuver (holding the breath)
- Always use low to moderate intensity
- Perform in higher repetition ranges (12-15)
- Slow contractile speed using good form

If the pregnant exerciser experiences any of the below contraindications, she should stop exercising immediately and consult with the appropriate health care professional:

- Vaginal bleeding
- Chronic fatigue
- Abdominal pain
- False contractions after exercise
- Unexplained high blood pressure and heart rate
- Unusually increased or decreased fetal movement

Remember, when training a pregnant woman, you have the life of two people in your care; it is especially important that extra pre-cautions be taken to assure that physical training is to the benefit, not the detriment, of herself or her unborn child's health.

Diabetes

According to a 2014 report from the Center of Disease Control (CDC), 29+ million people – over 9% of the U.S. population – have diabetes. This metabolic disease has been increasingly on the rise, in both adults and children. The two main types of diabetes are:

Type 1 (a.k.a. 'Juvenile Diabetes') is a chronic (lifelong) disease that occurs when the pancreas produces too little insulin to regulate blood sugar levels appropriately.

Type 2 Diabetes is a chronic endocrine disorder characterized by the inability of body tissues to properly utilize sugar, specifically glucose, a simple carbohydrate. This results in excessively high glucose levels in the blood. Diabetes involves either relative or absolute shortage of insulin, a hormone that regulates the body's breakdown of carbohydrates. A higher percentage of obese individuals have Type 2 Diabetes than does the general population.

All diabetics MUST consult with their primary care physician for exercise clearance, proper procedures to follow, and considerations relative to exercise.

Type 1 Diabetes
Insulin is the hormone that allows glucose to enter body cells. With Type 1 Diabetes, the beta cells of the pancreas produce little or no insulin. Once glucose enters a cell, it is used as fuel. Without adequate insulin, glucose builds up in the bloodstream

instead of going into the cells. The body is unable to use this glucose for energy despite high levels in the bloodstream, leading to increased hunger. In addition, the high levels of glucose in the blood causes the individual to urinate more, which in turn causes excessive thirst. The American Diabetes Association and the American Dietetic Association has information for planning healthy balanced meals. Consultation with a registered dietitian or nutrition counselor is an invaluable tool for meal planning and dietary control for diabetics.

Type 2 Diabetes

Diabetes is a disease in which blood glucose levels are above normal. People with diabetes have problems converting food to energy. After a meal, food is broken down into glucose which is carried by the blood to cells throughout the body. Cells use the hormone insulin, made in the pancreas, to help them process blood glucose into energy.

People develop Type 2 Diabetes because the cells in the muscles, liver, and fat do not use insulin properly. Eventually, the pancreas cannot make enough insulin for the body's needs. As a result, the amount of glucose in the blood increases while the cells are starved of energy. Over the years, high blood glucose damages nerves and blood vessels, leading to complications such as heart disease, stroke, blindness, kidney disease, nerve problems, gum infections, and amputation.

Symptoms of Diabetes:

Increased thirst
Increased urination
Weight loss, despite increased appetite
Nausea
Vomiting
Abdominal pain
Blurred vision
Fatigue
Absence of menstruation

Exercise and the Diabetic

Regular exercise is especially important for the person with diabetes as it helps control the amount of sugar in the blood and helps to burn excess calories and fat to achieve optimal weight - but, before people with diabetes begin any exercise program, they should obtain medical approval. Diabetics must take special precautions before, during, and after participation in intense physical activity or exercise.

Hypertension

According to the American College of Sports Medicine, adults with **hypertension** should seek to get at least 30 minutes of moderate to intense physical activity on most, if not all, days of the week. This should be done while being evaluated, treated, and monitored closely.

Hypertension is a common medical disorder associated with increased risk of disease. It is the most prevalent cardiovascular condition found in recreational exercisers and athletes. Hypertension increases with age, and is higher in young men than in young women, although the reverse is true in older adults. Resting blood pressure (BP), family history, body mass index, and fitness level are known predictors of hypertension.

Exercise programs that involve endurance activities, such as walking, jogging, running, or cycling, coupled with resistance training, help to prevent the development of hypertension and lower BP in adults. Individuals with controlled hypertension and no cardiovascular or kidney disease may participate in an exercise program, although there is limited ability to forecast exercise BP and cardiovascular complications due to possible underlying clinical conditions.

A higher level of physical activity and fitness, resulting from long-term (chronic) exercise training, has a protective effect against hypertension; that is, fitter people with hypertension will have lower BP than those who are less fit. In addition, those with higher baseline BP levels will experience greater BP reductions from exercise. Even a single session (acute) exercise bout provides an immediate reduction in BP, which can last for a major portion of the day (up to 22 hours.)

Older adults experience these same benefits, but the evidence is not clear in children and adolescents. The rise in childhood obesity will likely lead to increased numbers of hypertensive children and adolescents.

Special considerations for exercise with hypertension include:

- The type, frequency, and duration of activity are important. People with hypertension should exercise daily for 30 minutes or more at a moderate level to gain health benefits.
- People using medications, such as beta-blockers, should be cautious of developing heat illness when exercising. These medications and diuretics impair the ability to regulate body temperature.
- Adults with hypertension should extend the cool-down period of the workout. Antihypertensives, such as alpha blockers, calcium channel blockers, and vasodilators may cause BP to lower too much after abruptly ending exercise.
- Overweight and obese adults with hypertension should combine regular exercise and weight loss to effectively lower resting BP.
- Promoting the BP-lowering effects of single exercise sessions may best motivate people to exercise. Physicians are encouraged to promote the role of exercise in controlling BP to their patients.
- A physician evaluation and clearance is necessary for those with severe or uncontrolled BP prior to beginning an exercise program. Higher risk patients (such as those with coronary **artery** disease or chronic heart failure) should lessen the intensity of their training program.

Arthritis

Arthritis refers to the inflammation of a joint(s) causing pain, swelling, and stiffness. According to the National Institute of Arthritis and Musculoskeletal and Skin Diseases, more than 50 million people, 1 in 5, in the United States have some form of arthritis or arthritic pain. By 2030, it is estimated that 20% of Americans (about 70 million people) will have some form of arthritis, this correlates strongly to the number of Americans who will be over the age of 65 by this time. Younger people can get osteoarthritis, usually resulting from joint injuries, but osteoarthritis most often occurs in older people. In addition, more than half of the population age 65 or older, both male and female, will show x-ray evidence of osteoarthritis in at least one joint.

According to the Center of Disease Control, arthritis is the leading cause of disability in the United States. The CDC has found that each year arthritis impacts the United States with approximations of:

- 9,500 deaths from falls
- 750,000 hospitalizations
- 8 million people with limitations
- 36 million ambulatory care visits
- 49 million people with self-reported, doctor-diagnosed arthritis
- $51 billion in medical costs and $86 billion in total costs

Exercise and Arthritis

A general anticipation of pain, and the resulting avoidance of activity, keeps many arthritis pain sufferers from being more active; the limited mobility in turn accelerates the condition. It is acceptable for arthritis pain sufferers to perform any form of non-load bearing exercises that their specific joint conditions will reasonably allow. These activities may include swimming, walking, and cycling. Other activities range anywhere from resistance exercise programs to the brisk performance of beneficial Activities of Daily Living (ADLs). Exercise must "accommodate" the effected joints to make activity a more enjoyable experience. Some more specific recommendations are to:

- Perform 30 total minutes of activity each day (can be performed in 10 minute intervals).
- Perform moderate resistance exercise to help reduce joint pain.
- If multiple joints are effected, it may be appropriate for the arthritic pain sufferer to consult with a qualified Rheumatologist.
- Physical therapy may be necessary for the more severe multi-joint pain sufferer.
- Local YMCAs have programs for arthritis pain sufferers and most communities have support groups called "People with Arthritis Can Exercise" (PACE).

Coronary Heart Disease

With Coronary Heart Disease (CHD), damage to the heart occurs because its blood supply is reduced. Fatty deposits build up on the linings of the blood vessels that supply the heart muscles with blood, causing them to narrow. The narrowing reduces the blood supply to the heart muscles and causes pain known as ***angina***, or ‘chest pain’.

According to the American Heart Association, coronary heart disease caused is the single leading cause of death in America today. About 600,000 people in the U.S. die of heart disease each year, that’s about 1 in every 4 deaths.

Exercise and Coronary Heart Disease (CHD)

All persons with a history of CHD interested in a fitness program MUST consult with their primary care physician for exercise instruction and rehabilitative program referrals. You are not qualified to design a fitness program for those with CHD as this is well beyond your scope of practice. Exercise programs for this population are considered “rehabilitative,” requiring direct involvement of rehabilitative health professionals. As a fitness trainer, you may offer to assist health care professionals in implementing their specific recommendations. However, you are not qualified to design programs for a CHD patient or take part in their physician’s consideration.

In the event you are allowed by the health professional to assist in fitness programming, you MUST have ALL appropriate waivers and documents completed. Always maintain CPR certification as well as having a routine and well practiced “Emergency Medical System” in place and on site.

In Summary

For all special populations discussed in this section, we have not covered the in-depth and detailed understandings and information of these demographics and conditions that, related specifically to exercise, would be required to work with these populations. Training these, and other, special populations, is not within your scope of practice as a NFPT - CPT. Limit your risk, and have a greater impact on the safe and effective exercise programming, by training apparently healthy individuals, or those absent from a specific risk category. In this section, we have provided you with baseline information for consideration, as these can be overlooked with, subsequently ,very negative effects on both client and trainer. NFPT recommends refraining from conducting personal training services with special populations, unless otherwise educated and credentialed for training the respective demographic.

CHAPTER 17

Injury Prevention and Management

As much attention should be given to injury prevention, treatment, and management as is given to the effectiveness of the overall fitness program. There are a multitude of considerations regarding injuries. This chapter will act as a guide to injury risk identification, prevention of injury, managing risks, and minor injury treatment.

Everything, from seemingly harmless stretching to advanced ballistic training, places the participant at risk of injury. For this reason, it is appropriate to inform the personal training client, up-front, that there is an inherent risk of injury associated with all aspects of a fitness program. It is incumbent upon you to minimize that risk.

Injury Risk Factors

Training frequency: training a specific muscle too often will result in overuse injury. Dependant upon intensity and volume of an exercise bout, the working muscles require between 48 to 72 hours of rest.

Activity too long in duration: energy and fluid depletion may result in exhaustion, dehydration, and related heat injuries.

Increased intensity: acute injury to muscle and connective tissue may result from excessive applied resistance.

Quick directional changes: these movements are referred to by most as "plyometrics". The greater the load during plyometrics the greater the risk of injury.

Extreme temperatures: without proper attention, fluid loss associated with sweating may result in heat stroke or heat exhaustion. Hydration is crucial.

Related health conditions: involvement of a qualified health professional can minimize risks of medical related injury.

Muscle weakness: A de-conditioned client requires a more gradual increase in intensity, volume, and duration.

Limited flexibility: short muscles are more easily injured, therefore, inflexible clients are at a greater risk of injury.

Aging clients: generally speaking, these clients are at greater risk not because of their age specifically but due to the likely development of risks associated with other factors on this list.

Obesity: there are several obvious metabolic disorders associated with obesity that put overweight clients at risk.

Injury Prevention Measures

Adequate initial screening: there is a step-by-step screening guideline, provided in the *NFPT Consultation Guidelines* section, page 305, that addresses injury risk identification and related actions on your part as a conscientious fitness professional.

Attention to contraindications: constantly remind the beginning client of symptoms of overexertion and risk of injury. The following are the contraindications to exercise: *blurred vision, joint pain, dizziness, nausea, rapid pulse, excessive sweating, extreme muscle soreness, cramping, or chest pain.* The client who experiences one or several of these symptoms should stop exercising and contact you. If need be, refer them to the appropriate health care professional.

Minimize ballistic training: do this especially if you are not uniquely qualified and/or the participant is not experienced in proper technique.

Proper footwear: the right shoes will help minimize shock and in some cases, when desired, support the ankle.

Properly maintained equipment: poorly maintained, or improper use of, equipment is the number one source of reported injuries. Damaged exercise equipment and a cluttered exercise floor can lead to acute accidental injury.

Caution while training in unstable environments: it is not desirable to apply a significant load when performing exercises while unstable. The general functional fitness client experiences more risks as more joints become involved and/or when under a load. Enhancing coordination and not strength increase is the desired goal here.

Minor Injury Treatment

Prevention of injury is your first line of defense as a personal trainer. When injuries happen, assess the cardinal signs, assess function, and implement PRICE. If the injury is severe, recommend that your client see a physician.

PRICE is the commonly referred to acronym when it comes to injury treatment, it stands for:

Protection
Rest
Ice
Compression, and
Elevation

When a body part (such as a muscle, tendon, ligament, or joint) is injured, the injured person should immediately take steps to prevent the injury from worsening. PRICE is the recommended treatment of choice after injury. Before the concept of PRICE is expounded upon, a review of what constitutes acute and chronic injuries is essential.

An injury in the acute phase generally has four signs or characteristics. These characteristics are called the "cardinal signs" and they are dolor, calor, rubor, and turgor. In plain English, the signs are pain, warmth, redness, and swelling respectively. Acute injuries develop the four signs over a period of time, and if the injury is more severe, the cardinal signs also become more intense. As the injury heals the cardinal signs become less pronounced, and a return to normal is experienced as the cardinal signs disappear and function is restored.

Muscles and ligaments are commonly injured during fitness activities. During resistance exercise, specifically, the muscle is most vulnerable to injury when the tissue is elongated. Whether a muscle or ligament injury, both types of are classified on a three point scale as grade one, two, or three. A grade one muscle strain is a minor injury that involves the tearing of a few muscle fibers, slight pain, slight warmness of the skin over the muscle, little or no noticeable redness, and generally no swelling that can be felt. A more severe muscle strain is rated as a grade two muscle strain and includes more torn muscle fibers and a pain that is more severe, especially when stretching or contacting the muscle. With a grade two muscle strain, the skin over the muscle is warm or hot to the touch, redness is observed, and the muscle may feel swollen. A very severe muscle strain is a grade three strain that is characterized by the majority of muscle fibers being torn resulting in severe pain, prolonged heating of the skin over the muscle, prolonged redness, and swelling. The muscle belly (or the muscle-tendon junction) is torn causing the contour of the muscle to change, resulting in muscle function that is lost or severely impaired.

Ligamentous injuries, or ligament sprains, have similar Cardinal sign characteristics. The more involved the ligament sprain, the more pronounced are the cardinal signs. A grade three sprain will not usually have an obvious deformity, but functions such as running, cutting, or lifting will be impaired. The acute phase of injury usually subsides within 24 to 72 hours, but the better way of determining if the injury is beyond the acute phase is to monitor the cardinal signs. When the signs have subsided the acute phase is over.

Chronic injuries may develop quickly from acute injuries, or they may develop subtly over time without the telltale presence of the cardinal signs. Chronic injuries lack all four cardinal signs but pain and loss of function may be present.

The personal trainer should be attuned to injuries and be able to decide on a course of action if a client is injured. In a situation where the client complains of a pain, the cardinal signs are slight, and function is not lost, the personal trainer can recommend PRICE as the treatment of choice.

Examples:

1) Your client is performing hamstring curls on a machine and, despite your warnings about not bending the knee beyond 90 degrees, his improper technique causes pain in the lateral hamstring. You assess the situation and determine he has developed a grade one muscle strain. First aid will consist of protection and rest by preventing him from working the hamstring; ice the muscle for 15 minutes twice daily, and wrapping the thigh with an elastic bandage when he is not icing. As part of the rest component, elevate the leg for a few minutes. If the pain and swelling persist beyond 48 hours you may consider referring the client to their physician.

2) Another of your clients is determined to improve pectoral muscle development and has been overtraining on the pec-deck. The client experiences sharp pain and a tearing sensation in the right upper chest. Quickly, the skin over the pectoral muscle becomes warm and red, and there is a slight bulge of the muscle near the shoulder. You suspect either a grade two or grade three strain. You quickly apply ice to the area, offer some compression with an elastic bandage, and advise the client to see their personal physician. Since the injury is more severe, a strong recommendation on your part that the client seek medical attention is appropriate. Your client may be referred to a physical therapist or an athletic trainer once the extent of the injury has been determined by the client's doctor.

3) As part of a total fitness program, you place a client on a three time per week running program. Unfortunately, this particular client turns his ankle on a curb near the club. He limps back to the club complaining of ankle pain but you notice that he is bearing weight on the foot and his pain is not too severe. Your analysis suggests a lateral ankle sprain with slight swelling, redness, and warmth. Your client is able to move the foot and ankle well and he is able to walk but with a slight limp. The client relates that he often "turns" his ankle and that he has not had rehabilitation for this problem. PRICE is appropriate for him as well as a recommendation that he see his doctor or physical therapist for rehabilitation of the ankle. Without rehabilitation he will most likely continue to sprain the lateral ankle.

How Does PRICE Work?

Protection prevents the muscle fibers or ligamentous fibers from tearing further. Protection also prevents excessive muscle contractions or stresses on ligaments by keeping weight off of the body part so that the capillaries are not encouraged to bleed into the injured tissues.

Rest is essential to allow the normal healing after an injury to begin and progress toward a normal state. Rest does not mean that the client can sit on the sofa all day. Rest means that the injured body part or tissue is rested while the client can still be encouraged to continue to exercise as appropriate.

Ice (or cryotherapy) cools the injured tissues, slows bleeding into the injured tissues, prevents additional swelling, and reduces the pain of injury. Don’t over do it, icing for long periods of time can cause injury. Recommend to your injured clients that they ice between 15 and 30 minutes every two to four hours. Ice is not necessary after normal exercise, and it may not be necessary during chronic injury phases. Regardless, ice generally doesn't hurt anything if it is administered properly.

