Domain 1: Basic and Applied Sciences and Nutritional Concepts

Concepts and Structures of Anatomy & Functions of Exercise Physiology

The Nervous System

**Nervous system**—communication network within the body.

**Central nervous system (CNS)**—brain and spinal cord; controls and interprets information.

**Peripheral nervous system (PNS)**—nerves connecting the CNS to the rest of the body and environment.

**Peripheral nervous system subdivisions:**
- **Somatic**—outer areas body and skeletal muscle; voluntary.
- **Autonomic**—involuntary systems (e.g., heart, digestion).
  - **Autonomic subdivisions:**
    - **Parasympathetic**—decreases activation during rest and recovery.
    - **Sympathetic**—increases activation to prep for activity.

**Neuron**—functional unit of the nervous system.
- **Motor (efferent) neurons**—transmits nerve impulses from CNS to effector sites.
- **Sensory (afferent) neurons**—respond to stimuli; transmit nerve impulses from effector sites to CNS.

**Mechanoreceptors**—sense distortion in body tissues.
Joint receptors—respond to pressure, acceleration, and deceleration of joints.
Golgi tendon organs (GTO)—sense changes in muscular tension.
Muscle spindles—sense changes in muscle length.

**The Muscular System**

**Tendons**—connect muscle to bone; provide anchor for muscles to produce force.
**Fascia**—outer layer of connective tissue surrounding a muscle.
**Fascicles**—bundle of individual muscle fibers.

**Cross-Section of a Muscle**

**Muscle fiber**—cellular components and myofibrils encased in a plasma membrane.
**Sarcomere**—produces muscular contraction; repeating sections of actin and myosin.
**Sliding filament theory**—thick and thin filaments slide past one another, shortening the entire sarcomere.

**Type I (slow twitch) muscle tissue**—smaller size; slower to produce tension; fatigue slowly.
**Type II (fast twitch) muscle tissue**—larger size; quick to produce tension; fatigue quickly.

**Motor unit**—one motor neuron and the muscle fibers it connects with.
**Neural activation**—contraction of a muscle generated by neural stimulation.
**Neurotransmitters**—chemical messengers that transport impulses from nerve to muscle.
Local stabilization system—attach directly to vertebrae.
   *Consists of:* transverse abdominis, internal oblique, multifidus, pelvic floor, diaphragm.

Global stabilization system—attach from pelvis to spine.
   *Consists of:* quadratus lumborum, psoas major, external obliques, rectus abdominus, gluteus medius, adductor complex.

Movement system—attach spine and/or pelvis to extremities.
   *Consists of:* latissimus dorsi, hip flexors, hamstring complex, quadriceps.

Refer to Appendix D of the textbook for detailed descriptions of all major muscles.

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The Skeletal System

Axial skeleton—skull, rib cage, and vertebral column.

Appendicular skeleton—upper and lower extremities, shoulder and pelvic girdles.

Skeletal system functions—supports, protects, allows bodily movement.

Depressions—flattened or indented portions of a bone; can be muscle attachment sites.

Process—projection protruding from a bone; muscles, tendons, and ligaments can attach.

Ligaments—connects bone to bone; little blood supply; slow to heal.

Arthrokinematics—joint motion.

Non-synovial joints—no joint cavity, connective tissue, or cartilage; little to no movement.

Synovial Joints—held together by joint capsule and ligaments; greatest capacity for motion.

Major motion types—roll, slide, and spin.

Important joint types to know:
   - Hinge—elbows, ankles; sagittal plane movement.
   - Ball-and-socket—shoulders, hips; most mobile, all three planes of motion.

Weight-bearing exercise—the best method to strengthen bones.
The Endocrine System

**Endocrine system**—system of glands; secretes hormones to regulate bodily function.
**Testosterone**—anabolic hormone; responsible for male sex traits.
**Estrogen**—influences fat deposition on hips, buttocks, and thighs; responsible for female sex traits.
**Growth hormone**—anabolic hormone; responsible for bodily growth up until puberty.
**Insulin**—regulates energy and glucose metabolism in the body.

The Cardiorespiratory System

**Cardiorespiratory system**—cardiovascular and respiratory systems.
**Cardiovascular system**—heart, blood, and blood vessels.

**Cardiac muscle**—shorter, more tightly connected than skeletal muscle; involuntary; fires synchronously.
**Atria**—smaller, superior chambers of the heart; receive blood from veins.
- **Right atrium**—gathers deoxygenated blood returning to the heart.
- **Left atrium**—gathers oxygenated blood from the lungs.

**Sinoatrial (SA) node**—located in right atrium; initiates impulse for heart rate; “pacemaker for the heart”.

**Ventricles**—larger, inferior chambers of the heart; pump blood out.
- **Right ventricle**—pumps deoxygenated blood to lungs.
- **Left ventricle**—pumps oxygenated blood to the body.

**Arteries**—carry blood away from the heart.
**Veins**—transport blood back to the heart.
**Arterioles**—small branches of arteries; end in capillaries.
**Capillaries**—smallest blood vessels; site of gas, chemical, and water exchange.
Venules—very small veins; connect capillaries to larger veins.

Stroke volume—amount of blood pumped with each contraction.
Heart rate—the rate at which the heart pumps; average untrained adult = 70-80 bpm.
Cardiac output—volume of blood pumped per minute; heart rate × stroke volume.

Respiratory system—lungs and respiratory passageways; brings in oxygen, removes CO₂.
Inspiration—contracting inspiratory muscles to move air into lungs.
  Inspiratory muscles:
  - Primary—diaphragm, external intercostals,
  - Secondary—scalenes, pectoralis minor, sternocleidomastoid.
Expiration—relaxing inspiratory muscles (passive), contracting expiratory muscles (active) to move air out.
  Expiratory muscles—internal intercostals, abdominals.
Resting oxygen consumption (VO₂)—3.5 ml × kg⁻¹ × min⁻¹ = 1 metabolic equivalent (MET)
Maximal oxygen consumption (VO₂max)—highest rate of oxygen transport and utilization achieved at maximal physical exertion.

Dysfunctional breathing—associated with stress and anxiety; may result in headaches, fatigue, poor circulation, and/or poor sleep patterns.

Cardiorespiratory exercise:
  - Increases—cardiac output, breathing efficiency, oxygen transport and use, use of fats for fuel, mental alertness, ability to relax and sleep, tolerance to stress, lean body mass, metabolic rate.
  - Decreases—resting heart rate, cholesterol, blood pressure, and the risks of heart disease, blood clots, depression, anxiety, obesity, and diabetes.

Bioenergetics and Exercise Metabolism

Bioenergetics—study of energy in the human body.
Metabolism—process in which nutrients are acquired, transported, used, and disposed of by the body.
Aerobic—requires oxygen.
Anaerobic—without oxygen.
Adenosine triphosphate (ATP)—energy storage and transfer unit within cells.
Anaerobic threshold—where the body can no longer produce enough energy with normal oxygen intake.
Excess post oxygen consumption (EPOC)—elevation of metabolism after exercise.
Fundamentals of Biomechanics

**Biomechanics**—science concerned with internal and external forces acting on the body.

**Force**—influence applied by one object to another, accelerates or decelerates the second object.

**Torque**—a force that produces rotation. *The closer the load to the point of rotation, the less torque it creates (i.e., bent arm is easier than straight arm)*.

**Lever**—rigid “bar” that rotates around a stationary fulcrum.
- **1st class**—fulcrum in middle (*nodding head*).
- **2nd class**—resistance in the middle (*calf raise*).
- **3rd class**—effort in the middle (*biceps curl*); most common in human limbs.

