Section 1: Professional Development and Responsibility

Chapter 1. The Modern State of Health and Fitness Summary

- The focus on scientific principles makes NASM's systems and methodologies safe and effective for any client working toward any fitness goal.
- NASM recommends that all fitness professionals maintain a focus on an evidence-based practice to attain the highest levels of success.
- Evidence-based practice is the conscientious use of current best evidence in making decisions about patient or client care.
- NASM's proprietary approach to exercise training, the OPT model, was developed with evidence-based practice as a core guiding philosophy.
- Acute disease is any suddenly occurring medical condition that can be treated and healed in a short period of time.
- A chronic disease is a medical condition that persists without quickly going away or being cured altogether.
- The terms *overweight* and *obesity* refer to a body weight that is greater than what is considered normal or healthy for a certain height, specifically due to excess body fat.
- Being overweight or obese greatly increase the chances of developing a chronic disease.
- *Cardiovascular disease* is a broad term describing numerous problems of the heart and blood vessels, including stroke, heart attacks, heart failure, heart valve problems, and arrhythmias.
- Hypertension is one of the primary risk factors for heart disease and stroke, which are the global leading causes of death.
- Cholesterol is a waxy substance found in the blood that is made up of a combination of protein and fatty acids.
- Diabetes is a disease in which blood glucose levels are too high. Glucose comes from the foods we eat.
- Insulin is a hormone produced by the pancreas that helps glucose get into cells to provide the energy for work.
- Cancer is an abnormal growth of cells that can result from a wide range of genetic and environmental factors.
- *COPD* is an umbrella term for lung diseases characterized by increased breathlessness, airflow limitation, and accelerated decline of lung function.

Two of the most common issues at the foot and ankle are sprains and plantar fasciitis. An ankle sprain occurs when a person rolls, twists, or turns an ankle, which stretches or tears ligaments, whereas plantar fasciitis causes pain in the plantar fascia tissue located on the underside of the foot.

The LPHC is made up of the lumbar spine (low-back area), pelvis, abdomen, and hip musculoskeletal structures; it is more commonly referred to as the "core." The LPHC is an important anatomical structure because it connects the upper and lower halves of a person's body.

Shoulder dysfunction is very common in the greater population, especially in those who frequently lift objects overhead.

Regular exercise and increased physical activity have been frequently shown by research to improve numerous types of musculoskeletal dysfunction and chronic disease.

Understanding the scopes of practice for all adjacent allied health professionals, as well as all relevant local laws and regulations, will ensure CPTs are always working within their own scope of practice.

Networking with other allied health professionals and certified fitness professionals can lead to great levels of success in the fitness industry.

An NASM-CPT must always adhere to the NASM Code of Professional Conduct.

Important Concepts (not an exhaustive list)	
Body Mass Index** very important	<18.5 = underweight 18.5-24.9 = healthy weight 25-29.9 = overweight 30-34.9 = obese 35-39.9 = obese II ≥40 = obese III
Blood Pressure** very important	Normal (healthy): Less than 120/80 mm Hg Elevated: Systolic between 120 and 129 and diastolic less than 80 mm Hg Stage 1 hypertension: Systolic between 130 and 139 or diastolic between 80 and 89 mm Hg Stage 2 hypertension: Systolic 140 or higher or diastolic 90 mm Hg or higher Hypertensive crisis: Systolic greater than 180 and/or diastolic greater than 120 mm Hg
LDL Cholesterol	LDL cholesterol, sometimes referred to as "bad cholesterol," tends to increase the risk of cardiovascular disease. LDLs, specifically, are the form of cholesterol that makes up the plaque that clogs arteries. Ideally, LDL levels should be less than 100 milligrams per deciliter (mg/dL).

HDL Cholesterol	Sometimes referred to as "good cholesterol." It does not have the tendency to clog arteries like LDL cholesterol does and, in fact, actually helps remove some LDL cholesterol from the body. To help reduce the risk of heart disease, in conjunction with lowering LDL levels below 100 mg/dL, HDL levels should typically be kept around 60 mg/dL.
Type 1 Diabetes	With type 1 diabetes, the pancreas does not make enough insulin (or none at all), which is a hormone that helps transport glucose into cells to be used for energy. Without insulin, glucose in the blood (i.e., blood sugar) can rise to dangerous levels, causing numerous health complications. Type 1 diabetes is typically genetic and is not something a person can actively prevent. However, regular exercise can help people with type 1 diabetes considerably improve their blood glucose management and quality of life.
Type 2 Diabetes	With type 2 diabetes, the body still produces insulin; however, it is not used properly by the cells. When excess carbohydrates (specifically sugar) are chronically consumed in the diet, high levels of insulin need to be produced to help regulate blood sugar. When excess insulin continually tries to deliver glucose to cells when they already have more than they can use, cells stop responding to it. This state is called insulin resistance. Once cells have become insulin resistant, a person is said to have developed type 2 diabetes. Regulating blood sugar can become very difficult for these individuals, which may lead to uncontrolled blood sugar levels and a wide variety of health complications.

Chapter 2. The Personal Training Profession Summary

From working in a large health club, to training clients in their own homes, fitness professionals have numerous options to establish a personal training practice with a consistent flow of clients.

Another employment choice for fitness professionals is starting a fitness business, which could include working with clients in their homes, running outdoor group workout programs, or opening a studio.

As technology is evolving, there are many options for offering training services online.

Working as an independent contractor allows a fitness professional to establish his or her own pay rates and to earn the entire amount, but operational expenses, insurance costs, and taxes must also be accounted for.

The first step in succeeding as a CPT is offering uncompromising customer service.

Selling personal training services is about asking a client to make a commitment to an exercise program to improve his or her own health, wellness, and fitness, which makes selling an activity of uncovering client needs and presenting solutions to those problems.

If rapport is properly built with a prospective client, sales will feel natural and automatic.

Forecasting techniques should be used to predict how many clients will need to be serviced to support a desired annual financial goal.

Marketing is the process of communicating how a specific product or service will meet the wants and needs of a potential client.

The Four Ps of marketing include product, price, promotion, and place.

Social media and other digital marketing campaigns are extremely important for growing a modern fitness business.

Continuing education courses are not just necessary for recertification; they can teach fitness professionals how to work with niche populations and enable the expansion of a fitness business to new and exciting areas.

The most popular methods of earning CEUs are attending workshops or conferences or completing online education programs. Additionally, CEUs can be earned by participating in livestream webinars, reading fitness articles and passing a quiz or test, or contributing to the industry by creating content for fitness education programs, speaking at conferences, and presenting webinars.

Important Concepts (not an exhaustive list)	
SWOT Analysis	**Strengths:** Identify the strengths and competitive advantages including education, skills, abilities, or work experience with a specific population. Examples of strengths might be education, certifications earned; the name or location of employer, which itself may have a strong brand identity; or experience working with a particular type of client. The strengths can ultimately help identify the professional traits to develop a brand identity. **Weaknesses**: Identify any and all weaknesses; be honest and thorough, the more honestly a fitness professional can assess their weakness, the more opportunities for growth can be identified. Examples of weaknesses might be unfamiliarity with specific types of clients such as elite athletes, being uncomfortable with the sales process, or overall lack of fitness industry experience. **Opportunities:** Identify the opportunities for developing new professional skills or expanding into new business opportunities, such as being able to coach group workout programs. Weaknesses can be turned into opportunities; for example, the lack of education in a specific area of exercise science is actually

	an opportunity to take a continuing education workshop to gain the necessary knowledge to work with a specific type of client. **Threats:** Identify all of the threats that might impact a fitness professional's business. Examples of threats are the general economic climate, the number of other fitness professionals working in a health club, or competitors who plan on growing or expanding into the marketplace. In some cases, threats are due to external forces that cannot be controlled (such as an economic recession), while in other cases they can be turned into opportunities for new business.
4 Ps of Marketing** very important	Communicating the benefits of using a **product.** Identifying a competitive **price** of the service. Determining how the service will be **promoted.** Selecting the **place** or method of distribution.
Continuing Education** very important	A total of 2.0 CEUs is required to renew the NASM-CPT credential every 2 years: 1.9 CEUs from continuing education efforts and 0.1 CEU from renewing a CPR/AED certification.

Section 2: Client Relations and Behavioral Coaching

Chapter 3. The Psychology of Exercise Summary

- Psychology is an important component to behavioral change and plays a key role in adopting a regular habit to exercise.
- Psychologists and psychiatrists are trained and licensed professionals who treat people with mental illnesses.
- Sport and exercise psychology is a subtopic of psychology that focuses on understanding why people participate in sports and exercise, including motives and barriers to participation.
- Extrinsic motivation happens when someone does something for rewards or recognition.
- Intrinsic motivation describes the motivation to do something that comes from within an individual; it is strongly related to long-term adherence.
- Motivation to exercise differs among individuals and will change over time; therefore, motives should be reevaluated over time.
- Common barriers to exercise include lack of time, unrealistic goals, lack of social support, social physique anxiety, lack of convenience, and ambivalence, but all barriers can be either eliminated or minimized with some basic strategies that provide realistic solutions or alternatives.
- Lack of time can be minimized by improving time management and reevaluating daily priorities.
- Setting unrealistic goals can become a barrier to exercise, therefore, the fitness professional should assist clients with setting appropriate outcome and process goals.
- Social physique anxiety refers to people feeling anxious about how others perceive their bodies and can be a barrier to exercise participation. Helping clients find activities that reduce this type of anxiety will help create a comfortable exercise environment.
- The perception barrier of exercise as inconvenient can be overcome by making the exercise experience as appealing as possible, both by providing excellent customer service in clean facilities and by helping clients find ways to exercise outside of a fitness facility.
- Ambivalence to exercise occurs when someone has mixed feelings about exercise and likely sees pros and cons to participation.
- Social influences on exercise can come from other people, the internet, or the environment; these influences can lead people both toward and away from exercise.

- Social support consists of a source (who or what provides it) and a type (instrumental, emotional, informational, and companionship), and clients will have different needs and expectations of social support.
- Instrumental support includes the tangible things that assist people with the ability to exercise, such as providing transportation to a fitness facility, assisting with childcare, or packing someone's gym bag.
- Emotional support comes from being caring, empathetic, and concerned about someone's experience with exercise.
- Showing empathy includes the ability to relate to the way another person feels or views a situation.
- Informational support is one of the main reasons why someone will seek out a fitness professional; it includes providing accurate and current information about fitness and exercise.
- Companionship support is when someone exercises with another person.
- Group influences on exercise refer to the influence held by other people over whether or not someone exercises and can come from family members, parents, exercise leaders, exercise groups, or the surrounding community.
- Parental influence is important for children and adolescents, whereas instrumental support is often cited as the most influential type of support.
- The exercise leader sets the tone of the class and is responsible for creating an inviting and inclusive exercise environment.
- Once formed, exercise groups often feel distinct from others and can lead to additional accountability and encouragement.
- The community influences exercise by the safety level of the exercise environment and the number of opportunities for exercise, which includes sidewalks, green spaces, playgrounds, and walking trails.
- Exercise provides several psychological benefits that can enhance overall well-being, including improved mood, better sleep quality, increased self-esteem, improved body image, and fewer depression and anxiety symptoms.

Important Concepts (not an exhaustive list)	
Examples of extrinsic motivation for exercise** very important	Social recognition Rewards from competitions (trophy or award) Improvement of physical appearance
Examples of Intrinsic motivation for exercise** very important	Stress relief Increasing energy Finding new ways to be challenged physically
Examples of outcome goals** very important	Place in top 10 in a 10K race Achieving a certain level of body fat Achieving a certain level of strength improvement

Examples of process goals** very important	Jog for 45 minutes, starting at 6:30 a.m. Monday–Friday to assist with weight loss efforts. Eating 1600 calories per day of mostly whole, unprocessed foods to assist with weight loss efforts. Strength training 5 days per week, targeting each muscle group to increase gains in muscle mass.

Chapter 4. Behavioral Coaching Summary

- Clients expect professionalism, thus, it is crucial to build relationships and maintain a facility that supports training competency.
- Program designs should be based on the clients' abilities and should address their health concerns and goals.
- Self-efficacy is one of the strongest determinants of physical activity in adults; most coaching efforts are directed at increasing a person's self-efficacy.
- Planning and self-monitoring are essential techniques in developing a self-regulatory strategy to improve self-efficacy.
- Affective judgments and subjective norms can impact a person's readiness to perform resistance training.
- CPTs should assess a client's stage of change and promote competency in exercise.
- The stages of change include precontemplation, contemplation, preparation, action, and maintenance.
- Both verbal and nonverbal forms of communication are important for developing professional client relationships.
- Active listening refers to having a genuine interest in understanding the client's health and fitness goals. It involves asking appropriate questions, avoiding distractions and inner dialogue, and providing appropriate feedback.
- Motivational interviewing is a style of coaching that is used to enhance intrinsic motivation for change. CPTs can use some techniques from motivational interviewing, such as developing a discrepancy between a client's current state and ideal state, promoting change talk, and assessing readiness, willingness, and perceived ability to change.
- BCTs are used to enhance the determinants of behavior. CPTs may use any number of strategies to enhance a client's confidence, motivation, or self-regulation skills through planning, self-monitoring, and goal setting.
- Cognitive strategies that can help change behaviors include positive self-talk, imagery, and the practice of psyching up before activity.
- Goals that clients set should be SMART: specific, measurable, attainable, realistic, and timely. Clients should also focus on both process goals and outcome goals.
- For the best outcomes, clients should determine long-term bigger goals, then develop a series of smaller goals that help drive progress to the main goal.

Important Concepts (not an exhaustive list)	
Self-efficacy	One's belief that they can complete a task, goal, or performance; also known as self-confidence.
Self-monitoring	Observing, measuring, and evaluating one's own behavior, often in the form of a diary or log.
Stages of Change Model** very important	**Precontemplation:** Client does not exercise and is not planning to start exercising within 6 months. **Contemplation:** When a person is thinking about implementing change but has not yet taken any steps to get started; an individual may take action within the next 6 months. **Preparation:** The client intends to act in the near future, usually within the next month. **Action:** The client has made specific modifications in their exercise routine within the past 6 months. **Maintenance:** The client has been exercising for more than 6 months and is working to prevent relapse.
Decisional balance	Reflects the clients' weighing of the pros and cons of changing.
Examples of closed-ended questions** very important	Are you motivated to exercise? Can you commit to exercising three days per week? Do you enjoy exercise?
Examples of open-ended questions** very important	How might you go about making this change? What challenges do you see, and how can you plan to overcome them? What work are you prepared to do to reach your goal? What have you tried in the past to reach your fitness goal?
Examples of SMART goals** very important	I will gain 5 pounds (2.27 kg) of muscle within 5 months, starting today, by weight lifting a minimum of 4 days per week for 1 hour each session. I will reduce my blood pressure by five points within 6 months by walking a minimum of 30 minutes each day and reducing my daily salt intake to no more than 2,300 milligrams per day. I will lose 10 pounds (4.53 kg) of body fat within 3 months by reducing my daily calories from 3,000 to 2,000 per day and exercising at a moderate intensity at a minimum of 150 minutes per week. Examples that are **not** SMART Goals I will lose weight so I can become the best version of myself. ○ This goal is not specific or measurable— how much weight? ○ This goal does not have a timeframe— how long is this goal?

	I will gain 10 pounds of muscle, so I'm ready for beach season. ○ This goal is not specific— what steps will you perform to gain muscle? I will lose 50 pounds in two months, so I look my best for my upcoming class reunion. ○ This goal is not realistic— losing 50 pounds in two months in a safe fashion is impossible for most people.

Section 3: Basic and Applied Sciences and Nutritional Concepts

Chapter 5. The Nervous, Muscular, and Skeletal Systems Summary

Nervous System

- The human movement system includes an integration of the nervous, skeletal, and muscular systems.
- The nervous system provides sensory (afferent) and motor (efferent) information.
- The neuron is the functional unit of the nervous system.
- The nervous system includes the CNS (brain and spinal cord) and PNS (somatic and autonomic nervous system).
- The PNS contains different types of sensory receptors such as mechanoreceptors, nociceptors, chemoreceptors, and photoreceptors.
- The muscle spindle and Golgi tendon organ are two important sensory receptors (mechanoreceptors).
- The PNS contains two subdivisions: the somatic and autonomic nervous systems.
- The nervous system requires different electrolytes for proper function, which include sodium, potassium, magnesium, and water.
- Motor skill development often occurs in three stages: cognitive, associative, and autonomous.
- The nervous system develops as humans age from childhood to adulthood.