Compression is useful during the acute phase of injury as it increases the pressure inside the injured tissue thereby slowing down bleeding and swelling. Gentle pressure is usually sufficient. Remember, a tourniquet is not being applied. The client must be able to feel the body part, and the limb must not turn blue indicating insufficient blood circulation. Compression can be kept on for 30 minutes or more in the form of elastic bandages, which are useful compressive devices.

Elevation of the injured part is useful by reducing the blood flow to the limb, thereby reducing the amount of bleeding. Elevating the limb 6 to 12 inches above the heart is usually sufficient.

Stretching as an Injury Treatment?

Stretching movements should be performed mildly in the absence of pain. Intense stretching can result in microscopic trauma. It is also important that you should never stretch an injured tendon until you are well into the rehabilitation phase.

EMERGENCY MEDICAL SYSTEM

As fitness professionals, we are responsible for the health and well-being of our clients. There is no argument that exercise brings with it inherent risk of serious injury, even in the apparently healthy individual. Understand that the risk of serious injury, cardiovascular accidents and even death can occur, even in the most carefully and thoroughly screened exercise participant. It is for this reason that you need to have a system in place designed to deal with emergency situations.

CPR Certification

You need to maintain CPR certification and review CPR protocols regularly. This goes for all of the members of your staff as well. Even those who are not acting in a "personal training" capacity may someday find themselves present during a cardiorespiratory accident. Contact your local American Red Cross, American Heart Association (AHA), or medical service provider to learn and maintain CPR certification.

Contraindications to Exercise

The following is a list of symptoms that are early warning signs of a possible life threatening medical episode: *joint pain, dizziness, nausea, rapid pulse, excessive sweating, extreme muscle soreness, cramping, or chest pain.* It is not enough for you and your staff alone to be watchful of these symptoms. You should repeatedly, to the point of annoyance with those at risk, quiz the participant on their knowledge and focused attention to these underlying symptoms. Instruct the client to immediately stop exercising and alert you to the presence of any one or more of these symptoms. Most are manageable, however, if symptoms are severe there may be need to involve the appropriate medical professional or even to initiate your pre-planned emergency medical system.

Collecting Emergency Data

When you screen your new clients, always keep their specific data on hand. In the event there is a medical emergency, this information needs to be readily available. The first thing emergency responders and EMTs need upon arrival is patient data such as:

- Patient age
- Patient medical history
- Current medications and allergies
- Circumstances leading to the event
- Time of the incident
- Visible symptoms and vital signs (if possible)
- The name of closest relative and contact information

Medical Equipment and Supplies

Equip your facility and train your staff on the use of appropriate first aid supplies and emergency medical equipment. Seek out the advice of a qualified health professional concerning the actual equipment and supplies you will need. It is the recommendation of the NFPT that the certified fitness professional contact the local American Red Cross for the purpose of obtaining an Automated External Defibrillator (AED) and receive proper instruction and training on its use.

Medical Response Training

Emergency medical response training kits are available at reasonable, affordable prices. This approach might be most appropriate if you provide mobile/off-site fitness training services, work exclusively with apparently healthy individuals, or you feel comfortable learning from educational materials with no personal instruction. On the other hand, emergency first responder training is available in every community and is the desirable approach to learning everything from the proper application of bandaging to life saving techniques.

Preparing for Emergency Medical Response

Contact the ambulance service and the actual first responders who serve your area. Make arrangements for an on site visit. Ask for their professional advice on the following issues:

- Special equipment you may need on hand and how to use it properly. Consider s first responder/first aid training course in your area.
- "Universal precautions" and the proper disposal of contaminated materials
- Exactly what phone number should be called: always call 911 as the first step in your emergency response plan! Make sure to collect your client's emergency contact numbers as well, and to place a call to this individual/s/ immediately following the stabilization of the emergency situation.
- How to position the patient prior to ambulance arrival.
- Discuss where best to stage an ambulance upon arrival.

It is always advisable to have a phone within sight of the exercising client at all times in order to initiate the emergency medical response as quickly as possible.

Having an emergency medical response system in place is crucial and reassures the client that you have their best interests in mind and that you are a conscientious fitness professional. You will find that local medical service providers are very willing to help plan and be involved in your unique emergency medical response system.

CHAPTER 18

Client Troubleshooting

The basics are behind us. Now we can discuss the application of your recommendations through the consistent monitoring of your client's training and diet; and troubleshoot any client concerns regarding the progress towards their respective goals.

In this chapter, we will be covering several of the most typical situations that you will come up against when consulting and training your clients. We will also be reviewing several of the most applicable principles that will help you with finding a solution to the perceived 'problem'.

Problem: ***How do you handle the weight loss client who isn't losing weight?***

Solution: Tell him or her that, when using resistance exercise for fat loss, you are not trying to lose weight, you are trying to lose fat. For re-enforcement purposes, perform a body composition test. They will then see that their lean body weight has increased, and, because of these measurements, they will also see that there has been a dramatic decrease in total fat. This should keep them motivated to continue with their regular exercise program. Remember, losing fat occurs as a result of resistance training because fat is released into the bloodstream during the recovery between resistance training workouts. This fat is then taken up into the muscles and used as energy for recovery activities. The result of this fat conversion is a much heavier (energy replenished) muscle fiber, and less stored fat. Hence, a total weight increase occurs. What used to be 'excess baggage' is now increased muscular energy, that now has the lesser burden of carrying around so much 'baggage'. This is one of the many reasons why NFPT promotes resistance exercise as being better for health and weight management than aerobic exercise alone.

Problem: ***What do you say to the strength athlete who stops getting stronger while on your program of performing sets of 4 to 6 reps?***

Solution: It is possible that he or she is not adhering to your recommended diet, training, and/or recovery methods. The other possibility is that he or she has simply reached a plateau. Make sure that they are getting complete proteins every 3 to 4 hours. If they are already getting complete proteins, they may need to increase their total caloric intake, using carbohydrates as a source, to ensure replenishment of post workout energy stores. Consider a 500 calorie/day increase in carbs, and monitor results through skin-fold and strength testing.

Allow 2 weeks and re-evaluate client progress. If this hasn't worked, you may need to also increase their training intensity, shorten their session, and take more time to recover between 4-6 rep sessions. Keeping close records, watch to see what progress the client is making, always using skin-fold calipers as the monitoring device of choice, along with a regular strength test. If you change rep ranges or movement selection, as long as strength levels are being maintained, the client is ensured against loss of tissue. This principle of maintaining just enough heavy sets to monitor strength and muscle tissue maintenance, while performing sets in other rep ranges, can and should be used right up to a contest or athletic event to ensure a minimum of lean tissue loss.

Problem: ***What if the weight gain client stops, or isn't, gaining weight?***

Solution: The obvious answer to this is that they are simply not eating enough. They may complain that they feel bloated, and that eating as often as you have told them to just isn't practical. If this is the case, recommend the further use of high calorie protein drinks, and carbohydrate loading drinks, in addition to their current nutrition program. The rest is up to them. The other concern is he or she being a fairly *new* client, following all of your recommendations, and are not gaining weight. Tell them that they will start to gain weight slowly, this won't happen quickly; expect an approximate rate of about 1 lb per week (3,500 calories/week above maintenance intake). Weight gain, at a rate any faster than this, may result in too much fat accumulation. As a drastic approach to weight increase, add 500 calories/day, every 2 weeks, to the client's diet, and continue performing skin-fold tests. When there is the slightest body fat increase, it is time to fine tune total calories (stop increasing). You would also be correct in recommending against the performance of frequent aerobic exercise, at least until the amount of weight gained is satisfactory to the client.

Problem: ***How do you find out what type of sporting events a client is most suited for?***

Solution: Earlier mentioned was the advantage one athlete has over another in a given sport, due to his or her motor unit composition. The "Holistic Training Principle", which, basically, focuses on training diversity for a more well-rounded approach that encompasses each of the different responses to various stresses, equally targets each of the three different motor units by simply consisting of sets from all the rep ranges, the 4 to 6; the 12 to 15; and the 20 to 25. Maintaining proper diet, and the practice of the overload principle, a client who is progressing faster in the 4 to 6 rep range may have a predominance of white fast twitch motor units in those particular prime movers, and would probably make a better strength athlete.

A client who does better in the 12 to 15 rep range has a predominance of the red, fast twitch motor units, and would probably perform best as an incremental athlete (such as a basketball player, tennis player, boxer, or linebacker). Lastly, a client who is progressing faster in the 20 to 25 rep range would probably make a better endurance athlete. It is important to remember that, just because a person has a predominance of white fiber motor units in one muscle group, this does not mean that all of the other muscle groups are the same as well. Each muscle group will differ and should be weighed into your findings. This very simple and effective principle can be an extremely valuable tool to all who are considering the potential of athletes, of all ages.

Problem: ***How do you answer a question like this, "I have been running for months with no fat loss and I am already on a strict diet of only 1,200 calories per day. Why can't I lose this "spare tire"?***

Solution: Not eating enough is the source of their problem. You need to be able to explain this to them in terms that they will understand. The body views fat as the most efficient source of survival energy, and will store it more readily when it perceives a starvation situation. So, if the client is too active and not eating enough food, the body is actually starving, and will react by eating muscle for energy, thus increasing the storage of what the body views as the most efficient source of survival energy... fat. Also, in addition to eating more food, if the client's body was convinced that it needed to spare muscles from being eaten away for survival energy (through the performance of resistance exercise) it would be forced to use it's fat reserves and keep its muscle tissue. Therefore, once again, resistance training and a proper diet are the keys to solving yet another fat loss dilemma.

Problem: ***What can I do to convert a starvation dieter?***

Solution: A client may insist on losing weight at a rate faster than one pound per week, which is not recommended. If the client decides to go on a starvation diet, that is below RMR, there are several things you should discuss with that client. First of all, the lower the client's total caloric intake, the less activity that client can safely perform. There is a serious danger related to using too much body tissue for energy while on a starvation diet. Prolonged starvation diets lead to Keto-Acidosis. This disorder can result in serious health complications, and even death. The first signs of this problem may go unnoticed for several days. Some past and present conventional bodybuilding pre-contest preparation diets take the bodybuilder well into, and sometimes past, the first stages of Keto-Acidosis. Inform the starvation dieting client of the following early signs and symptoms: extreme dizziness, light-headedness, faintness, loss of balance, confusion and restlessness. If the client experiences these symptoms, he or she should ingest more total calories, especially carbohydrates. There are two very objective approaches you can take in safeguarding the health of the starvation dieter. To start with, do strength tests on a frequent basis. If the client's strength is falling off, too much muscle tissue is being used for energy, and the client must at least increase his or her total calories slightly. Secondly, suggest the possible use of "**Keto-Stix**" as a form of proof that their dieting is at a dangerous stage. When an extremely high amount of body tissue is used for energy, there is a toxin, **acetate**, that accumulates in the blood and spills over into the urine. This acetate can be detected using Keto-Stix. This is considered a self-test, the proper application of the Stix is provided within the respective instructions. There is a color code; the darker the shade, the greater the use of body tissue. Inform the client that any color shade is unacceptable. If a color shade appears, it is a sign that there is too much body tissue being used for energy and the client should slightly increase his or her carbohydrate intake for their own personal safety.

Problem: ***How do I get rid of the fat around my waist... sit-ups?***

Solution: First of all, contrary to popular belief, localized extra-muscular fat loss is an absolute physiological impossibility. Furthermore, everyone has different fat distribution. Some people have fat deposited evenly throughout their body, while others seem to have more fat in some areas than in others. Regardless, fat is released uniformly throughout the body. The client, with unevenly distributed body fat, is simply at the mercy of his or her genetic make-up, where difficulty in losing unevenly distributed fat is concerned.

Of great importance is the absolute advice *against* any device, supplement, or activity that claims to be effective at losing localized fat in and around the waist, hips, etc. Without a proper diet, and a scientifically based overall fitness program, you could perform all of the abdominal exercises you can possibly do and it will NEVER result in localized fat loss around your waist - the only thing that would be accomplished is a well developed, conditioned abdominal region that is completely hidden behind the fat, which you will not be able to lose using a localized fat loss method! The implementation of a good overall resistance program, along with a moderate amount of aerobic activity, while on a reasonably low calorie diet that is slightly lowered in carbohydrates, and is eaten all throughout the day, is the only scientifically based recommendation that should be made. To be brief, eat less, more often, and exercise more. In almost every case, where a device, supplement or localized activity seems to work, it's because those who are taking your money suggest that, "for best results", you have to take this product or use this device while practicing a low calorie diet and an aggressive exercise program. It is the latter that is responsible for any positive results that the user may experience, NOT the product or device. Place significant emphasis on the methods for fat loss that actually work:

- Lengthen duration of activity
- Lower intensity
- Increase frequency of exercise
- Use compound movements
- Use high repetitions
- Eat smaller, more frequent meals

Problem: ***I'm an endurance athlete, why should I train with weights?***

Solution: Performing regular resistance exercise in high rep ranges, using the overload principle, forces the muscle to adapt by storing more glycogen. The more glycogen you start out with in an aerobic event, the more work you can perform before "hitting the wall".

Through the study of the mechanics involved in an activity, resistance exercise can be applied to the muscle groups involved; training them to store more energy. Use sets of 12 to 15 for the incremental athlete, or sets of 20 to 25 for the endurance athlete.

Problem: ***Is it safe for my 14 year old son or daughter to lift weights?***

Solution: Yes. Weight training, ***when properly administered and supervised,*** is extremely healthy and beneficial for everyone (including your 14 year old). In fact, new research reveals that there are as many positive effects relating to resistance exercise among youth as there are among adults. Your teen athlete's performance can benefit tremendously by using a safe and effective overall fitness and athletic conditioning program, as provided for in this manual.

Problem: ***How is someone, who is so much smaller than me, so much stronger?***

Solution: Our earlier discussion of genetics holds the answer to this question. There are two major genetic factors that determine strength. The first factor is leverage. The further the tendon inserts away from the fulcrum (or joint), the greater the leverage. The greater the leverage, the more weight that can be lifted. The second variable is the proportion of motor units in a particular body part. The greater the number and proportion of white, fast twitch fiber motor units, the stronger that particular muscle group will be. When you add these two genetic gifts together, often times the result is incredible strength. In contrast, a person with fewer white, fast twitch fiber motor units, combined with poor leverage, will be weaker and more vulnerable to injury, regardless of his or her apparent size. No matter how big, or how small, a person is before they start lifting weights, they can only get as big as their motor unit proportion and leverage (tendon insertion) will allow. This means that there is hope for the 'little guy'. There are methodologies in this manual that can uncover the potential for success in anyone, whether it's different forms of athletics or the potential for pure muscle size and strength increase.

Problem: ***How do I know if I'm overtraining?***

Solution: If you feel totally run down after a workout, experience chronic joint stiffness, and/or an unexplained lean weight loss, then you are most likely overtraining.

Factors that lead to negative effects of overtraining:

- Too many sets per body part
- Too little rest between heavy workouts
- Too few total calories
- Too little protein intake
- Frequent training beyond failure

Signs of overtraining include:

- Lack of progress
- Negative attitude towards exercise
- Resting morning heart rate is 5 to 10 BPM too high
- Increase in body temperature
- A positive Keto-Stix reading
- Experiencing insomnia
- Development of chronic overuse injury (usually in the joints)

Problem: ***I understand that the heavier you lift, the bigger you get; but why is it that some people do high rep sets and still get bigger?***

Solution: These gains are not entirely muscle, and may even be quite superficial and brief in their contribution to size increase. This is, in part, due to an increase in the movement of fluids into the muscle fiber associated with light, high rep, training that will contribute temporarily to size. The development of new mitochondria may lead to a small degree of size increase (relatively insignificant). Short-term size increase, associated with this type of activity, is in part due to the amount of fluids that enter the muscle along with the transported glucose from the blood. Basically then, it is mostly fluid. Furthermore, while on an extremely high caloric intake, those lifting fast and light may also experience an increase in size for yet another reason. This can best be explained by first realizing that the body is an adaptive mechanism. It will prepare itself for the future based on what it knows about the past. If a lifter has, in the past, been training hard and fast in the higher rep ranges, his or her body will adapt by storing energy (fat) and water (interstitial fluid) closer, around the endomysium (surrounds muscle cell membrane), and in the interstitial area (surrounding the endomysium) spaces. This energy, while on a diet that exceeds recommended total calories, in excess of about 1,000 calories/day, will be mostly stored in the form of intramuscular fat. This is obviously not muscle at all, but it does add to the size of the muscle (making it appear quite large). If these lifters dramatically reduced their total caloric intake, reduce the incredibly high frequency and volume of resistance training, and/or begin a regular program of aerobic activity, they would experience a rapid muscle tissue (intramuscular fat and water) loss. Long lasting muscle tissue is gained only through years of heavy training while on a proper diet.

Problem: ***Is there any way I can speed up my metabolism?***

Solution: Generally speaking, the performance of all types of resistance exercise results in either a long-term or short-term increase in BMR/RMR; while aerobic activity raises metabolism only during the performance of the chosen activity and for a few minutes afterward.

Increases in BMR/RMR, that are long-term, result from those types of resistance exercises that cause the greatest increase in lean tissue size. The greater the "metabolically active" muscle volume, the more energy the body expends throughout the day. This reflects a long-term increase in metabolism, resulting in fat loss.

Since digestion requires energy and, therefore, increases metabolism, it is important to eat many small meals throughout the day as opposed to eating infrequent large meals. This also maintains a healthy blood sugar level.