Anatomic locations

**Superior**—above a point of reference.
**Inferior**—below a point of reference.
**Proximal**—nearest to a point of reference.
**Distal**—farthest from a point of reference.
**Anterior**—front of the body.
**Posterior**—back of the body.
**Medial**—closer to the midline.
**Lateral**—farther from the midline.
**Contralateral**—on the opposite side of the body.
**Ipsilateral**—on the same side of the body.
Planes of Motion

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<td>Side lateral raise, side lunge, side shuffle</td>
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<tr>
<td></td>
<td>Lateral flexion</td>
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<td></td>
<td>Eversion/inversion</td>
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<tr>
<td>Sagittal</td>
<td>Flexion/extension</td>
<td>Biceps curl, triceps pushdown, squat</td>
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<tr>
<td>Transverse</td>
<td>Rotation</td>
<td>Throwing, golfing, swinging a bat</td>
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<tr>
<td></td>
<td>Horizontal adduction/abduction</td>
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</table>

Joint Motions

- **Flexion**—bending movement; decreases relative angle between segments.
- **Extension**—straightening movement; increases relative angle between segments.
- **Plantarflexion**—extension at the ankle.
- **Dorsiflexion**—flexion at the ankle.
- **Abduction**—movement away from the middle.
- **Adduction**—movement toward the middle.
- **Horizontal abduction**—transverse plane arm movement from anterior to lateral (e.g. chest flies).
- **Internal rotation**—rotation toward the mid line.
- **External rotation**—rotation away from the midline.
Length-tension relationship—resting length of a muscle and the tension it can produce at that length.

Force-couple—muscles working together to produce movement.

Force-velocity curve—as the velocity of a contraction increases, concentric force decreases and eccentric force increases.

Neuromuscular efficiency—ability to produce and reduce force, and stabilize the kinetic chain in all three planes of motion.

Structural efficiency—alignment of the musculoskeletal system that allows center of gravity to be maintained over a base of support.

Davis’s law—soft tissue models along the lines of stress.

Autogenic inhibition—when neural impulses that sense tension are greater than the impulses that cause muscles to contract; inhibits muscle spindles.

Reciprocal inhibition—simultaneous contraction of one muscle, and relaxation of its antagonist to allow movement.

Relative flexibility—tendency of the body to seek the path of least resistance.
Pattern overload—consistently repeating the same motion; places abnormal stresses on the body.

Postural distortion patterns—predictable patterns of muscle imbalances.

Altered reciprocal inhibition—muscle inhibition caused by a tight agonist, which inhibits its functional antagonist.

Synergistic dominance—synergist takes over function for a weak or inhibited prime mover.

Muscle imbalance—alteration of muscle length surrounding a joint.

The OPT Model

Stabilization—ability to maintain postural equilibrium and support joints during movement.

Strength—ability of the neuromuscular system to produce internal tension to overcome an external force.

  Strength endurance—muscles’ ability to contract for an extended period.
  Maximal strength—largest force a muscle can produce in a single voluntary effort.
  Muscular hypertrophy—enlargement of skeletal muscle fibers from resistance training.

Power—ability to produce the greatest force in the shortest time.
Principles of Motor Development

Key Concepts

**Motor behavior**—motor response to internal and external stimuli.
**Motor control**—how the CNS integrates sensory information with previous experiences.
**Motor learning**—integration of motor control processes through practice, leading to a relatively permanent change to produce skilled movement.
**Motor development**—the change in motor skill behavior over time throughout the lifespan.

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**Sensorimotor integration**—ability of the nervous system to gather and interpret information, and execute the proper motor response.

**Muscle synergies**—groups of muscles that are recruited by the CNS to provide movement.

**Proprioception**—cumulative sensory input from all mechanoreceptors that sense position and limb movements.

**Feedback**—use of sensory information and sensorimotor integration to help the HMS in motor learning.
  - **Internal feedback**—sensory information is used by the body to reactively monitor movement and the environment.
  - **External feedback**—information provided by some external source (e.g., fitness professional, recording, mirror, etc.).
Macronutrients

Carbohydrates

Carbohydrates—sugars, starches, and fiber; chief source of energy.
- Monosaccharide—a single sugar unit (glucose, fructose).
- Disaccharides—two sugar units (sucrose, lactose, maltose).
- Fiber—complex carbohydrate; provides bulk in diet and intestinal health; regulates absorption of glucose.
  - Soluble fiber—dissolved by water; helps lower blood glucose and cholesterol.
  - Insoluble fiber—does not dissolve in water.

Glucose—simple sugar made by the body from carbs, fats, and sometimes protein; main source of fuel.
Glycogen—complex carbohydrate used to store energy in liver and muscle tissue.

Carb Quick Facts!
- Provides nutrition that fat and protein can’t.
- Keeps glycogen stores full.
- Helps maintain fluid balance.
- Spares protein for building muscle.

Glycemic index—the rate carb sources raise blood sugar and the effect on insulin release:
- High = >70
- Moderate = 56-69
- Low = <55

Lipids

Triglycerides—chemical form of most fat in food and in the body.

<table>
<thead>
<tr>
<th>Food sources of lipids</th>
<th>Monounsaturated</th>
<th>Polyunsaturated</th>
<th>Saturated</th>
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<tbody>
<tr>
<td>Olive oil</td>
<td>Sunflower oil</td>
<td>Meat</td>
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</tr>
<tr>
<td>Avocados</td>
<td>Soy oil</td>
<td>Coconut oil</td>
<td></td>
</tr>
<tr>
<td>Peanuts</td>
<td>Omega-3s (fish, flax)</td>
<td>Dairy</td>
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</table>
**Saturated fatty acid**—raises “bad” LDL cholesterol.

**Trans-fatty acids**—used to increase shelf life in foods; raises bad and lowers good cholesterols.

**Unsaturated fatty acid**—increases “good” HDL cholesterol; decreases risk of heart disease.

**Monounsaturated fatty acid**—lipid missing one hydrogen; one double bond.

**Polyunsaturated fatty acid**—lipids with more than one point of unsaturation.

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### Protein

**Protein**—amino acids linked by peptide bonds.

**Essential amino acids**—cannot be manufactured by the body; must be obtained from food; **there are 8**.

**Nonessential amino acids**—can be manufactured by the body.

**Complete protein**—supplies all essential amino acids.

**Incomplete protein**—contains less than all 8 essential amino acids.

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### Micronutrients

**Key Concepts**

**Micronutrients**—vitamins and minerals needed for health.

**Toxicity**—degree to which a substance causes harm
Hydration

Key Concepts

**Hydration Recommendations:**
- The body is approximately 60% water.
- Average consumption should be: **3L per day for men, 2.2L per day for women**.
- Drink cold water for more rapid gastric emptying.
- If exercise exceeds 60min, use sports drink containing up to 8% carbs.
- Drink an extra 8oz of fluid for every 25lbs overweight.
- Dehydration adversely affects circulatory function and decreases performance.

Recommendations and Guidelines for Caloric Intake and Expenditure

Key Concepts

- **Calorie (lower case c)**—amount of heat energy required to raise 1 gram of water by 1°C.
- **Resting metabolic rate (RMR)**—amount of energy expended at rest.
- **Thermic effect of food (TEF)**—additional energy use for digestion; 6-10% of total energy expenditure.
- **Energy expended during physical activity**—around 20% of total energy expenditure.