Important Concepts (not an exhaustive list)	
Human movement system (HMS)	The collective components and structures that work together to move the body: muscular, skeletal, and nervous systems.
Neuron	Specialized cell that is the functional unit of the nervous system.
Three components of a neuron	Neurons are composed of three main parts: cell body, axon, and dendrites.
Central nervous system (CNS)	A division of the nervous system that includes the brain and spinal cord.
Peripheral nervous system (PNS)	Nerves that connect the rest of the body to the central nervous system.
Afferent pathway	Sensory pathway that relays information to the central nervous system.
Efferent pathway	A motor pathway that relays information from the central nervous system to the rest of the body.

Mechanoreceptors	Specialized structures that respond to mechanical forces (touch and pressure) within tissues and then transmit signals through sensory nerves.
Somatic nervous system	Nerves that serve the outer areas of the body and skeletal muscle and are largely responsible for the voluntary control of movement.
Autonomic nervous system	A division of the peripheral nervous system that supplies neural input to organs that run the involuntary processes of the body (e.g., circulating blood, digesting food, producing hormones).
Sympathetic nervous system	Subdivision of the autonomic nervous system that works to increase neural activity and put the body in a heightened state.
Parasympathetic nervous system	Subdivision of the autonomic nervous system that works to decrease neural activity and put the body in a more relaxed state.
Proprioception	The body's ability to naturally sense its general orientation and relative position of its parts.
Muscle spindles** very important	Sensory receptors sensitive to change in **length** of the muscle and the rate of that change.
Golgi tendon organ (GTO) ** very important	A specialized sensory receptor located at the point where skeletal muscle fibers insert into the tendons of skeletal muscle; sensitive to changes in muscular **tension** and rate of tension change.
Three stages of motor skill development	During stage 1 (cognitive), you may need to use simple instructions and break down the skill into smaller steps so your clients will be able to understand the goals of the movement. During stage 2 (associative), you may need to help refine your clients' skills through practice and regular feedback. During stage 3 (autonomous), you may be able to teach your clients new versions of the skill to further challenge them.

Skeletal System

- The skeletal system provides support for the body and protects the internal organs.
- The skeletal system has two divisions: axial and appendicular.
- Human bones act as attachment sites and levers (rigid rods) to produce movement when muscles contract.
- Bone growth occurs throughout life and remodels itself with specialized cells called osteoblasts and osteoclasts.
- There are five categories of bones: long, short, flat, irregular, and sesamoid.
- The vertebral column has five distinct regions: cervical, thoracic, lumbar, sacrum, and coccyx.
- In between each vertebra is an intervertebral disc that acts as a shock absorber and assists with movement.
- Joints are formed by one bone articulating with another and can be categorized by their shape, structure, and function.

- Osteokinematic describes bone movement, and arthrokinematic describes movement at the joint surface.
- Synovial joints are unique with a synovial capsule but also contain other connective tissues, such as ligaments and fascia that provide support.
- Synovial joints have six classifications: gliding (plane), condyloid, hinge, saddle, pivot, and ball-and-socket joints.
- Exercise and proper nutrition can have a major positive impact on bone mass with the aging adult.

<table>
<tr><th colspan="2">Important Concepts (not an exhaustive list)</th></tr>
<tr><td>Skeletal system</td><td>A description of the bones of the body. In the human skeletal system, there are 206 bones of which approximately 177 are used in voluntary movement.</td></tr>
<tr><td>Axial skeleton</td><td>A division of the skeletal system consisting of the skull, the rib cage, and the vertebral column. There are approximately 80 bones in the axial skeleton.</td></tr>
<tr><td>Appendicular skeleton</td><td>A division of the skeletal system consisting of the arms, legs, and pelvic girdle. The appendicular skeleton encompasses approximately 126 bones.</td></tr>
<tr><td>Remodeling</td><td>The process by which bone is constantly renewed by the resorption and formation of the bone structure.</td></tr>
<tr><td>Osteoclasts</td><td>Special cells that break down and remove old bone tissue.</td></tr>
<tr><td>Osteoblasts</td><td>Special cells that form and lay down new bone tissue.</td></tr>
<tr><td>Types of Bones</td><td>
<table>
<tr><th>Bone Type</th><th>Characteristic</th><th>Example</th></tr>
<tr><td>Long</td><td>Long, cylindrical shaft with irregular or widened ends</td><td>Humerus (i.e., the upper arm bone)
Femur (i.e., the thigh bone)</td></tr>
<tr><td>Short</td><td>Similar in length and width and appear somewhat cubical in shape</td><td>Carpals of the wrist
Tarsals of the ankle</td></tr>
<tr><td>Flat</td><td>Thin, protective surfaces that provide broad surfaces for muscles to attach</td><td>Scapulae (i.e., the shoulder blades)
Sternum (i.e., the breast plate)
Ribs</td></tr>
<tr><td>Irregular</td><td>Unique shape and function from all other bone types</td><td>Vertebrae (i.e., the spinal column)</td></tr>
<tr><td>Sesamoid</td><td>Small, often round bones embedded in a joint capsule or found in locations where a tendon passes over a joint</td><td>Patella (i.e., the kneecap)</td></tr>
</table>
</td></tr>
<tr><td>Depressions</td><td>Flattened or indented portions of bone.</td></tr>
<tr><td>Processes</td><td>Projections protruding from the bone where tendons and ligaments can attach.</td></tr>
</table>

<table>
<tr><td>Segments of Vertebral Column</td><td>
<table>
<tr><th>Segment</th><th>Description</th></tr>
<tr><td>Cervical spine (C1–C7)</td><td>First seven vertebrae starting at the top of the spinal column
Form a flexible framework and provide support and motion for the head</td></tr>
<tr><td>Thoracic spine (T1–T12)</td><td>Twelve vertebrae located in the upper and middle back behind the ribs
Each vertebra articulates with a rib helping form the rear anchor of the rib cage
Larger than cervical vertebrae and increase in size from top to bottom</td></tr>
<tr><td>Lumbar spine (L1–L5)</td><td>Five vertebrae of the low-back below the thoracic spine
Largest segments in the spinal column
Support most of the body’s weight and are attached to many back muscles</td></tr>
<tr><td>Sacrum</td><td>Triangular bone located below the lumbar spine
Composed of five vertebrae that fuse together as the body develops into adulthood</td></tr>
<tr><td>Coccyx</td><td>Located below the sacrum, more commonly known as the tailbone
Composed of three to five small fused bones</td></tr>
</table>
</td></tr>
<tr><td>Osteokinematics</td><td>Movement of a limb that is visible.</td></tr>
<tr><td>Arthrokinematics</td><td>The description of joint surface movement; consists of three major types: roll, slide, and spin.</td></tr>
<tr><td>Synovial joints</td><td>A joint with a fluid-filled joint capsule.</td></tr>
<tr><td>Nonaxial</td><td>A gliding joint that moves in only one plane, either back and forth or side to side.</td></tr>
<tr><td>Nonsynovial joints</td><td>Joints that have no joint capsule, fibrous connective tissue, or cartilage in the uniting structure.</td></tr>
</table>

Muscular System

- The muscular system links the nervous and skeletal systems and generates force to move the human body.
- Muscles have a complex structure that includes different layers of connective tissue that surround the contractile muscle fibers.
- Myofibrils consist of repeating sarcomeres and the myofilaments actin and myosin, which create the muscle contraction called the sliding filament theory. Adenosine triphosphate is also needed to create energy for this process.
- Excitation-contraction coupling describes the steps in the muscle contraction process involving the nervous and muscular systems.
- The electrolyte calcium and neurotransmitter acetylcholine are involved in the excitation-contraction coupling process.

- The all-or-nothing principle describes how a motor unit either maximally contracts or does not contract at all.
- Muscles involved with fine motor skills have motor units with fewer innervated fibers. Motor units involved in gross motor control have motor units with more innervated fibers.
- Type I, slow-twitch, muscle fibers are smaller in size, produce less force, and are fatigue resistant.
- Type II, fast-twitch, muscle fibers are larger in size, produce more force, and fatigue quickly.

Important Concepts (not an exhaustive list)	
Three types of muscles	The three types of muscles in the body are skeletal, cardiac, and smooth.
Skeletal muscle	The type of muscle tissue that connects to bones and generates the forces that create movement.
Fascia	Connective tissue that surrounds muscles and bones.
Epimysium	Inner layer of fascia that directly surrounds an entire muscle, commonly referred to as the "deep fascia."
Fascicles	Largest bundles of fibers within a muscle. Fascicles are surrounded by perimysium.
Perimysium	Connective tissue surrounding a muscle fascicle.
Endomysium	Connective tissue that wraps around individual muscle fibers within a fascicle.
Tendons v. Ligaments	Tendons connect muscles to bones. Commonly discussed tendons include the Achilles tendon at the ankle and the patellar tendon of the knee. When a tendon is overstretched or torn, this is known as a strain. Ligaments connect bones to bones. A commonly discussed ligament is the anterior cruciate ligament of the knee that connects the tibia to the femur. When a ligament is overstretched or torn, it is known as a sprain.
Myofibrils	The contractile components of a muscle cell; the myofilaments (actin and myosin) are contained within a myofibril.
Myofilaments	The filaments of a myofibril; include actin and myosin.
Actin	The thin, stringlike, myofilament that acts along with myosin to produce muscular contraction.
Myosin	The thick myofilament that acts along with actin to produce muscular contraction.
Sarcomere	The structural unit of a myofibril composed of actin and myosin filaments between two Z-lines.
Motor unit	A motor neuron and all of the muscle fibers that it innervates.

Sliding filament theory	The series of steps in muscle contraction involving how myosin (thick) and actin (thin) filaments slide past one another to produce a muscle contraction, shortening the entire length of the sarcomere.
Type I muscle fibers** very important	Muscle fibers that are small in size, generate lower amounts of force, and are more resistant to fatigue.
Type II muscle fibers** very important	Muscle fibers that are larger in size, generate higher amounts of force, and are faster to fatigue.

Chapter 6. The Cardiorespiratory, Endocrine, and Digestive Systems Summary

- The cardiorespiratory system is comprised of the heart, blood, blood vessels, and lungs.
- The respiratory system is comprised of the respiratory airways, lungs, and respiratory muscles.
- The heart is contained in an area referred to as the mediastinum.
- A normal heart rate ranges from 60 to 100 beats per minute.
- Each side of the heart has two chambers: an atrium and a ventricle.
- The body will increase the heart rate in response to exercise and decrease the heart rate during sleep.
- The electrical conduction system of the heart is responsible for its function and begins with the sinoatrial node, which is in the right atrium.
- The sinoatrial node is referred to as the pacemaker of the heart and sends the electrical signal to the atrioventricular node and ultimately into the ventricles.
- The right atrium gathers deoxygenated blood returning to the heart from the body and then sends it to the right ventricle and to the lungs for oxygenation.
- The left atrium receives oxygenated blood from the lungs and sends it to the left ventricle to be pumped out into the body.
- Special valves are present in the heart to ensure that blood is pumped in a one-way fashion.
- The pulmonary artery transports deoxygenated blood from the right ventricles to the lungs, whereas the pulmonary vein transports oxygenated blood from the lungs to the left atrium.
- As part of the normal integrated functioning of the cardiorespiratory system, the carbon dioxide from the deoxygenated blood pumped into the lungs from the right ventricle is ultimately expelled to the environment through normal expiration.
- Stroke volume is the amount of blood pumped out of the heart with each contraction.
- End-diastolic volume is the volume of blood in the ventricle prior to contraction, whereas the end-systolic volume is the amount of blood present in the ventricle after contraction.

- Stroke volume is ultimately a product of end-diastolic volume minus end-systolic volume.
- Cardiac output is the volume of blood pumped out of the heart in a minute and is a function of both heart rate and stroke volume.
- Normal blood pressure is a systolic less than 120 mm Hg with a diastolic of less than 80 mm Hg.
- Arteries transport blood away from the heart to the body, whereas veins transport blood back to the heart, and capillaries function as an exchange channel between the vessels and bodily tissues.
- Breathing (ventilation) is divided into two phases, referred to as inspiration and expiration.
- The respiratory system is tasked with bringing in oxygen, filtering air from inspiration, and subsequently oxygenating blood from the heart as well as exhaling carbon dioxide.
- A normal respiratory rate is 12 to 16 breaths per minute and relies on the primary respiratory muscles (diaphragm and intercostals).
- During normal inspiration, active contraction of respiratory muscles occurs, whereas relaxation occurs during expiration.
- During forced or heavy breathing, expiratory ventilation relies on secondary muscles to compress the thoracic cavity and force air out.
- *Diffusion* is a term used to describe the process of getting oxygen from the environment to the body's tissues.
- Abnormal breathing patterns will affect exercise performance and may be identified by shallow breaths, which often are associated with the use of secondary respiratory muscles (sternocleidomastoid, upper trapezius, or scalenes).
- A respiratory rate of less than 8 breaths per minute would be considered too slow (bradypnea), whereas a rate of greater than 24 breaths per minute is considered too high (tachypnea).
- The endocrine system is comprised of glands that secrete hormones.
- When hormones are released into the bloodstream, they are protected by transporters, which carry them to the intended organ or structure, where they bind with a receptor to stimulate a particular function.
- The hypothalamus and pituitary gland control a majority of functions for the endocrine system.
- Cortisol, which is stimulated by the adrenal cortex, may be used to aid in recovery from exercise and as a marker of overtraining.
- Insulin and glucagon both function to control blood glucose levels and work opposite to each other; glucagon aids in the metabolism of glucose, and insulin aids in the cellular uptake and storage of glucose.

- The catecholamines, which consist of epinephrine and norepinephrine, are immediately stimulated from the adrenal medulla in response to exercise.
- Cortisol, considered a catabolic hormone, is produced by the adrenal cortex and is sensitive to blood sugar and sleep.
- Although testosterone levels decline with age, they can be stimulated through intense exercise.
- Growth hormones are responsible for growth and development as well as lipolysis and are produced from the pituitary gland.
- One of the most potent of the anabolic hormones is insulin-like growth factor, which is produced by the liver in response to growth hormones binding on liver receptors.
- Testosterone, growth hormones, and insulin-like growth factors are stimulated in response to anaerobic resistance training as well as vigorous aerobic activity (e.g., high-intensity training styles).
- Thyroid hormones serve numerous functions in the body, including metabolism and increasing bone mineral density through the secretion of calcitonin.
- Adequate sleep is a necessary requirement for glucose metabolism, hormone function, and muscle recovery.
- The digestive system consists of the oral cavity (head and mouth), the upper GI system (stomach, small intestine [duodenum, jejunum, and ileum], and the lower GI tract (large intestine, rectum, and anus), as well as the liver, gall bladder, and pancreas.
- Ingested foods and liquids are first processed in the oral cavity where mastication (the mechanical process of chewing and breaking down food) begins the digestive process.
- Once food is broken down, it passes through the esophagus into the stomach where gastric juices aid in digestion, kill bacteria, and turn food into chyme, which is then passed into the small intestine.
- The small intestine has a key function of absorption of carbohydrates, lipids, calcium, amino acids, and iron. Additionally, electrolytes including water, are absorbed into the small intestines.
- The large intestine absorbs electrolytes and vitamins, and serves to pass waste from nondigested food into the rectum.
- While fluids are absorbed into both the small and large intestine, the large intestine uses water to help pass waste into the rectum.
- The liver, gall bladder, and pancreas produce and store digestive juices, which are secreted into the small intestine to help with digestion.
- Evidence suggests that exercise can improve digestive function by increasing transit time of food from the upper to the lower GI tracts.

