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Exercise Physiology

As a Personal Trainer, you should have a basic understanding of exercise physiology including how the body produces energy and responds to exercise. The information below will introduce you to energy systems within the body, which will assist you with creating effective training sessions for your Clients.

Energy:

*Adenosine Triphosphate (ATP)* is considered the body’s energy currency.

- ATP is a high-energy compound stored in our cells and is the source of all energy used at rest and during exercise.

- ATP consists of a molecule of *Adenine* (a protein) and *Ribose* (a sugar) - forms Adenosine, linked to three phosphate molecules.
  - Two outermost phosphate bonds are high-energy bonds containing the stored energy within ATP.
  - Work is possible by splitting the outermost high-energy bond from ATP releasing **7.3 kilocalories** of energy, which does not require oxygen.

- **At rest** the body expends approximately 1.0 - 1.3 kcal/min (only ~ 20% used by skeletal muscle) whereas **during heavy exercise** the body can expend 20 - 25 kcal/min (~ 80% used by skeletal muscle).

Figure 1: A molecule of ATP

![Figure 1: A molecule of ATP](image1)

Figure 2: Energy Release from Splitting ATP

![Figure 2: Energy Release from Splitting ATP](image2)

ATP is used to build molecules, contract muscles, generate electrical impulses and convert the energy found in food to power our bodies and brains.

The Two Energy Pathways:

The body contains two energy pathways: *Aerobic* and *Anaerobic*.

- **Aerobic (oxidative) pathway** contributes most significantly to our energy needs; requires oxygen, generates energy at slower rates, and can use carbohydrates, fats and proteins as a fuel.
**Anaerobic pathways** provide limited, more rapid energy; use ONLY carbohydrates as a fuel and provides energy when:

- Additional energy is needed when intensities exceed the capacity of the aerobic pathway.
- Immediate energy is needed during any increase/change in activity or exercise intensity.
- When aerobic stores cannot supply the energy needed to fuel the increased capacity of the pathway, it is called the “anaerobic threshold,” which is the level at which the body burns stored sugars to help meet the demands placed on it, and produces lactic acid faster than it is cleared away.

Within the anaerobic pathways:

- **ATP-PCr system** (phosphagen system) creates energy for the body’s most immediate needs, but also generates the least amount of energy (~10 seconds of all-out effort).
- **Glycolytic (anaerobic glycolysis) system** takes over as phosphagen system becomes depleted, and generates a larger amount of energy.

**Figure 3: Relative Contribution of the Aerobic and Anaerobic Pathways**

**Table 1: Percent Contribution of the Energy Pathways during Exercise**

<table>
<thead>
<tr>
<th>Duration of Event</th>
<th>Event Intensity</th>
<th>Primary Energy System</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 6 seconds</td>
<td>Extremely High</td>
<td>Phosphagen</td>
</tr>
<tr>
<td>6 - 30 seconds</td>
<td>Very High</td>
<td>Phosphagen and Anaerobic Glycolytic</td>
</tr>
<tr>
<td>30 - 120 seconds</td>
<td>High</td>
<td>Anaerobic Glycolytic</td>
</tr>
<tr>
<td>2 - 3 minutes</td>
<td>Moderate</td>
<td>Anaerobic Glycolytic and Oxidative</td>
</tr>
<tr>
<td>&gt; 3 minutes</td>
<td>Lower</td>
<td>Oxidative</td>
</tr>
</tbody>
</table>

It is not only important to understand how the body works from an energy perspective, but a Personal Trainer must also have a basic understanding of how the body’s nervous system and endocrine system work to produce muscular contractions. A basic understanding of how the cardiovascular and musculoskeletal systems work together will insure your success when designing programs for Clients. The next section focuses on the neuromuscular and endocrine systems.
Neuromuscular Physiology:

**Neural Arrangement:**
The nervous and endocrine systems are the two major communication systems within the body that help control/maintain a stable internal environment (homeostasis) regardless of our surrounding environment or the stimulus placed upon the body (e.g. exercise).

- Both are instrumental in coordinating functions at a cellular, tissue, and organ level.
- The **nervous system** responds quickly to changes and has short-lived, more localized effects.
- The **endocrine system** responds more slowly in response to changes and has longer-lasting, more generalized effects throughout the body.

The nervous system has two major components:

- **Central Nervous System (CNS)** that consists of the brain and the spinal cord.
- **Peripheral Nervous System (PNS)** that consists of the **sensory (afferent)** division and the **motor (efferent)** division.
  - The afferent (sensory) division relays information towards the CNS.
  - The efferent (motor) division relays information from the CNS.
    - This division is further subdivided into the **Autonomic** (non-voluntary) and **Somatic** (voluntary) systems

**Figure 4: Organization of the Nervous System**

- The sensory (afferent) system receives information from the periphery (from the skin, muscles, tendons, sense organs – taste, sight, smell, etc.) and transmits that information to the CNS for processing.
- Information entering the CNS varies with regard to the degree of identification, interpretation and selection of response needed.
Basic reflexive responses such as a knee jerk generally operate through the spine without any need for higher processing, but as the sensory information becomes more advanced and complex, it will travel to higher portions of the brain for processing and selection of an appropriate response.

The responses will exit the spine and travel along the motor (efferent) nerves to the appropriate muscles to elicit a response.

**ADAPTATIONS TO TRAINING:**
While muscles generate force and produce movement, it is the nerves (or neurons - individual nerve fibers) that attach to muscle fibers within a large muscle or group of muscles and communicate the need for muscle action.

When starting a resistance training program, a beginner will demonstrate some rapid, initial gains over the first two weeks that are not attributed to muscle growth.

- **Muscle growth or hypertrophy**, which is the increase in the size of a muscle, does not typically occur until weeks four through six.