**Macronutrient Intake Recommendations**

<table>
<thead>
<tr>
<th>Protein</th>
<th>Carbohydrates</th>
<th>Fats</th>
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<tbody>
<tr>
<td>- 4 calories per gram</td>
<td>- Average healthy adults: 4 calories per gram</td>
<td>- 9 calories per gram</td>
</tr>
<tr>
<td>- Sedentary adults: 0.8 g/kg/day (0.4 g/lb/day)</td>
<td>- 6-10 g/kg/day</td>
<td>- Should be 20-35% of total food intake</td>
</tr>
<tr>
<td>- Strength athletes: 1.2-1.7 g/kg/day (0.5-0.8 g/lb/day)</td>
<td>- 28-38g from fiber</td>
<td></td>
</tr>
<tr>
<td>- Endurance athletes: 1.2-1.4 g/kg/day (0.5-0.6 g/lb/day)</td>
<td>- 45-65% of diet</td>
<td></td>
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<tr>
<td>- 10-35% of diet</td>
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</tbody>
</table>
Using carbs for performance:  1) Eat a high-carb meal 2-4 hours before exercise.
  2) Eat 1.5g/kg carbs 30min before exercise to max glycogen stores.
  3) Eat 30-60g/hour carbs during exercise lasting more than 60min.

Dietary Reference Intakes

General Recommendations

Dietary reference intakes (DRI)—guidelines for adequate intake of a nutrient.
  Recommended dietary allowance (RDA)—average daily nutrient intake level to meet the requirement of healthy individuals.
  Tolerable upper intake (UL)—highest daily intake level likely to pose no risk to health.
  Adequate intake (AI)—recommended daily nutrient intake level adequate for healthy individuals.

Portion Sizes, Meal Timing, and Frequency

General Recommendations

For fat loss:
  • Eat less than 10% of calories from saturated fat.
  • Distribute carbs, protein, and fat throughout the day.
  • 4-6 meals per day; helps control hunger, minimizes blood sugar fluctuation, and increases energy.
  • Avoid “empty” calories and highly processed foods.
  • Drink a minimum of 9-13 cups water daily.
  • Weigh and measure food.
  • Diets under 1200 calories per day need physician supervision.
For lean mass gain:
- Eat 4-6 meals per day.
- Spread protein intake throughout the day
- Ingest carbs and protein within 90 minutes of exercise to increase recovery and protein synthesis.
- Do not neglect carbs and fat.

For general health:
- Select carb sources that are low-glycemic and high in fiber.
- Total calorie intake and burn in a 24 hour period dictates weight lost or gained.

Common Nutritional Supplements

Key Concepts

**Ergogenic aid**—something that enhances athletic performance.

**Creatine:**
- Made in the body; creatine phosphate (ATP-PC system).
- Can increase muscle mass, strength, and anaerobic performance during exercise.

**Caffeine:**
- Consuming 3-6mg/kg 1 hour before exercise has been shown to increase performance.
- Effects will occur on an individual basis.

**Prohormones and anabolic steroids:**
- Prohibited by the World Anti-Doping Agency.
Domain 2: Assessment

The PAR-Q

Key Concepts

Physical Activity Readiness Questionnaire (PAR-Q):
- Determines safety or risk of exercising.
- Identifies individuals who need medical evaluation.
- If a client answers YES to one or more questions, refer to a physician.

Elements of Personal, Occupational, and Family Medical History

Key Concepts

Extended periods of sitting—can lead to: tight hip flexors, rounding of shoulders, and forward head.
Repetitive movement patterns—can create pattern overload (e.g., arms constantly overhead – construction, painting, etc. – can lead to tight latissimus dorsi and weak rotator cuff).
Dress shoes—constantly plantarflexed position leads to tight gastrocnemius and soleus causing decreased dorsiflexion and over-pronation (flat feet).

Mental stress—can cause:
- Elevated heart rate, blood pressure, and ventilation at rest and when exercising.
- Abnormal breathing patterns that cause imbalances in the neck, shoulders, chest, and low back.
Past injuries/surgeries:
- Strong predictor of future risk of injury.
- Ankle sprains decrease neural control to the gluteus medius and maximus.
- Knee injuries decrease neural control to muscles that stabilize the kneecap.
- Non-contact knee injuries are often the result of hip or ankle dysfunction.
- Low back pain can cause decreased neural control of core stabilization muscles.
- Shoulder injuries can lead to altered neural control of the rotator cuff.

Common medications—can effect exercise performance; e.g., beta-blockers lower heart rate and blood pressure.

Chronic conditions—medical conditions such as: hypertension and other cardiovascular conditions, cardiorespiratory conditions, diabetes, stroke, or cancer.

Cardiorespiratory Assessments

Key Concepts

Cardiorespiratory assessments—submaximal tests to estimate $\text{VO}_{2\text{max}}$ and determine cardiorespiratory exercise starting point.

Calculating maximal heart rate:
- Straight percentage method: $\text{HR}_{\text{max}} = 220 - \text{age}$ ...easiest, less accurate.
- Regression formula: $\text{HR}_{\text{max}} = 208 - (0.7 \times \text{age})$ ...more accurate.

YMCA 3-minute step test:
- Perform 96 steps per minute, on 12-inch step, for 3 minutes.
- Within 5 seconds of stopping take recovery pulse for 60 seconds.
- Match recovery pulse to chart on pg. 130 of the text.
- Assign to proper HR zone:
  - Poor and fair = zone 1
  - Average and good = zone 2
  - Very good = zone 3
Rockport walk test:
- Record weight.
- Walk 1 mile on a treadmill.
- Record the time.
- Immediately take heart rate.
- Calculate the VO$_2$ score using the formula on pg. 131 of the text.
- Match the VO$_2$ score with age and sex to the chart on pg. 132 of the text.
- Assign to proper HR zone:
  - Poor and fair = zone 1
  - Average and good = zone 2
  - Very good = zone 3

Key Concepts

Radial pulse—measured with two fingers below the wrist on the thumb side of the arm.
Carotid pulse—measured on the neck; not a preferred method to use on clients.

Resting heart rate (RHR)—heart rate when the body is not physically active.
To determine: take pulse in the morning for 3 mornings and average the readings.
Average RHR for a: male = 70 bpm; female = 75 bpm. Typical adult RHR range = between 70 and 80 bpm.

Blood pressure—trainers should take a professional course to learn before using with clients. Two readings:
- Systolic—pressure within the arteries after the heart contracts. Healthy systolic = less than 120 mm Hg.
- Diastolic—pressure within the arteries when the heart is resting and filling with blood. Healthy diastolic = less than 90 mm Hg.
### Key Concepts

**Kinetic chain checkpoints**—major joint regions of the body: feet, knees, LPHC, shoulders, and head/neck.

### Static Postural Assessment

#### STATIC POSTURAL ASSESSMENT – Optimal Posture

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<tr>
<td><strong>Feet</strong></td>
<td>Straight and parallel, not flattened or externally rotated</td>
<td>Feet</td>
<td>Neatral position, leg vertical at right angle to sole of foot</td>
</tr>
<tr>
<td><strong>Knees</strong></td>
<td>In line with toes, not adducted and internally rotated</td>
<td>Knees</td>
<td>Neutral position, not flexed or hyperextended</td>
</tr>
<tr>
<td><strong>LPHC</strong></td>
<td>Level</td>
<td>LPHC</td>
<td>Neutral position, not anteriorly or posteriorly rotated</td>
</tr>
<tr>
<td><strong>Shoulders</strong></td>
<td>Level, not elevated or rounded</td>
<td>Shoulders</td>
<td>Normal kyphotic curve, not excessively rounded</td>
</tr>
<tr>
<td><strong>Head/neck</strong></td>
<td>Neutral, not tilted or rotated</td>
<td>Head/neck</td>
<td>Neutral position, not migrating forward</td>
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### POSTURAL DISTORTION PATTERNS – Muscle Imbalances

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<td><strong>Lengthened Muscles</strong></td>
<td><strong>Shortened Muscles</strong></td>
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<td>Anterior tibialis</td>
<td>Gastrocnemius</td>
</tr>
<tr>
<td>Soleus</td>
<td>Posterior tibialis</td>
<td>Soleus</td>
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<tr>
<td>Peroneals</td>
<td>Gluteus maximus</td>
<td>Adductors</td>
</tr>
<tr>
<td>Adductors</td>
<td>Gluteus medius</td>
<td>Hip flexor complex</td>
</tr>
<tr>
<td>Iliotibial (IT) band</td>
<td></td>
<td>Latissimus dorsi</td>
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<tr>
<td>Hip flexor complex</td>
<td></td>
<td>Erector spinae</td>
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<tr>
<td>Biceps femoris (short head)</td>
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Assessments from Adjacent Professionals