Important Concepts (not an exhaustive list)
Cardiovascular System

Atrium (atria)	Superior chamber(s) of the heart that gathers blood returning to the heart.
Ventricle	Inferior chamber of the heart that pumps blood to the lungs and body.
Blood flow through the heart** very important	Right atrium: receives deoxygenated blood returning from the body and sends it to the right ventricle. Right ventricle: receives deoxygenated blood from the right atrium and sends it to the lungs. Left atrium: receives oxygenated blood from the lungs and sends it to the left ventricle. Left ventricle: receives oxygenated blood from the left atrium and sends it to the body.
Resting heart rate	Resting heart rates for most of the population are between 60 and 100 beats per minute
Sinoatrial (SA) node	Located in the right atrium, this node initiates an electrical signal that causes the heart to beat.
Atrioventricular (AV) node	Located between the atria and ventricles, this node delays the impulse from the sinoatrial node before allowing it to pass to the ventricles.
Stroke volume	The amount of blood pumped out of the heart with each contraction.
End-diastolic volume	The filled volume of the ventricle before contraction.
End-systolic volume	The volume of blood remaining in the ventricle after ejection.
Bradycardia	When the heart rate is less than 60 beats per minute.
Tachycardia	When the heart rate is greater than 100 beats per minute.
Cardiac output** very important	The overall performance of the heart (heart rate × stroke volume).
Arteries	Vessels that transport blood away from the heart.
Capillaries	The smallest blood vessels and the site of exchange of elements between the blood and the tissues.
Veins	Vessels that transport blood back to the heart.
Arterioles	Small arteries that eventually divide into capillaries
Venules	Small veins that allows blood to drain from capillaries into the larger veins.
Venous pooling	The accumulation of blood into the extremities due to slow blood flow though the veins (venous return) or backflow.
Stages of hypertension** very important	**American Heart Association Blood Pressure Classification** / **Criteria (mm Hg)** Normal: Systolic <120 and diastolic <80 Elevated: Systolic 120–129 and diastolic <80 Stage 1: Systolic 130–139 or diastolic 80–89 Stage 2: Systolic ≥140 or diastolic ≥90 Hypertensive crisis: Systolic >180 and/or diastolic >120
Respiratory System	

Structures of respiratory pump	**Bones**	Sternum (breastbone)
		Ribs
		Vertebrae (spine)
	Inspiration Muscles	Diaphragm
		External intercostals (muscles between individual ribs)
		Scalenes (side of neck muscles)
		Sternocleidomastoid (front of neck muscle)
		Pectoralis minor (smaller chest muscle)
	Expiration Muscles	Internal intercostals (muscles between individual ribs)
		Abdominals
Valsalva maneuver	A process that involves expiring against a closed windpipe, creating additional intra-abdominal pressure and spinal stability.	
Structures of respiratory passages	**Conducting Airways**	Nasal cavity
		Oral cavity
		Pharynx
		Larynx
		Trachea
		Right and left pulmonary bronchi
		Bronchioles
	Respiratory Airways	Alveoli
		Alveolar sacs
Tachypnea	Respiratory rate that is too fast; greater than 24 breaths per minute.	
Bradypnea	Respiratory rate that is too slow; fewer than 8 breaths per minute.	
Dyspnea	Shortness of breath or labored breathing.	
Endorcine System		
Lipolysis	The breakdown and utilization of fat for energy.	
Insulin	A hormone secreted by the pancreas that is responsible for glucose metabolism.	
Glucagon	A hormone secreted by the pancreas that regulates blood glucose and functions opposite to insulin.	
Glycogen	Glucose that is deposited and stored in bodily tissues, such as the liver and muscle cells; the storage form of carbohydrate.	
Growth hormone	An anabolic hormone produced by the pituitary gland that is responsible for growth and development.	
Catecholamines	Hormones produced by the adrenal glands that are part of the stress response known as the fight-or-flight response.	
Catabolic	Metabolic process that breaks down molecules into smaller units used for energy.	
Gluconeogenesis	The formation of glucose from noncarbohydrate sources (proteins and fats).	
Testosterone	A hormone producing secondary male sex characteristics.	
Anabolic	Metabolic process that synthesizes smaller molecules into larger units used for building and repairing tissues.	

Insulin-like growth factors (IGF)	Anabolic hormone produced by the liver, which is responsible for growth and development.
Calcitonin	Thyroid hormone that helps the body use calcium properly to aid with maintaining bone mineral density.
Glucose intolerance	A condition that results in elevated blood glucose levels.

Chapter 7. Human Movement Science Summary

- Movement is described in three dimensions that are based on planes, which include the sagittal, frontal, and transverse planes.
- Osteokinematic describes the observable movement of a limb, whereas arthrokinematic describes the movement taking place at the joint itself.
- Movement is described using biomechanical terminology that is universal to all professions in the allied health industry.
- The sagittal plane is an imaginary line that bisects the body into right and left sides. Movements in the sagittal plane include flexion and extension and plantar flexion and dorsiflexion of the foot and ankle.
- The frontal plane bisects the body to create front and back halves. Movements in the frontal plane include abduction and adduction of the limbs (relative to the trunk), lateral flexion of the spine, and eversion and inversion at the foot and ankle complex.
- The transverse plane bisects the body to create upper and lower halves. Movements in the transverse plane include internal rotation and external rotation for the limbs, right and left rotation for the head and trunk, horizontal abduction and horizontal adduction of the limbs, and radioulnar pronation and supination.
- Motions of the scapulae include scapular retraction, scapular protraction, scapular depression, and scapular elevation.
- Muscle actions are described as isotonic, isometric, and isokinetic.
- Isotonic muscle actions can be broken down into the concentric and eccentric phases.
- Muscles can play the role of agonist, synergist, stabilizer, or antagonist depending on the movement being performed.
- Closed-chain movements anchor the body to the ground or immovable object, whereas open-chain movement involves the distal limb moving freely in space.
- Placing a muscle in a shortened position or lengthening a muscle beyond optimal length may reduce force output, because optimal length is the position with maximal overlap of actin and myosin filaments.
- The stretch-shortening cycle involves three phases, which include the eccentric phase, amortization phase, and concentric phase.

- The term *force-couple* is used to describe muscles that work in a synergistic function around a joint.
- The local muscular system involves muscles that generally attach on or near the spine and provide stability for the LPHC.
- The global muscle system can be broken down into subsystems, which include the deep longitudinal, posterior oblique, anterior oblique, and lateral subsystems.
- The subsystems describe the integrated function of muscle groups to transfer force for complex multijoint movements and stabilization of the HMS.
- The amount of force produced by the HMS relies on not only muscle recruitment but also the lever type of the joint that is moving.
- Lever systems are classified as first, second, and third class. Third-class levers are the most predominate levers in the human body.
- Muscle synergies describe the cooperative function of multiple muscles recruited by the nervous system to complete a given movement pattern.
- Proprioception is the intrinsic awareness of movement and bodily position in space.
- Feedback can come from internal or external sources and aids the process of motor learning.
- Motor learning is the integration of motor control processes, with practice and experience, leading to a relatively permanent change in the capacity to produce skilled movements.

Important Concepts (not an exhaustive list)

Anatomic locations** very important

Anatomic Location	**Definition**
Medial	Relatively closer to the midline of the body
Lateral	Relatively farther away from the midline or toward the outside of the body
Contralateral	Positioned on the opposite side of the body
Ipsilateral	Positioned on the same side of the body
Anterior	Positioned on or toward the front of the body
Posterior	Positioned on or toward the back of the body
Proximal	Positioned nearest to the center of the body or other identified reference point
Distal	Positioned farthest from the center of the body or other identified reference point
Inferior	Positioned below an identified reference point
Superior	Positioned above an identified reference point

<table>
<tr><td>Dorsiflexion</td><td>Flexion occurring at the ankle (i.e., top of the foot moves toward the shin).</td></tr>
<tr><td>Plantar flexion</td><td>Extension occurring at the ankle. Pointing the foot downwards.</td></tr>
<tr><td>Muscle actions** very important</td><td>
<table>
<tr><th>Action</th><th>Performance</th></tr>
<tr><td>Isotonic</td><td>Force is produced, muscle tension is developed, and movement occurs through a given range of motion. Isotonic muscle actions are subdivided into concentric and eccentric muscle actions.</td></tr>
<tr><td>Isometric</td><td>Muscle tension is created without a change in muscle length and no visible movement of the joint.</td></tr>
<tr><td>Isokinetic</td><td>The speed of movement is fixed, and resistance varies with the force exerted.

It requires sophisticated training equipment often seen in rehabilitation or exercise physiology laboratories.</td></tr>
</table>
</td></tr>
<tr><td>Agonists** very important</td><td>The primary muscles providing force for a movement. Examples include:
The gluteus maximus is the agonist for hip extension (i.e., squats).
The anterior deltoid is the agonist for shoulder flexion (i.e., shoulder presses).
The biceps brachii is the agonist for elbow flexion (i.e., biceps curls).
The triceps brachii is the agonist for elbow extension(i.e., triceps pushdowns).</td></tr>
<tr><td>Synergists** very important</td><td>Muscles that assist agonists to produce a movement. Examples include:
The hamstring complex and the erector spinae are synergistic with the gluteus maximus during hip extension (i.e., squats).
The brachioradialis and brachialis (forearm muscles) assist the biceps brachii during a biceps curl.
The triceps brachii assist the pectoral muscles during a chest press.
The biceps brachii assist the latissimus dorsi during a pull-up.</td></tr>
<tr><td>Stabilizers** very important</td><td>Muscles that contract isometrically to stabilize the trunk and joints as the body moves. Examples include:
The transversus abdominis (a deep abdominal muscle), internal obliques, and multifidus (deep muscles of the spine) stabilize the LPHC during hip extension (i.e., squats).
The rotator cuff muscles (supraspinatus, infraspinatus, teres minor, and subscapularis), stabilize the shoulder during upper extremity movements.</td></tr>
<tr><td>Antagonists** very important</td><td>Muscles on the opposite side of a joint that are in direct opposition of agonist muscles. Examples include:
The biceps brachii (an elbow flexor) is an antagonist to the triceps brachii during elbow extension (i.e., triceps pushdown).
During elbow flexion, the triceps become the antagonist to the biceps (i.e., biceps curl).
The hip flexor complex is antagonistic to the gluteus maximus during hip extension (i.e., squats).
The latissimus dorsi is antagonistic to the deltoids during a shoulder press.</td></tr>
</table>

Example closed-chain exercises** very important	Push-ups Pull-ups Squats Lunges
Example open-chain exercises** very important	Biceps curls Lat pulldowns Bench presses Leg curls Leg extensions
Length-tension relationship** very important	The resting length of a muscle and the tension the muscle can produce at this resting length.
Altered length-tension relationship** very important	When a muscle's resting length is too short or too long, reducing the amount of force it can produce.
Reciprocal inhibition** very important	When an agonist receives a signal to contract, its functional antagonist also receives an inhibitory signal allowing it to lengthen.
Altered reciprocal inhibition** very important	Occurs when an overactive agonist muscle decreases the neural drive to its functional antagonist.
Muscle imbalance	When muscles on each side of a joint have altered length-tension relationships.
Integrated performance paradigm	To move with efficiency, forces must be dampened (eccentrically), stabilized (isometrically), and then accelerated (concentrically).
Force-couple relationship** very important	The synergistic action of multiple muscles working together to produce movement around a joint
First-class levers	First-class levers have the fulcrum in the middle, like a seesaw. Nodding the head is an example of a first-class lever, with the top of the spinal column as the fulcrum.

Second-class levers	Second-class levers have a resistance in the middle with the fulcrum and effort on either side, similar to a load in a wheelbarrow where the axle and wheel are the fulcrum points. The body acts as a second-class lever when one engages in a full-body push-up or calf raise.
Third-class levers	Third-class levers have the effort placed between the resistance and the fulcrum. The effort always travels a shorter distance and must be greater than the resistance. Most limbs of the human body operate as third-class levers. An example of a third-class lever is the human forearm; the fulcrum is the elbow, the effort is applied by the biceps brachii muscle, and the load is in the hand, such as a dumbbell when performing a biceps curl. Another example of a third-class lever is the standing hamstring curl, whereby the knee joint is the fulcrum, hamstring muscle is the effort, and resistance is at the ankle.
Motor behavior	Motor response to internal and external environmental stimuli.
Motor control	How the central nervous system integrates internal and external sensory information with previous experiences to produce a motor response.
Motor learning	Integration of motor control processes through practice and experience, leading to a relatively permanent change in the capacity to produce skilled motor behavior.
Motor development	Change in skilled motor behavior over time throughout the life span.
Internal feedback	Process whereby sensory information is used by the body to reactively monitor movement and the environment.
External feedback	Information provided by some external source, such as a fitness professional, video, mirror, or heart rate monitor, to supplement the internal environment.

Chapter 8. Exercise Metabolism and Bioenergetics Summary

- The human body needs a constant supply of energy to function properly and meet the demands of exercise.
- The energy molecule used to do cellular work is called adenosine triphosphate (ATP), and it is made from food substrates consumed in the diet.
- The first law of thermodynamics states that energy can neither be created nor destroyed, only converted from one form into another.
- The fuels used to create ATP are glucose from carbohydrates, free fatty acids from fat, amino acids from protein, and ketone bodies. These fuels are mostly obtained through the diet.
- Carbohydrates in the diet are broken down into glucose, which can produce ATP quickly via the process of glycolysis.
- Glucose is stored in the form of glycogen; the amount of glycogen that can be stored in the body is much less than the amount of fat that can be stored.
- Free fatty acids are the by-products of the breakdown of stored or consumed fats. They are oxidized exclusively via the aerobic pathway, which uses oxygen to create ATP.
- Amino acids are the by-product of protein breakdown or digestion.

- Amino acids can be metabolized via oxidative phosphorylation, but this is not typical in healthy people because protein is usually reserved for muscle building rather than ATP production.
- Ketone bodies are produced by the liver during periods of low energy intake or low carbohydrate availability. They can be oxidized via the oxidative phosphorylation pathway to create ATP.
- Exercise is categorized by two factors: intensity and duration. The higher the intensity of the activity, the shorter the duration must be.
- To perform exercise, the body needs fuel, which comes from food that is broken down through a series of chemical reactions to provide energy (ATP) and heat.
- The ATP-PC pathway is the simplest and fastest way to generate ATP. This system can only support short duration activities because the supply of PC is limited.
- Glycolysis is an anaerobic process and generates ATP quickly, but not a tremendous amount. The end products of glycolysis are ATP and pyruvate, which can become lactate under anaerobic conditions.
- Oxidative phosphorylation is a process that uses oxygen to create ATP from substrate molecules at a relatively slow rate.
- Oxidative phosphorylation can use pyruvate (starting from glucose), fatty acids, amino acids, or ketone bodies as substrate molecules. This oxidative metabolism produces carbon dioxide as a by-product, which is then exhaled.
- The most important factors determining the type of energy use during exercise are intensity and duration.
- The intensity and duration of an activity are inversely related, which means that as intensity goes up, duration must go down.
- Steady-state exercise is defined as a situation in which a person engages in the same level of activity, without increases or decreases in intensity, for several minutes.
- Intermittent exercise is defined as frequent changes in the work requirement (intensity) during an activity.
- Exercise increases metabolic rate, and breathing rate increases in proportion with it.
- When breathing rate becomes too rapid to allow talking, the body has shifted to oxidizing almost exclusively carbohydrate to fuel the activity.
- Lower-intensity activities use a higher percentage of fat as a fuel but generally do not burn a lot of calories unless performed for a very long time.
- Higher-intensity activities have a higher percentage of energy coming from carbohydrate and usually burn more total calories in a given time.
- Daily food (energy) intake needs to be adequate to maintain a healthy body weight, allow for proper bodily function, and support physical activity.
- If daily food intake is matched to energy needs, a person is said to be in energy balance.

- Calories are the basic unit of energy provided by food, and the total number of calories that a person burns in a day is called the total daily energy expenditure (TDEE).
- The resting metabolic rate (RMR) is the minimum number of calories needed at rest to keep a person alive and meet all functional needs of the body.
- The thermic effect of food (TEF) is the number of calories that are used to digest a meal.
- Nonexercise activity thermogenesis (NEAT) involves burning calories in activities that are not structured exercise.
- Exercise activity thermogenesis (EAT) is the calories burned during structured physical activity or purposeful exercise.

