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>
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</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.