Key Concepts

**Cholesterol**—blood lipid associated with cardiovascular disease and obesity.
- **HDL**—high density lipoprotein, aka “good cholesterol.”
- **LDL**—low density lipoprotein, aka “bad cholesterol.”
- Healthy total cholesterol level = less than 200 mg/dL

Body Composition Assessments

Key Concepts

**Overweight**—a person with a BMI of 25 to 29.9, or 25lbs over the recommended weight for his/her height.

**Obesity**—when a person’s BMI is 30 or more.

**Skin-fold measurements**—uses caliper to measure subcutaneous fat.
- **4 sites**: biceps (vertical fold), triceps (vertical fold), subscapular (45° fold), iliac crest (45° fold). All on the right side of the body.
- **Durnin-Wormsley formula**—add total of measurements and compare to the solutions table in the textbook to determine body fat percentage.

**Fat mass** = body fat % × scale weight.

**Lean body mass** = scale weight – fat mass.

**Bioelectrical impedance**—conducts electrical current through the body to estimate fat content.

**Underwater weighing**—used in exercise physiology labs; lean mass sinks, fat mass floats; dry weight compared to underwater weight.

**Circumference measurements**—assess girth changes in the body; not accurate estimate of fatness.

Measure at the neck, chest, waist, hips, calves, and biceps.

**Waist-to-hip ratio**—divide the waist circumference measurement by the hip measurement.
- Ratios greater than 0.80 for women and 0.95 for men increases risk of obesity-related disease.
Body mass index (BMI)—a person’s weight compared to his/her height.
- Not designed to assess body fat.
- Risk of chronic disease increases with a BMI of 25 or greater.

Performance Assessments

Key Concepts

- **Davies test**—assesses upper extremity stability and agility.
- **Shark skill test**—assesses lower extremity agility and neuromuscular control.
- **Bench press test**—estimates 1-rep max; upper body maximal strength.
- **Squat test**—estimates 1-rep max; lower body maximal strength.
- **Push-up test**—assesses upper extremity muscular endurance.
- **LEFT test**—assesses agility, acceleration, deceleration, and neuromuscular control.

Dynamic Postural Assessments

Key Concepts

- **Overhead squat assessment (OHSA)**—assesses dynamic posture to identify movement dysfunction and muscle imbalances.

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<td>LPHC</td>
<td>Excessive forward lean</td>
<td>Soleus</td>
<td>Anterior tibialis</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Gastrocnemius</td>
<td>Gluteus maximus</td>
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<td></td>
<td></td>
<td></td>
<td>Hip flexor complex</td>
<td>Erector spinae</td>
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<td>Abdominal complex</td>
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</tbody>
</table>
### Low back arches (ante prior pelvic tilt)
- Hip flexor complex
- Erector spinae
- Latissimus dorsi
- Intrinsic core stabilizers

### Low back rounds (posterior pelvic tilt)
- Hamstring complex
- Rectus abdominis
- Gluteus maximus
- Erector spinae

### Upper body
- Arms fall forward
- Latissimus dorsi
- Middle / lower trapezius
- Teres major
- Rhomboids
- Pectoralis major / minor
- Rotator cuff

### Feet
- Turn out
- Soleus
- Lateral gastrocnemius
- Medial gastrocnemius
- Biceps femoris (short head)
- Medial hamstring complex
- Gracilis
- Sartorius
- Popliteus

### Anterior

#### Knees
- Move inwards
  - Adductor complex
  - Soleus
  - Gastrocnemius
  - Biceps femoris (short head)
  - Tensor fasciae latae (TFL)
  - Vastus lateralis
- Move outwards
  - Soleus
  - Gastrocnemius
  - Biceps femoris (short head)
  - Piriformis

#### Single leg squat — assesses ankle proprioception, core strength, and hip joint stability.

**SINGLE LEG SQUAT ASSESSMENT — Solutions Table**

<table>
<thead>
<tr>
<th>View</th>
<th>Kinetic Chain Checkpoint</th>
<th>Compensation</th>
<th>Overactive Muscles</th>
<th>Underactive Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Knees</td>
<td>Move inward</td>
<td>Adductor complex</td>
<td>Gluteus medius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biceps femoris</td>
<td>Gluteus maximus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TFL</td>
<td>Vastus medialis oblique</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vastus lateralis</td>
<td></td>
</tr>
</tbody>
</table>

#### Pushing assessment — assesses movement efficiency and potential muscle imbalances during pushing movements.

**PUSHING ASSESSMENT — Solutions Table**

<table>
<thead>
<tr>
<th>View</th>
<th>Kinetic Chain Checkpoint</th>
<th>Compensation</th>
<th>Overactive Muscles</th>
<th>Underactive Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral</td>
<td>LPHC</td>
<td>Low back arches</td>
<td>Hip flexors</td>
<td>Intrinsic core stabilizers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Erector spinae</td>
<td></td>
</tr>
</tbody>
</table>
Shoulder complex | Shoulder elevation | Upper trapezius | Mid trapezius | Upper trapezius | Mid trapezius |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Protrudes</td>
<td>Upper trapezius</td>
<td>Mid trapezius</td>
<td>Upper trapezius</td>
<td>Mid trapezius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid trapezius</td>
<td></td>
<td>Mid trapezius</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower trapezius</td>
<td></td>
<td>Lower trapezius</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sternocleidomastoid</td>
<td></td>
<td>Sternocleidomastoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Levator scapulae</td>
<td></td>
<td>Levator scapulae</td>
<td></td>
</tr>
</tbody>
</table>

**Pulling assessment**—assesses movement efficiency and potential muscle imbalances during pulling movements.

### PULLING ASSESSMENT – Solutions Table

<table>
<thead>
<tr>
<th>View</th>
<th>Kinetic Chain Checkpoint</th>
<th>Compensation</th>
<th>Overactive Muscles</th>
<th>Underactive Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral</td>
<td>LPHC</td>
<td>Low back arches</td>
<td>Hip flexors</td>
<td>Intrinsic core stabilizers</td>
</tr>
<tr>
<td>Shoulder complex</td>
<td></td>
<td>Shoulder elevation</td>
<td>Erector spinae</td>
<td>Mid trapezius</td>
</tr>
<tr>
<td>Head</td>
<td>Protrudes</td>
<td>Upper trapezius</td>
<td>Sternocleidomastoid</td>
<td>Lower trapezius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid trapezius</td>
<td>Levator scapulae</td>
<td>Deep cervical flexors</td>
</tr>
</tbody>
</table>

**Gait assessment**—assesses movement efficiency and potential muscle imbalances during walking and running.

### GAIT ASSESSMENT – Solutions Table

<table>
<thead>
<tr>
<th>Kinetic Chain Checkpoint</th>
<th>Compensation</th>
<th>Overactive Muscles</th>
<th>Underactive Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>Flatten</td>
<td>Peroneal complex</td>
<td>Anterior tibialis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral gastrocnemius</td>
<td>Posterior tibialis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biceps femoris (short head)</td>
<td>Medial gastrocnemius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TFL</td>
<td>Gluteus medius</td>
</tr>
<tr>
<td></td>
<td>Turn out</td>
<td>Soleus</td>
<td>Medial gastrocnemius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral gastrocnemius</td>
<td>Medial hamstring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biceps femoris (short head)</td>
<td>Gluteus medius/maximus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TFL</td>
<td>Gracilis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sartorius</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Popliteus</td>
</tr>
<tr>
<td>Knees</td>
<td>Move inward</td>
<td>Adductor complex</td>
<td>Medial hamstring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biceps femoris (short head)</td>
<td>Medial gastrocnemius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TFL</td>
<td>Gluteus medius/maximus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lateral gastrocnemius</td>
<td>Vastus medialis oblique</td>
</tr>
</tbody>
</table>
### Considerations for Performing Assessments with Special Populations

**Key Concepts**

**Pregnancy**—avoid power and speed assessments; perform push-up assessment on the knees; modify single-leg squat to simply single-leg balance; reduce range of motion for overhead squat.