Important Concepts (not an exhaustive list)	
First law of thermodynamics	Energy cannot be created or destroyed but merely converted from one form to another.
Glucose	The simplest form of carbohydrate used by the body for energy.
Glycogen	Glucose that is deposited and stored in bodily tissues, such as the liver and muscle cells; the storage form of carbohydrate.
Triglyceride	The chemical or substrate form in which most fat exists in food as well as in the body.
Essential amino acid (EAA)	Amino acid that must be obtained through the diet as the body does not make it; there are nine essential amino acids.
Nonessential amino acids	Amino acids that can be synthesized by the body and do not, under normal circumstances, need to be obtained in the diet.
Gluconeogenesis	The formation of glucose from noncarbohydrate sources (proteins and fats).
Aerobic	Processes relating to, involving, or requiring oxygen.
Anaerobic	Processes relating to the absence of oxygen.
ATP-PC system** very important	An energy system that provides energy very rapidly, for approximately 10–15 seconds, via anaerobic metabolism. Example exercises that predominately use the ATP-PC system include: ○ Short sprints ○ Olympic weightlifting ○ Jumping and plyometrics
Glycolytic system** very important	A metabolic process that occurs in the cytosol of a cell that converts glucose into pyruvate and adenosine triphosphate. Anaerobic glycolysis refers to when this process occurs in the absence of oxygen. It lasts longer, with a capacity of approximately 30 to 60 seconds of duration. Example exercises that predominately use the glycolytic system include: ○ Strength training (8-12 repetitions)
Oxidative system** very important	The most complex of the three energy systems is the oxidative system—a process that uses oxygen to convert food substrates into ATP. This process is called oxidative phosphorylation, and it is defined as an aerobic process because it needs oxygen to complete the reactions. Example exercises that predominately use the oxidative system include: ○ Jogging and running for an extended period

Electron transport chain (ETC)	A series of protein complexes that transfer protons and electrons received from the citric acid cycle through a series of reactions to create adenosine triphosphate.
Excess postexercise oxygen consumption (EPOC)	The state in which the body's metabolism is elevated after exercise.
Resting metabolic rate (RMR)	The rate at which the body expends energy (calories) when fasted and at complete rest, such as asleep or lying quietly.
Exercise activity thermogenesis (EAT)	The calories expended through structured exercise or training.
Thermic effect of food (TEF)	The energy required to digest, absorb, and process nutrients that are consumed.
Nonexercise activity thermogenesis (NEAT)	Energy expenditure through daily activities outside of structured exercise, such as walking, completing household chores, and taking the stairs.

Chapter 9. Nutrition Summary

Registered and licensed dietitians and nutritionists are authorized to provide nutrition counseling, medical nutrition therapy, and meal plans.

Fitness professionals (who are not also registered or licensed dietitians or nutritionists) can provide general nutrition guidelines, direct clients to credible nutrition resources, refer clients to dietitians and nutritionists, and provide accountability and support with dietary changes.

Credible and reliable nutrition information includes peer-reviewed research and scholarly sources.

Protein is comprised of 20 amino acids; 9 are essential and must be obtained via the diet.

The role of protein is the synthesis of tissues, organs, hormones, enzymes, and peptides.

Dietary sources of complete proteins include soy and animal foods, such as meat, poultry, seafood, and dairy. Plant-based, incomplete protein foods include legumes, grains, and vegetables.

Protein contains 4 calories per gram.

The RDA for protein is 0.8 g/kg bodyweight (considered a minimum to maintain nitrogen balance).

The AMDR for protein is 10% to 35% of total calories.

Carbohydrates include simple sugars, complex carbohydrates, glycogen, and fiber.

Carbohydrates are an important energy source of exercising individuals and athletes.

Dietary sources of carbohydrates include plant foods and dairy, including grains, vegetables, legumes, fruit, milk, and yogurt.

Simple sugars include the monosaccharides (glucose, fructose, galactose) and disaccharides (lactose, sucrose, maltose).
Complex carbohydrates are long chains of glucose units called polysaccharides, which are slower to digest and raise blood glucose levels slowly.
Sources of complex carbohydrates include starches, legumes, and vegetables.
The glycemic index reflects the effect of a carbohydrate on blood sugar levels; low GI foods cause smaller rises in blood glucose compared to high GI foods.
Glycemic load is a better indicator of a carbohydrate's effect on blood sugar levels, because it accounts for the glycemic index and the quantity of carbohydrates consumed.
Carbohydrates contain 4 calories per gram.
Glycogen is the storage form of carbohydrates in animals and humans. Glycogen is stored in the liver and skeletal muscle.
Fiber is indigestible carbohydrates associated with various health benefits and includes both soluble and insoluble fiber.
The AMDR for carbohydrate is 45% to 65% of calories in the diet.
Fiber recommendations: 25–28 g of fiber a day for women (aged 19–50 years) and 30–34 g of fiber a day for men aged 19–50 years.
Lipids are commonly referred to as fats and include triglycerides, phospholipids, and sterols.
Saturated fat sources include animal fats, full-fat dairy, coconut, and palm oil.
Polyunsaturated fat sources include omega-6 (nuts, seeds, oils), omega-3 (fatty fish, flaxseed, walnuts, chia seeds, fortified milk/eggs, dairy from grass-fed cows, and green vegetables).
Monounsaturated fat sources include olives, olive oil, avocado, peanuts, and canola.
Phospholipid sources include meats, egg yolks, seafood, poultry, soybeans, and grains.
Sterols sources include cholesterol from animal foods, egg yolks, and plant sterols.
Lipids contain 9 calories per gram.
The AMDR for lipids is 20% to 35% of total calories.
Vitamins (organic) and minerals (inorganic) are compounds essential to regulating metabolic processes, such as energy metabolism. Deficiencies and insufficiencies can contribute to health issues.
Vitamins include two groups: fat soluble and water soluble.
Vitamins A, D, E, and K are fat soluble.
Water-soluble vitamins include vitamin C and B vitamins (thiamin, riboflavin, niacin, folate, B12, pantothenic acid, biotin).
A balanced diet with a wide variety of minimally processed foods will likely supply adequate vitamins.
Minerals include major minerals and trace minerals.

Fluid recommendations (general population): approximately 11.5 cups a day (2.7 L) of fluid for women and approximately 15.5 cups (3.7 L) for men.

Hydration guidelines for athletes include 12–16 oz of fluid every 10–15 minutes for activities longer than 60 minutes.

Athletes should replace fluid at 1.25 times the amount of body weight lost during an event.

Sports drinks may be hypotonic (lower concentration than body fluids), isotonic (similar concentration as body fluids), or hypertonic (higher concentration than body fluids).

Sports drinks are likely unnecessary for short-duration exercise lasting less than 60 minutes (unless in hot or humid temperatures).

Strategy combinations are used to help clients achieve their weight goals, primarily including modification of energy intake and physical activity.

The first law of thermodynamics states that energy cannot be created or destroyed but only converted from one form to another.

Weight gain is the result of energy intake exceeding energy output, whereas weight loss is the result of energy output exceeding energy intake.

Other factors that influence weight include sleep, medications, and endocrine disorders.

Food labels convey information on the nutritional value and content of products via the nutrition facts panel and the ingredients list.

Food labels can help clients make informed decisions about how a food item contributes to their nutrition and fitness goals.

Fat loss requires a net calorie deficit but with the goal of minimizing loss of lean body mass and any reduction in TDEE due to adaptive thermogenesis.

Adequate caloric intake, especially adequate protein intake combined with resistance training, remains an essential element for increasing muscle mass.

Nutrition strategies for improved sports performance are numerous and include ensuring adequate energy (calories) and macronutrient intake. Meal timing and hydration are also important to maximize sport performance.

Important Concepts (not an exhaustive list)			
Macronutrients and alcohol energy** very important	Protein: 4 calories per gram Carbohydrate: 4 calories per gram Lipid (fat): 9 calories per gram Alcohol: 7 calories per gram		
Amino acids	**Essential**	**Nonessential**	**Conditionally Essential**

	Leucine Isoleucine Valine Methionine Phenylalanine Threonine Tryptophan Lysine Histidine*	Alanine Arginine Aspartic acid Asparagine Cysteine Glutamic acid Glutamine Glycine Proline Serine	Histidine Arginine Glutamine
Complete protein	A protein source that provides all essential amino acids.		
Incomplete protein	A protein that lacks one or more of the amino acids required to build cells.		
RDA for protein	0.8 g/kg of body weight		
Acceptable macronutrient distribution ranges (AMDR) ** very important	Protein: 10% to 35% of total calories Carbohydrate: 45% to 65% of total calories Lipid (fat): 20% to 35% of total calories		
Triglycerides	The triglyceride family is composed of fats and oils; it comprises 98% of the stored lipids in the body and approximately 95% of the lipids in foods.		
Fat-soluble vitamins** very important	A, D, E, K		
Water-soluble vitamins** very important	C, B-vitamins		
Fluid intake	Women: 11.5 cups per day (2.7 L) Men: 15.5 cups per day (3.7 L)		

Chapter 10. Supplementation Summary

- Dietary supplements are products (other than tobacco) intended to supplement the diet that bears or contains one or more of the following dietary ingredients: vitamins; minerals; herbs or other botanicals; amino acids; dietary supplements used by humans to supplement the diet by increasing the total dietary intake; or concentrates, metabolites, constituents, extracts, or combination of any previously described ingredient.
- In the United States, dietary supplements are regulated by the FDA according to the Dietary Supplement Health and Education Act. However, supplements do not require review or approval prior to being marketed and sold.

- The fitness professional should understand the required components of the dietary supplement label, including the active ingredients, other ingredients, pertinent warnings, total contents, usage instructions, and serving size.
- Dietary supplements may be used for health and/or performance goals.
- Dietary supplements used specifically for performance are classified as ergogenic aids.
- Vitamin and mineral supplements may be used by individuals to correct or supply insufficient dietary intake in an effort to consume the DV each day.
- Vitamin and mineral intake should not exceed the UL unless by the direction of a dietitian or physician.
- Dietary supplements and other ergogenic aids may produce adverse effects or serious adverse effects. Such effects may arise from the dietary supplements themselves or from a change to or the contamination of the products.
- Protein supplements are convenient methods to increase total daily protein intake, the most important consideration for protein intake. Protein needs depend on the activity level, body size, and body composition goal of the individual.
- An effective dose of creatine is at least 0.03 g per kg body weight, but a typical dose at 5 g per day ensures complete muscle saturation.
- An effective dose of caffeine is 3 to 6 mg/kg (1.4–2.7 mg/lb) per day.
- Banned substances may not always be illegal substances, and athletes must check with their governing body (such as the NCAA or WADA) prior to consuming a dietary supplement. It is also wise for athletes to choose a supplement with third-party verification from Informed Choice or NSF.
- It is beyond the scope of practice for a fitness professional to prescribe dietary supplements to clients to treat a medical condition or disease. It is appropriate for the fitness professional to provide general education about supplements or to direct a client to consult with a dietitian or medical professional.

Important Concepts (not an exhaustive list)	
Dietary supplement	A product (other than tobacco) intended to supplement the diet that bears or contains one or more of the following dietary ingredients: vitamin; mineral; herb or other botanical; amino acid; substance used by man to supplement the diet by increasing the total dietary intake; or concentrate, metabolite, constituent, extract, or combination of any previously described ingredient.
Dietary Supplement Health and Education Act of 1994	The primary legislation of the U.S. government regulating dietary supplements.
Tolerable upper limit	The greatest quantity of a vitamin or mineral that may be consumed in a day without risk of an adverse health effect.

<table>
<tr><td>Ergogenic aid</td><td colspan="2">A dietary supplement that may enhance performance or body composition; it may also be referred to as a performance supplement.</td></tr>
<tr><td>Adverse effects of anabolic steroids</td><td colspan="2"><table>
<tr><th>Men</th><th>Women</th></tr>
<tr><td>Acne</td><td>Development of masculine features</td></tr>
<tr><td>Loss of head hair</td><td>Increased body and facial hair</td></tr>
<tr><td>Gynecomastia (development of breasts)</td><td>Deepening of voice</td></tr>
<tr><td>Irritability and aggression</td><td>Irritability and aggression</td></tr>
<tr><td>Altered sex drive (increased or decreased)</td><td>Altered sex drive (increased or decreased)</td></tr>
<tr><td>Sleeplessness</td><td>Fluid retention</td></tr>
<tr><td>Testicular atrophy</td><td>Menstruation irregularities</td></tr>
<tr><td>Decreased sperm count</td><td>Breast atrophy</td></tr>
<tr><td>Worsened cholesterol profiles</td><td>Clitoral enlargement</td></tr>
<tr><td>Prostate enlargement</td><td>Acne</td></tr>
</table></td></tr>
</table>

Section 4: Assessment

Chapter 11. Health, Wellness, and Fitness Assessments Summary

- The general purposes of conducting physiological assessments are to collect baseline data to help fitness professionals develop personalized exercise programs.
- The PAR-Q+ is considered an appropriate minimal screening tool for conducting a HRA.
- Fitness professionals should also gather additional information, through the use of a HHQ, that may prove useful in selecting fitness assessments, designing exercise programs, and monitoring progress.
- A HHQ includes information about a client's medical history (e.g., injuries, surgeries, medications, and chronic disease) and lifestyle habits (e.g., exercise, diet, sleep, stress, and occupation).
- Resting and exercising heart rate and blood pressure responses provide valuable information pertaining to health risks and training adaptations.
- There are many anatomical locations that can be used to measure a client's RHR. However, for accuracy, safety, and ease of administering, NASM recommends that fitness professionals measure a client's radial pulse.
- Blood pressure (BP) is defined as the outward pressure exerted by blood on the arterial walls. BP scores are important because higher scores indicate greater risks for developing cardiovascular disease, which can become life-threatening. A normal BP reading is less than 120/80 mm Hg.
- Anthropometry is the field of study of the measurement of living humans for purposes of understanding physical variation in size, weight, and proportion.
- Many different anthropometric measures exist, including body fat assessments, BMI, and circumference measurements. Anthropometric measurements provide useful information related to predicting a client's risk for mortality and morbidity.
- There are many methods for measuring a client's body fat percentage, including underwater weighing, skinfold measurements, and bioelectrical impedance analysis. While all methods are valid, for ease of use, bioelectrical impedance is arguably the most popular method used in fitness facilities.
- Cardiorespiratory assessments help the fitness professional identify safe and effective starting exercise intensities as well as appropriate modes of cardiorespiratory exercise for clients. Examples of cardiorespiratory assessments include $\dot{V}O_{2max}$ testing, the YMCA 3-minute step test, the Rockport walk test, and the 1.5 mile run test.
- $\dot{V}O_{2max}$ testing is considered the gold standard for identifying a client's level of cardiorespiratory fitness, but it requires specialized equipment and training to conduct.

In addition, it requires the client to exert maximal effort. Consequently, this test is not commonly used outside of exercise laboratories or medical facilities.

- The talk test is an informal cardiorespiratory assessment used to gauge the intensity of cardiorespiratory activity based on the client's ability to hold a conversation.
- The VT1 test is an incremental test performed on any device (e.g., treadmill, bike) that gradually progresses in intensity level and relies on the interpretation of how a person talks to determine a specific event at which the body's metabolism undergoes a significant change. A key point to this protocol is to remember that it is an aerobic test that aims to estimate the intensity where the body is using a balance of fuels (i.e., 50% fat, 50% carbohydrates).
- The VT2 talk test measures the intensity where the body can work at its highest sustainable steady-state intensity for more than a few minutes.