Increases in metabolism that are short-term result from high rep, light weight, and frequent resistance exercises. Between resistance workouts, muscle energy is being replaced. During this process, the body functions faster. This reflects a short-term increase in metabolism.

As previously mentioned, aerobic activity raises the metabolism only during and shortly after the performance of the activity. So, contrary to popular belief, aerobic performance burns fat calories, but does little to significantly raise metabolism.

Problem: ***Can I do aerobics and still maintain muscle size?***

Solution: One of the problems concerning the frequent performance of aerobic activity is the rate of testosterone degradation. Excluding the use of synthetic forms of testosterone, all men, by comparison to other men, and all women by comparison to other women, synthesize approximately the same amount of testosterone each day. Women produce far less testosterone than men and are therefore less apt to get extremely muscular.

Testosterone is slowly degraded by the liver. Performing intense and/or frequent aerobic activity accelerates the testosterone degradation rate, reducing the circulating levels of testosterone. Therefore, performed to extreme, aerobics can negatively affect size and strength increase. Moreover, there are various intensity ranges for the performance of aerobic exercise. The more intense the aerobic exercise becomes, the faster the depletion of cellular catalysts. When these catalysts are depleted, muscle tissue is likely to be eaten away to replace them.

Aerobic activity's greatest value is in the health and conditioning of the cardiorespiratory system. This can best be accomplished by performing aerobic activity at no more than 70% of your maximum heart rate, 3 to 5 times per week, for about 20 to 30 minutes per session. This will safely act to spare muscle tissue.

Problem: ***Can I get bigger using electronic muscle stimulation?***

Solution: Probably not. There have been studies which have shown increases in muscle strength for those using electronic muscle stimulation (EMS) as compared to controls who did not exercise at all. However, when compared to a group of subjects who exercised, the EMS group was unable to achieve similar intensity levels. EMS is, however, used quite effectively in the strengthening of weakened muscle/s/ as a result of injury. In brief, EMS is designed to aid in injury recovery, not for athletic enhancement. Take interest in knowing that EMS can be a useful tool in measuring and demonstrating the neuromuscular efficiency in the athlete, and anyone else for that matter. At a particular electronic impulse strength (pads attach to muscle group being tested), a conditioned muscle will contract much stronger than an unconditioned muscle. As a coach, with an athlete who has been left to him- or herself to perform resistance exercise, one could do regular EMS evaluations to test contractile intensity. In theory, if an EMS stimulated contraction is mild, the subject has performed too little resistance exercise. As a conditioned resistance training athlete, you would be surprised at the level of contractile intensity that a good EMS device can stimulate. EMS is NOT a replacement for resistance training.

Problem: ***What kind of food should I eat to keep from getting fat?***

Solution: First of all, no more than 20-25% of your total caloric intake should come from fat. Eating more protein will force the body to convert amino acids into energy, which results in a more gradual increase in blood sugar. This process expends energy and is therefore beneficial to fat loss. Reducing carbohydrates will minimize the availability of sugar, requiring the body to find other fuel such as body tissue (fat). Because it's not as easy for the body to use protein for energy, extreme approaches to carb limiting and protein increase should be avoided. Consuming carbohydrates that are absorbed into the blood stream slower will minimize fat accumulation that results when too much sugar is rapidly introduced into the blood. Tell the client to consult a "Glycemic Index" and learn more about the "Glycemic Load" of foods (refer to the *Master Food List*). This index-load reflects the rate that sugars, from carbohydrates, are absorbed into the blood on a scale of 0 to 110; the higher the number, the more rapid the absorption. Instruct the client, as a general rule of thumb, to choose foods that are low on the Glycemic Index; and even more specifically, low on the Glycemic Load.

It should be noted that, although some very healthy foods rate somewhat high on this index, this doesn't mean that they shouldn't be eaten; but, inform the client to eat these high glycemic index carbohydrates in combination with low glycemic index carbohydrates, proteins, and fats. This will act to compromise their rate of absorption.

CHAPTER 19

Legal and Marketing Considerations

In May of 1987, the Illinois Supreme Court decided a very important case in the fitness industry. This case, Larsen vs. Vic Tanny International, confirmed that an individual who:

1) knew of the dangers which may cause an injury in a health club,
2) realized the possibility of injury, and
3) entered into a contract not to sue a health club voluntarily can waive the right to sue a health club if they become injured.

Simply put, this means that if you require your clients to sign a waiver of liability (specifically, an informed consent form) prior to their beginning an exercise program, they may not be able to sue.

After you have your legalities in order, it's time to think about some marketing concepts and how you can put your trainer certification to work! We will cover the basics of both legal and marketing considerations in this chapter.

When Larsen vs. Vic Tanny International came before the Illinois Supreme Court, it was assumed that more clubs would become aware of the fact that they can protect themselves from suit by effectively using a precisely worded informed consent document. The cost of insurance should have plummeted since there would be fewer claims, and droves of attorneys should have contacted their health club clients and redrafted their old waivers of liability. Unfortunately, this was not the case at all. What we continue to see are the tired and incorrect statements that... "waivers of liability are not worth the paper that they are written on", which is simply not true. Understand that anyone *can* sue anyone for just about anything; so, protecting yourself with a wall of defenses that will demonstrate your attention to the safe and careful implementation of an exercise program will be your ultimate best position and protection against a lawsuit. Now, of course, a lawsuit is only likely to occur if a client has been negligently hurt, deceived or negatively impacted by your services - so, the first thing to be sure of is that you are always doing your absolute best to provide safe, effective and professional services to your clients. But, in case something goes awry, make sure to always have the following three things for your protection:

- **CPR & AED Certification**
- **Liability Insurance**
- **Signed Informed Consent/Waiver of Liability**

Now, of course, these three things should be in addition to the documentation concerning your client's consultation, assessments/tests, training program recommendations and physician's release form - some of which may or may not be needed, as they may not apply, per the individual client; but, it is significantly important that you have accurate, organized and detailed records of your client's sessions, and all related professional documents. Protect yourself and protect your business - these steps and extra measures may feel like unnecessary technicalities, but, if the time comes that you will need to fall back on this documentation, then your diligence and professional business mindedness will undoubtedly keep you from suffering the serious consequences of an unsuccessful lawsuit.

CPR and Liability Insurance are fairly easily obtained. Use online sources for your liability insurance options; you will find that most policies, that are needed for basic liability, will cost between $150/$250 per year (or about $15-$25 per month) - not bad for the 'just in case'. CPR certification can be done locally through Red Cross or other allied health facilities; do some local research on this and find a class near you. Consider not only CPR, but AED (Automated External Defibrillator) and First Aid training as well; these classes are usually an add-on to the CPR class and will not cost much more time or money to obtain - they are well worth having.

Now, let's look at the differences between the informed consent and the liability waiver - why both?

Informed Consent

This document states that the client has been fully informed of the risks and possible discomforts of a physical fitness program. The client assumes the risk of any possible injury that is inherently associated with exercise, and is given this opportunity to make

an informed decision regarding this risk. According to the The Office of Human Research Protections (OHRP), a division of the Department of Health and Human Services (HHS), an informed consent agreement should:
1) be obtained in writing,
2) be understandable,
3) be obtained in non-coercive circumstances, and
4) contain no language suggesting a relinquishment of rights

In other words, you, as the personal trainer, should make sure to deliver this informed consent agreement in a way that the client fully understands, with contractual language that is easy to follow and pertains to the client specifically. Make sure to go through each part of the agreement with your client in a step by step fashion, allowing him or her to ask questions, which you should be able to satisfactorily answer. Keep in mind, an informed consent agreement, like it sounds, is written acknowledgment that you have informed your client of the risks associated with a training program and have received their consent to move forward, despite the risks involved. An informed consent agreement does not protect against any potential negligence on the part of the personal trainer.

Waiver of Liability

A waiver of liability offers protection of the personal trainer (or club/business)against a suit that is brought on as the result of the negligence of the personal trainer. Essentially, it is a blanket agreement whereby the client is waiving their right to bring a legal liability suit against you. In this context, the client is made aware that there are associated risks with the training program or activity that is being implemented while also understanding that they agree to "hold harmless and indemnify" all individuals involved in the training program or activity.

The big difference between a waiver of liability and an informed consent form is that, with informed consent, the client has been informed of the possible injuries that could occur to them prior to contractually waiving the right to sue if the injuries were to occur.

A few things to remember when working through your Informed Consent and Liability Waiver:

1) **Nothing is infallible:** the enforceability of your contractual agreements depends on things like, contract language, state law/regulation and how the contract was delivered/communicated.
2) **Careful attention to contractual content**: the subject matter must be legal, it must be specific to the individual, and the agreement must be mutual (i.e. there must be equal bargaining power between or among the contracting parties).
3) **It is not "just a formality"**: make sure that you don't slide these documents in front of your potential client with the attitude that they don't matter, take it seriously. If you were to come against a lawsuit, the method by which you delivered these documents, and how well you explained them, will be extremely important.

The safety of your client is always first priority, and this should verbalized to him or her - but, in the case of these contractual agreements, you must do the best that you can to protect yourself should an unexpected incident occur.

What to Include (*and What NOT to Include*)

In the past, waivers of liability have not been upheld because they were found to be "unconscionable". An unconscionable contract is one that includes clauses that are so one-sided as to oppress or unfairly surprise one of the contracting parties. A contract that is one-sided is often coupled with the fact that the imbalance is buried in the 'fine print' and often couched in language that is "unintelligible". Unequal bargaining power can more certainly lead to a contract not being upheld. In short, make sure that the interests of the client are represented in the contract, do NOT make it a one-sided document and do NOT stick confusing legalise into the document. You will not see a positive outcome in a case where the contract is so difficult to understand or is so riddled with 'fine print' that it becomes unintelligible to the client.

Fortunately, there has been a natural progression toward mutuality in client/trainer contracts as the result of healthy competition. Twenty years ago, health clubs and exercise facilities were few and far between, but, now, you can find a club or private studio almost anywhere. Because of this, the public has greater bargaining power than they once did. Thus, the client/member can pick and choose between facilities - hence, they have greater negotiating/bargaining power. Informed Consent and Liability Waivers, today, are written more with the client in mind, than they have been in the past, and have therefore become more mutually favorable to both parties.

In some states, the client must also have been informed of the possible injuries or discomforts that may occur, specifically (such as muscles tears or strains, broken bones, heart attacks, etc.) Courts reason that if a client voluntarily assumes the risk of an injury, especially one that has been specifically stated in writing, the trainer (or club) should not be held liable. In other states, it may only be the 'range of activities' that need to be stated specifically, as opposed to detailing the possible injuries which may result - but this only holds true if the client is able to reasonably deduce that he or she assumes the risk of any number of injuries resulting from the specific 'range of activities'. We suggest detailing specific injuries that may occur as the result of the client's specific training program.

When drafting a waiver of liability that incorporates an assumption of risk clause, we can look to history and what has been expected by other courts ruling on these matters. With this in mind, our recommendations for content that should be included in your Informed Consent and/or Liability Waiver agreements are the following:

- Inform the client of the exercise program that you intend to implement, including all the various activities ("range of activities") in which the participant may engage in, and the particular injuries that may occur as a result, to include death.
- Inform the client that he or she is free, at any time, to withdraw and discontinue participation without prejudice.
- Include a statement to the effect that the participant acknowledges that he or she is in "good physical condition".

- Include a statement that inhibits the client's "heirs and assigns" from suing your facility.
- Make sure that the client fully comprehends what he or she is signing, and allow him or her time for questions.
- Make sure that the contract outlines responsibilities of both parties, and is easily read by someone of average education level.
- Offer guidance to anyone who appears puzzled. Make sure that the client speaks English fluently and understands what he or she is reading (hence, is legally 'informed').
- Have the client initial or circle something half-way through the waiver to document the fact that the contract was actually read.
- At the conclusion of the contract, have an "attestation" clause. An attestation clause is a phrase such as... "I attest that I have read and fully understand the above waiver..." This encourages the actual act of reading the agreement, again leading to the client being legally 'informed'.
- Make sure that the waiver is on a separate piece of paper that is professionally delivered; not on the same paper as their printed brochure, enrollment receipt, or membership contract. This ensures that the contract was voluntarily entered into and not a requirement of service. Make sure to give a copy of this and other relevant professional documents to your client.

the sample consent form and waiver, provided in this manual, only serves as a guide to start from. Remember, the rules for these professional documents vary from state to state. Do not assume that the consent form or waiver will hold up in your state court. Have a local attorney review your professional documents for approval.

Marketing Your Personal Fitness Trainer Services

In this section, we want to give you a place to start from in order to assist you in your successful pursuit as a personal trainer. We'll give you some basics here, but we encourage you to research and brainstorm ideas that work for you and the community that you serve.

It is important to know that you can be the most competent and qualified personal fitness trainer in your area, and still lack the people skills and business know-how that can ultimately keep you from success. It is up to you to apply yourself in the areas of marketing, administration and communications. Develop goals and specific strategic plans for achieving them. It is important to have both short-term and long-term goals, with estimated time-lines for each; and, never be afraid to ask for advice from those who have experience in the business of personal training.

Conduct and Character

We'll start here because it is the most important foundation for long-term success - you are putting on a professional hat, and must act accordingly. Character qualities are something that cannot be taught in a manual, but they can be reinforced. Good character is required in this line of work (and in all lines of work, for that matter). A passion for fitness, an upbeat personality, positivity and enthusiasm, a willingness to serve and share knowledge, organization and communication skills are all examples of qualities that are shared by true professionals in this field. As a good communicator, you should pay attention, listen and really try to understand what your client is feeling; don't be quick to offer your own competitive story or try to solve their problem by interrupting mid-sentence. Look your client in the eye, engage them without interrupting; and especially, don't be distracted with your cell phone! Both verbal and nonverbal communications are equally important. For example, if you answer your phone during a conversation with your client, even if you verbally apologize while you do it; or, if you non-verbally demonstrate your irritation for the poor timing of the call, but you answer it anyway, neither of these communications have made the client feel more important than the phone call - quite the opposite actually, you have demonstrated to your client that they are less important than the call, regardless of your apology. You can also demonstrate good listening skills and caring attentiveness by the simple way in which you stand or position yourself during the conversation. For example, instead of crossing your arms, which non-verbally demonstrates agitation and defensiveness, keep an open posture with hands out in front of you and palms up as this is a non-verbal demonstration of attentiveness and also displays truthfulness and honesty. Think about the attentiveness that you expect, and appreciate, from a friend, colleague and, especially, a professional service provider - communicate with that same level of care.

You must also demonstrate the characteristics of a 'natural' leader - be confident, but be patient, kind and an inspiration to your clients in order that they will benefit from your services; you must also be able to lead with an organized plan of action and adapt to situations that may be frustrating or compromising. Many of these characteristics do come naturally, to some, but if they don't for you that's o.k.; fortunately, the more that we practice new learned behaviors, the more naturally they will start to occur in every day life. Being a better person tomorrow, than you are today, is not impossible - and remember, you get what you give. Your ethical being is the grid for which your conduct and character come through; and it won't take long for your clients to learn of the kind of person that you are by the way that you conduct yourself and your business, good or bad. You represent yourself in all that you do, or don't do - let the person you strive to be come out in your work and with the people that you work around. Everyone has bad days, undoubtedly you will too, but don't let a bad day (or a bad month) dictate who you are to your clients, friends, family and co-workers - tomorrow is anew. The expressions of good character and a positive attitude on a day-to-day basis can be hard work, and it's part of your work as a personal trainer. On the other side of the coin are those things that can be taught or gained over time, like additional knowledge or training, experience in your field and even business know-how - these learned attributes, though they too are hard work, are often easier than the day-to-day practice of your noticeably good character and conduct. Keep up the good work!

Do Your Homework

Find a need for your services in the community long before you begin business operations. In today's fitness conscious climate, it is safe to say that every community has a need for fitness trainer services, you simply need to find which services are in demand and how best to reach your market. For example, consider some kind of survey of people in your community, ask people what they are looking for in the way of fitness trainer services. This kind of survey can be verbal, written in a questionnaire format and/or conducted via social networking channels - over some period of time, you will find that you've asked enough people to make a fair assessment of the needs and desires of your community. Based on the demographic that you have surveyed (e.g. socioeconomic condition, age and gender will be factors in your results), you may find that a program for older adults is most needed, or a 24-hour access facility is what people are looking for, or maybe personal instruction in the home is a popular interest. By not surveying community members first, you may find yourself offering services that already exist, or that no one wants or needs. The bottom line is, do your homework, don't go into a business blind about what is already available and what it is that people want - the laws of supply and demand should figure into your strategy for business.

It is most certainly of tremendous value to assess your competition. Determine what services other clubs/trainers are offering. If their services are lacking in areas where you are strong, it may mean that you have a greater chance of success competing with these clubs/trainers. On the other hand, if existing competitive services are currently meeting the community's needs, or the demand is such that it may not support another club/trainer, you would have at least done your homework and figured that out before you start investing. Your best option in this case would be to align yourself with a professional facility or studio, don't try to jump into business for yourself until you have learned the ropes and feel comfortable with the day-to-day obligations of a personal training business. Understand that most trainers start off by working in a club or private studio, this is the best way to 'get your feet wet' and gain real practical experience. You may even decide to stay with a club or studio where you are doing well, and are treated well, because of the value that your mutual relationship brings - be aware of opportunity where opportunity may come knocking, sometimes it may not be exactly what you expected, but, in the long run, it could be better.

Personal Trainer or Fitness Consultant?