**Obesity**—Rockport walk test is preferred cardio assessment; consider single-leg balance modification of single-leg squat assessment; may need to perform push-up test on knees or with a bench.

<table>
<thead>
<tr>
<th>LPHC</th>
<th>Vastus lateralis</th>
<th>Anterior tibialis</th>
<th>Posterior tibialis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low back arch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip flexor complex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erector spinae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External obliques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adductor complex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive rotation</td>
<td>Hamstrings</td>
<td>Gluteus medius/maximus</td>
<td>Intrinsic core stabilizers</td>
</tr>
<tr>
<td>Quadratus lumborum (opposite side)</td>
<td></td>
<td>Adductor complex (same side)</td>
<td></td>
</tr>
<tr>
<td>TFL/gluteus minimus (same side)</td>
<td></td>
<td>Gluteus medius (same side)</td>
<td></td>
</tr>
<tr>
<td>Shoulders</td>
<td>Rounded</td>
<td>Pectorals</td>
<td>Middle and lower trapezius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Latissimus dorsi</td>
<td>Rotator cuff</td>
</tr>
<tr>
<td>Head</td>
<td>Forward</td>
<td>Upper trapezius</td>
<td>Deep cervical flexors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Levator scapulae</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sternocleidomastoid</td>
<td></td>
</tr>
</tbody>
</table>
Indicators that a Client’s Condition is Outside Scope of Practice

Key Concepts

Fitness professionals do NOT:

- Diagnose medical conditions.
- Prescribe or provide treatment or rehabilitation of any injury or disease.
- Prescribe diets.
- Provide counseling (mental health).

Criteria for Reassessment

Key Concepts

Reassessments should happen:

- Every 4 weeks or when major changes in programming are occurring.
- When a client has shown significant signs of improvement.
- If the client is identifying new goals.
- If the client has major lifestyle changes (diets, smoking cessation, job change, etc.).
### Domain 3: Program Design

#### Flexibility Training Methods

**Key Concepts**

**Corrective flexibility** — increases joint range of motion, improves muscle imbalances, and corrects altered joint motion; autogenic inhibition; use for Phase 1 training.

**Active flexibility** — improves extensibility of soft tissue and increases neuromuscular efficiency; reciprocal inhibition; use for Phase 2, 3, and 4 training.

**Functional flexibility** — maintains integrated, multiplanar soft tissue extensibility and optimal neuromuscular control; reciprocal inhibition; use for Phase 5 training.

**Self-myofascial release** — gentle pressure breaks up knots within muscle and helps release unwanted tension; autogenic inhibition.

**Static stretching** — passively taking a muscle to the point of tension and holding the stretch for a minimum of 30 seconds; autogenic inhibition.

**Active-isolated stretching** — uses agonists and synergists to dynamically move joints into a range of motion; reciprocal inhibition.

**Dynamic stretching** — uses force production and momentum to move joints through full ranges of motion; reciprocal inhibition.
Resistance Training Systems

Key Concepts

**Single-set**—one set of each exercise; good for beginners.
**Multiple-set**—multiple sets of each exercise.
**Pyramid**—increasing (or decreasing) weight with each set.
**Superset**—performing two exercises in rapid succession with little-to-no rest between.

**Circuit training**—performing a series of exercises, one after the other with minimal rest between.
**Peripheral heart action**—variation of circuit training; alternates upper- and lower-body exercises to improve circulation.
**Split-routine**—breaking the body up into parts to be trained on separate days.
**Vertical loading**—alternating body parts trained from set to set; start with upper- and move to lower-body, then repeat.
**Horizontal loading**—performing all sets for an exercise or body part before moving on to the next.

Resistance Training Methods

Key Concepts

<table>
<thead>
<tr>
<th>RESISTANCE EXERCISES</th>
<th>Strength (Phases 2, 3, &amp; 4)</th>
<th>Power (Phase 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stabilization (Phase 1)</strong></td>
<td>2/0/2 tempo, moderate to heavy weight, low to moderate reps with full range of motion</td>
<td>Explosive tempo, light weight, moderate reps with full range of motion</td>
</tr>
<tr>
<td>4/2/1 tempo, lower weight, and higher reps in an unstable, but controlled, environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ball squat, curl to press</td>
<td>• Lunge to two-arm dumbbell press</td>
<td>• Two-arm medicine ball chest pass</td>
</tr>
<tr>
<td>• Multiplanar step-up balance, curl, to overhead press</td>
<td>• Squat to two-arm press</td>
<td>• Rotation chest pass</td>
</tr>
<tr>
<td>• Ball dumbbell chest press</td>
<td>• Two-arm push press</td>
<td>• Ball medicine ball pullover throw</td>
</tr>
<tr>
<td>• Pushup</td>
<td>• Barbell clean</td>
<td>• Wood chop throw</td>
</tr>
<tr>
<td>• Standing cable row</td>
<td>• Flat dumbbell chest press</td>
<td></td>
</tr>
</tbody>
</table>
Cardiorespiratory Training Methods

Key Concepts

**Stage training**—progressive cardio training that ensures continual adaptation and minimizes the risk of overtraining and injury.

**Stage I**—used to improve cardio for apparently healthy sedentary individuals.
- Uses HR zone 1.
- Start slowly, work up to 30-60 minutes of exercise.

**Stage II**—for individuals with low-to-moderate cardio fitness who are ready to train at higher intensities.
- Uses HR zone 2 intervals, with zone 1 for recovery.
- 1 minute in zone 2, 3 minutes in zone 1 (1:3 work/rest ratio).
- Ready for Stage III when work/rest ratio is progressed to 1:1.

**Stage III**—for advanced exercisers with moderately high cardio fitness levels; athletic performance.
- Uses HR zone 3 intervals, with zone 2 for recovery, and zone 1 for warm-up and cool-down.
- Once per week is adequate, with Stage II and Stage I days needed to avoid overtraining.
**Importance of properly training for stabilization:**
- Few people have properly developed local stabilization muscles.
- An efficient core is necessary for maintaining proper muscle balance throughout the chain.
- If the movement system of the core is strong, but the stabilization system is weak, forces are not transferred or used properly.

**Drawing-in maneuver**—recruit core stabilizers by drawing the navel toward the spine (local stabilization system).

**Bracing**—contracting abdominals, lower back, and glutes together to stabilize the LPHC (global movement system).

**Benefits of balance training:**

**Integrated Performance Paradigm**
- Increases awareness of limit of stability (balance threshold) using controlled instability.
- Develops, improves, and restores synergy and synchronicity of muscle-firing patterns required for dynamic joint stabilization and optimal neuromuscular control.
- Trains functional movements in a proprioceptively enriched environment with appropriate progressions, correct technique, and at varying speeds.
- Facilitates maximal sensory input to the central nervous system, resulting in the selection of the proper movement patterns.