<table>
<tr><th colspan="2">Important Concepts (not an exhaustive list)</th></tr>
<tr><td>Contraindication</td><td>A specific situation where a medication, procedure, or exercise should be avoided because it may prove to be harmful to the individual.</td></tr>
<tr><td>Physical Activity Readiness Questionnaire (PAR-Q+)</td><td>A detailed questionnaire designed to assess an individual's physical readiness to engage in structured exercise.</td></tr>
<tr><td>Health history questionnaire (HHQ)</td><td>A questionnaire with lists of questions that pertain to health history and habits, such as exercise history, eating behaviors, and general lifestyle</td></tr>
<tr><td>Manual heart rate measurement</td><td>For accuracy, safety, and ease of administration, NASM recommends that fitness professionals measure a client's radial pulse.</td></tr>
<tr><td>Blood pressure ranges</td><td>Normal (healthy): Less than 120/80 mm Hg
Elevated: Systolic between 120 and 129 and diastolic less than 80 mm Hg
Stage 1 hypertension: Systolic between 130 and 139 or diastolic between 80 and 89 mm Hg
Stage 2 hypertension: Systolic 140 or higher or diastolic 90 mm Hg or higher
Hypertensive crisis: Systolic greater than 180 and/or diastolic greater than 120 mm Hg</td></tr>
<tr><td>Body mass index (BMI)</td><td>The measurement of a person's weight relative to his or her height, which is used to estimate the risks of obesity.
Metric formula: BMI = weight (kg) ÷ [height (m)]^2
Imperial formula: BMI = 703 × weight (lb) ÷ [height (in.)]^2</td></tr>
<tr><td>Bioelectrical impedance analysis (BIA)</td><td>A body composition assessment technique that estimates body fat percentage by measuring the resistance to the flow of electrical currents introduced into the body.</td></tr>
<tr><td>BMI Classification</td><td>
<table>
<tr><th>BMI</th><th>Disease Risk</th><th>Classification</th></tr>
<tr><td><18.5</td><td>Increased</td><td>Underweight</td></tr>
<tr><td>18.5–24.9</td><td>Low</td><td>Healthy weight</td></tr>
<tr><td>25.0–29.9</td><td>Increased</td><td>Overweight</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td><table>
<tr><td>30.0–34.9</td><td>High</td><td>Obese</td></tr>
<tr><td>35.0–39.9</td><td>Very high</td><td>Obesity II</td></tr>
<tr><td>≥40.0</td><td>Extremely high</td><td>Obesity III</td></tr>
</table></td></tr>
<tr><td>Waist-to-hip ratio (WHR)</td><td>The relative score expressing the ratio of the waist circumference to the hip circumference, which correlates to the risk for developing cardiovascular disease.
WHR = Waist Measurement ÷ Hip Measurement</td></tr>
<tr><td>WHR Classifications</td><td><table>
<tr><th>Health Risk</th><th>Men</th><th>Women</th></tr>
<tr><td>Low</td><td>0.95 or lower</td><td>0.80 or lower</td></tr>
<tr><td>Moderate</td><td>0.96–1.0</td><td>0.81–0.85</td></tr>
<tr><td>High</td><td>1.0 or higher</td><td>0.86 or higher</td></tr>
</table></td></tr>
<tr><td>Jackson and Pollock Seven-Site Measurement</td><td>Men: Chest, mid-axillary, subscapular, triceps, abdomen, suprailiac, thigh
Women: Chest, mid-axillary, subscapular, triceps, abdomen, suprailiac, thigh</td></tr>
<tr><td>Jackson and Pollock Three-Site Measurement</td><td>Men: Chest, abdomen, thigh
Women: Triceps, suprailiac, thigh</td></tr>
<tr><td>Durnin–Womersley Four-Site Measurement**very important</td><td>Men & Women: Biceps, triceps, subscapular, and suprailiac</td></tr>
</table>

Chapter 12. Posture, Movement, and Performance Assessments Summary

- Static posture is typically assessed in standing position and is used to identify the three postural distortions: pes planus distortion syndrome, upper crossed syndrome, and lower crossed syndrome.
- Pes planus distortion syndrome is characterized by flat feet, knee valgus, and internally rotated and adducted hips.
- Lower crossed syndrome is characterized by an anterior pelvic tilt and excessive lordosis of the lumbar spine.
- Upper crossed syndrome is characterized by a forward head and protracted shoulders.
- The OHSA is the first movement assessment performed for clients and serves as the basis for all other movement assessments. It evaluates dynamic posture, core stability, and neuromuscular control of the whole body during a squatting motion.
- During the OHSA, notate all movement impairments to identify potential muscle imbalances. From the anterior view, look for feet turning out or knees caving in. From the lateral view, look for low-back arching, excessive forward lean of the torso, or arms falling forward.
- The single-leg squat assessment should be used by clients who have performed well in the OHSA, or if the fitness professional is considering single-leg exercises in their

programming. This test is a good assessment of an individual's ability to balance, which is an important functional consideration for activities of daily living and exercise programming.

- Pushing and pulling assessments evaluate function of the upper extremity and concurrent core stability. They can be used as an intake assessment or an integrated part of the actual programming.
- When performing pushing or pulling assessments, look for the following movement impairments: low-back arching, shoulders elevating, or head jutting forward.
- Performance assessments can be used for clients looking to improve athletic performance, and measure maximal strength, power, muscular endurance, and speed and agility.
- The push-up test measures muscular endurance of the upper extremities during a pushing movement.
- The bench press and squat strength assessments measure maximal strength capabilities. These tests are advanced assessments for strength-specific goals and may not be suitable for clients with limited experience with resistance training.
- The vertical jump and long jump assessments measure lower-body power.
- The LEFT test is designed to test lateral speed and agility. LEFT is considered an advanced assessment for speed and performance-specific goals.
- The 40-yard dash assessment evaluates reaction capabilities, acceleration, and maximal sprinting speed.
- The pro shuttle (5-10-5) test assesses acceleration, deceleration, agility, and control. This test is most appropriate for clients with athletic goals seeking to assess agility and sprinting speed.
- All assessments need to be sequenced in a specific order to help guarantee accurate results. Nonfatiguing assessments, such as a preparticipation health screening and physiological and body composition assessments, should be conducted prior to posture, movement, cardio, and performance assessments.
- Fitness professionals should always use caution when implementing movement and performance assessments with their clients. Certain populations, such as overweight or obese, youths, older adults, and prenatal clients, may need to modify or avoid certain movement and performance assessments. Some assessments are not applicable because they do not relate to the client's goals. Other assessments may cause safety concerns.

Important Concepts (not an exhaustive list)	
Pes planus distortion syndrome** very important	**Static Positions** Ankle joints—pes planus (collapsed arch) Knee joints—valgus and internally rotated Hip joints—adducted and internally rotated

	Potential overactive muscles Gastrocnemius and soleus (calves) Adductor complex (inner thighs) Hip flexors (muscles near front of hips) **Potential underactive muscles** Anterior and posterior tibialis (shin muscles) Gluteus maximus and medius (butt muscles)
Lower crossed syndrome** very important	**Static Positions** Hip joints—flexed Pelvis—anterior pelvic tilt Lumbar spine—excessive lordosis (extension) **Potential overactive muscles** Hip flexors Lumbar extensors (low-back muscles) **Potential underactive muscles** Gluteus maximus and medius Hamstring complex Abdominals
Upper crossed syndrome** very important	**Static Positions** Thoracic spine—excessive kyphosis (hunchback, flexed posture) Shoulders—protracted (rounded forward) and internally rotated Head and neck—jutted forward **Potential overactive muscles** Pectoralis major and minor (chest muscles) Levator scapula and sternocleidomastoid (neck muscles) Upper trapezius **Potential underactive muscles** Middle and lower trapezius, rhomboids (mid-back muscles) Deep cervical flexors (muscle deep within the neck)
Overhead Squat Assessment	
Feet turn out** very important	**Overactive** Gastrocnemius/soleus (calves) Hamstrings complex **Underactive** Anterior and posterior tibialis (shin muscles) Gluteus maximus and medius
Knees cave in (knee valgus) ** very important	**Overactive** Tensor fascia latae (TFL)(muscle near front of hip) Adductor complex (inner thigh muscles) **Underactive** Gluteus maximus and medius Anterior and posterior tibialis

Low-back arches** very important	**Overactive** Hip flexors (rectus femoris, psoas, TFL) Lumbar extensors (low-back muscles) Latissimus dorsi (large back muscle) **Underactive** Gluteus maximus Hamstrings complex Abdominals
Excessive forward trunk lean** very important	**Overactive** Hip flexors Gastrocnemius/soleus Rectus abdominis and external obliques (superficial abdominal muscles) **Underactive** Gluteus maximus Hamstrings complex Lumbar extensors
Arms fall forward** very important	**Overactive** Latissimus dorsi Pectoralis major and minor (chest muscles) Teres major (posterior shoulder muscle) **Underactive** Middle and lower trapezius (mid-back muscle) Rhomboids (muscles near shoulder blades) Posterior deltoids (back of shoulder muscles) Portions of the rotator cuff (small muscles that stabilize the shoulder)
Single-leg Squat Assessment	
Knee caves in (knee valgus) ** very important	**Overactive** Tensor fascia latae (TFL) Adductor complex **Underactive** Gluteus maximus and medius Anterior and posterior tibialis
Pushing Assessment	
Low-back arches** very important	**Overactive** Hip flexors (rectus femoris, psoas, TFL) Lumbar extensors **Underactive** Gluteus maximus Hamstrings complex Abdominals
Scapular elevation** very important	**Overactive** Levator scapulae (posterior neck muscles) Upper trapezius **Underactive** Lower trapezius

Head juts forward** very important	**Overactive** Levator scapulae Sternocleidomastoid (anterior neck muscles) **Underactive** Deep cervical flexors (deep neck stabilizer muscles)
Pulling Assessment	
Low-back arches** very important	**Overactive** Hip flexors (rectus femoris, psoas, TFL) Lumbar extensors **Underactive** Gluteus maximus Hamstrings complex Abdominals
Scapular elevation** very important	**Overactive** Levator scapula Upper trapezius **Underactive** Lower trapezius
Head juts forward** very important	**Overactive** Levator scapulae Sternocleidomastoid **Underactive** Deep cervical flexors

Section 5: Exercise Technique and Training Instruction

Chapter 13. Integrated Training and the OPT Model Summary

- Integrated training combines flexibility, cardiorespiratory, core, balance, plyometric, SAQ, and resistance training into one system.
- When an exercise program is progressive and systematic, using a progressive overload approach, the body becomes stronger by adapting to the new demands placed on it.
- Fundamental movement patterns include squatting, hip hinge, pulling, pushing, and pressing.
- Maintaining ideal posture places the client's body in the most optimal state to perform movement patterns safely and effectively.
- Optimal ROM allows joints to move freely.
- Fitness professionals should provide programming that requires movement in all three planes of motion: sagittal, frontal, and transverse.
- The acute variables for training include repetitions, sets, training intensity, repetition tempo, rest interval, training volume, training frequency, training duration, exercise selection, and exercise order.
- An ever-changing integrated training approach provides a systematic and progressive approach to fitness training; its components include flexibility, cardiorespiratory, core, balance, plyometric (reactive), SAQ, and resistance training.
- Benefits of flexibility training include increased joint ROM, possible decrease in muscle soreness, and a potential reduction in injury risk.
- Benefits of cardiorespiratory training include decreased heart rate and blood pressure while increasing stroke volume and cardiac output.
- Benefits of core training include enhanced posture; better bodily function for daily living; increased balance, stabilization and coordination of the kinetic chain; minimized low-back pain; and improved skill-related movements.
- Benefits of balance training include reducing risk of falls and ankle sprains while improving proprioception and agility-based activities.
- Benefits of plyometric (reactive) training include improved bone mineral density and soft tissue strength, expression of power and explosiveness, while also increasing metabolic expenditures required for weight management.
- Benefits of SAQ training include improved top speed, change in direction, and rate of acceleration and deceleration.

- Benefits of resistance training include increased endurance, strength, and power; muscular hypertrophy; and weight management.
- The OPT model is based on the scientific rationale of human movement science and uses the principles of integrated training.
- The OPT model is divided into three different levels of training: stabilization, strength, and power, which are subdivided into five phases.
- Phase 1 Stabilization Endurance Training is designed to teach optimal movement patterns (e.g., pushing, pulling, pressing, squatting, hip hinging), core and joint stability, and helps clients become familiar with various modes of exercise.
- The goal of Phase 2 Strength Endurance Training is to enhance stabilization endurance while increasing prime mover strength.
- Phase 3 Muscular Development Training is designed for individuals who have the goal of maximal muscle growth or altered body composition (i.e., fat loss).
- Phase 4 Maximal Strength Training works toward the goal of maximal prime mover strength by lifting heavy loads.
- The goal of phase 5 Power Training is to increase maximal strength and rate of force production.

<table>
<tr><th colspan="2">Important Concepts (not an exhaustive list)</th></tr>
<tr><td>OPT model</td><td>The stabilization level has one phase of training:
Phase 1 Stabilization Endurance Training
The strength level has three phases of training:
Phase 2 Strength Endurance Training
Phase 3 Muscular Development Training
Phase 4 Maximum Strength Training
The power level has one phase of training:
Phase 5 Power Training</td></tr>
<tr><td>Phase 2 example supersets</td><td>
<table>
<tr><th>Body Part</th><th>Strength-Focused Exercise</th><th>Stabilization-Focused Exercise</th></tr>
<tr><td>Chest</td><td>Bench press</td><td>Push-up</td></tr>
<tr><td>Back</td><td>Seated cable row</td><td>Standing cable row</td></tr>
<tr><td>Shoulders</td><td>Shoulder press machine</td><td>Single-leg dumbbell overhead press</td></tr>
<tr><td>Legs</td><td>Barbell squat</td><td>Single-leg squat</td></tr>
</table>
</td></tr>
<tr><td>Phase 5 example supersets</td><td>
<table>
<tr><th>Body Part</th><th>Strength-Focused Exercise</th><th>Power-Focused Exercise</th></tr>
<tr><td>Chest</td><td>Bench press</td><td>Medicine ball chest pass</td></tr>
<tr><td>Back</td><td>Lat pulldown</td><td>Medicine ball soccer throw</td></tr>
<tr><td>Shoulders</td><td>Dumbbell shoulder press</td><td>Front medicine ball oblique throw</td></tr>
<tr><td>Leg</td><td>Barbell squat</td><td>Squat jump</td></tr>
</table>
</td></tr>
</table>

Chapter 14. Flexibility Training Concepts Summary

- Flexibility is defined as the normal extensibility of all soft tissues that allows the complete ROM of a joint.
- Flexibility has a major influence on mobility during dynamic motion.
- Poor flexibility can lead to the development of relative flexibility, which is the process in which the HMS seeks the path of least resistance during functional movements.
- The HMS, also known as the kinetic chain, comprises the muscular, skeletal, and nervous systems. The body's kinetic chain can be further classified into two regional chains: upper kinetic chain and lower kinetic chain.
- Muscle imbalance can be caused by postural distortions, repetitive movement, cumulative trauma, emotional duress, poor training technique, poor bodily control, and biased training patterns.
- Muscle imbalance may result in altered reciprocal inhibition, synergistic dominance, and osteo- and arthrokinematics dysfunction.
- Synergistic dominance is a neuromuscular phenomenon that occurs when synergists take over function for a weak or inhibited prime mover (agonist). This leads to altered reciprocal inhibition of the antagonist muscle.
- Osteokinematics describes how the bones and joints are moving through a ROM, and arthrokinematics describes the motion at the joint surfaces. Altered joint motion can be caused by altered muscle length-tension relationships, force-couple relationships, and poor joint surface motion, which results in poor movement efficiency.
- Neuromuscular efficiency is the ability of the nervous system to recruit the correct muscles, produce force, reduce force, and dynamically stabilize the body's structure in all three planes of motion. To allow for optimal neuromuscular efficiency, individuals must have proper flexibility in all three planes of motion.
- The scientific rationale for flexibility training is illustrated through the concept of pattern overload and the cumulative injury cycle.
- Common types of flexibility exercise include self-myofascial techniques and static, active, and dynamic stretching.
- Self-myofascial rolling is thought to produce both local mechanical and neurophysiological effects on the myofascial tissues.
- Static stretching is the process of passively taking a muscle to the point of tension and holding the stretch for a minimum of 30 seconds.
- Active stretching is the process of using agonists and synergists to dynamically move the joint into a ROM, holding for 1 to 2 seconds and repeating for 5 to 10 repetitions.
- Dynamic stretching uses the force production of a muscle and the body's momentum to take a joint through the full available ROM.

- Fitness professionals should have a comprehensive understanding of controversial stretches, medical precautions, and contraindications to program a safe flexibility program for clients of all fitness levels.