First of all, after taking and passing your personal trainer examination, you will gain the industry standard title of "Certified Personal Trainer", or CPT. But, some do consider their services more in line with a Fitness Consultant, or even a Fitness Coach; there is not one or another title that is better, but it is important to strategically and intelligently use your words to best describe who you cater your services towards. A "Fitness Consultant", for example, will usually be perceived by health club administrators as more of a peer rather than a prospective employee. Therefore, if you are interested in offering services on your own, or on a contract basis to health clubs, they may be more receptive to working with an independent "Fitness Consultant" - but, if you feel uncomfortable or are unable to perform/provide diagnostic testing, such as blood pressure, fasted blood sugar, submaximal pre-exercise testing, etc., you should not call yourself a "Fitness Consultant". Also, if you are looking for employment directly with a health club, you should use your CPT title without the "Fitness Consultant" distinguisher, this is what a club looks for as a pre-requisite to employment, generally speaking. We recommend always using your CPT title, as it is the industry standard; however, we also recognize a need for distinguishing yourself among other trainers in your area and honing in on the specific client/training goals that you serve through the use of a specific title. Use your best judgment when you 'hang out your shingle', because the last thing that you want to do is confuse potential clients and/or employers by changing your title, business name or logo after you realize it could use some improvement, for example. Take your time and do some research, ask around and compare your services to those of others before jumping into decisions regarding your fitness training business.

Working with Health Clubs

Many trainers work as Independent Contractors in local health clubs, this is, often times, a win-win for the trainer and the club (e.g. the club avoids additional payroll liabilities and the trainer is their own boss). Approaching a health club with a plan for this win-win relationship is the best pro-active way to start this proposition. Don't expect anyone to come to you, it's important that you put yourself out there in your community and into the circles of other fitness professionals. Here are some ways/ideas to assist in your efforts for preparing a plan to approach clubs and/or private studio owners in your area:

1 Suggest to the club/studio owner that he or she offer a standard membership for those who need little training assistance, and a slightly more expensive alternative membership fee that includes your fitness trainer services - and then propose a shared percentage of these additional trainer membership fees.

2 Commit to solicit non-members as clients (through various marketing and advertising means that you conduct personally), then require your client to join the club/studio (if possible, at a reduced rate) as a primary location in which you will provide your services.

3 Suggest that the club/studio owner market your services to his or her members, as well as to the general public (maybe during the next scheduled promotional push). This will act to test the initial interest in your services and the potential for profit.

4 Agree to screen your clients, make recommendations, and then send them to the health club/studio for training assistance and possibly a discounted membership fee. Offer the club/studio owner's members reduced rates for your services. This may get you in the door as your services become more popular.

5 Sublet office space in the health club/studio in which you can internally offer your services to client-members.

6 Pay the club/studio owner a "user fee" each time you bring a client in to be trained (pass additional cost on to the client).

7 Offer the club/studio owner a percentage of your fees, charged to every client you train in his or her facility.

Since there is not a lot of room for error when it comes to approaching a health club/studio owner, you need to be as prepared as possible for your communications with them. You can have the greatest ideas in the world, but if the guy or gal in charge is in the wrong mood, or you seem like a know-it-all, then he or she may send you on your way - so, here, we stress the importance of timing and preparedness.

Since you can't afford to make many mistakes, especially when there is a limited number of clubs/studios in your area, you need to take sufficient time before-hand to prepare for your meetings with these prospects. You should get to know the club owner, director or manager, and their club/studio business, as much as possible. And remember, these individuals take great pride in their facility; chances are, they have poured their hearts and souls, not to mention their money, into making their club what it is today. Don't offend him or her by pointing out problems, or by being smug as though you are the answer to all of their problems.

When you first meet with the owner or manager of the club/studio (which we will refer to as 'facility' for a broader reference, since several fitness settings are applicable here), dress for success - wear, at least, business casual. Dressing professionally shows respect, sincerity, and the ability to reflect a presence of professionalism as you represent your employer. Always remember, you only get one chance to make a first impression. Be punctual, polite and personable. Have a resume and/or your business card to provide the prospective employer; this is not only an opportunity to show him or her, on paper, who you are and what you want to accomplish with this position, but it also is a way for you to 'leave a piece of yourself' for them to remember you by. Do not overstay your welcome, but make sure to ask questions. Be an attentive, good listener; this should put you in a better spot to ask relevant questions. Your questions should be thought through, this will demonstrate that you care enough to ask, as long as they are not questions that put the employer on the defensive. Thank the owner for his or her time, and express your sincere interest in making a positive impact in their facility - you may even find your chance of employment to be higher if you let him or her know that you are willing to work your way up to the position that you desire. If you are interested in an Independent Contractor relationship, this would not be as applicable, but, if you offer to do more than 'your part' than you will be recognized as someone who is willing to go the extra mile as a true team player.

By now, if all has gone well, you will at least have established a favorable first impression. Ultimately, do not leave it up to the club owner to be the one who makes the next move, at this stage. It is likely that he or she is very busy and, like it or not, they may forget to get back to you right away, even if they are interested. It is okay to wait until the next day and email the contact that you made inside the club with a friendly "thank you for your time" message. Make sure that your email of gratitude is short and sweet. Do not imply that you have the job, or attempt to urge them into signing an agreement, and instead give them the opportunity to take the next step - you've done all that you can to this point and you do not want to become the 'squeaky wheel' for this potential employer. Give it time.

If you are attempting an Independent Contractor arrangement, or similar, and have not heard from the facility owner/manager within a week (or 2-3 weeks, depending on the time of year and his or her scheduling conflicts), call to see if another meeting can be arranged where you can answer any questions that the owner/manager has. Let him or her take the next step at this point. You may be pleasantly surprised and, though several weeks could go by, you could very well hear from this person with an offer - remember, sometimes these wheels turn slowly, don't give up or feel frustrated when it doesn't happen in your time. Keep pushing forward, which may mean approaching other facilities and/or applying for other open positions - the beauty of the fitness training market is that it is always hiring, fitness is not a 'fad' nor is it a 'trend', it is here to stay; and, according to the Bureau of Labor Statistics (www.bls.gov), it is a market on the rise, with an expected growth rate of 13% or more between 2012 and 2022.

Remember, a good rule for professional (and personal) relationships is to "never burn a bridge". If the facility owner does not return your email and/or your phone call, that's okay, look to the next opportunity that life has to offer you. Don't sit on your hands and wait. Think outside the box. Think outside the club. Consider your local community center, sports/recreation center, resort area or even a cruise ship, for examples. If you have applied for work everywhere that you can think of, to no avail, don't give up and always follow up. Someone who may not hire you at present may have an opportunity for you in the future. Developing a good rapport will be of great benefit to you in the event that a future opportunity presents itself.

Marketing Ideas for Clubs and Trainers

1 Consider establishing a referral program with medical professionals. No one knows more people who need a personal fitness trainer than a physician, and no one knows more about how to help people reach their desired health and fitness goals than a personal fitness trainer!

2 Seek out and develop a relationship with physical therapists in your community. Often times physical therapy patients' medical coverage runs out long before their ailments totally subside. With confidence in your ability as a personal fitness trainer, a physical therapist may refer these individuals to your care, with some discussion of the post-patient's problems and how you should address them. After all, physical therapists currently have no choice but to send their patients to area clubs, where they are typically at their own mercy. Some call this post physical therapy service, "Exercise Therapy"!

3 You should establish a relationship with area schools. Work with athletic directors in promoting fund raisers, performing body composition tests, and providing seminars to their athletic teams. This should open up your services to a lot of young fitness conscious minds (remember to get parental consent while working with those under the age of 18). If you are a club owner, offer discounts on memberships in your facility for area high school athletes. You may even want to offer a group rate for an entire athletic team whose gym facilities are inadequate.

4 Develop marketing literature for distribution in health and fitness related businesses. This literature must catch the eye and be done professionally. If you are able, invest a little in the services of a good designer. If you are not able to invest in the consultation and design by a professional, there are online resources and applications for home use as well - just make sure to get the opinions of those around you, especially those who know business and have experience in marketing.

5. Get your foot in the door with area businesses by first offering body composition testing, blood pressure screening, etc., for all of their employees. Eventually, you can attempt regularly scheduled health screenings and may even be able to schedule on site fitness sessions with a company's employees. Up-sell your services at every opportunity; show the business owner and/or potential client the value in your service and that you are willing to invest in them, at no up front cost, in a way that demonstrates the long term benefit of what you offer. For example, if you make a business owner aware of the potential for employee health care cost reduction and more productivity from employees as the result of your attention to their health and well-being, this business owner will see that his or her employees are happier, healthier, more motivated to work and more eager to engage with one another and their customers. This on-site strategy can work in small and large business alike; consider, for example, a local dentist office with 15 employees who rotate in small group workout sessions with you once a week, inside their office! It's a small investment, on the business owner's part, that will pay out tremendously long term.

6. Offer services in clients' homes and offices, one-on-one. Purchase what you consider a minimum required amount of equipment to provide for a full body workout. Place the equipment in the trunk of your car, and travel to your clients' homes and offices. You may even have the opportunity to encourage home based clients to purchase this equipment from you, so it can remain on-site for greater convenience. If you establish several of these types of clients, you could profit well by buying and selling exercise equipment. Familiarize yourself with all forms of exercise equipment and offer consultation on home exercise equipment purchases. This service would undoubtedly include your demonstration of the proper use of the equipment once purchased; so, select and work directly as a distributor for a few basic equipment lines that you have confidence in.

Understand the importance of maintaining and updating your resume regularly. This will make it easier to sell yourself when the need arises, and when opportunities present themselves.

A successful career in personal training requires a passion for health and fitness with a strong desire to help others achieve their fitness goals. And because, generally speaking, the fruit of any labor is not awarded without honest hard work and determination; it can be reasonably concluded that if you truly wish to help your clients realize their fitness goals, and you are willing to put forth a sincere and all-out effort, you can already consider yourself a success!

Fitness Participant Disclosure Agreement

This agreement is entered into between ____________________________(*trainer name*) of _______________________________________(*company name*), herein referred to as Trainer and Company; and ____________________________________ (*fitness participant/client name*), herein referred to as Participant; residing at:

____

(*Participant's address*)

1. Participant requests to participate in a fitness service offered by Trainer and Company. As a condition of participation in the fitness program, Participant agrees to supply certain information concerning Participant, including Participant's contact information (address, phone numbers, emergency phone numbers) and Participant's physical and mental condition (Health Data) to Trainer and Company.

2. Participant's Health Data will be supplied to Trainer and Company for the purposes of: (i) assessing whether the fitness program is suitable for the Participant; (ii) outlining a fitness program for the Participant; and (iii) assessing the Participant's fitness progress.

3. Trainer and Company agrees to hold the Participant's Health Data confidential except as may be required to disclose under any law or by order of a court, and except as stated below:

    a. Participant agrees that trainer may provide such Health Data to 3rd parties in a form that does not associate the Participant's name or contact information with the Participant's Health Data.

    b. Participant agrees that Trainer and Company may use and publish such Health Data in connection with an assessment of the fitness program in a manner that does not associate the name or address of the Participant with the Participant's Health Data.

4. Trainer and Company agrees that the Participant's contact information will not be used in a manner that subjects the Participant to solicitation for other products or services except those offered by Trainer and Company.

x__________________________________ Date: ______________

Trainer Signature

x__________________________________ Date: _______________

Participant Signature

Informed Consent Waiver

I, the undersigned participant, am hereby enrolling in a program of strenuous physical activity including, but not limited to, aerobic/endurance activity, weight lifting, stationary bicycling, step and rowing machines, treadmill and the use of various aerobic conditioning machinery. I have been strongly encouraged to consult with my physician prior to starting an exercise program, or increasing the intensity of an existing program, indicated both in this document and verbally in consultation with my personal trainer, ________________________________. I assume the responsibility, as indicated by my below signature, of all risk associated with the exercise program that I will engage in. It has been explained to me that no exercise program is without inherent risk of injury, and I fully understand that, if I choose to participate, I may experience possible minor or major injury, and even death. I hereby affirm that, to the best of my knowledge, I do not suffer from any condition that would prevent or limit my participation in the fitness programming of my personal trainer, and I have not withheld any related information regarding my current health condition.

In the event that, through the screening process with my personal trainer, I have been determined to be other than apparently healthy, I have been given a physician's release, as required by my personal trainer, to exercise. I am taking no medications that may adversely affect my fitness activities; and, with or without physician's restrictions, this information has been given to my personal trainer, verbally or in writing. In addition, I acknowledge that if my health changes or if I do not feel comfortable at any given time with any part of the fitness programming, it is my responsibility to recognize the change, inform my personal trainer and seek medical advice to help me decide if my continued participation in the fitness program, or any part of the fitness program, is still right for me.

By signing below, I acknowledge the following:

- My participation in this fitness program is completely voluntary, and I understand that my participation in this fitness program does not guarantee the achievement of my fitness goals
- I understand that physical risks are possible, but I believe that the benefits of this fitness program are greater than the associated risks
- I understand that certain physical touching, as is specific in respect to the exercise, may be necessary for the demonstration and correction of exercise technique and alignment
- I have been able to ask questions and receive answers to my questions from my trainer
- It has been recommended to me that I consult my physician regarding the implementation of this fitness program
- I have no health condition that would impair me from exercise; and, if that changes or if I experience any discomfort, I will notify my personal trainer immediately

I hereby affirm that I have read, have been honest and fully understand the above information.

x____ Date: _____________

Participant Signature

x____ Date: ______________

Trainer Signature

Liability Waiver

This agreement applies to personal injury, which I understand may arise due to my voluntary participation in exercise activities, and any and all claims resulting from personal bodily injury while utilizing the services of my personal trainer, ____________________________ __________ (*trainer's name*), herein referred to as 'My Trainer'.

I fully understand that I may injure myself as a result of my participation in the fitness program of My Trainer. Injuries may include, but are not limited to, heart attacks, death, muscle strains, pulls or tears, broken bones, shin splints, heat prostration, knee/lower back/foot injuries, and any other illness, soreness, or injury, however caused, occurring during, or after, my participation in the fitness program offered, unless caused by My Trainer's recklessness or intentional misconduct.

In consideration of my participation in My Trainer's fitness program, I, for myself, my personal representatives, administrators, heirs and assigns, hereby holds harmless My Trainer, its Board, employees and agents, from any claims, demands, and causes of action, to include reasonable legal expenses and attorney's fees arising from my participation in the fitness program, unless caused by My Trainer's recklessness or intentional misconduct.

I hereby release My Trainer, its Board, employees and agents, from any liability now or in the future for any injury that I may sustain as the result of participation in My Trainer's fitness training programming.

x_______________________________________ Date: ________________

Participant Signature

Physician's Exercise Release

I have examined____

I have found the following:

☐ The above named may participate fully in a progressive physical activity program consisting of cardiorespiratory, strength, and flexibility training without limitation.

— or —

☐ The above named may participate should NOT participate in a progressive physical activity program consisting of cardiorespiratory, strength, and flexibility training without limitation.

— or —

☐ The above named may participate in a progressive physical activity program with the following limitations:

Notes:

x________________________________ Date: ____________

Physician's Name (Print)

x________________________________

Physician's Signature

NFPT Consultation Guidelines

The most valuable client service you provide is risk factor identification. Always recommend, verbally and in writing, that the client consults with their physician prior to starting an exercise program, or if increasing the intensity of an existing program.

Questionnaire Procedure

Recommended for 1st Appointment (form templates to follow)

Inform the client of professional confidentiality, see the sample *Disclosure Agreement* form, included in these Guidelines. Ask the following questions to identify the risk category of your prospective client: low, medium or high

Major Health Risk Factor Identification

1. Do you have Diabetes?
2. Does your weight/body composition or general state of health interfere with the performance of activities of daily living?
3. Do you know your total serum (i.e. blood) cholesterol level? (should be less than 180 mg/dcl, or LDL less than 130mg/dcl)
4. Do you have an irregular heartbeat? Have you ever had an electrocardiogram (ECG) to test the regularity and rate of your heartbeat?

Client Personal Medical History

Have you ever, or presently, experienced:

heart attack
bypass surgery
cardiac surgery
extreme chest discomfort
irregular heart beat
high blood pressure >140/90
heart murmurs
rheumatic fever
ankle swelling
vascular diseases
phlebitis
unusual shortness of breath
abnormal blood fats
asthma, emphysema, bronchitis
stroke
history of diabetes
emotional disorders
recent hospitalization (cause?)
drug allergies
orthopedic problems, or arthritis
cigarette smoking (over 35 yrs old?)

Family History of Illness or Disease

- Premature, non-accidental, death of immediate family member who was under the age 50?
- Heart, blood or genetic disease/disorder/s/ in immediate family member/s/? (first generation family member)

Cardiovascular Risk Profile Information

A score of 32 or higher constitutes a risk factor, see the *CVD Risk Profile Questionnaire* provided.

Current Client Medication?

Chronic Illness, Injury, or Range-of-Motion Limitation?

Par-Q & You form/evaluation, see sample provided

Ever advised against exercise?

Any concerns not listed that may affect your ability to start a fitness program?

*If there is a response of "**yes**" to any of the above questions, then the client **must** be required to get a complete physical and/or a Physician's Release prior to exercise. Following the instructions on the Par-Q form may require physician's involvement as well. (Sample Physician's Release and Par-Q forms are included in these Guidelines)*

Prior to conducting client pre-exercise screenings, where activity is required, discuss and complete your Informed Consent Waiver, even if there is a Physician's Release and completed Par-Q form. (Sample Informed Consent Waiver included)

*Describe "**contraindications to exercise**", both prior to and during exercise performance.*

Contraindications include*:*
Blurred Vision, Joint Pain, Dizziness, Nausea, Rapid Pulse, Excessive Sweating, Extreme Muscle Soreness, Cramping, Chest Pain. If any of these occur, your client should be instructed to stop exercising and inform you immediately. An appointment/consultation with their personal physician may be required.