**Proprioceptive Manipulation**

### Key Concepts

#### Proprioceptive progressions:
- Stable → unstable
- Static → dynamic
- Slow → fast
- Two arms/legs → single-arm/leg
- Eyes open → eyes closed
- Known → unknown

#### Progressing body position:
- Supine (most stable)
- Prone
- Side-lying
- Kneeling
- Half-kneeling
- Standing:
  - Two legs/stable (on floor)
  - Single leg/stable (on floor)

### Proprioceptive modalities:
- Floor (most stable)
- Balance beam
- Half foam roll
- Foam pad (Airex)
- Balance disc (Dyna Disc)
- Wobble board (BOSU; least stable)
Two legs/unstable (on proprioceptive modality)

Single leg/unstable (on proprioceptive modality; least stable)

---

**Plyometric Training Methods**

**Key Concepts**

**Plyometric (reactive) training**—quick, powerful movements involving an eccentric contraction immediately followed by an explosive concentric contraction.

**Amortization (transition) phase**—transition between eccentric (loading) and concentric (unloading) muscle actions during plyometric movements; the faster the switch, the more powerful the concentric action.

---

**SAQ Training Methods**

**Key Concepts**

**Speed, agility, and quickness (SAQ) training**—react to ground forces; enhances ability to accelerate, decelerate, and dynamically stabilize the entire body.

- **Speed**—ability to move the body in one intended direction as fast as possible; stride rate × stride length.
- **Agility**—ability to start, stop, and change direction quickly, while maintaining proper posture.
- **Quickness**—ability to react and change body position with maximum rate of force production.

**Cone and speed ladder drills**—the primary method to train SAQ with clients.
Exercise Progression/Regression

**Key Concepts**

Fitness professionals need to know how to progress and regress each exercise detailed in the textbook.

General Adaptation Syndrome

**Key Concepts**

*General adaptation syndrome*—how the body responds and adapts to stress; 3 stages:

- **Alarm reaction**—initial reaction to a stressor, activates protective processes in the body.
- **Resistance development**—body increases functional capacity to adapt to a stressor; once adapted, the increased stress is needed to produce a new response.
- **Exhaustion**—stressor is too much or lasting too long for systems to handle; causes breakdown or injury.

Principle of Specificity

**Key Concepts**

*Specific adaptation to imposed demands (SAID) principle (principle of specificity)*—the body will specifically adapt to the type of demand placed on it.

- **Mechanical specificity**—the weight and movements placed on the body.
- **Neuromuscular specificity**—the speed of contractions and exercise selection.
- **Metabolic specificity**—the energy demand placed on the body.
**Key Concepts**

**The principle of progressive overload**—training stimulus must exceed current capabilities to elicit optimal physical, physiological, and performance adaptations.

**Key Concepts**

1. Variation can keep a person from reaching exhaustion, while maximizing overload.
2. Important rationale for challenging the kinetic chain with a wide variety of exercises.

**Periodization Concepts**

**Periodization**—dividing a training program into distinct periods, training different adaptations in each.

**Training plan**—annual, monthly, and weekly programming; start with high-volume, low-intensity training (Phase 1) and progress to low-volume, high-intensity training (Phases 4 or 5); progress OPT Phase every 4 – 6 weeks in a linear fashion.
Undulating periodization—Changing the OPT Phase or acute variables daily or weekly to train multiple adaptations while still allowing for proper recovery (e.g., High-intensity Power workout Monday, low-intensity Stabilization workout Wednesday while still recovering, moderate-intensity Strength workout Friday).

### Key Concepts

**Intensity**—exercise level of effort compared to maximal effort; written as percentage of 1RM.

**Volume**—amount of physical training performed within a specific period of time; varies based on OPT Phase and individual status and abilities.

Review all acute variable charts in the book.

#### The FITTE Principle

- **Frequency** - the number of training sessions in a given timeframe
- **Intensity** - the level of demand that a given activity places on the body
- **Time** - the length of time an individual is engaged in a given activity
- **Type** - the type of physical activity being performed
- **Enjoyment** - the amount of pleasure derived from the training session
Modality Risks and Rewards

Key Concepts

**Bodyweight training**—no additional load; least expensive, most accessible; all planes of motion.

**Suspension training**—ropes or webbing used to manipulate body position and stability.

**Free weights and implements**—barbells, dumbbells, kettlebells, medicine balls, and sandbags; all planes of motion; full range of motion; requires base of stabilization.

**Strength-training machines**—great for beginners needing stability; fixed plane of motion; limited range of motion.

**Proprioceptive modalities**—stability balls, wobble boards (BOSU), balance discs (Dyna Disc), foam pads (Airex), balance beams, half foam rolls, vibration trainer machines; used to increase instability of an exercise.

Overtraining, Rest, and Recovery

Key Concepts

**Signs of overtraining syndrome:**
- Decreased performance

- Fatigue
- Altered hormonal states
- Poor sleeping patterns
- Reproductive disorders
- Decreased immunity
- Loss of appetite
- Mood disturbances

⚠️ It is important to follow the suggested days off and rest periods within the OPT model parameters to avoid overtraining.
Current Trends and Their Application to Training

Key Concepts

- **Mobile apps**—
  - Provide guidance to clients during travel; remote training services.
  - Organize and track acute variables.
  - Remote client monitoring.
  - Manage personal nutrition.

- **Activity trackers**—
  - Track movement and provide information on physical activity patterns.
  - Some also track heart rate and sleep patterns.
  - Can show signs of improvement or overtraining.

- **Social media**—
  - Connect with clients and prospects outside the gym.
  - Establish professional reputation and presence.
  - Share educational topics and information about services and events.
  - Encourage and motivate clients.
  - Network and grow by connecting with peers and experts.

- **Emerging technologies**—
  - Wearable devices that sync with mobile apps and activity trackers
# Program Design for Special Populations

## Youth Training Considerations

<table>
<thead>
<tr>
<th><strong>Mode</strong></th>
<th>Walking, jogging, running, games, sports, resistance training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>5-7 days per week cardiorespiratory activity</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>Moderate to vigorous</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>60 minutes per day</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Follow the flexibility protocols for each OPT Level</td>
</tr>
<tr>
<td><strong>Resistance training</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency:</td>
<td>2-3 days per week</td>
</tr>
<tr>
<td>Sets:</td>
<td>1-5 sets</td>
</tr>
<tr>
<td>Repetitions:</td>
<td>3-30 per set</td>
</tr>
<tr>
<td>Intensity:</td>
<td>45%-85% of 1-RM</td>
</tr>
<tr>
<td>OPT Phases 2 – 5</td>
<td>should be reserved for mature adolescents on the basis of</td>
</tr>
<tr>
<td></td>
<td>dynamic postural control</td>
</tr>
<tr>
<td></td>
<td>and physician recommendations.</td>
</tr>
<tr>
<td><strong>Special considerations</strong></td>
<td>Progress based on postural control, not on the amount of weight used.</td>
</tr>
<tr>
<td></td>
<td>Make exercising fun!</td>
</tr>
</tbody>
</table>

## Older Adult Training Considerations

<table>
<thead>
<tr>
<th><strong>Mode</strong></th>
<th>Stationary or recumbent cycling, aquatic exercise, treadmill with handrail support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>3-5 days per week moderate cardiorespiratory activity; or, 3 days per week vigorous cardiorespiratory activity</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>40-85% of VO₂max</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>30-60 minutes per day; or, 8- to 10-minute bouts</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>SMR and static stretching</td>
</tr>
<tr>
<td><strong>Resistance training</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency:</td>
<td>3-5 days per week</td>
</tr>
<tr>
<td>Sets:</td>
<td>1-3 sets</td>
</tr>
<tr>
<td>Repetitions:</td>
<td>8-20 per set</td>
</tr>
<tr>
<td>Intensity:</td>
<td>40-80% 1-RM</td>
</tr>
<tr>
<td>OPT Phases 2 – 5</td>
<td>should be progressed to based upon dynamic postural control and physician recommendations.</td>
</tr>
<tr>
<td><strong>Special considerations</strong></td>
<td>Progression should be slow and well monitored.</td>
</tr>
<tr>
<td></td>
<td>Exercises should be progressed toward free sitting or standing.</td>
</tr>
<tr>
<td></td>
<td>Breath normal, avoid the Valsalva maneuver.</td>
</tr>
<tr>
<td></td>
<td>Use slow active or dynamic stretches if SMR or static stretching isn’t tolerated.</td>
</tr>
</tbody>
</table>
### Pregnancy Training Considerations