Important Concepts (not an exhaustive list)	
Relative flexibility	The process in which the body seeks the path of least resistance during functional movements. A prime example of relative flexibility is seen in people who squat with their feet excessively externally rotated because individuals may have limited ankle ROM that prevents adequate ankle dorsiflexion to perform a squat with proper mechanics. A second example can be seen when people perform an overhead shoulder press with excessive lumbar extension (arched low-back).
Force-couple relationships**very important	The synergistic action of multiple muscles working together to produce movement around a joint.
Reciprocal inhibition**very important	When an agonist receives a signal to contract, its functional antagonist also receives an inhibitory signal allowing it to lengthen.
Altered reciprocal inhibition**very important	Occurs when an overactive agonist muscle decreases the neural drive to its functional antagonist.
Synergistic dominance**very important	The neuromuscular phenomenon that occurs when synergists take over function for a weak or inhibited prime mover (agonist).
Altered length-tension relationship**very important	When a muscle's resting length is too short or too long, reducing the amount of force it can produce.
Muscle spindle**very important	Sensory receptors sensitive to change in **length** of the muscle and the rate of that change.
Golgi tendon organ (GTO**very important)	A specialized sensory receptor located at the point where skeletal muscle fibers insert into the tendons of skeletal muscle; sensitive to changes in muscular **tension** and rate of tension change.
Autogenic inhibition**very important	The process by which neural impulses that sense tension are greater than the impulses that cause muscles to contract, providing an inhibitory effect to the muscle spindles.
Pattern overload	Consistently repeating the same pattern of motion over long periods of time that can lead to dysfunction or injury.
Davis's law	States that soft tissue models along the line of stress.
Self-myofascial rolling	Mechanism of Action: Autogenic inhibition Training Variables: 1-3 sets, hold each tender area for 30 seconds
Static stretching	Mechanism of Action: Stretch tolerance and/or reciprocal inhibition (depending how stretch is performed) Training Variables: 1-3 sets, hold each stretch for 30 seconds

Active stretching (formerly called active-isolated stretching)	Mechanism of Action: Reciprocal inhibition Training Variables: 1-3 sets, hold each stretch for 1-2 seconds and repeat for 5–10 repetitions
Hip flexor, adductor, and latissimus dorsi static and active stretches**very important	Posteriorly rotate the pelvis to increase the effectiveness of the stretch.
Dynamic stretching	Mechanism of Action: Reciprocal inhibition Training Variables: 1-3 sets, 5–10 repetitions, 3-10 exercises

Chapter 15. Cardiorespiratory Fitness Training Summary

Cardiorespiratory fitness reflects the ability of the cardiovascular and respiratory systems to supply oxygen-rich blood to skeletal muscles during sustained physical activity.

Cardiorespiratory fitness is one of five components to health-related physical fitness; the others include muscular strength, muscular endurance, flexibility, and body composition.

Research has confirmed that an individual's cardiorespiratory fitness level is a strong predictor of morbidity and mortality.

Research demonstrates that cardiorespiratory exercise and physical activity provide many benefits that enhance health, longevity, and weight loss.

Cardiorespiratory exercise must be individually determined and should use the FITTE-VP principle. FITTE-VP stands for frequency, intensity, type, time, enjoyment, volume, and progression.

Frequency refers to the number of training sessions in a given time period, usually expressed as per week.

Moderate-intensity exercise (e.g., brisk walking) should be performed at least five times per week, whereas vigorous-intensity exercise (e.g., jogging or running) should be performed at least three times per week, or a combination of moderate-intensity and vigorous-intensity is also acceptable.

Intensity refers to the level of demand that a given activity places on the body.

Some methods for monitoring cardiorespiratory exercise intensity include calculating $\dot{V}O_2$ max, using percentages of maximal heart rate (HR_{max}), heart rate reserve (HRR), metabolic equivalents (METs), ratings of perceived exertion (RPE), and using the talk test.

Time refers to the length of time engaged in an activity or exercise training session and is typically expressed in minutes.

Adults should accumulate 2 hours and 30 minutes (150 minutes) of moderate-intensity aerobic activity (i.e., brisk walking) every week or 1 hour and 15 minutes (75 minutes) of

vigorous-intensity aerobic activity (i.e., jogging or running) every week, or an equivalent mix of moderate- and vigorous-intensity aerobic activity.

Type refers to the mode of activity selected, such as cycling, running, or swimming.

Enjoyment refers to the amount of pleasure derived from engaging in a specific exercise or activity.

Volume of exercise represents the total amount of work performed in each timeframe, typically 1 week.

Progression refers to how an exercise program advances.

Each exercise training session should also include a warm-up phase, conditioning phase, and cool-down phase.

Stage 1 is designed to help improve cardiorespiratory fitness levels in apparently healthy sedentary clients using a target intensity below ventilatory threshold 1 (VT1) and involves steady-state aerobic exercise.

A stage 2 workout consists of a mix of recovery intervals just below VT1 (moderate intensity) and work intervals performed at an intensity just above VT1 (challenging to hard intensity).

Once clients become accustomed to stage 2 intervals and have shown positive signs of adapting to the physical demands, they can begin performing moderately intense steady-state cardio exercise just above VT1, if desired.

A stage 3 workout includes the client moving in and out of training zones 1, 2, and 3.

A stage 4 workout involves interval training integrating all four training zones.

Stage 5 focuses on drills that help improve conditioning using linear, multidirectional, and sport-specific activities performed as conditioning and often combines high-intensity interval training with small-sided games and agility drills.

Common postural deviations that clients may exhibit while engaging in cardiorespiratory training include round shoulders and forward head, an anterior pelvic tilt, or adducted and internally rotated knees and pronated feet.

Caution should be made to monitor a client's posture during cardiorespiratory exercise.

Important Concepts (not an exhaustive list)

Aerobic activity recommendations

Frequency	Time	Type
At least 5 days per week	150 minutes per week	Moderate-intensity aerobic activity (i.e., brisk walking)
At least 3 days per week	75 minutes per week	Vigorous-intensity aerobic activity (i.e., jogging or running)
3–5 days per week	Combination of moderate and vigorous intensity: Any combination of moderate- and vigorous-intensity aerobic activities	

<table>
<tr><td>Training zones</td><td>
<table>
<tr><th>Training Zone</th><th>Metabolic Marker</th><th>Description</th></tr>
<tr><td>Zone 1</td><td>Below VT1</td><td>Light to moderate
Starting to sweat but can still carry on a conversation effortlessly</td></tr>
<tr><td>Zone 2</td><td>VT1 to Midpoint</td><td>Challenging to hard
Noticeable sweating and using larger volumes of breath
Continual talking is becoming challenging</td></tr>
<tr><td>Zone 3</td><td>Midpoint to VT2</td><td>Vigorous to very hard
Profuse sweating
Vigorous breathing and ability to talk is limited to short phrases</td></tr>
<tr><td>Zone 4</td><td>Above VT2</td><td>Very hard to maximum effort
Breathing as hard as possible
Speaking is impossible or limited to grunts of single words</td></tr>
</table>
</td></tr>
<tr><td>Clients with an anterior pelvic tilt</td><td>Initial use of bicycles or steppers may not be warranted, or should be minimized, because the hips are placed in a constant state of flexion, adding to what may already be an overactive hip flexor complex for many clients. If they are used, emphasize flexibility techniques for the hip flexors before and after use. Additional strengthening exercises for the core and gluteal complex are also recommended.</td></tr>
<tr><td>Clients with adducted and internally rotated knees and pronated feet</td><td>Cardiorespiratory exercise that involves the lower extremities requires proper mobility at the ankle joint. Emphasize self-myofascial techniques and stretching for the calves, adductors, and hip flexors. Additional strengthening exercises for the gluteus medius and maximus are also recommended.
Using the treadmill and steppers that require climbing may initially be too extreme for constant repetition if clients are allowed to hold onto the rails and speed up the pace. If these modalities are used, emphasize the flexibility exercises mentioned previously and keep the pace at a controllable speed until these postures are corrected.</td></tr>
</table>

Chapter 16 Core Training Concepts Summary

Core training is critical for improving posture, enhancing performance, increasing injury resistance, and accelerating injury rehabilitation.

The core is defined by the structures that make up the lumbo-pelvic-hip complex (LPHC) and includes the global and local core musculature.

Local core muscles generally attach on or near the vertebrae. Local muscles provide dynamic control of the spinal segments, limiting excessive compression, shear, and rotational forces between spinal segments.

Global core muscles are more superficial on the trunk. Global muscles act to move the trunk, transfer loads between the upper and lower extremities, and provide stability of the spine by stabilizing multiple segments together as functional units.

When designing a core training program, the local and global muscles should both be trained to develop proper core stability and overall movement efficiency.

Core strength is imperative for maintaining the natural curvatures of the spine, both at rest and during movement.

Large curvatures of the spine away from midline are considered abnormal and may be considered either structural or functional scoliosis.

Core training has been demonstrated to improve injury resistance by contributing to more coordinated motion between the trunk and lower extremities during high-energy, sport-specific activities.

When developing a core training program, emphasize increasing proprioceptive demand initially instead of increasing the external resistance. Additionally, emphasize quality of movement across the LPHC.

There are many variables that can be manipulated when designing a core training program, including planes of motion, ranges of motion, speed of motion, volume, and exercise modalities. Be cautious not to change too many variables at one time when progressing an exercise program to ensure that the client is able to demonstrate appropriate mastery at each stage.

Initially, start with core exercises that involve little motion of the spine and target the local core musculature. Example exercises include (but are not limited to) marching, floor/ball bridge, floor/ball cobra, plank, side plank, dead bug, and Palloff press.

The next-level core exercise progression incorporates more motion at the spine that also targets global core muscles. Example exercises include (but are not limited to) floor/ball crunch, back extension, reverse crunch, knee-up, and cable rotation, lift, and chop.

The last core exercise progression involves explosive movement through the trunk and extremities. Example exercises include (but are not limited to) medicine ball chest pass, ball medicine ball pullover throw, front medicine ball oblique throw, side medicine ball oblique throw, medicine ball soccer throw, medicine ball woodchop throw, and medicine ball overhead throw.

Important Concepts (not an exhaustive list)	
Examples of local muscles	Rotatores, Multifidus, Transverse abdominis, Diaphragm, Pelvic floor musculature, Quadratus lumborum
Examples of global muscles	Rectus abdominis, External abdominal obliques, Internal abdominal obliques, Erector spinae, Latissimus dorsi, Iliopsoas (iliacus + psoas)
Drawing-in maneuver	A maneuver used to recruit the local core stabilizers by drawing in the navel toward the spine.

<table>
<tr><td>Bracing</td><td colspan="2">Contracting the global abdominals such as the rectus abdominis and obliques at the same time.</td></tr>
<tr><td>Core training variables</td><td colspan="2"><table>
<tr><td>Planes of motion
Sagittal
Frontal
Transverse</td><td>Volume
Sets
○ Low
○ Moderate
○ High
Repetitions
○ Low
○ Moderate
○ High</td></tr>
<tr><td>Range of motion
Full
Partial
End range</td><td>Progression
Little or no motion of spine
Controlled spinal flexion, extension, rotation
Explosive trunk movements</td></tr>
<tr><td>Speed of motion
Slow
Medium
Fast
Explosive</td><td>Resistance
Body weight
Light
Medium
Heavy</td></tr>
<tr><td></td><td>Exercise equipment
Tubing
Cables
Medicine balls
Free weights
Balance equipment (e.g., foam pad, wobble board, balance disc)</td></tr>
</table></td></tr>
<tr><td>Core training progression 1</td><td colspan="2">When initiating a core training program, exercises should initially focus on stabilization through the spine and pelvis without gross movement of the trunk. These exercises are designed to improve neuromuscular efficiency and intervertebral stability, focusing on drawing-in and then bracing during the exercises. These exercises primarily target the local core muscles. Sample exercises include:
Marching, Floor bridge, Ball bridge, Floor cobra, Ball cobra, Fire hydrant, Plank, Side plank, Dead bug, Bird dog, Pallof press, and Farmer’s carry</td></tr>
<tr><td>Core training progression 2</td><td colspan="2">The next progression is to involve more dynamic eccentric and concentric movements of the spine throughout a full range of motion. In other words, these exercises involve flexion, extension, and rotation of the trunk. In this progression, specificity, speed, and neural demands are also increased using moderate to fast repetition tempos. Sample exercises include:
Floor crunch, Ball crunch, Back extension, Reverse crunch. Knee-up. Cable rotation, Cable lift, and Cable chop</td></tr>
<tr><td>Core training progression 3</td><td colspan="2">The last progression includes exercises that are designed to improve the rate of force production (power) and movement efficiency of the core musculature and extremities. Example exercises include:</td></tr>
</table>

	Medicine ball rotation chest pass, Ball medicine ball pullover throw, Front medicine ball oblique throw, Side medicine ball oblique throw, Medicine ball soccer throw, Medicine ball woodchop throw, and Medicine ball overhead throw
Cable rotation, Cable lift exercises** very important	Make sure to pivot the back leg into triple extension: Hip extension Knee extension Ankle plantarflexion (extension)
Cable chop	The cable chop is an opposite motion of the cable lift exercise. This time the back leg will be in flexion rather than extension.

Chapter 17 Balance Training Concepts Summary

Balance training is a critical component of an exercise program to optimize performance, improve injury resistance, and enhance injury rehabilitation.

Maintaining balance involves the ability of an individual to control the position of the center of gravity over the base of support.

Types of balance include static (stationary body position), semi-dynamic (the base supporting the body is in movement), and dynamic (ever-changing base of support) and can be manipulated to change the level of difficulty during a balance training program.

The balance mechanism involves three key senses:

- Vision, which is typically used to provide information to the central nervous system about the body's location in space
- The vestibular senses, which are controlled by sensory receptors in the inner ear and provide the brain information about spatial orientation and the movement of the head in space
- Somatosensation, which is the ability to feel changes in pressure on the skin, muscle length, and joint angles

Balance training has been shown to improve performance and reduce injury rates in athletes when incorporated into a comprehensive injury prevention program that is carried throughout the course of an athletic season.

Strong evidence demonstrates that balance training programs can reduce the risk of falls in healthy older adults.

Fitness professionals should always emphasize safety when designing a progressive balance training program, especially for clients with a history of injuries or a current injury.

When developing a balance training program, emphasize a safe and progressive increase in proprioceptive demand based on the client's performance.

Many variables can be manipulated when designing a balance training program, including planes, range, and speed of motion, as well as the proprioceptive environment. Be cautious not to change too many variables at one time when

progressing an exercise program to ensure that the client is able to demonstrate appropriate mastery at each stage.

<table>
<tr><th colspan="2">Important Concepts (not an exhaustive list)</th></tr>
<tr><td>Limits of stability</td><td>The area within which an individual can move one’s center of gravity without changing the base of support (i.e., moving the feet) without falling.</td></tr>
<tr><td>Proprioceptively enriched environment</td><td>An unstable (yet controllable) exercise environment that causes the body to use its internal balance and stabilization mechanisms.</td></tr>
<tr><td>Balance training parameters</td><td>
<table>
<tr><th>Exercise Selection</th><th>Variables</th></tr>
<tr><td>Safe
Progressive
Easy to hard
Simple to complex
Stable to unstable
Static to dynamic
Slow to fast
Eyes open to eyes closed
Known to unknown (cognitive task)
Single task to dual task
Balance equipment examples
○ Floor
○ Balance beam
○ Half-foam roll
○ Foam pad
○ Balance disc
○ Wobble board</td><td>Plane of motion
○ Sagittal
○ Frontal
○ Transverse
Lower-body progressions**very important
○ Two-legs/stable (e.g., standing on the floor)
○ Wide stance → Narrow stance → Tandem stance (heel-to-toe)
○ Single-leg/stable (e.g., standing one-legged on the floor)
○ Two-legs/unstable (e.g., standing two-legged on a balance modality)
○ Single-leg/unstable (e.g., standing one-legged on a balance modality)
Perturbation
○ Mild to moderate (e.g., gentle push in one direction → gentle push in multiple directions)</td></tr>
</table>
</td></tr>
<tr><td>Balance training progression 1</td><td>When introducing balance exercises into an exercise program, the exercises should initially involve little joint motion of the balance leg. These entry-level balance exercises are designed to improve reflexive (automatic) muscle contractions to increase joint stability. Sample exercises include:
Tandem stance, Single-leg balance, Single-leg balance reach, Single-leg hip internal and external rotation, Single-leg lift and chop, Single-leg arm and leg motion, Single-leg windmill and Single-leg throw and catch</td></tr>
<tr><td>Balance training progression 2</td><td>The next progression involves dynamic eccentric and concentric movement of the balance leg through a full range of motion. The speed and neural demands of each exercise are progressed. Sample exercises include:
Single-leg squat, Single-leg squat touchdown, Single-leg Romanian deadlift, Multiplanar step-up to balance, and Multiplanar lunge to balance</td></tr>
<tr><td>Balance training progression 3</td><td>The last progression includes exercises that are designed to develop proper deceleration ability to move the body from a dynamic state to a controlled stationary position. In other</td></tr>
</table>

	words, these exercises combine hopping motions with a single-leg stance landing (holding the landing position for 3–5 seconds). Example exercises include: Multiplanar hop with stabilization, Multiplanar single-leg box hop-up with stabilization, and Multiplanar single-leg box hop-down with stabilization

Chapter 18 Plyometric (Reactive) Training Concepts Summary

Plyometric training, also known as jump or reactive training, is a form of exercise that uses explosive movements, such as bounding, jumping, or powerful upper body movements, to develop muscular power.