**Always err on the side of caution: if you feel that the prospective client is at too high a risk for an exercise program, or if you do not feel qualified to train this individual, then do not proceed with screening and fitness program design.*

General Client Information

For each client, you should have a personal and confidential file for your records which gives you a place for recording demographic and general client information as well as for the purpose of tracking and recording activity related to progress. Various software programs exist for the purpose of record keeping and tracking. Consider an easy to use Customer Relationship Management (CRM) program, and/or be well organized with retaining and securing your paper files. For each client, the following should be on file (these data points represent general and/or demographic information only, it is not an all-encompassing list. All information related to your fitness consultation, assessment screenings, performance tests, measurements, professional documents, etc. should be included in your records for each of your respective clients):

- Age
- Gender
- Weight
- Height
- Daily activities (occupation and leisure)
- Eating habits/routine
- Sleeping habits/schedule
- Most recent exercise program
- Water intake
- Stress levels and tolerance
- Long and short-term goals

Client Eating Habits

Information to collect relevant to fitness programming:

- food selection
- number of meals
- meal timing
- size of meals
- hunger between meals
- current supplements

Controllable Dietary Health Risk Habits

Coffee: caffeine has negative effects on fluid balance, diuretic effect and stimulates nervous activity

Soda: high concentrations of caffeine and sugar. Excessive sugar causes blood glucose problems and it is too quickly absorbed causing the rise and fall of blood sugar levels. Sugar, in frequent or large quantities, contributes to fat deposits

Chocolate: Sugar, caffeine (diuretic effect)

Salt: excess sodium causes fluid retention, potassium loss and contributes to high blood pressure

Red Meats: overconsumption has negative impact on cholesterol levels and higher risk for cardiovascular conditions

Fried Foods: saturated fats and oils lead to high cholesterol, clogged arteries and veins, risks of cardiovascular diseases and stored carbs (leads to obesity)

Low Fiber Intake: not enough fiber causes poor digestion, poor assimilation of foods, contributes to cancers and metabolic disorders
Alcohol: Suppresses nervous function, overworks the liver, and acts as a diuretic
Drugs: All drugs have effects on the nervous and endocrine systems
Tobacco: Nicotine constricts vessels contributing to high blood pressure; contains carcinogens that destroy respiratory tissues

Determine Client Goals

Fat loss: through diet and activity
General fitness: dietary, aerobics, muscle strength/endurance, flexibility
Improve functional fitness: client age and range-of-motion is a factor
Aerobic conditioning: beginner, intermediate or advanced?
Muscle endurance: beginner, intermediate or advanced?
Muscle stamina: beginner, intermediate or advanced?
Muscle strength: beginner, intermediate or advanced?

Diagnostic Tests to Perform

Depending on Experience and Skill, some tests are not necessary for the respective goal

- Accurate measurement of client weight
- Circumference measurements
- Body composition measurement
- Blood sugar analysis (12 hr fasted) (normal range = 70 to 110)
- Ketone testing (keto-stix)
- Blood pressure testing (below 140/90 OK)
- Blood Lipid Profile
- Muscle Strength (heavy weight)
- Muscle Endurance (light weight)
- Step Test Aerobic Capacity
- Sit-and-Reach Flexibility Test

Compile Recommendations

After you have assessed risk and have recorded general client information through consultation and/or diagnostic testing, as applicable, it is then time to compile and share recommendations with your client. Use the *NFPT Charts & Tables*, following this section, as a guide through your recommendations.

Exercise Routine and Degrees of Recovery

General Exercise Recommendations

Movements and Number of Sets to be Performed

Suggested Movements and Total Sets Table

Goal Oriented Repetition Ranges and Intensity

Rep Range Chart

Dietary Recommendations
General Dietary Advice Chart
Activity Expenditure Chart
Master Food List (provide a copy of this to you client to encourage accountability for the foods that he or she chooses)

Supplements
Supplement Table

> **NFPT does not advocate the use of mega-dose individual supplements of any kind. Be aware of the additional risk factors involved in this type of supplementation, i.e. there can be ingredients found in some supplements which could aggravate an existing, hidden or known, risk factor.*

Schedule Periodic Re-Evaluations

Every four to eight weeks, depending on the consistency of your client's training regime and the realistic timing of performance progress, a re-evaluation with possible adjustments to the exercise program should be reviewed and considered.

Perform appropriate diagnostic tests and record progress: for both performance and non-performance factors, these tests will reveal progress, as well as lack of progress.

Re-assess client goals: depending on progress, or lack thereof, are the client's goals realistic? Is the client following your recommendations? When there is positive progress, over a period of time, does your client desire to work on higher level goals?

Make adjustments: your client's exercise program may need adjustment based on your re-assessment. Explain the need and importance of these adjustments, your client should understand the 'why' and 'how' of these revisions in order that you may encourage his or her follow through of your recommendations.

For ease of use of these guidelines, feel free to use the forms to follow for a quick and easy way to implement the applications of these recommendations.

Client Consultation Information

Name______________________________________ Today's date:___________

__Female ___Male Age:____

Phone (h)___________________(w)_________________

Address____

Email___________________________

<u>Medical Information</u>:
When was your last complete physical examination?
What were the results?:

List any medications you are currently taking, or have taken in the past 6 months.

Provide the reason that these medications were/are prescribed:

List any operations that you have had (include date):

Are you on a special diet? Describe what kind of diet and why:

Have any member of your immediate family (mother, father, sister, brother) had:
__Heart Disease
__Hypertension
__High Cholesterol
__Heart Attack
__Diabetes
__Stroke
__Obesity

Indicate any of the following which currently exist, or has ever existed, for you:

__Anemia
__Arthritis
__Asthma
__Back pain/injury
__Bursitis
__Cancer
__Diabetes
__Epilepsy
__Frequent Dizziness
__Frequent Headaches
__Heart problems
__Hernia
__Hypoglycemia
__Neurological Disorder
__Joint Problems
__Kidney Problems
__Liver Disease
__Lung Disease
__Shortness of Breath
__Ulcer
__Weight Problems
__Chest Pains
__High Blood Pressure
__Low Blood Pressure
__Thyroid Problems
__High Cholesterol
__Osteoporosis
__Other (Explain:___________________)

Do you currently smoke? Y/N

If No, have you ever smoked? Y/N
At what age did you smoke: ____

Are you pregnant or trying to become pregnant? Y/N

Current Eating Habits

On average, how many times do you eat per day?_____
Do you eat breakfast? Y/N
List the approximate times & types of foods that you eat on a normal day:

Do you take any supplements? Y/N
If Yes, what types: ____

What kind of activity do you have on your average weekday? (i.e. sedentary at a desk, or highly active, at work)

Hours per week that you work at your job______

How would you rate your daily stress level? (circle one)
High Stress Moderate Stress Low Stress

Rate your daily energy level? (circle one)
High Energy Moderate Energy Low Energy

Do you enjoy exercising? Y/N
How often do you perform resistance training?___________________________

How often do you perform moderate exercise?___________________________
Give an example of your moderate exercise:_____________________________

How often do you perform vigorous exercise? ___________________________
Give an example of your vigorous exercise:______________________________

How would you rate your current fitness level? (circle one)
Poor
Below Average
Moderate Above Average
Excellent
Competitive Athlete

How many hours of sleep do you get on average?____

List any other factors which might affect your safe participation in a fitness program:

Personal Goals: (check all that apply)

__Weight loss (by approx. how many pounds:_____)
__Improve strength
__General fitness
__Reduce risk of disease
__Improve flexibility
__Improve cardiovascular health
__Improve posture
__Tone and firm
__Injury rehabilitation
__Strengthen bones
__Improve balance and stability
__Specific sport training (type:________________________)
__Other (explain:___________________________________)

Please list anything else that you think would help your fitness programming to successfully reach your specific goal/s/:

Parrillo 9-Site Body Fat Composition Measurement Form

Body Fat % = [27 x (Sum of all sites)] ÷ Body Weight

1. Pinch the skin and fat in line with the underlying muscle, using the right side of the body. *(see pinch orientations and details on page 236-241)*

2. Have the client flex their muscle for two seconds to ensure that you are not pinching it along with the fat and skin (make sure they relax before you record the measurement).

3. Place the calipers in the middle of the skinfold, below where the fingers are pinching. It is a common mistake to place calipers too close to where the skin is being pulled, resulting in a larger number than what is accurate.

4. Hold the pinch for a few seconds to let the calipers sink into the skin. Open the calipers completely so not to scratch the client (gently remove the calipers).

5. Measure to the nearest millimeter. The measurement form to follow calculates for 3 measurement per site. Add the measurements together and divide by 3 *(if taking only 2 measurements, then divide by 2).*

6. Find the average measurement for each site: chest, abs, thigh, bicep, tricep, sub-scapular, supra-iliac, low back, calf), add them up.

7. Use the Parrillo 9-Site formula, enter in figures for:
Body Fat % = [27 x (Sum of all sites)] ÷ Body Weight

8. Mark the results with the date and re-measure every 3-6 weeks.

Body Fat % Composition Ratings

Rating (WOMEN)	Age 20-39	Age 40-59	Age 60-79
Underfat	< 21%	< 23%	< 24%
Healthy	21.1 - 33%	23.1 - 34%	24.1 - 36%
Overfat	33.1 - 39%	34.1 - 40%	36.1 - 42%
Obese	> 39%	> 40%	> 42%

Rating (MEN)	Age 20-39	Age 40-59	Age 60-79
Underfat	< 8%	< 11%	< 13%
Healthy	8.1 - 20%	11.1 - 22%	13.1 - 25%
Overfat	20.1 - 25%	22.1 - 28%	25.1% - 30%
Obese	> 25%	> 28%	> 30%

Parrillo 9-Site Body Fat Composition Measurement Form *(cont.)*

Body Fat% = [27 x (Sum of 9 Sites)] ÷ Body Weight

1. Chest	______	+	______	+	______	=	______	÷	3	=	______
2. Bicep	______	+	______	+	______	=	______	÷	3	=	______
3. Tricep	______	+	______	+	______	=	______	÷	3	=	______
4. Sub-scapular	______	+	______	+	______	=	______	÷	3	=	______
5. Mid-axillary	______	+	______	+	______	=	______	÷	3	=	______
6. Abdominals	______	+	______	+	______	=	______	÷	3	=	______
7. Supra-iliac	______	+	______	+	______	=	______	÷	3	=	______
8. Thigh	______	+	______	+	______	=	______	÷	3	=	______
9. Calf	______	+	______	+	______	=	______	÷	3	=	______

Add 9-Site Averages, SUM TOTAL = ______

Body Fat % = [27 x (______)] ÷ ______

body weight here

Body Fat % = [______] ÷ ______

Body Fat % = ______

DATE:__________

Client Measurement Information (Trainer's Use Only)

Client's Name: ______________________________________ ***Date:*** _______

DOB: _____________ **Age:** ______ **Height:**_________ **Weight:**_________

Lowest Weight:________ **Highest Weight**:________ **Ideal Weight**:________

LBW:________ **Body Fat%**_________

1 pound (lb) = .453592 kilograms
# of lbs x .453592 = # of kg

1 inch = 2.54 centimeters (cm)
# of inches x 2.54 = # of cm

Convert kg to lbs:
# of kilograms x 2.2 = pounds

LBW (Male) = (0.32810 x weight, in kg) + (0.33929 x height, in cm) - 29.5336

= (0.32810 x _______) + (0.33929 x ________) - 29.5336

LBW = (___________) + (___________) - 29.5336

LBW (Female) = (0.29569 x weight, in kg) + (0.41813 x height, in cm) - 43.2933

= (0.29569 x _______) + (0.41813 x ________) - 43.2933

LBW = (___________) + (___________) - 43.2933

Circumference Measurements: Waist______ Thigh______ Chest______ Arms______

Blood Pressure:____/____ (Time of Day/Activity Level:____________________)

RMR:________ (LBW x 11 = RMR estimate)

Rest HR ______ (15 Second Resting Pulse x 4)

Max HR ______ [208 - (0.7 x Age)]

PERFORMANCE VARIABLE ASSESSMENTS

Cardiorespiratory Condition:

VO2Max TEST

(**Male**) = 108.844 - (weight in kg x 0.1636) - (time for one mile x 1.438) - (HR at end of mile x 0.1928)

= 108.844 - (______ x 0.1636) - (_______ x 1.438) - (______ x 0.1928)

= 108.844 - (________) - (________) - (________)

VO2Max = _________

(**Female**) = 100.5 - (weight in kg x 0.1636) - (time for one mile x 1.438) - (HR at end of mile x 0.1928)

= 100.5 - (________ x 0.1636) - (_______ x 1.438) - (______ x 0.1928)

= 100.5 - (________) - (________) - (________)

VO2max = ________

3 MINUTE STEP TEST HR Results ___ Below Avg: ___ Avg: ___ Above Avg: ___ Good: ___ Excellent: ___

Muscular Endurance:

UPPER BODY (record # performed/check rating)

Push-ups: ______ Poor: ___ Fair: ___ Good: ___ Very Good: ___ Excellent: ___

Chin-ups: ______ Poor: ___ Fair: ___ Very Good: ___

LOWER BODY (record # performed/check rating)

Squats: ______ Poor: ___ Below Avg: ___ Average: ___ Above Avg: ___ Very Good:___

CORE

Plank: ______minutes Poor: ___ Fair: ___ Good: ___ Excellent: ___

Bent Knee Crunch:______ Poor: ___ Fair: ___ Good: ___ Excellent: ____

NOTES:

Muscular Strength

1RM **= weight in pounds ÷ [{1.0278) - (0.0278 x reps)]**
*starting weight for client varies

1RM = ____ ÷ [{1.0278) - (0.0278 x ____)]

1RM = _______

1RM divided by client's body weight = dynamic strength score (_______ ÷ _______ = ________)

SCORE = ______ Very Poor: ___ Poor: ___ Fair: ___ Average: ___ Good: ___ Excellent: ___

NOTES:

Flexibility

Modified Sit and Reach: _______inches Poor: ___ Average: ___ Above Avg: ___ Good: ___

Reach Over: ______inches Poor: ___ Average: ___ Above Avg: ___

NOTES:

Par - Q & You

Physical Activity Readiness
Questionnaire - PAR-Q(revised 1994)

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day.
Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.
If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.
Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? condition?
☐	☐	7. Do you know of any other reason why you should not do physical activity?

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want - as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active - begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal - this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

DELAY BECOMING MUCH MORE ACTIVE:

- If you are not feeling well because of temporary illness such as a cold or a fever – wait until you feel better; or
- If you are or may be pregnant – talk to your doctor before you start becoming more active

Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional.
Ask whether you should change your physical activity plan.

<u>Informed Use of the PAR-Q</u>: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction.

NAME: ____

SIGNATURE: ____ **DATE:** ________________________________
SIGNATURE OF PARENT: ______________________________________ **WITNESS:** ______________________________
or GUARDIAN (for participants under the age of majority)

Note: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

You are encouraged to copy the PAR-Q but only if you use the entire form

Health Canada Santé Canada

Cardiovascular Risk Profile

Name:____________________

Comments:____________________

							Start	End
Gender	Female 1	Female Over 45 Years 2	Male 4	Bald Male 5	Bald Short Male 6	Bald Short Stocky Male 7		
Age	10 - 20 Years 1	21 - 30 Years 2	31 - 40 Years 3	41 - 50 Years 4	51 - 60 Years 6	60+ Years 8		
Heredity: Parents & Siblings	No Family History Of CVD 1	One With CVD Over 60 Years 2	Two With CVD Over 60 Years 3	One Death From CVD Under 60 Years 4	Two Deaths From CVD Under 60 Years 6	Three Deaths From CVD Under 60 Years 7		
Personal History of CVD	Completely Benign 0	CVD Symptoms Not Medically Confirmed 2	CVD Mild: Medically Confirmed (BP Drugs) 4	CVD Moderate Occasional Symptoms 6	CVD Severe Frequent Symptoms 8	Hospitalized For CVD 10		
Diabetes	No Symptoms Negative Family History 0	Latent Positive Family History 1	Chemical 2	Mild Dietary Control 5	Moderate: Oral Drug Control 7	Severe: Insulin Control 9		
Gout	No Symptoms Negative Family History 0	Family History 1	Elevated Uric Acid Level But No Symptoms 2	Onset of Gout Early Detection 3	Repeated Chronic Gout Attacks 5	Gout With Renal & Osteo Complica- tions 8		
Present CVD Symptoms	None 0	Ocassional Fast Pulse and / or Irregular Rhythm 2	Frequent Fast Pulse and / or Irregular Rhythm 4	Ocassional Angina 6	Exertional Angina 8	Frequent Angina Exertional and Resting 10		
Weight	More Than 5 lbs Below Standard Weight 0	(+ or -) 5 lbs Off Standard Weight 1	5 To 20 lbs Over Standard Weight 2	21 To 35 Lbs Over Standard Weight 3	36 To 50 Lbs Over Standard Weight 5	51 To 65 Lbs Over Standard Weight 7		
Smoking	Non-Smoker 0	Ocassional Cigar Or Pipe 1	Cigarettes 10 Or Less Per Day 2	Cigarettes 11 To 20 Per Day 4	Cigarettes 21 To 30 Per Day 6	Cigarettes Over 31 Per Day 10		
Exercise	Intensive Job & Recreational Exertion 0	Moderate Job & Recreational Exertion 1	Sedentary Job & Intensive Recreation 2	Sedentary Job & Moderate Recreation 4	Sedentary Job & Light Recreation 6	Sedentary Job & No Recreation 8		
Diet	Low Fat Diet & No Sugar Intake 1	Below Average Fat & Sugar Intake 2	Normal Fat & Sugar Intake 3	High Fat & Normal Sugar Intake 5	High Fat & High Sugar Intake 5	Excessive Fat & Sugar Intake 8		
Systolic BP	Below 110 mm Hg 0	111 To 130 mm Hg 1	131 To 140 mm Hg 2	141 To 160 mm Hg 3	161 To 180 mm Hg 5	Above 180 mm Hg 7		
Diastolic BP	Below 80 mm Hg 0	80 To 85 mm Hg 1	85 To 90 mm Hg 2	91 To 95 mm Hg 4	96 To 100 mm Hg 7	Above 101 mm Hg 9		
Resting EKG	Normal 0	Borderline 2	Frequent PVC s 3	Conduction Defect 4	Ischemia 7	Infarction 10		
Stress	No Stress 1	Ocassional Mild Stress 2	Frequent Mild Stress 3	Frequent Moderate Stress 4	Frequent High Stress 5	Constant High Stress 7		
						(before & after) **Total Scores:**		

If you scored...