<table>
<thead>
<tr>
<th>Mode</th>
<th>Low impact movement that avoids jarring motions: treadmill walking, stationary cycling, aquatic exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>3-5 days per week cardiorespiratory activity</td>
</tr>
<tr>
<td>Intensity</td>
<td>Stage I cardio only, stage II with physician clearance</td>
</tr>
<tr>
<td>Duration</td>
<td>15-30 minutes per day</td>
</tr>
<tr>
<td>Flexibility</td>
<td>SMR, static and active-isolated stretching</td>
</tr>
<tr>
<td>Resistance training</td>
<td>• Frequency: 2-3 days per week.</td>
</tr>
<tr>
<td></td>
<td>• Sets: follow OPT Phase</td>
</tr>
<tr>
<td></td>
<td>• Repetitions: 12-15 per set</td>
</tr>
<tr>
<td></td>
<td>• Intensity: light loads</td>
</tr>
<tr>
<td></td>
<td>• Only OPT Phases 1 and 2 advised; use only Phase 1 after first trimester.</td>
</tr>
<tr>
<td>Special considerations</td>
<td>Avoid prone or supine exercises after 12 weeks of pregnancy.</td>
</tr>
<tr>
<td></td>
<td>Avoid SMR on varicose veins and areas of swelling.</td>
</tr>
<tr>
<td></td>
<td>Avoid plyometric training during second and third trimesters.</td>
</tr>
<tr>
<td></td>
<td>Avoid power and speed assessment.</td>
</tr>
<tr>
<td></td>
<td>Modify pushup assessment to the knees.</td>
</tr>
<tr>
<td></td>
<td>Test single-leg balance instead of single-leg squat assessment.</td>
</tr>
<tr>
<td></td>
<td>Decrease ROM for the overhead squat assessment.</td>
</tr>
</tbody>
</table>

### Obesity Training Considerations

<table>
<thead>
<tr>
<th>Mode</th>
<th>Low impact activities: treadmill walking, rowing, stationary cycling, aquatic exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>5-7 days per week cardiorespiratory activity</td>
</tr>
<tr>
<td>Intensity</td>
<td>60-80% HR\text{max}; can be adjusted to 40-70%; use talk test</td>
</tr>
<tr>
<td>Duration</td>
<td>40-60 minutes per day; or, 20-30 minute sessions twice per day</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Perform stretches seated or standing, use SMR if tolerated</td>
</tr>
<tr>
<td>Resistance training</td>
<td>• Frequency: 2-3 days per week.</td>
</tr>
<tr>
<td></td>
<td>• Sets: 1-3 sets.</td>
</tr>
<tr>
<td></td>
<td>• Repetitions: 10-15 per set.</td>
</tr>
<tr>
<td></td>
<td>• Intensity: follow OPT Phase</td>
</tr>
<tr>
<td></td>
<td>• Use circuits for Phases 1 and 2</td>
</tr>
<tr>
<td>Special considerations</td>
<td>Make sure the client is comfortable.</td>
</tr>
<tr>
<td></td>
<td>Exercise should be performed standing or seated when possible.</td>
</tr>
<tr>
<td></td>
<td>The client may have other obesity-related chronic diseases.</td>
</tr>
<tr>
<td></td>
<td>Use Rockport walk test for cardio assessment.</td>
</tr>
<tr>
<td></td>
<td>Modify pushup assessment to the knees.</td>
</tr>
<tr>
<td></td>
<td>Test single-leg balance instead of single-leg squat assessment.</td>
</tr>
</tbody>
</table>
### Hypertension Training Considerations

<table>
<thead>
<tr>
<th><strong>Mode</strong></th>
<th>Stationary cycling, treadmill walking, rowers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>3-7 days per week cardiorespiratory activity</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>50-85% HR&lt;sub&gt;max&lt;/sub&gt;, can adjust to 40-70% if needed; stage I cardio progressing to stage II</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>30-60 minutes per day</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Static and active-isolated stretching; standing or seated</td>
</tr>
<tr>
<td><strong>Resistance training</strong></td>
<td></td>
</tr>
<tr>
<td>• Frequency: 2-3 days per week</td>
<td></td>
</tr>
<tr>
<td>• Sets: 1-3 sets</td>
<td></td>
</tr>
<tr>
<td>• Repetitions: 10-20 per set</td>
<td></td>
</tr>
<tr>
<td>• Intensity: follow OPT Phase</td>
<td></td>
</tr>
<tr>
<td>• Do not exceed 1 second for isometric and concentric muscle actions.</td>
<td></td>
</tr>
<tr>
<td>• Use circuit or PHA training systems with appropriate rest.</td>
<td></td>
</tr>
<tr>
<td><strong>Special considerations</strong></td>
<td>Avoid heavy lifting and the Valsalva maneuver.</td>
</tr>
<tr>
<td></td>
<td>Do not over-grip weights or clench fists when training.</td>
</tr>
<tr>
<td></td>
<td>Perform exercises in a standing or seated position.</td>
</tr>
<tr>
<td></td>
<td>Stand up slowly to avoid dizziness.</td>
</tr>
<tr>
<td></td>
<td>Progress slowly.</td>
</tr>
</tbody>
</table>

### Osteoporosis Training Considerations

<table>
<thead>
<tr>
<th><strong>Mode</strong></th>
<th>Treadmill with handrail support</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>2-5 days per week cardiorespiratory activity</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>50-90% HR&lt;sub&gt;max&lt;/sub&gt;; stage I cardio progressing to stage II</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>20-60 minutes per day; or, 8- to 10-minute bouts</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Static and active-isolated stretching</td>
</tr>
<tr>
<td><strong>Resistance training</strong></td>
<td></td>
</tr>
<tr>
<td>• Frequency: 2-3 days per week</td>
<td></td>
</tr>
<tr>
<td>• Sets: 1-3 sets</td>
<td></td>
</tr>
<tr>
<td>• Repetitions: 8-20 per set</td>
<td></td>
</tr>
<tr>
<td>• Intensity: up to 85% 1-RM</td>
<td></td>
</tr>
<tr>
<td><strong>Special considerations</strong></td>
<td>Progression should be slow, well monitored, and based on postural control.</td>
</tr>
<tr>
<td></td>
<td>Progress, if possible, toward free sitting or standing.</td>
</tr>
<tr>
<td></td>
<td>Focus the exercises on the hips, thighs, back, and arms.</td>
</tr>
<tr>
<td></td>
<td>Avoid excessive spinal loading on squat and leg press exercises.</td>
</tr>
<tr>
<td></td>
<td>Avoid the Valsalva maneuver.</td>
</tr>
</tbody>
</table>
Domain 4: Exercise Technique and Training Instruction

Key Concepts

1. Review set-up and correct technique for all exercises detailed in the text.
2. Categorize every exercise (e.g., core-stabilization, balance-strength, total body-power, etc).
3. Regress each exercise.
4. Progress each exercise.
5. Perform each exercise.

Warm-up & Cool-down Protocols

- **General warm-up**—low intensity movement that does not necessarily relate to more intense exercise to follow.
- **Specific warm-up**—low intensity movement that mimics the more intense exercise to follow.
  - **Benefits and effects of a warm-up:**
    - Increases heart and respiratory rate.
    - Increases cardio systems capacity to perform work.
    - Increases blood flow to active muscle tissue.
    - Increases oxygen exchange capacity.
    - Increases tissue temperature.
    - Increases rate of muscle contraction.
    - Increases metabolic rate.
    - Increases soft tissue extensibility.
    - Increases psychological preparation for bouts of exercise.
- **Cool down**—smooth transition from exercise back to steady state of rest; 5 – 10 minutes light cardio, SMR, and static stretching.