Employing plyometric training develops efficient control and production of ground reaction forces, which can be used to project the body with a greater velocity or speed of movement.

Clients must possess adequate core strength, joint stability, and range of motion and must balance efficiently prior to performing explosive plyometric exercises.

The integrated performance paradigm states that to move with precision, forces must be loaded (eccentrically), stabilized (isometrically), and then unloaded or accelerated (concentrically).

The three distinct phases of the stretch-shortening cycle involved in a plyometric exercise include the eccentric or loading phase, the amortization phase or transition phase, and the concentric or unloading phase.

Plyometric exercises increase rate of force production (power) and motor unit recruitment.

Plyometric exercises should progress from simple to intermediate to advanced movements and from low intensity to moderate intensity to high intensity.

Intensity should be prescribed by the client's ability to execute the movement and maintain adequate training technique. If technique is lost, the intensity should drop until proper technique is achieved.

Plyometric intensity describes the amount of effort or stress applied by the muscles, connective tissue, and joints during plyometric drills and by the distance covered (height of a jump).

Plyometric volume is expressed as the number of foot contacts, throws, or catches. An example would be the completion of three sets of five squat jumps, equating to a volume of 15.

A general recommendation is to allow at least 1 day between intense plyometric training sessions. At least 48 to 72 hours between sessions are the recommended guidelines when implementing plyometrics for novice individuals.

Since plyometric training involves jumping, bounding, and other explosive movements, it is essential to teach proper landing and rebounding mechanics.

As a general rule, recovery times of 60 to 120 seconds between drills should be

sufficient for full recovery, but this is dictated by the client's fitness level.

When introducing plyometric exercises—especially to new or beginner clients—the movements should initially involve small jumps, and clients should hold the landing position for 3–5 seconds and make any adjustments necessary to correct faulty postures before performing the next jump.

The next progression is to involve jumps with more amplitude and dynamic motion performed with a repetitive tempo.

The last progression includes exercises that are performed as fast and as explosively as possible.

<table>
<tr><th colspan="2">Important Concepts (not an exhaustive list)</th></tr>
<tr><td>Stretch-shortening cycle</td><td>Loading of a muscle eccentrically to prepare it for a rapid concentric contraction.</td></tr>
<tr><td>Integrated performance paradigm</td><td>To move with efficiency, forces must be dampened (eccentrically), stabilized (isometrically), and then accelerated (concentrically).</td></tr>
<tr><td>Components of the stretch-shortening cycle</td><td>
<table>
<tr><th>Phase</th><th>Physiological Event</th><th>Action</th></tr>
<tr><td>Eccentric</td><td>Stored elastic energy; stimulation of muscle spindles, signal sent to spinal cord</td><td>Stretch of agonist muscle</td></tr>
<tr><td>Amortization</td><td>Nerves meet synapse in spinal cord, signal sent to stretched muscle</td><td>Time between the eccentric and concentric phases</td></tr>
<tr><td>Concentric</td><td>Elastic energy release, enhanced muscle force production</td><td>Shortening of agonist muscle</td></tr>
</table>
</td></tr>
<tr><td>Plyometric training variables</td><td>
<table>
<tr><td>Planes of motion
1. Sagittal
2. Frontal
3. Transverse</td><td>Volume
Sets
Low
Moderate
High
Repetitions
Low
Moderate
High</td></tr>
<tr><td>Speed of motion
1. Slow
2. Medium
3. Fast
4. Explosive</td><td>Safety
Performed with supportive shoes
Performed on a proper training surface
Grass field
Basketball court
Tartan track surface
Rubber track surface</td></tr>
</table>
</td></tr>
</table>

		Performed with proper supervision
	Progressive 1. Easy to hard 2. Low to high amplitude 3. Simple to complex 4. Known to unknown 5. Body weight to loaded 6. Activity specific	**Recovery** Allow at least 24 hours between plyometric training sessions ○ 48–72 hours for new or deconditioned clients
Plyometric training progression 1	When introducing plyometric exercises, especially to new or beginner clients, the movements should initially involve small jumps (lower amplitude) to best learn the movement pattern. When an individual lands during these exercises, they should hold the landing position (or stabilize) for 3–5 seconds. During this time, individuals should make any adjustments necessary to correct faulty postures before performing the next jump. Example exercises include: Squat jump with stabilization, Box jump-up with stabilization, Box jump-down with stabilization, and Multiplanar jump with stabilization	
Plyometric training progression 2	The next progression involves jumps with more amplitude and dynamic motion. The speed of the jumps is also progressed. These exercises are performed in a repetitive fashion, spending a relatively short amount of time on the ground before repeating the drill. In other words, the client will no longer hold the landing position for 3–5 seconds but instead initiate another jump upon landing using a moderate (repeating) tempo. Some example exercises include: Squat jump, Tuck jump, Butt kick, and Power step-up	
Plyometric training progression 3	The last progression includes exercises that involve explosive, powerful movements. These exercises are performed as fast and as explosively as possible. Some example exercises include: Ice skaters (also known as skater jumps), Single-leg power step-up, Proprioceptive plyometrics, and Depth jump	

Chapter 19 Speed, Agility, and Quickness Training Concepts Summary

- SAQ training is a useful and effective method of fitness training stimulating muscular, neurological, connective tissue, and even cardiovascular fitness adaptations.
- SAQ exercises can promote improvements in physical performance and sustain youthful movement throughout life.
- SAQ training will allow clients to enhance their ability to accelerate, decelerate, and dynamically stabilize their entire body during high-velocity movements in all planes of motion.
- Speed, the product of stride rate and stride length, refers to the velocity of distance covered divided by time.
- Agility necessitates the ability to start (or accelerate), stop (or decelerate and stabilize), and change direction while maintaining postural control.

- Quickness refers to the ability to react to a stimulus and appropriately change the motion of the body in response to that stimulus.
- Stride rate is the number of strides taken in a given amount of time (or distance).
- Stride length is the distance covered in one stride.
- Proper running mechanics will enable the client to maximize force generation through biomechanical efficiency.
- Components of an SAQ program can significantly improve the physical health profile of apparently healthy, sedentary, nonathletic adults and those with medical or health limitations.
- SAQ programs for youth have been found to decrease the likelihood of athletic injury, increase the likelihood of exercise participation later in life, and improve physical fitness.
- SAQ training for older adults may help prevent age-related decreases in bone density, coordinative ability, and muscular power.
- The high-intensity, short bouts of SAQ drills make them a valid choice for interval training protocols with appropriate nonathletic populations, including weight-loss clients.

Important Concepts (not an exhaustive list)	
Speed	The ability to move the body in one intended direction as fast as possible.
Agility	The ability to start (or accelerate), stop (or decelerate and stabilize), and change direction in response to a signal or stimulus quickly while maintaining postural control. Examples of agility include: Rapidly changing running direction to avoid a tackler in American football Performing a crossover in basketball to attack the basket Rapidly changing running direction in an obstacle course
Quickness	The ability to react and change body position with maximal rate of force production, in all planes of motion and from all body positions, during dynamic activities. Examples of quickness include: Hitting a baseball Returning a tennis serve Swerving to avoid a car accident
Stride rate	The number of strides taken in a given amount of time (or distance).
Stride length	The distance covered with each stride during the gait cycle.
Frontside mechanics	Proper alignment of the lead leg and pelvis during sprinting, which includes ankle dorsiflexion, knee flexion, hip flexion, and a neutral pelvis.
Backside mechanics	Proper alignment of the rear leg and pelvis during sprinting, which includes ankle plantarflexion, knee extension, hip extension, and a neutral pelvis.

Chapter 20 Resistance Training Concepts Summary

The GAS model outlines three stages of response to stress: alarm reaction, resistance development, and exhaustion.

The alarm reaction stage, the initial reaction to a stressor, can include fatigue, joint stiffness, or delayed onset muscle soreness.

The resistance development stage involves numerous physiological changes that ultimately lead to training adaptations that promote increases in performance.

Prolonged or intolerable amounts of stress lead to the exhaustion stage, which is characterized by stress fractures, muscle strains and ligament sprains, joint pain, and emotional fatigue.

The principle of specificity, often referred to as the SAID principle, describes the body's responses and adaptations to exercise.

Mechanical specificity refers to the weight and movements placed on the body.

Neuromuscular specificity refers to the speed of contraction and exercise selection.

Metabolic specificity refers to the energy demand placed on the body.

The main adaptations that occur from resistance training include stabilization, muscular endurance, hypertrophy, strength, and power.

Stabilization is the body's ability to provide optimal dynamic joint support to maintain correct posture during all movements.

Muscular endurance is the ability to produce and maintain force production for prolonged periods of time.

Muscular hypertrophy is the enlargement of skeletal muscle fibers.

Strength is the ability of the neuromuscular system to produce internal tension, specifically in the muscles and connective tissues that pull on the bones, to overcome an external force.

Power is the ability of the neuromuscular system to produce the greatest possible force in the shortest possible time.

Acute variables include repetitions, sets, training intensity, repetition tempo, rest intervals, training volume, training frequency, training duration, exercise selection, and exercise order.

There are numerous training systems that can be used to structure resistance training programs for a variety of effects. Several of the most common training systems include warm-up set, single set, multiple set, pyramid, superset, complex training, drop set, giant set, rest-pause set, circuit training, peripheral heart action, split routine, vertical loading, and horizontal loading.

Fitness professionals must safeguard their clients from harm. This requires maintaining a safe environment, ensuring proper equipment set up, using appropriate spotting procedures, and monitoring exercise technique using the five kinetic chain checkpoints.

Resistance exercises should initially focus on optimizing ideal movement patterns. Once a client displays adequate movement competency, resistance exercises should progress in a systematic fashion using three steps: (1) stabilization-focused exercises, (2) strength-focused exercises, and (3) power-focused exercises.

<table>
<tr><th colspan="2">Important Concepts (not an exhaustive list)</th></tr>
<tr><td>Stabilization</td><td>The body's ability to provide optimal dynamic joint support to maintain correct posture during all movements.</td></tr>
<tr><td>Muscular endurance</td><td>The ability to produce and maintain force production for prolonged periods of time.</td></tr>
<tr><td>Muscular hypertrophy</td><td>The enlargement of skeletal muscle fibers.</td></tr>
<tr><td>Strength</td><td>The ability of the neuromuscular system to produce internal tension to overcome an external load.</td></tr>
<tr><td>Power</td><td>Force × Velocity or Work ÷ Time</td></tr>
<tr><td>Rate of force production</td><td>Ability of muscles to exert maximal force output in a minimal amount of time.</td></tr>
<tr><td>Suggested repetitions, sets, and training intensity</td><td>
<table>
<tr><th>Training Adaptation</th><th>Suggested Acute Variables*</th></tr>
<tr><td>Stabilization and muscular endurance</td><td>Moderate to high repetitions: ~12–20 or higher
Low to moderate sets: ~1–3 sets
Low to moderate training intensities: ~50–70% 1RM</td></tr>
<tr><td>Muscular hypertrophy†</td><td>Low to moderate repetitions: ~6–12 or higher
Moderate to high sets: ~3–6 sets
Moderate to high training intensities: ~75–85% 1RM</td></tr>
<tr><td>Maximal strength</td><td>Low repetitions: ~1–5
High sets: ~4–6 sets
High training intensities: ~85–100% 1RM</td></tr>
<tr><td>Power</td><td>Low to moderate repetitions: ~1–10
Moderate to high sets: ~3–6
Low training intensities: ~10% of bodyweight (when using a medicine ball) or ~30–45% (when using weights)</td></tr>
<tr><td colspan="2">*The acute variables listed in this table are not absolutes. A client's training program, goals, and fitness level dictate appropriate acute variable selection.
† Muscle hypertrophy adaptations can be attained with various repetition, set, and intensity schemes depending on the total volume of training and the client's fitness level.</td></tr>
</table>
</td></tr>
<tr><td>Resistance training systems</td><td>
<table>
<tr><th>Type</th><th>Definition</th></tr>
<tr><td>Warm-up set</td><td>1–2 sets at a low intensity to psychologically and physiologically prepare for the resistance training exercise</td></tr>
<tr><td>Single set</td><td>Performing one set of each exercise</td></tr>
<tr><td>Multiple set</td><td>Performing a multiple number of sets for each exercise</td></tr>
</table>
</td></tr>
</table>

	Pyramid	Increasing (or decreasing) weight with each set
	Superset	Performing two exercises in rapid succession with minimal rest
	Complex training	Performing a multijoint or compound exercise, with a heavy load, immediately followed by an explosive movement (e.g., a barbell squat then a vertical jump)
	Drop set	Performing a set to failure, then removing a small percentage of the load and continuing with the set
	Giant set	Performing four or more exercises in rotation with as little rest as possible between sets
	Rest pause	Incorporating a slight pause between repetitions within a series of sets
	Circuit training	Performing a series of exercises, one after the other, with minimal rest
	Peripheral heart action	A variation of circuit training that alternates upper and lower body exercises throughout the set
	Split routine	A resistance training routine that trains different body parts on separate days
	Vertical loading**very important	A form of training in which strength training exercises are performed in rapid succession, starting with the upper body and working down to the lower body (i.e., total-body → chest → back → shoulders → biceps → triceps → legs)
	Horizontal loading**very important	Performing all sets of an exercise (or body part) before moving on to the next exercise (or body part)
Spotting checklist**very important	The following checklist should be used by the fitness professional during spotting activities: The spotter should regulate the number of total repetitions performed by the client prior to the beginning of each set. The spotter should stand and maintain a stable, wide-stance body position to increase maximal safety of the corresponding exercise. An experienced spotter delivers adequate and ample support for the client to successfully execute the lift, especially when lifting through the sticking point. The Certified Personal Trainer is encouraged to spot at the client's wrists instead of the elbows when using dumbbells (i.e., in a dumbbell shoulder press). Spotting at the wrist provides better support for the lifter and eliminates the elbows collapsing inward. During the barbell squat exercise, the spotter should be positioned behind the lifter and place their upper arms underneath the lifter's armpits. This provides maximum spotting security between the spotter and the lifter. The Certified Personal Trainer is encouraged to use an additional spotter for exercises when the load surpasses what a single spotter can successfully manage on their own. For example, two spotters will stand on opposite sides of the barbell during a heavy barbell back squat exercise. When and if needed, the spotters will assist the	

<table>
<tr><td></td><td>client in accomplishing the movements by lifting the ends of the barbell until they are able to complete the exercise.
It is not recommended for fitness professionals to spot machine-based or cable-based exercises by placing their hands underneath the weight stack. This increases risk of injury to the spotter and the lifter.</td></tr>
<tr><td>Resistance training variables</td><td>
<table>
<tr><td>Progressive
Easy to hard
Simple to complex
Static to dynamic
Slow to fast
Stabilization → strength → power</td><td>Volume
Sets
Low
Moderate
High
Repetitions
Low
Moderate
High</td></tr>
<tr><td>Range of motion
Full
Partial
End range
Mixed ranges</td><td>Planes of motion
Sagittal
Frontal
Transverse
Multiplanar</td></tr>
<tr><td>Speed of motion
Slow
Medium
Fast
Explosive</td><td>Resistance
Body weight
Light
Medium
Heavy</td></tr>
</table>
</td></tr>
<tr><td>Stabilization-focused exercises</td><td>This form of resistance training should provide greater demands on core stability and proprioception by progressing from bilateral to unilateral movements, using slow repetition tempos, and high repetition schemes. For example, the standing cable row can be progressed from two-arm movements to alternating-arm movements to one-arm movements, providing greater variety in one exercise.
Exercises can also be progressed in this category by decreasing one’s base of support. For example, the same cable row sequence (two-arm, alternating-arm, one-arm) can be advanced to a single-leg stance to further challenge the client’s posture, balance, and joint stability.</td></tr>
<tr><td>Strength-focused exercises</td><td>These exercises focus on the adaptations of strength and muscular hypertrophy and typically require heavier loads than stabilization-focused resistance exercises. The goal is to increase the amount of stress placed on the body for increased muscle size and strength. This period of training is a necessary progression from stabilization for anyone who desires to increase muscle size, muscle strength, and bone mineral density. Common exercises in this category include squats, Romanian deadlifts, bench presses, and other common weightlifting exercises.</td></tr>
<tr><td>Power-focused exercises</td><td>The last progression focuses on the adaptation of muscular power. Power-focused resistance exercises are designed to increase the rate of</td></tr>
</table>

	force production (or speed of muscle contraction). This form of training uses the adaptations of stabilization and strength acquired previously and applies them with more realistic speeds and forces that the body will encounter in everyday life and in sports. Examples of power-focused resistance exercise include explosive movements, such as medicine ball throws and explosive plyometrics.