- 6 - 14 = Risk well below average
- 15 - 19 = Risk below average
- 20 - 25 = risk about average
- 26 - 32 = Risk moderate
- 33 - 40 = Risk Dangerous: You must reduce your score
- 41 - 55 = Risk Very Dangerous: Reduce score immediately
- 56 + = Risk Extreme: Seek urgent medical attention

BASIC MOVEMENT ASSESSMENTS

SQUAT

Start with feet shoulder width apart and squat down. Check for the following indicators:

Knees caving in - tight adducters
Hyperpronation - weak intrinsic foot muscles
Can't get to 90 degrees- tight hips and hamstrings
Leans forward - weak trunk/poor hip mobility
Hip drops - weak glute medius
Patella sheer - weak hips/quad dominant
Pelvic shift - poor hip stability
Poor balance - weak glute maximus

BASIC SUGGESTIONS:
Foam Roller Squat
Peterson Step Up
Glute Bridge

NOTES:

1 LEG STANCE

Pick 1 leg up off of the floor (do this test with eyes open and eyes closed), check for the following indicators:

Pelvic shifting (hip dropping) - weak glute medius
Pelvic swaying - weak glute medius and core
Knee shaking - weak popliteus, calf, and quad
Hyperpronation of foot - weak peroneals, intrinsic foot muscle
*Weak glute muscle causes opposite side, low back pain

BASIC SUGGESTIONS:
Balance Boards
1 Leg Med Catch
Chops

NOTES:

PUSH-UP

When performing a push-up, check for the following indicators:

Trap elevation - tight upper traps/weak lower
Scapular winging (medial border) - weak serratus
Scapular winging (inferior angle) - weak rhomboid
Scapular adduction - tight rhomboid/weak pec
Poor lumbopelvic stability - weak core
Delayed scapular movement - poor proprioception

BASIC SUGGESTIONS:
Serratus push-up
Knee push-up
Planks

NOTES:

SIDE BRIDGE ENDURANCE TEST

Perfrom a side bridge, check for the following indicators:

How long can it be held?
Hip dropping
Hypersextension of lower back
Shoulder shrugging
Inability to extend hip
Kyphosis
Shoulder pain
*this test will reveal shoulder/core weakness

BASIC SUGGESTIONS:
Knee Planks
Dead Bug on Roller
Corkscrew

NOTES:

CROSSOVERS

Start in a push-up position, legs spread wider than shoulder width. With back straight, touch one hand to another and return to starting position without shifting your body. Immediately do the same thing with the other hand and continue to alternate. Check for the following indicators:

Can't keep neutral spine
Trap hiking
Scapular winging
Hip rotation
*this tests trunk stability

BASIC SUGGESTIONS:
Planks
Disc Crunch
Low Chop

NOTES:

DEAD BUG w/FOAM ROLLER (NO ARMS)

Place roller along spine, plant feet on floor and hold a neutral spine, then pick up one foot and stabilize with the other. Check for the following indicators (on each side):

Knee shaking
Trunk shaking
Can't hold position
Inversion of foot
Eversion of foot
Back pain

BASIC SUGGESTIONS:
Glute Bridging
Clams
Planks

NOTES:

HIP HINGE

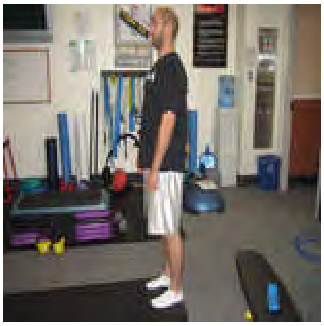
CORRECT: keep spine straight by hinging at the hips

INCORRECT: spine bends forward, putting low back in a harmful position.

Hold pole against back of head and tail bone; once the pole 'breaks' away from the body, the hips are not being used. Bend at the knees to get lower - master this before using weights.
*this is not a test, it is a method for you to visualize any poor bending mechanics

NOTES:

LUNGE



Start with feet shoulder width apart. Step forward w/knee bent and lower back knee towards the floor; keeping neutral spine, return to start. Check for the following indicators:

Knee adduction/shaking/pain - tight adductors
Pronation of foot - weak intrinsic foot muscles
Leaning forward - weak core/glute max
Pause on return - overall lower body weakness
Can't reach floor w/back knee - tight quad
Patella sheer - poor hip mobility

BASIC SUGGESTIONS:
1 Leg Balance Exercises
Supported Static Lunge
Split Squat

NOTES:

**A basic movement screening is an important part of assessing your client for his or her needs and abilities so that you may effectively recommend exercises that will see them safely to their goals. Use the chart to follow to keep track and note the current abilities and the progress of your clients as you assess their performance of these basic movements.*

NFPT
National Federation of
PROFESSIONAL TRAINERS

TRAINING RECORD

Client Name:______________________________

	DATE	DATE	DATE	DATE	DATE	DATE
EXERCISE						
SETS/REPS						
WEIGHT						
EXERCISE						
SETS/REPS						
WEIGHT						
EXERCISE						
SETS/REPS						
WEIGHT						
EXERCISE						
SETS/REPS						
WEIGHT						
EXERCISE						
SETS/REPS						
WEIGHT						
EXERCISE						
SETS/REPS						
WEIGHT						

NFPT Charts and Tables

General Exercise Recommendations

GOAL	REP RANGE	ROUTINE	SET INTENSITY	DURATION	RECOVERY HR
Strength/Size	4-6	3 Day Split	90-100 %	30-60 min	100 BPM
General Fitness/Stamina	12-15	2 Day Split	85-95%	45-70 min	115 BPM
Fat Loss/Endurance	20-25	Total Body Circuit	60-90%	45-90 min	125 BPM

Suggested Movements and Total Sets

MUSCLE GROUP	TOTAL SETS 4 TO 6 REPS (HIGH INTENSITY)	TOTAL SET 12-15 REPS (LOW INTENSITY)	CIRCUIT 20-25 REPS	SUGGESTED MOVEMENTS
Chest	6 to 8 sets	8 to 10 sets	4 to 5 sets	Flat/Incline Bench Press/Push-Ups/Cable Pressing
Back (upper)	8 to 10 sets	10 to 12 sets	4 to 5 sets	Pull-Ups/Cable Rows/Pull-Downs
Back (lower)	4 to 6 sets	6 to 8 sets	4 to 5 sets	Hyperextensions
Shoulders	4 to 6 sets	6 to 8 sets		Rear Fly, Dumbbell Side Raises
Triceps	4 to 6 sets	6 to 8 sets		Shoulder Press/Tricep Extensions/Close Grip Bench
Biceps	3 to 5 sets	5 to 7 sets		Curl w/Dumbbells or Bar
Traps	3 sets	3 sets		High Pull and Hang Cleans
Quads	8 to 10 sets	10 to 12 sets	4 to 5 sets	Squat/Leg Press/Deadlift/Lunges
Hams	3 to 4 sets	3 to 4 sets		Stiff Leg Deadlifts/Supine Leg Ball Curl
Calves	3 to 4 sets	3 to 4 sets		Standing/Seated Toe Raise
Abs	1 to 2 sets	1 to 2 sets		Crunch/Chop/Ab Wheel
Forearms	2 to 4 sets	2 to 4 sets		Wrist Curl/Reverse Wrist Curl

Range Chart

Chart is only effective with proper diet and recovery

Intensity during set and effect on tissues

	(4-6) REP RANGE	(12-15) REP RANGE	(20-25) REP RANGE
Effect on Tissue at 70% Intensity	Maintain Strength	Maintain Stamina	Some Fat Conversion
Effect on Tissue at 80% Intensity	Increase Strength	Increase Stamina	Moderate Fat Conversion
Effect on Tissue at 90% Intensity	Maximize Strength	Maximize Stamina	Maximum Fat Conversion
Effect on Tissue at 100% Intensity	Build White Tissue	Build Red Fast Tissue	Build Red Slow Tissue
Effect on Tissue at 110% Intensity	Tissue Damage	Tissue Damage	Tissue Damage

Rep Ranges: Relative to % Intensity and Point of Contraction Failure

RPE*	(4-6) REP RANGE/STRENGTH	(12-15) REP RANGE/STAMINA	(20-25) REP RANGE/ENDURANCE
Somewhat Hard (Borg 4) 70% Intensity	3 reps short of failure	6 reps short of failure	9 reps short of failure
Hard (Borg 6) 80% Intensity	2 reps short of failure	4 reps short of failure	6 reps short of failure
Very hard (Borg 7-8) 90% Intensity	1 rep short of failure	2 rep short of failure	3 rep short of failure
Very, very hard (Borg 9) 100% Intensity	Max; Unassisted failure (Good)	Max; Unassisted failure (Good)	Max; Unassisted failure (Good)
Exhaustion 110% Intensity	Past failure; Forced reps (Bad)	Past failure; Forced reps (Bad)	Past failure; Forced reps (Bad)

*Rate-of-Perceived-Exertion

Overload Training Principle

Example (4-6 reps): Select a weight that can be controlled throughout the entire range of motion, in strict form, barely being able to complete 4 reps with absolutely no forced reps. Sufficient between set recovery will allow for the performance of the same number of reps in the following sets in this particular movement. When it is possible to perform 6 reps in strict form in all the required sets of this movement, it will be appropriate to increase the weight used until again only 4 reps can be performed
in each set using strict form with absolutely no forced reps.

Note: The Overload Principle explained above, applies to all rep ranges including the (12-15) rep range and the (20-25) rep range. The Overload Principle applied in each rep range, has a different effect on the target muscle group(s).

Activity Expenditure Chart

ADD TRAINING EXPENDITURE TO DAILY ACTIVITY EXPENDITURE

100 BPM = Recovery Heart Rate (between sets)	500 Calories per Hour Training (Expenditure)
115 BPM = Recovery Heart Rate (between sets)	750 Calories per Hour Training (Expenditure)
125 BPM = Recovery Heart Rate (between sets)	1,000 Calories per Hour Training (Expenditure)
Average person's day-to-day activity requirement	500 Calories For Daily Activity (Approximate)

General Dietary Advice Chart

GOAL =	WEIGHT LOSS	WEIGHT MAINTENANCE	WEIGHT GAIN
TOTAL CALORIES =	TOTAL EXPENDITURE - 500 CALORIES	TOTAL EXPENDITURE	TOTAL EXPENDITURE + 500 CALORIES
% Protein =	25%	20%	15%
% Carbs =	50%	55%	60%
% Fats =	25%	25%	25%
# of Meals/Day	4-5 Meals	4-5 Meals	5-6 Meals

Supplement Table

GOALS	WEIGHT GAIN	GENERAL FITNESS	WEIGHT LOSS	SIZE AND STRENGTH	INTERMEDIATE	ENDURANCE
BCAAs	■	■	■	■	■	■
FREE FORM AMINOS	■	■	■	■	■	■
PROTEIN DRINK	■	■	■	■	■	■
B-COMPLEX	■	■	■	■	■	■
MULTI-VITAMIN	■	■	■	■	■	■
CARB LOAD DRINK	■			■	■	■
HCL (PEPSIN)	■			■		

***While NFPT does not advocate that the trainer use or recommend supplements, these supplements are recognized as generally safe and effective for the respective goals stated, in the above chart**

NFPT Master Food List

GI*	SUGARS	SERVING	PROTEIN (g)	CARB (g)	FAT (g)	FIBER (g)	Sodium Na (mg)	Potassium K (mg)	CAL
105	MALTOSE (CORN SYRUP)	1 cup	0	236	0	0	0	0	0
100	GLUCOSE (BLOOD SUGAR)	-	-	-	-	-	-	-	-
87	HONEY	1T	0.1	17.3	0	0	1	11	64
59	SUCROSE (TABLE SUGAR)	1T	0	4	0	0	0	-	16
20	FRUCTOSE (FRUIT SUGAR)	1t	0	4	0	0	-	-	15

GI	BEVERAGES	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
	COFFEE	6 oz	0	0	1.8	0	2	117	1.8
	TEA	8 oz	0	<1	0	0	19	48	2.4
	SODA (COLA)	12 oz	0	35	0	0	20	7	136
	DIET SODA	11 oz	0	0.4	0	0	15	0	<1
	FRUIT-FLAVORED DRINK (V8 SPLASH)	8 oz	0	18	0	0	52	34	70.5
	DIET FRUIT DRINK (V8 SPLASH)	8 oz	0	3	0	0	31	36	9.5
	VEGETABLE JUICE	8 oz	2	10	0.2	0.8	481	469	51
	TOMATO JUICE (CAMPBELL'S)	8 oz	2	11	0	0	481	501	51

GI	CONDIMENTS	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
	BUTTER	1 oz (2T)	0.12	<1	11.5	0	90	5.2	101
	MARGARINE	1T	0	0	7	0	110	6	60
	VEGETABLE OIL	1T	0	0	14	0	0	0	120
	OLIVE OIL	1T	0	0	14	0	0	0	120
	JAM	1T	<1	14	0	<1	<1	16	54
	JELLY	1T	<1	15	0	0	6	13	56
	MOLASSES, Dark	1T	1	12	0	0	10	585	60
	MOLASSES, Reg	1T	0	19	0	0	3	183	50
	SYRUP, Regular Maple	1T	0	13	0	0	2	11	52
	SYRUP, Lite	1T	0	8	0	0	32	0	30
	KETCHUP	1T	0.3	3.8	0.1	<1	156	58	16
	MUSTARD	1T	0.9	0.9	0.9	0.3	56	21	3
	MAYONNAISE	1T	0.2	0.4	11	0	73	2	103
	CAESAR DRESSING	1 oz	0	1	19	0	105	4	180
	RANCH DRESSING	1 oz	0	1	14	0	135	4	120
	BLUE CHEESE DRESSING	1 oz	2	3	16	0	328	11	151
	SPAGHETTI SAUCE, Red	1/2 cup	2	18	3	3	525	404	110
	SPAGHETTI SAUCE, White	1/2 cup	5	11	13	0	443	200	184
	BARBECUE SAUCE	1 oz	0	17	0	0	290	40	70

GI	DAIRY	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
36	ICE CREAM	1 cup	7	39	24	1	116	257	269
	FROZEN YOGURT	1 cup	5	40	6	2	110	407	221
36	YOGURT, Plain	1 cup	13	17	7	0	171	351	154
	YOGURT, Lowfat Plain	1 cup	13	17	3	0	159	531	144
	YOGURT, Lowfat Fruit	1 cup	11	45	3	<1	142	475	225
34	MILK,Whole	8 oz	8	11	8	0	120	370	150
32	MILK,Skim	8oz	8	12	<1	0	126	206	86
	EGG, Whole, fried	1 egg	6	0	7	0	94	65	90
	EGG, White (prepared)	1 oz	3	<1	0	0	50	45	13
	CHEDDAR CHEESE	1 oz	7	1	5	0	203	26	79
	COLBY CHEESE	1 oz	7	<1	9	0	171	36	112
	SWISS CHEESE	1 oz	8	1	8	0	54	21	107
	MOZZARELLA, Whole Milk	1 oz	6	1	6	0	176	21	84
	Part Skim	1 oz	7	1	5	0	173	24	72
	COTTAGE CHEESE, 2% Milkfat	1 cup	31	8.2	4.36	0	450	217	152

	CREAM CHEESE	1 oz	2.14	0.75	9.9	0	84	34	99
	PARMESAN CHEESE, Grated	1T	2	0.19	1.5	0	93	5	23
	SOUR CREAM	1 cup	7.27	9.82	48.2	0	123	331	493

GI	FRUITS	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
64	RAISINS, Packed	1/2 cup	3	54.5	0	0.5	8.5	681	230
52	BANANA	1	1.18	26.7	0.55	0.57	1	451	105
46	ORANGE JUICE	8 oz	1.74	25.8	0.5	0.25	2	496	111
45	GRAPES	1 cup	1.06	28.4	0.92	0.72	3	269	114
48	ORANGE	1	1.23	15.4	0.16	0.56	0	237	62
39	APPLE, Golden Delicious	1	0.27	21	0.49	1.06	1	159	81
34	PEAR	1	0.65	25	0.66	2.32	1	208	98
29	PEACH	1	0.61	9.65	0.08	0.56	0	171	37
25	GRAPEFRUIT	1/2	0.75	9.7	0.12	0.24	0	167	38
	PLUM	1	0.52	8.59	0.41	0.4	0	113	36
	CHERRIES	1 cup	1.74	24	1.39	0.58	1	325	104
	STRAWBERRIES	1 cup	0.91	10.4	0.55	0.79	2	247	45
	BLUEBERRIES	1 cup	0.97	20.5	0.55	1.88	9	129	82
	APRICOTS	5	1.5	26.3	0	1	3	482	105
	DATES	10	1.63	61	0.37	1.83	2	541	228
	FIGS, Dried	10	5.7	109	2.18	8.97	20	1332	477
	PRUNES	10	2.19	52.7	0.43	1.72	3	626	201
	AVOCADO	1	3.99	14.8	30.8	4.24	21	1204	324
	MELON, Cantaloupe	1 cup	1.34	14	0.74	0.97	23	437	54
	Honeydew	1 cup	1.18	15.5	0.26	1.54	26	388	61
72	WATERMELON	1 cup	0.99	11.5	0.68	0.48	3	186	50