**Triple extension/flexion**—when the hip, knee, and ankle are extended or flexed at the same time; happens with gait mechanics; cable rotation exercises.
Kinesthetic, Auditory, and Visual Cueing

Key Concepts

Feedback—sensory information and sensorimotor integration that helps develop permanent motor patterns.

External feedback—information provided by outside source: personal trainer, fitness apps and trackers, looking in the mirror; things that are told or shown to a client; two types:

Knowledge of results—external feedback on total performance after completing a movement.
Knowledge of performance—external feedback on specific performance while a movement is occurring

Internal feedback—sensory information used to monitor movement and the environment.

To best explain an exercise to a client:
1) Tell them how to do it (auditory cuing)
2) Show them how to do it (visual cuing)
3) Have them do it and think about how it feels (kinesthetic cueing; integrating internal and external feedback)

Safe Training Practices

Key Concepts

Essential safety questions:

WHAT ...exercises are appropriate for my client?
...exercises are contraindicated for my client?
...intensities are appropriate for my client?

HOW ...many exercises are appropriate for my client?
...many sets and repetitions should I have my client perform?
...many days per week should my client train?

Review the NASM Code of Conduct for the ethics and guidelines all fitness professionals should follow to protect the public and the profession.
Safe and Effective Spotting Techniques

Key Concepts

- Determine how many reps the client is going to perform before starting.
- Never take weight away from the client unless there is immediate danger of dropping or losing control.
- Provide just enough assistance for the client to successfully push past the “sticking point.”
- Spot at the client’s wrists, not the elbows, especially when using dumbbells.
- Never spot a machine-based exercise by placing your hands underneath the weight stack.

Proper Breathing Technique

Key Concepts

Abnormal breathing patterns:

- Shallow breathing can result from the use of secondary respiratory muscles rather than the diaphragm.
- Overactivity of respiratory muscles may result in headaches, lightheadedness, and dizziness.
- Excessive breathing can lead to altered carbon dioxide and oxygen levels in the blood.
  - Inadequate oxygen and retention of metabolic waste within muscles can create fatigued, stiff muscles.
- Teach clients to breathe through the stomach to maintain normal respiration.
**Domain 5: Client Relations and Behavioral Coaching**

### Communication Components

#### Key Concepts

**Tips to enhance communication:**
- Use good body language.
- Explain important policies, procedures, and expectations to the client.
- Be sensitive to clients’ feelings; connect emotionally.
- Use positive communication; encouragement, support, positive reinforcement.
- Greet clients with a hello, a handshake, and a smile.

**Non-verbal communication considerations—**
- What someone is thinking or feeling is reflected in body language and facial expressions.
- Humans are programmed to notice small changes in physical appearance, posture, gestures, and body position in other people.

**Active listening**—having an attitude and genuine interest in seeking a client’s perspective.
- **Closed-ended (directive) questions**—can be answered in one word; yes or no.
- **Open-ended (nondirective) questions**—allow clients to give more information.
- **Reflecting**—repeating back to the client the meaning of what was just heard.
- **Summarizing**—series of reflections to show depth of listening.
## SMART Goals

### Key Concepts

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
| S | SPECIFIC  
  • Clearly defined so anyone can understand the intended outcome. |
| M | MEASURABLE  
  • If a goal is not quantifiable, a client cannot manage it. |
| A | ATTAINABLE  
  • Challenging, but not extreme |
| R | REALISTIC  
  • Must be something the client is both willing and able to work toward. |
| T | TIMELY (time oriented)  
  • Specific date of completion; realistic but not too far in the future. |

## Goal Expectation Management

### Key Concepts

- Understand what improvements clients hope to achieve.
- Clarify vague client statements (e.g., “I want to feel better,” or “I want to get fit”).
- Have clients verbalize goals for clarification.
- Recognize what is unrealistic for a client.
- Only set goals that are SMART.
- Differentiate process from product goals.
- Understand all clients will progress at different speeds.
- Determine when and how each client’s goals will be revisited and reevaluated.
Behavior Change Strategies

Key Concepts

Behavior modification techniques:
- **Self-confidence**—building clients’ confidence leads to increased exercise adherence.
- **Motivational interviewing**—collaborative, person-centered form of coaching to elicit and strengthen motivation for change.
- **Autonomy-supportive coaching**—creating an environment that emphasizes self-improvement, rather than beating others (direct competition).
- **Prompting**—using cues to initiate behavior.
- **Contracting**—written statements outlining behaviors and consequences for fulfillment.
- **Intrinsic approach**—emphasize internal enjoyment and fun of exercise, not just goal completion.
- **Cognitive-behavioral approaches**—association and dissociation techniques, positive self-talk, psyching up, imagery, social support.

Forms of support:
- **Instrumental support**—tangible, practical factors necessary to help a person achieve a goal.
- **Emotional support**—expressed through encouragement, caring, empathy, and concern.
- **Informational support**—directions, advice, and suggestions from the professional.
- **Companionship support**—the availability of family and friends to exercise together.

Psychological Response to Exercise

Key Concepts

Exercise has been shown to:
- Promote positive mood, reduce stress, improve sleep, and reduce depression and anxiety.
Barriers to Behavior Change

Key Concepts

Common barriers:
- Time, unrealistic goals, lack of social support, social physique anxiety, convenience.

Client Expectation Management

Key Concepts

Before the end of the initial session, discuss...
- ...whether clients have everything they need, are ready to begin, or need more information.
- ...the clientele of the facility and how to fit in.
- ...what clothing is appropriate for exercise.
- ...the effect of other exercisers on their behavior (social facilitation).
**Domain 6: Professional Development and Responsibility**

**Professional Guidelines and Standards**

**Key Concepts**

Review the NASM Code of Conduct for the ethics and guidelines all fitness professionals should follow to protect the public and the profession.

**Business Fundamentals**

**Key Concepts**

**Forecasting**—apply specific percentages based on previous performance to predict future sales or other measurable outcomes, such as sessions serviced.

**Steps to success:**

1. Determine desired annual income.
2. Determine weekly earnings needed to support annual goal.
3. Calculate number of sessions needed to meet weekly income goal.
4. Determine needed closing percentage.
5. Create timeline to acquire clients with urgency.
6. Calculate total number of needed interactions based on closing percentage.
7. Determine how many interactions per day are needed to meet weekly goals.
8. Break down daily interactions by the hour.
9. Always ask for contact information.
10. Follow up.
Marketing Concepts and Techniques

Key Concepts

The 4 P’s of Marketing:

- Product
- Price
- Place
- Promotion

Sales Concepts and Techniques

Key Concepts

Prospecting—activities designed to search for potential customers or clients.

Asking for the sale:
- Roam the floor; always be visible and available for clients.
- Demonstrate value and build rapport by providing uncompromising customer service.
- Never be afraid to ask for the sale; most sales are lost that are not asked for.
- Keep in consistent contact with both current and potential clients.

Overcoming objections to a sale:
- Validate the client’s concerns
- Isolate the real problem
- Remind why change is needed
- Resolve with a plan
Requirements for Maintaining Certification

Key Concepts

NASM fitness professionals are required to renew CPR/AED certification, obtain 2.0 continuing education units (CEUs), and complete the recertification application every 2 years.

Resources for Credible Information

Key Concepts

- CEU courses.
- Traditional advanced education.
- Live events.
- Publications.
- Mentors.
- Networking

Opportunities for Professional Growth

Key Concepts

- Effectively write a resume.
- Adopt a “lifetime learner” mentality.
- Personal trainers can work in commercial fitness centers, as independent contractors, and even own and operate their own fitness facilities.