Section 6: Program Design

Chapter 21. The Optimum Performance Training Model

Exercise programs need individuality, based on the client's assessment results, to make them impactful for clients, which likely increases adherence to the program.

Fitness professionals should adopt an integrated, multicomponent approach to program design that includes flexibility, cardiorespiratory, core, balance, plyometric, SAQ, and resistance training.

Exercise programs must consider many variables, such as teaching proper movement patterns, improving mobility and stability, enhancing endurance, and reducing the likelihood of injury.

A training plan determines the forms of training to be used, how long it will take, how often it will change, and what specific exercises will be performed.

Periodization is a systematic approach to program design that varies the amount and type of stress placed on the body to produce a physical adaptation and reduce the likelihood of overtraining and injury.

An annual training plan, or macrocycle, demonstrates the long-term training program and how it progresses each month.

A monthly training plan, or mesocycle, typically outlines a training plan for one month.

A weekly plan, or microcycle, describes the specific workouts for the week.

Linear periodization gradually increases the intensity of the training program while simultaneously decreasing volume over a specific period of time.

Undulating periodization uses changes in volume, intensity, and exercise selection to provide loading differences on a daily or weekly basis.

The OPT model consists of three levels: stabilization, strength, and power.

The OPT model includes five unique phases of training: Phase 1 Stabilization Endurance Training, Phase 2 Strength Endurance Training, Phase 3 Muscular Development Training, Phase 4 Maximal Strength Training, and Phase 5 Power Training.

The OPT workout template is divided into six parts: Warm-up, Activation, Skill Development, Resistance Training, Client's Choice, and Cool-down. Cardiorespiratory training can be integrated into any section of the OPT template.

Phase 1 Stabilization Endurance Training teaches clients how to perform proper movement patterns, including pushing, pulling, pressing, squatting, hip hinging, trunk rotation, and overall movement competency.

Once clients display adequate movement patterns, Phase 1 programs are progressed by placing a greater emphasis on enhancing proprioception, balance, and postural control.

Phase 2 Strength Endurance Training is a hybrid form of training that involves the use of superset training in which a strength-focused exercise is immediately followed by a stabilization-focused exercise with similar biomechanical motions.

Phase 3 Muscular Development Training is designed to enhance muscle hypertrophy using a high volume of strength-focused exercises.

Phase 4 Maximal Strength Training requires the inclusion of heavy resistance training exercises to increase muscular strength.

Phase 5 Power Training uses superset techniques to increase rate of force production. These superset techniques include performing a heavy resistance training exercise immediately followed by an explosive power-based exercise with similar biomechanical motions.

The OPT model is an exercise program model that uses both linear and undulating periodization to help clients of all levels and abilities achieve a variety of different goals, including but not limited to reduced body fat, increased muscle mass, and improved athletic performance.

Important Concepts (not an exhaustive list)

Phase 1 resistance training protocols

Sets	Reps	Tempo	Rest	Intensity
1-3	12-20	Slow	0-90 secs	12-20 RM

**very important

Phase 2 resistance training protocols

Sets	Reps	Tempo	Rest	Intensity
2-4	8-12 (strength) 8-12 (stability)	Moderate and Slow	0-60 secs after each superset	8-12 RM

**very important

Phase 2 example superset sets

Strength-Focused Exercise	Stability-Focused Exercise
Bench press	Push-up
Machine chest press	Single-leg cable press
Machine lat pulldown	Stading lat pulldown
Machine cable row	Standing cable row
Machine shoulder press	Standing bottoms-up kettlebell press
Seated dumbbell shoulder press	Single-leg dumbbell shoulder press
Barbell squat	Single-leg squat
Romanian deadlift	Single-leg Romanian deadlift
Machine calf raise	Single-leg calf raise

Phase 3 resistance training protocols

Sets	Reps	Tempo	Rest	Intensity
3-6	6-12	Moderate	0-3 minutes	N/A

Notes: 12-20 reps is allowed if additional muscular endurance is desired

**very important

Phase 4 resistance

Sets	Reps	Tempo	Rest	Intensity
4-6	1-5	Explosive	0-3 minutes	1-5RM

<table>
<tr><td>training protocols</td><td>**very important</td></tr>
<tr><td>Phase 5 resistance training protocols</td><td>
<table>
<tr><th>Sets</th><th>Reps</th><th>Tempo</th><th>Rest</th><th>Intensity</th></tr>
<tr><td>3-5</td><td>1-5 (strength)
and
8-10 (power)</td><td>Explosive</td><td>1-2 minutes between pairs; 3-5 minutes between circuits</td><td>1-5RM
and
8-10 RM, or
30-45% 1RM</td></tr>
</table>
**very important</td></tr>
<tr><td>Phase 5 example superset sets</td><td>
<table>
<tr><th>Strength-Focused Exercise</th><th>Power-Focused Exercise</th></tr>
<tr><td>Bench press</td><td>Medicine ball chest pass</td></tr>
<tr><td>Machine chest press</td><td>Plyometric push-up</td></tr>
<tr><td>Machine lat pulldown</td><td>Medicine ball soccer throw</td></tr>
<tr><td>Machine cable row</td><td>Medicine ball pullover throw</td></tr>
<tr><td>Machine shoulder press</td><td>Front medicine ball oblique throw</td></tr>
<tr><td>Seated dumbbell shoulder press</td><td>Overhead medicine ball throw</td></tr>
<tr><td>Barbell squat</td><td>Squat jump</td></tr>
<tr><td>Romanian deadlift</td><td>Tuck jump</td></tr>
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Chapter 22. Introduction to Exercise Modalities

- Exercise modalities are tools that are designed to enhance an exercise or movement to create a desired outcome.
- There are many types of exercise modalities, including resistance training equipment, balance tools, and fitness trackers.
- It is important to keep safety and effectiveness in mind when deciding which training modalities may be the best to use and when to integrate them into a program.
- Because most novice exercisers lack resistance training experience, strength-training machines may offer a safer and effective option to free weights. Strength-training machines, however, are regarded as inferior to free weights for improving core stability and muscular coordination, as they offer artificial support instead of using one's core musculature.
- Free weights can be used by most populations, in a variety of fashions, for many goals, and in all phases of the OPT model. Although extremely versatile, free weights can be intimidating for some clients.
- Cable machines can provide greater ROM when compared to selectorized strength equipment. When using cable machines, it is important to match the cable's resistance to the muscle's natural line of pull.
- Elastic bands and tubing also allow clients to perform resisted exercises that mimic sport-specific movements, such as a golf swing or tennis forehand. Elastic resistance is portable and inexpensive but may not be ideal when trying to develop high levels of strength and muscular hypertrophy.

- Medicine balls can be used like other resistance implements to add load or instability to an exercise. Medicine balls can be used with a variety of populations as part of a program to increase muscular strength, endurance, and power, or in some cases, to help rehabilitate from injury.
- A kettlebell differs from a dumbbell, barbell, or medicine ball in that the center of mass is away from the handle, which may require more strength and coordination, as well as increased recruitment from stabilizers and prime movers simultaneously during particular movements. Many kettlebell exercises involve multiple joint motions and muscle groups.
- Suspended bodyweight training is an innovative approach to bodyweight fitness training in that it uses a system of ropes and webbing that allows the user to work against their own bodyweight while performing various exercises.
- Sandbags are designed to be carried, lifted, thrown, and pulled, and most come with several handles to easily change grips. Unlike barbells, dumbbells, and selectorized machines, the sand within the bag is constantly shifting, providing continuous instability.
- ViPR is an acronym for vitality, performance, and reconditioning. It is designed to be dragged, tossed, lifted, pulled, pressed, and carried. This design provides the fitness professional the ability to perform multidirectional, full-body exercises with external load resistance, known as loaded movement training.
- Battle ropes are typically made of heavy-duty nylon and come in a variety of lengths and thicknesses. Battle ropes are low-impact activities, which provide less impact on the joints.
- Balance modalities improve balance, ankle stability, and coordination but should not be used to perform maximal or near maximal lifts for safety reasons.
- Stability balls, also known as Swiss balls, are frequently used in a variety of training facilities with a wide range of populations. They are primarily used to increase the demand for stability in an exercise, but they can also be used to reinforce proper posture during squatting movements.
- The BOSU ball is an inflated rubber hemisphere attached to a solid plastic surface; it looks like a stability ball cut in half. Training with the BOSU ball offers the ability to increase the intensity of an exercise by decreasing the stability.
- The Terra-Core is comprised of an inflatable rubber bladder and hard-surfaced backing. Unlike stability balls, it is safe to perform several resistance training exercises, such as a dumbbell chest press, while lying supine on the Terra-Core.
- Fitness trackers are electronic wearable devices that enable a user to track their activity levels. They come in many forms, such as watches, bands, rings, heart rate monitors, and pedometers. Ease of use and intrinsic motivation are key factors for continued use of fitness trackers among those who purchase trackers.

Important Concepts (not an exhaustive list)

Pros and cons of strength machines	**Pros**	**Cons**
	May be less intimidating for certain clients	Many machines do not allow the user to perform total-body exercises
	Can emphasize certain muscle groups for rehabilitation or bodybuilding purposes	Moves primarily in one plane of motion
	Various intensities (load) provided in one weight stack	Does little to provide challenge to the core stabilization system
	Does not require a spotter	May not be ideal for improving athletic performance
	Provides extra support for clients with special needs	Machines do not fit all body types (short, tall, or obese clients may have a hard time adjusting the machine)
	Keeps the client in a fixed plane of motion, which may limit excessive ranges of motion	Expensive in comparison to other strength-training modalities
Pros and cons of free weights	**Pros**	**Cons**
	Can be used to emphasize certain muscle groups or target multiple muscle groups	May require a spotter
	Can improve athletic performance	May be too difficult for beginning clients to perform until exercise technique is mastered
	Can challenge the core stabilization system	Requires multiple dumbbells or barbells to change intensity (load)
	May improve dynamic joint stabilization and proprioception	Potentially more dangerous
	Allows individuals to move in multiple planes of motion	Intimidating for certain individuals

Chapter 23. Chronic Health Conditions and Special Populations

- There is a significant need for increased awareness and access to general fitness training for youths year-round, not just during one or more sport seasons.
- Given the alarming increase in childhood obesity and diabetes, current youth fitness guidelines focus on promoting healthy lifestyles and health-related physical fitness. Current recommendations state that children and adolescents should get 60 minutes (1 hour) or more of moderate to vigorous physical activity daily.
- It is important to understand that there are fundamental physiologic differences between children and adults.
- Research has clearly demonstrated that resistance training is both safe and effective in children and adolescents.
- Despite the normal decline in physiologic functioning associated with aging, older adults—with and without other chronic health conditions—can and do respond to exercise much in the same manner as apparently healthy younger adults.

- By adhering to a systematic process, fitness professionals can make a dramatic impact on the overall health and well-being of older adults.
- Regular physical activity and exercise is one of the most important factors related to long-term successful weight loss.
- Exercise has been shown to have a substantial positive effect on the treatment and prevention of type 2 diabetes.
- Clients with stable coronary artery disease—especially those who have participated in a cardiac rehabilitation program—should know or be taught information on the importance and benefits of exercise, which include a lower risk of mortality, increased exercise tolerance, muscle strength, reduction in angina and heart failure symptoms, and improved psychological status and social adjustment.
- Exercise regimens that combine resistance training to increase BMD with flexibility, core, and balance training to enhance proprioception are important for clients with osteoporosis and osteopenia.
- It is important for fitness professionals to understand the difference between rheumatoid arthritis and osteoarthritis and be aware of the signs and symptoms of an acute rheumatoid arthritis exacerbation.
- Fitness professionals should also monitor the progress of clients with arthritis to assess the effects of the exercise program on joint pain.
- Exercise is an important intervention for clients recovering from cancer. It can improve exercise tolerance, reduce the cellular risks associated with cancer, and improve quality of life.
- There has been substantial research documenting the beneficial effects of exercise during pregnancy on the physiology and health of both the mother and developing fetus.
- Clients with lung disease experience fatigue at low levels of exercise and often experience dyspnea.
- The primary limiting factor for exercise in the client with PAD is leg pain.

Important Concepts (not an exhaustive list)	
Exercise considerations for youth clients	Progression for the youth population should be based on postural control and not on the amount of weight that can be used Make exercising fun
Exercise considerations for older adults	Progression should be slow, well monitored, and based on postural control. Exercises should be progressed if possible, toward free sitting (no support) or standing. Make sure the client is breathing in a normal manner and avoids holding their breath, as in a Valsalva maneuver.

	If the client cannot tolerate self-myofascial techniques or static stretches, they can opt for slow and controlled active and dynamic stretches.
Exercise considerations for overweight or obese clients	Make sure client is comfortable—be aware of positions and locations in the facility your client is in. Exercises should be performed in a standing or seated position. Clients may have other chronic diseases; in such cases, a medical release should be obtained from the individual's physician. Resistance exercises performed in a circuit-training manner, with higher repetitions, such as 20, may be used if tolerated by the individual.
Exercise considerations for diabetic clients	Make sure client has appropriate footwear, and have client or physician check feet for blisters or abnormal wear patterns. Advise client or class participant to keep a snack (quick source of carbohydrate) available during exercise to avoid sudden hypoglycemia. Avoid excessive plyometric training, and higher-intensity training is not recommended for clients with diabetes. Self-myofascial techniques may be contraindicated; a physician's approval is recommended.
Exercise considerations for hypertensive clients	Avoid heavy lifting and Valsalva maneuvers—make sure client breathes normally. Do not let client overgrip weights or clench fists when training. Modify tempo to avoid extended isometric and concentric muscle actions. Perform exercises in a standing or seated position. Allow client to stand up slowly to avoid possible dizziness. Progress client slowly. Use circuit or peripheral heart action system (PHA) weight training as an option, with appropriate rest intervals. Tempo should not exceed 1 second for isometric and concentric portions of the lift.
Exercise considerations for clients with coronary heart disease	Be aware that clients may have other diseases to consider as well, such as diabetes, hypertension, peripheral vascular disease, or obesity. Modify tempo or pace to avoid extended isometric and concentric muscle actions. Avoid heavy lifting and Valsalva maneuvers—make sure client breathes normally. Do not let client overgrip weights or clench fists when training. Perform exercises in a standing or seated position. Progress exercise slowly. Use circuit or peripheral heart action system (PHA) weight training as an option, with appropriate rest intervals. Tempo should not exceed 1 second for isometric and concentric portions of the lift.
Exercise considerations	Progression should be slow, well monitored, and based on postural control. Exercises should be progressed, if possible, toward free sitting (no support) or standing.

for clients with osteoporosis	Focus exercises on hips, thighs, back, and arms. Avoid excessive spinal loading on squat and leg press exercises. Make sure the client is breathing in normal manner and avoids holding their breath, as in a Valsalva maneuver.
Exercise considerations for arthritic clients	Avoid heavy lifting and high repetitions. However, high repetitions with low load may be appropriate. Stay in pain-free ranges of motion. Start out with only 5 minutes of exercise, if needed, and progressively increase, depending on the severity of conditions. May use a circuit or peripheral heart action training system.
Exercise considerations for clients with cancer	Avoid heavy lifting in initial stages of training. Allow for adequate rest intervals, and progress client slowly. There may be a need to start with only 5 minutes of exercise and progressively increase, depending on the severity of conditions and fatigue. May use a circuit or peripheral heart action training system.
Exercise considerations for pregnant clients	Avoid exercises in a prone (on stomach) or supine (on back) position after 12 weeks of pregnancy. Avoid self-myofascial techniques on varicose veins and areas of swelling. Plyometric training is not advised in the second and third trimesters. Moderate- to high-intensity resistance exercise may be used in the first trimester if the client is accustomed to exercise; however, in the second and third trimesters, lower-intensity exercise programs are advised.
Exercise considerations for clients with lung disease	Upper-body exercises cause increased dyspnea and must be monitored. Allow for sufficient rest between exercises. Peripheral heart action training system is recommended.
Exercise considerations for clients with intermittent claudication or PAD	Allow for sufficient rest between exercises. Workout may start with 5–10 minutes of activity. Slowly progress client. A circuit-training format is recommended.