GI	VEGETABLES	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
98	POTATO, Russet Baked	1	4	32.8	0.2	1.2	6	782	210
87	PARSNIPS	1 cup	2.3	23	0.8	3	12	587	102
47	CARROTS	1/2 cup	0.5	5.5	0.1	0.5	19	356	24
80	POTATO, Instant Mashed	1/2 cup	2	16	6	0	380	0	130
70	POTATO, White Boiled	1 cup	3.2	25.7	0.2	0.66	5	611	114
64	BEETS	1 cup	2	13.6	0.2	1	98	440	60
59	SWEET CORN	1 cup	4.96	29	1.8	1	23	416	132
51	PEAS, Frozen	1 cup	7.9	21	0.59	3.2	7	357	118
51	YAMS	1 cup	4.8	48.2	0.4	1.8	17	1508	210
	SWEET POTATO	1	2	32	0.38	1	17	265	136
	TOMATO SOUP	1 cup	2.06	16.6	1.92	0.49	872	263	86
	GREEN BEANS	1 cup	2	8	0.01	1.2	6	230	34
	BROCCOLI	1 cup	2.6	4.6	0.3	0.9	24	286	24
	CAULIFLOWER	1 cup	1.98	4.9	0.18	0.82	14	356	24
	MUSHROOMS	1 cup	1.5	3	0.3	0.52	2	260	18
	PARSLEY	1 cup	2.2	5.1	0.4	0.9	27	436	26
	LETTUCE; Iceburg	1 cup	0.7	2.2	0.12	0.35	7	131	10
	LETTUCE; Romaine	1 cup	0.9	1.3	0.12	0.4	4	162	8
	RADISH	10	0.27	1.6	0.24	0.24	11	104	7
	TOMATO	1	1.1	5.3	0.26	0.57	10	254	24
	SWEET PEPPER	1 cup	0.86	5.3	0.46	1.2	4	265	24
	SALAD (1 Tom, 2 Rad, 1/2 Car, 1c Let)	1	3.1	14.1	0.55	1.2	28	584	69

GI	DRIED LEGUMES	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
40	BAKED BEANS, Canned	8 oz	10	43	3	12	730	457	190
36	CHICK PEAS/GARBANZO BEANS	8 oz	41	122	9.6	10	52	1594	720
36	LIMA BEANS	1 cup	11.6	40	0.54	3.5	29	969	208
33	BLACK-EYED PEAS	1 cup	13.2	29.9	1.3	2	2	625	178

GI		SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
29	KIDNEY BEANS	1 cup	14.4	39.6	0.9	2.78	6	629	218
29	LENTILS	1 cup	15.6	38.6	<1	15	3	731	230
	NAVY BEANS	1 cup	14.8	40.3	1.1	3	13	790	224
	PINTO BEANS	1 cup	13	40.8	1.4	9.6	636	1870	224

GI	CEREALS (no milk)	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
80	CORNFLAKES, Kellogg's	1	1.84	19.5	0.08	0.24	281	26	88
67	SHREDDED WHEAT, Quaker	2	5	31	1	0	0	154	160
	WHEAT FLAKES, Quaker	1 cup	3.3	26	0.7	2.4	409	123	116
	WHEAT GRANULES, Grapenuts	1/2 cup	7.2	46.5	0.1	5.1	317	195	208
	WHEAT, Puffed	1 cup	1.8	9.5	0.1	0.4	0	42	44
66	MUESLIX, Kellog's Bran	1/2 cup	3	31	2	6	105	240	130
	MUESLIX, Five Grain	1/2 cup	4	32	1	4	55	85	140
51	ALL-BRAN, Kellog's	1/2 cup	4	22	1.1	10	75	316	81
	RAISIN BRAN, Kellog's	1 cup	3	39	1	5	230	280	160
49	OATMEAL, Total Unckd	1/3c	4	19	2	2.1	5	132	100
	OATMEAL, OATS, Puffed, Cheerios	1 cup	3.44	15.7	1.44	0.9	246	101	89
	CORN FLAKES, Kellogg's	1 cup	1.8	19.5	<1	0.2	281	26	88
	RICE, Puffed	1 cup	<1	12.6	0.1	0.1	0	16	56
	GRANOLA, NATURE VALLEY	1 cup	11.5	75.5	19.6	4.2	232	389	503
	WHEAT GERM, Kretschmer	3T	9	13	3	3	0	201	110

GI	GRAINS (prepared)	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
72	WHITE RICE, Long Grain, Enriched	1 cup	4	45	0	1.4	7	56	205
66	BROWN RICE, Long Grain	1 cup	5	45	2	4	10	84	216
71	WHOLE WHEAT BREAD	1 slice	4	12	<1	2	132	69	70
71	WHITE BREAD, Enriched	1 slice	2	15	1	1	204	30	80
51	BUCKWHEAT FLOUR	1 cup	15	85	4	12	13	690	400
	WHEAT FLOUR, Enriched	1 cup	11.6	83.7	1	<1	2	105	400
	WHOLE WHEAT FLOUR	1 cup	16	85.2	2.4	2.8	4	444	400
50	WHITE SPAGHETTI, Dry	2 oz	7	42	1	0.2	5	85	210
42	WHOLE GRAIN RYE BREAD	1 slice	2.1	12	0.3	0.1	128	33	56
42	WHOLE WHEAT SPAGHETTI	1 oz	1.5	7.4	<1	1.3	4.2	12.3	35

GI	BISCUITS/MUFFINS/ROLLS	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
	FLOUR BISCUITS, Enriched	1	6	30	1	1	255	33	146
72	BAGEL, Plain	1	11	56	2.57	<1	360	42.7	296
	ENGLISH MUFFIN, Enriched	1	7	27	1	1	248	67	130
	ROLL, Dinner, Enriched	1	3.1	20.1	2.2	0.1	192	36	113
	ROLL, Whole Wheat	1	3.5	18.3	1	0.6	197	102	90
	BUN, Hamburger/Hot Dog, Enriched	1	3.3	21.2	2.2	<1	202	38	119

GI	NUTS	SERVING	PROTEIN	CARB	FAT	FIBER	Na	K	CAL
15	SOYBEANS, cooked	1 cup	19.8	19.4	10.3	3	4	972	234
	SOYBEAN CURD, Tofu	3.5 oz	7.8	2.4	4.2	0.1	354		72
13	PEANUTS	1 cup	37.7	29.7	70.1	3.89	7	1009	838
	PEANUT BUTTER	1T	3.9	3.2	8.1	0.33	18	123	86
	SUNFLOWER SEEDS	1/2 cup	17.4	14.4	34.3	5.5	4	1334	406
	ALMONDS	1 cup	26.4	27.7	77	3.84	6	1098	849
	BRAZIL NUTS	1 cup	20	15.3	93.7	4.2	1	1001	916
	CASHEW NUTS	1 cup	24.1	41	64	1.96	21	650	785
	FILBERTS (Hazelnuts)	1 cup	17	22.5	84.5	1.05	3	950	856

GI	BEEF	SERVING	PRO	CARB	FAT	F	Na	K	CAL
	HAMBURGER, Regular	8 oz	40.6	-	48.1	0	105	1070	608
	HAMBURGER, Lean	8 oz	46.95	-	22.7	0	147		406
	STEAK, Sirloin	7 oz	31.1	-	49	0	124	569	576
	STEAK, T-Bone	7 oz	25.8	-	73.5	0	103	473	698
	STEAK, Porterhouse	8 oz	30.4	-	74	0	106	486	802
	ROAST BEEF	8 oz	33.5	-	43.7	0	117	536	580

GI	LUNCH MEAT	SERVING	PRO	CARB	FAT	F	Na	K	CAL
	HAM	4 oz	19.9	3.5	12	0	1494	754	207
	BOLOGNA, Beef	1 oz	3.31	0.55	8.04	0	284	44	89
	BOLOGNA, Pork	1 oz	4.34	0.21	5.63	0	289	80	70
	SALAMI, Hard	1/16" sl	2.29	0.26	3.44	0	186	38	42
	PEPPERONI	1 slice	1.15	0.16	2.42	0	112	19	27
28	SAUSAGE, Italian	1 link	13.4	1	17.4	0	618	204	216
	SAUSAGE, Polish	1 oz	4	0.46	8.14	0	248	67	92
	SAUSAGE, Pork	1 link	3.31	0.29	11.4	0	228	58	118
	BACON	4 oz	9.75	0.11	65.3	0	777	631	631
	PORK CHOP	1	20	-	29.2	0	63	346	345
	VEAL CUTLET	4 oz	18.1	0	10.3	0	63	289	170

GI	POULTRY	SERVING	PRO	CARB	FAT	F	Na	K	CAL
	CHICKEN, White	4 oz	23.5	-	3.2	0	76	237	216
	CHICKEN, White Skinned	4 oz	20.4	-	.36	0	60	210	100
	CHICKEN, Dark	4 oz	26.7	-	7.33	0	117	285	379
	CHICKEN, Dark Skinned	4 oz	21.9	-	1.18	0	93	241	136
	TURKEY, White	4 oz	39.0	-	3.3	0	106	489	286
	TURKEY, Dark	4 oz	28.7	-	3.33	0	108	396	243

GI	SEAFOOD	SERVING	PRO	CARB	FAT	F	Na	K	CAL
	SHRIMP	8 oz	41	3.4	1.8	0	318	499	207
	LOBSTER	8 oz	38.35	1.15	4.3	0	678	589	207
	COD	8 oz	39.9	-	1.66	0	159	866	177
	HADDOCK	8 oz	41.5	-	1.5	0	139	689	179
	HALIBUT	8 oz	47.4	-	2.5	0	123	1018	227
	SALMON	8 oz	51	-	30.4	0	109	885	492
	SMELT	8 oz	42.2	-	4.75	0	-	1064	223
	TROUT	8 oz	48.75	-	25.85	0	89	1065	443
	TUNA, water packed	1/2 can	20	-	1.6	0	512		99
38	FISH STICKS, Mrs Paul's	4	8	23	13	0			240

GI	MISC/'JUNK' FOODS	SERVING	PRO	CARB	FAT	F	Na	K	CAL
55	SNICKERS BAR (Reg Size)	1 (2 oz)	4	35	14	1	140	184	271
	REESE'S PEANUT BUTTER CUP	1	2	9	5	1	53	58	88
59	PASTRY, Danish, cheese	1	6	26	16	1	320	70	266
	PASTRY, Doughnut, glazed	1	3	21	8	1	163	42	168
51	POTATO CHIPS, Plain, salted	1 bag (8 oz)	15	113	85	10	1192	3727	1242
	POPCORN, microwaved, reg	1 cup	1	19.4	10	0	156	48	179
	PIZZA, Frozen cheese, cooked	8 oz	21	58	24	4	889	302	533
	FRENCH FRIES, McDonalds	1 Med	4	46	19	5	266	655	370
46	BURGER KING WHOPPER, w/cheese	1	35	53	48	3	1432	534	790

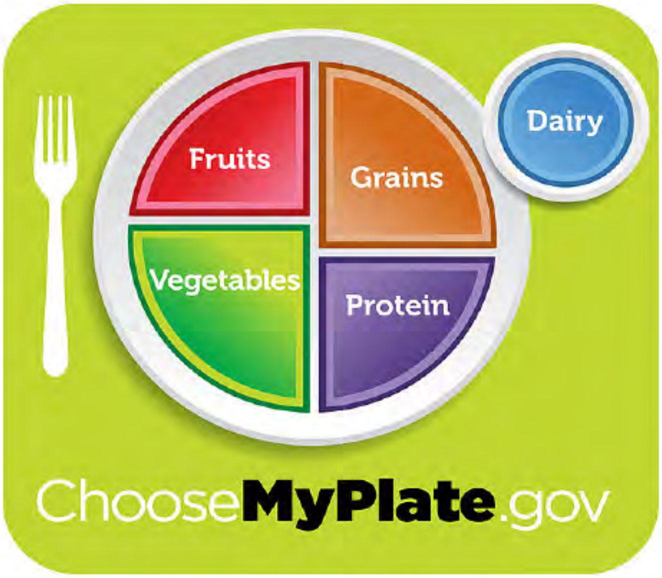
*There are many online sources for searching the GI of foods. One such recommended source is www.glycemicindex.com

American Dietary Guidelines are updated every 5 years by the Department of Health and Human Services (HHS) and the Department of Agriculture (USDA). According to these Dietary Guidelines for Americans, a healthy diet consists of:

- An emphasis on fruits, vegetables, whole grains and fat-free or low-fat milk products
- The inclusion of lean meats, poultry, fish, beans, eggs and nuts
- The avoidance of high saturated fats, trans fats, cholesterol, sodium and added sugars

MyPlate, which is a recommendation for the general public, age 2 years and older, is not meant for individuals with chronic health conditions or those who, for any reason, require a specialized diet for specific health needs. According to the Dietary Guidelines, which can be found at www.choosemyplate.gov, the recommendations set forth, as illustrated by the 'MyPlate' graphic, seen below, helps individuals to:

- Make smart choices from every food group
- Find balances between food and physical activity
- Get the most nutrition out of calories
- Stay within daily calorie need



In June 2011, the traditional 'Food Pyramid' was replaced with the MyPlate graphic in response to criticism that the pyramid illustration was too confusing.

GRAINS Make half your grains whole	VEGETABLES Vary your veggies	FRUITS Focus on fruits	MILK Get your calcium rich foods	MEAT & BEANS Go lean with protein
Eat at least 3oz of whole grains cereals, breads, crackers, rice or pasta every day 1oz is about 1 cup of breakfast cereal, ½ cup of cooked rice, cereal or pasta	Eat more dark green vegetables like broccoli, spinach and other leafy greens Eat more orange vegetables like sweet potatoes Eat more dry beans and peas like pinto beans, kidney beans and lentils	Eat a variety of fruit Choose fresh, frozen, canned or dried fruit Go easy on fruit juices	Go low-fat or fat-free when you choose milk, yogurt, and other milk products If you don't or can't consume milk, choose lactose-free products or other calcium sources such as fortified foods and beverages	Choose low-fat or less meats and poultry Bake it, broil it or grill it Vary your protein routine – choose more fish, beans, peas, nuts and seeds
Eat 6 ozs every day	Eat 2 ½ cups every day	Eat 2 cups every day	Get 3 cups every day For kids age 2-8, 2 cups	Eat 5 ½ ozs every day

*United States Department of Agriculture

This concludes the NFPT Personal Trainer Study and Reference Manual - we hope that you have learned from this material and that you have enjoyed your reading. If you are pursuing NFPT - CPT certification, please read all policy and procedure information as outlined in the NFPT Certification Handbook, found from your NFPT My Services account, or from the "Professional Documents" link at nfpt.com. This handbook will detail all Professional Standards for NFPT Certified Trainer Codes of Conduct as well as certification maintenance procedures. Thank you for your participation in the NFPT - CPT program.

We look forward to serving your Personal Trainer Certification needs. We extend our sincerest best wishes for you to achieve your fitness career goals and all professional fitness related endeavours. At NFPT, we are a family of fitness trainers and industry professionals, and we are happy to serve you in any effort that helps you succeed in this industry - we look forward to welcoming you to the family!

We encourage your questions, comments and input. Please feel free to contact NFPT Headquarters.

***NFPT Business Hours**:*
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Index

Glossary

Abduction: movement of an extremity away from the midline of the body

Acetate: an organic substance produced by the liver to be used for energy using cannibalized fat and muscle tissue; occurs during both starvation and overexertion; extreme levels are toxic to the brain

Actin: the smaller of the two contractile elements which sustain damage through applied resistance and are repaired through anabolism resulting in hypertrophy of the myofibril

Acute: rapid onset and severe symptoms of occurrence; usually referring to injury

Adipose: of a fatty nature; tissue that is used for the storage of fat

Adduction: movement of an extremity toward the midline of the body

ADP (Adenosine Diphosphate): resultant molecule of splitting ATP for energy, also used to regenerate ATP

Aerobic: requires the use of oxygen to adequately meet energy demands

Aerobic Metabolism: releases energy from carbohydrates, fats and proteins to form ATP, in the presence of oxygen

Agonists (Prime Movers): these muscles contract to create the ROM in a joint, they are primarily responsible for the movement

Amino acid: organic acids that link together to form proteins that are necessary for life

Amylase: carbohydrate digestive enzymes found in saliva and pancreatic fluid, that converts starch and glycogen into simple sugars

Anaerobic: relating to the absence of oxygen

Anaerobic Glycolysis: production of ATP in the absence of oxygen

Androgenic: contributing to the formation of male and/or female characteristics

Anemia: condition in which oxygen transport by the red blood cells is deficient

Anabolism: the stage of metabolism when damaged tissue is being repaired

Anatomy: the scientific study of the form and structure of the human body

Angina: periodic severe pain in the chest, radiating to the left shoulder and down the inner side of the left arm, usually precipitated by physical exertion or emotional stress

Antagonists: these muscles act to return a limb to its original place, they oppose the movement of the agonist

Antagonistic Multi-set: a slow "super set" involving the performance of two movements, back to back, targeting antagonistic muscle groups

Anterior: toward or on the front of the body

Arteriole: a very small artery

Artery: a vessel through which the blood passes away from the heart to the various parts of the body

ATP (Adenosine Triphosphate): a continuously recycled molecule that transports chemical energy within cells for metabolism

Atrium: each of the two upper chambers of the heart from which blood is passed to ventricles, receiving chambers

Atrophy: a wasting away or diminution in the size of a cell, tissue, organ, or part

Ballistic: jerky or projective movement, also known as 'power training' or 'Olympic lifting'

Beta Oxidation: energy producing process involving the breakdown of long chains of fatty acids into two carbon molecules which enter metabolic pathways to produce ATP

Bilateral: both sides of the body

Bile: emulsifier of fat; breaks fat down into easily metabolized droplets

Biology: the scientific study of life and living matter, including structure and function

Biomechanics: study of mechanical movement of the human body within the actions of external and internal forces

Blood sugar: circulating glucose within the cardiovascular system

Blood vessel: tubular structures carrying blood through the tissues and organs; a vein, artery, or capillary

Cannibalism: the breakdown and use of body tissue for energy in the absence of nutrients

Capillary: blood vessels that form a network between the arterioles and venules, where food and oxygen are released to the body cells, and carbon dioxide and other waste products are returned to the bloodstream

Cartilage: a tough yet flexible connective tissue located chiefly in the joints of major bones

Catabolism: is the set of metabolic processes that break down molecules into smaller units to release energy

Catalyst: a substance which changes the rate of a reaction but does not form part of the final product

Cell: known as the 'building blocks of life', able to independently replicate themselves, they are the smallest structural and functional unit of all living things

Cell Respiration: also known as aerobic metabolism, is the process for creating cell energy, occurring in mitochondria

Cerebrospinal Fluid: fluid which surrounds and circulates throughout the central nervous system

Circumduction: the motion of a circular movement of a limb

Citric Acid Cycle: taking place in the mitochondria, this cycle makes up all of the processes that are involved in the metabolic chain of chemical reactions to generate energy in all aerobic organisms

Collateral Circulation: fluid (blood) movement outside the main cardiovascular tree

Compensatory Acceleration: the increase in speed of a repetition as the leverage improves

Compound: the unity of two or more parts in the accomplishment of a task

Concentric Contraction: the occurrence of a contractile shortening of a muscle fiber or a group of fibers; positive rep

Contraindication: outward signal of internal dysfunction, or adverse bodily activity
Coronary Circulation: circulation of blood in the blood vessels of the heart muscle (the myocardium)

Cortisol: principle stress hormone released by the adrenal gland during times of physical and physiological stress, mobilizes fat and stimulates the liver to release tissue cannibalizing enzymes into the bloodstream

Cholesterol: substance found in blood born fats (lipids), it regulates membrane fluidity and functions as a precursor molecule in various metabolic pathways

Chronic: gradual in onset and very slow in recovery, usually refers to injury which is long in duration

Chylomicrons: packaged form of fatty substances entering into the blood from digestion via the lymphatic system

Creatine Phosphate: acts as store of high energy phosphate in muscle tissue

Cytosol: the fluid component of the cytoplasm of a cell where various organelles and particles are suspended

Deamination: the undesirable breakdown and use of amino acids for energy, performed by the liver, results in the toxic ammonia; later broken down into urea for excretion

Deep Muscle: a muscle that is towards the inner body

Delayed Onset Muscle Soreness (DOMS): generally the result of eccentric contraction damage, it is the pain and soreness experienced within hours, or a day or two, after strenuous or unaccustomed exercise

Deviation: departure from the midline

Diastole: in terms of blood pressure, represents the period of time when the ventricles are relaxed and blood is going from the left atrium and right atrium into the left ventricle and right ventricle, respectively. It is the recurring <u>relaxation</u> of the heart muscle

Dilation: the peripheral expansion of tissue; usually blood vessels

Distal: furthest from the point of origin from center of the body

Dorsiflexion: pointing foot up towards the shin

Dynamic Constant External Resistance (DCER): resistance training where joint flexion and extension occur with each repetition; external resistance does not change.

Dynamic Variable External Resistance (DVER): resistance training where external resistance is variable

Eccentric Contraction: a controlled contraction of a muscle fiber of group of fibers from the fully contracted state to the starting position; a contractile lengthening, the negative rep

Ectomorph: body type that is characterized by a relative tendency to remain very thin

Edema: the presence of an abnormally large volume of fluid in the interstitial spaces of the body

Endomorph: body type that is characterized by a relative tendency to remain heavy or obese

Endomysium: a fine connective tissue sheath surrounding the individual muscle cell fiber

Enzyme: a substance produced by an organism that acts as a catalyst to bring about a specific biochemical reaction

Epimysium: a fine connective tissue sheath that surrounds the entire muscle group, also known as deep fascia

Equilibrium: the stage in metabolism when neither damage or repair is occurring; the cell is at rest

Ergometer: device normally used for submaximal aerobic evaluation (exercise bike)

Eversion: turning both feet outward so the soles face away from each other

Exogenous: imposing an effect on the body from the outside environment

Extension: the straightening of a joint that increases the angle

Extracellular: all areas outside the tissue cell wall; usually referring to intramuscular areas

Fascia: a thin sheath of fibrous tissue enclosing a muscle or other organ

Fascicle: a bundle of muscle fibers

Fatty acids: the body's desired source of energy during steady state aerobic activity, and low level activity; used for ATP production in muscle tissue during recovery glycogen replenishment

Fixators: these muscles provide stabilization to support the rest of the body during the respective movement, and are sometimes referred to as stabilizers

Flexion: the bending of a joint that decreases the angle

Forced Rep: performing repetitions of an exercise beyond concentric failure with the assistance of spotter

Gliding: movement of non-angular joints over each other

Glucagon: hormone released in response to low blood sugar level; stimulates the liver to release stored glycogen in the form of glucose into the bloodstream, returning blood sugar levels to normal

Glucometer: self-testing device used to measure blood glucose

Gluconeogenesis: the formation of glucose from noncarbohydrate sources such as protein or fatty acids

Glucose: the principle blood sugar

Glucose polymers: chain of glucose molecules linked together

Gluco-Stix: blood blotting stick used in conjunction with glucometer testing

Glycemic Index: is a number associated with a particular type of food that indicates the food's impact on a person's blood glucose level. The number typically ranges between 50 and 100. On the extreme end of the scale the number 100 represents near pure glucose

Glycemic Load: a rating given to food as a measure of the quantity of carbohydrate

Glycerol: component of triglycerides capable of conversion to glucose

Glycogen: the primary form of stored glucose

Glycogenolysis: the intermittent release of stored glycogen from the liver to regulate blood sugar, primarily for brain function

Glycolysis: energy production using glucose

Golgi Tendon Organ (GTO): a proprioceptive sensory nerve ending embedded among the fibers of a tendon that prevents muscle contraction just short of serious acute muscle injury related to extreme overload

Gonadotrophic hormones: pituitary hormones released to act on the testes and adrenal glands

Growth Hormone (GH): also known as somatotropin or somatropin, is a stress hormone that raises the concentration of glucose and fatty acids. It stimulates growth, cell reproduction and regeneration

Gynecomastia: enlargement of breasts in the male as a result of hormonal manipulation

Hormones: regulatory substances transported in tissue fluids to stimulate specific cells that control a specific body process

Hydrolysis: water based decomposition

Hyperextension: extension beyond normal limits, over extended

Hyperplasia: an increase in the size of a muscle or organ resulting from an increase in the number of structural muscle/organ cells

Hypertension: abnormally high tension; usually high blood pressure

Hypertonic: having an osmotic pressure greater than that of another solution with which it is compared

Hypertrophic Protein Synthesis: process by which actin and myosin are repaired

Hypertrophy: the enlargement or overgrowth of a part due to an increase in the size of its cells

Hypoextension: extension that is less than normal, under-extended

Hypoglycemia: concentration of glucose in the blood below the normal limit

Hypotonic: having an osmotic pressure lower than that of a solution with which it is compared

Internal rotation: movement in which the anterior surface of the humerus (upper arm) turns inward toward the midline of the body.

Impermeable: not permitting for passage; usually fluid

Inferior: below, toward the lower part of the body

Innervation: a nerve supply that stimulates a motor unit to contract regardless of the angle of resistance, so long as the action potential exceeds the motor unit's contractile threshold

Insertion: place of attachment of a muscle to the bone which it moves; occurs at the end of the muscle furthest from the body

Insulin: hormone released during high blood sugar levels, or at the onset of exercise, responsible for reducing blood sugar to its normal level through its mediating affect on the uptake of sugar into various body tissues to include muscle and fat

Insulin Receptor Sites: gateways located on various body tissues, which in the presence of insulin, allow for the transport of nutrients into the cell

Intracellular: situated inside the cell

Intramuscular: areas which are situated anywhere inside a muscle group

Intercostal: muscles that are situated between the ribs

Interstitial: pertaining to, or situated in, the gaps between tissues

Inversion: turning both feet inward so the soles face each other

Isokinetic contraction: the muscle contracts and shortens at a constant rate of speed

Isometric Contraction: static contraction; contraction of a muscle resulting in neither a shortening or lengthening of the tissues

Isolation: to single out and develop a part separately

Joint: the location at which two or more bones come together for movement and mechanical support; the intersection of bones

Keto acid: an acid containing a ketone group in addition to the acid group

Keto-Stix: self-test sticks used to determine urine levels of acetate, ketones

Ketones: by-product of tissue use for energy, produced by the body when fat instead of glucose is burned for energy; large amounts are toxic to brain function

Kinematics: a branch of biomechanics that specifically studies the time taken to carry out an activity.

Kinesiology: study of anatomy, physiology, mechanics of human movement, also known as human kinetics

Kyphosis: excessive outward curvature of the spine

Lactic acid: a fuel that assists pyruvate and accumulates in muscle fibers during anaerobic glycolysis, faster than can be completely used inhibiting contraction; once removed, can be converted back into energy by the liver

Lateral: away from the middle of the body

Leverage: an angle from which resistance is applied against a muscular contraction

Ligament: strong stretchy bands of tough, fibrous tissue that hold joints together

Lipolytic enzymes: fat digestive enzymes

Lipolysis: the breakdown of fats and other lipids by hydrolysis to release fatty acids

Lordosis: excessive inward curvature of the spine

Lymphatic vessels: network of vessels that transport fluids from the interstitial areas back into the bloodstream

Lypase: one of two principle fat burning enzymes

Medial: towards the middle of the body

Menisci: crescent shaped structure that partly divides a joint cavity, provides cushioning at the joint's surface

Mesomorph: body type characterized by a relative tendency to remain/appear muscular and maintain normal weight

Metabolic Oxidation: chemical energy being made available for synthesis of ATP as one atom becomes oxidized and another atom becomes reduced

Metabolism: the chemical reactions that are required for maintaining a living state of cells in an organism. It is the sum of all the chemical and physical changes that take place in the body and enable continued growth and functioning

Minerals: naturally occurring inorganic substance obtained from food; cannot be synthesized by the body

Mitochondria: known as the 'powerhouse of the cell', these cell organelles take in nutrients and break them down to create energy for the cell

Molecule: the smallest unit of a chemical compound, always in motion, made up of atoms that are held together by chemical bonds formed by sharing or exchanging electrons

Motor Unit: a group of fibers stimulated to contract simultaneously in response to an action potential (resistance) of sufficient intensity to surpass its threshold of sensitivity

Myocyte: also known as the individual **muscle fiber**, it is the actual muscle cell found in the muscle tissue

Myofibril: contractile proteins inside the cell comprised of actin and myosin

Myosin: the larger of the two contractile elements making up the myofibrils

Neuron: a nerve cell transmitting an impulse allowing for the contraction of a motor unit

Nucleolus: surrounds nucleus and houses RNA

Nucleus: the controlling organelle embedded in cell membrane and houses DNA

Organ: a group of tissues joined together to function for a specific purpose inside the living organism

Organelle: any organized/specialized structure within a living cell (e.g. nucleus, mitochondria)

Organism: the material structure, as a whole, of any living thing

Organ System: group of organs working together to function as an entire system inside the living organism

Origin: the attachment of a muscle at the end closest to the center of the body

Oxidative Phosphorylation: the metabolic pathway, occurring in the electron transport chain, where energy that is released by the oxidation of chemical compounds generated in the citric acid cycle are used to reform ATP

Peptides: short chains of amino acid molecules linked together

Peripheral: toward the extremities

Perfusion: passage of blood through the vascular tissue into muscular interstitial space, providing for oxygen and nutrient rich blood to be delivered to body tissue

Perimysium: connective tissue sheath surrounding each motor unit

Phospholipids: a lipid consisting of a glycerol bound to two fatty acids and a phosphate group; they form the lipid bilayer in cell membranes

Plantar Flexion: flexing foot downward

Plateau: period of training in which no progress is observed

Posterior: toward or on the back of the body

Prime Mover: A muscle group directly responsible for the movement of resistance in a given exercise

Pronation: palm of hand turning downward into a posterior position when arm is down at side; the inward roll of the foot/arch decreased during normal walking motion

Protease: protein digesting enzymes

Protraction: forward (anterior) movement of the body part

Proximal: closest to the point of origin from the center of the body

Pulmonary circulation: process in the cardiovascular system by which the blood flows between the heart and lungs

Pyruvate: converted form of intracellular glucose used for producing ATP energy with oxygen

Red blood cells (erythrocytes): contains the pigment hemoglobin; transports oxygen and carbon dioxide to and from the tissues

Retraction: backward (posterior) movement of a body part

Ribosomes: elements located along myofibrils which act to manufacture and repair actin and myosin

Rotation: external rotation is the movement of the body part away from the axis or center of the body; internal rotation is the movement of the body part towards the axis or center of the body

Rough Sarcoplasmic Reticulum: houses ribosomes and surrounds myofibrils

Sarcolemma: a fine membrane that the myofibrils are wrapped in

Sarcomere: the contractile units of skeletal muscle, occurring in repeating segments along the length of the myofibril

Sarcoplasma: the gelatinous viscous material that encloses the individual muscle fibers

Sarcoplasmic Reticulum: a system of tubules, surrounding each myofibril, that transmits electrical impulses to 'excite' the sarcolemmal membrane into releasing the calcium ions and activating the contraction; calcium ions are released during muscle contraction and absorbed during relaxation

Scoliosis: abnormal lateral curvature of the spine

Sliding Filament Theory: the result of a repetitive cycle of thin filaments sliding over thick filaments, generating tension in the muscle, thus shortening the length of the sarcomere which shortens the length of the muscle fiber, enabling the contraction

Stress Hormones: released by the hormone regulating endocrine system, in situations that are potentially dangerous or stressful. These hormones, such as cortisol and epinephrine, mobilize energy from storage to muscles, increasing heart rate and blood pressure and decreasing metabolic and immune processes

Supination: palm of hand turning upward into an anterior position when arm is down at side; the outward roll of the foot, 'under-pronation'/arch heightened during normal walking motionSuperficial: towards the outer surface of the body

Superior: above, toward the upper part of the body

Symmetrical: opposite sides of the body corresponding with each other; usually refers to muscular development

Synergists: These muscles neutralize the extra motion from the agonists, and are sometimes referred to as neutralizers; they make sure that the force of the movement is acceptable for the desired plane of motion

Synovial Fluid: is a viscous fluid found in the spaces of synovial joints (such as a knee joint). The fluid prevents the bones of a joint from direct contact with each other, so as to eliminate friction

Synthesis: combining parts to form a more complete whole

Systemic Circulation: process of the cardiovascular system which carries oxygenated blood away from the heart to the body, and returns deoxygenated blood back to the heart

Systole: in terms of blood pressure, represents the time during which the left and right ventricles contract and eject blood into the aorta and pulmonary artery, respectively. A recurring contraction of the heart

Tendon: fibrous cord of connective tissue in which the muscles end, and are where muscles attach to bone or other structures

Tissue: a collection of similar cells from the same origin that function together for a specific purpose

Triglycerides: a compound formed from glycerol and three fatty acid groups; they are the main component of natural fats and oils

Tropic: triggering or influencing an action

Tubercles: the rounded nodules, or outgrowths, on bones that generally serve as sites for muscle insertions

Type 2 Diabetes: chronic disease in which there are high levels of sugar (glucose) in the blood, the most common form of diabetes

Unilateral: one side of the body

Urinary Urea Nitrogen (UUN) test: a method by which nitrogen is measured in the urine

Valsalva Maneuver: increasing of intrathoracic pressure by holding the breath and straining against a closed glottis; typically associated with coughing, defecation, and weight lifting

Vasoconstriction: the constriction, or narrowing, of blood vessels which results in increased blood pressure

Vasodialation: the dilation, or widening, of blood vessels which results in decreased blood pressure

Vein: vessel through which blood is delivered to the heart

Ventricle: chamber of the heart responsible for pumping blood to the aorta, the sending chambers; the heart has two of these chambers (left and right)

Vessels: a hollow tube or canal (e.g. artery, vein or lymphatic) in which a body fluid is contained or circulated

Vitamin: any group of organic compounds that are essential for growth and nutrition; cannot be synthesized by the body

VO_2max: the maximum amount of oxygen that the body can use during exercise, where (V) = Volume and (O_2max) = Oxygen Maximum

Wellness: the quality or state of being in good health, especially as an actively sought after goal

White blood cells (leukocytes): colorless cells that circulate in the body and blood fluids involved in counteracting foreign substances and disease

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