These initial strength gains are attributed to improvements in neural patterns and muscle fiber recruitment, where the muscles fire and contract in a more coordinated fashion to generate greater amounts of force.

**Muscle Actions:**
There are three types of muscle contractions (concentric, eccentric, and isometric)

- **Concentric** (positive) contractions occur when the muscle fibers shorten (e.g., lifting the bar when performing a biceps curl).

- **Eccentric** (negative) contractions occur when the muscle fibers lengthen (e.g., lowering the bar when performing a biceps curl).
  - It is during this phase that the greatest amounts of force are generated. Emphasize this phase of movement when training to build muscle strength.
  - However, it is also during this phase that the greatest amount of micro-tearing occurs within the muscle, which also provides a stimulus for muscle growth.
    - This onset of muscle soreness (**DOMS** – delayed onset of muscle soreness) that follows 12-72 hours post-exercise is a muscle’s protective mechanism to prevent use of that muscle and allow it time to heal and recover.
    - DOMS is experienced most frequently with novice exercisers or when starting a new phase or progression of a resistance training program.
    - Healing from DOMS can be accelerated with effective cool downs and stretching, and by training those same muscles very lightly (< 60 – 70 % of previous intensity) the following day.

- **Isometric** contractions take place when there is a load applied to muscles, but no change in muscle fiber length occurs (e.g., holding a static contraction like when in a plank pose).

- **Do not recommend isometric exercises for individuals with high blood pressure.**
  - Additionally, make sure clients are breathing while lifting and lowering weights.

**Gravity and Line of Pull** refers to the pull of gravity downward along an imaginary line that crosses the muscle longitudinally. A muscle contraction achieves the highest physiological and mechanical efficiency when performed along the line of pull. Therefore, for maximal strength gains, exercises should be performed along the line of pull.
• For example; changing the forearm position (supinated, prone) influences the line of pull when performing a biceps curl.
  o When the palm is supinated (face up), the line of pull is direct and the power output is maximal. When the palm is prone (face down), the line of pull is indirect, decreasing power output and neural efficiency.

Figure 5: Muscle Action

Muscle Fiber Composition:

Muscles also demonstrate different physiological properties based upon their fiber composition. Three basic fibers exist within the human body:

✓ Type I (also known as slow twitch) muscle fibers generate lower amounts of force, but do so for longer periods of time (synonymous with muscle endurance).
  • These fibers are trained best with lower intensities, larger volumes (sets x reps) and shorter rest intervals.
  • Many of your deeper, postural muscles that act as stabilizers of the body’s joints have higher concentrations of type I fibers (e.g., core muscles).

✓ Type IIx or IIb (also known as fast twitch) muscle fibers generate larger amounts of force, but do so for shorter periods of time – fatigue more rapidly (synonymous with muscle strength and power).
  • These fibers are trained best with higher intensities, smaller volumes (sets x reps) and longer rest intervals.
  • Many of your larger, more superficial muscles that act as mobilizers to move the body’s joints have higher concentrations of type II fibers (e.g., quadriceps).

✓ Type IIa are intermediate fibers with properties of both type I and type IIb fibers.
  o Type IIa can be trained for speed and power or endurance.
Table 2: Muscle Fiber Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Type I (slow twitch)</th>
<th>Type IIa (intermediate)</th>
<th>Type IIx / IIb (fast twitch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force Production</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Anaerobic Capacity</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Aerobic Capacity</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Fatigue Resistibility</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Ideal Training Style</td>
<td>Endurance &amp; Hypertrophy</td>
<td>Hypertrophy &amp; Strength</td>
<td>Strength &amp; Power</td>
</tr>
</tbody>
</table>

On average muscles contain 50% type I fibers, 25% type IIa fibers and 25% type IIb fibers.

✓ Cardiovascular training as well as muscular endurance and hypertrophy training can increase the concentrations of type I and type IIa fibers.

✓ Explosive power training can increase the concentration of type IIb fibers.

✓ Other points to consider
  • The Influence of Gravity and Line of Pull
    ○ See discussion on page 6.
    ○ Open and Closed Chain Exercises.
      ▪ Closed chain exercises are generally considered functional exercises and the body is usually in contact with the ground.
      ▪ Open chain exercises are usually a machine-based exercise, where the emphasis is on the muscle without consideration for joint support.
Endocrine Function:

Three components comprise the endocrine system:

- **Host glands**: Tissues or glands that manufacture, store and release hormones directly into the blood.

- **Hormones**: Chemical messengers released from one area of the body and transported elsewhere within the body (single or multiple target cells) to exert their effect.

- **Target cells**: Specific region or regions (cells) where the hormone action is executed.

Hormones control all essential reactions within the body that strive to maintain our constant internal environment when the body is subjected to:

- Changing external factors (e.g., temperature change).
- External influences entering the body (e.g., sugar entering the blood).
- External stimuli (e.g., exercise, muscle overload).

At the beginning of exercise and during sustained exercise, several different hormones perform critical functions to prepare the body for the stress of exercise as well as sustain the body’s ability to continue exercising. Some of the key functions performed by hormones during exercise include:

- Mobilizing fats from fat cells to use for energy.
- Breaking down stored glucose in the liver and muscle cells to utilize as fuel.
- Increasing blood distribution to the exercising muscles (vasodilation in exercising regions, vasoconstriction in non-exercising regions).
- Increasing heart rate, heart contractility and blood pressure.
- Dilating the airways to increase airflow into the lungs.
- Sweating to help eliminate heat from the body.
- Preserving body water and electrolytes lost to sweating.

The cardiorespiratory system consists of the heart and the lungs along the blood vessels and other structures that distribute blood and oxygen to all of the cells in the body. A basic understanding of the cardiorespiratory system is paramount to providing exercise recommendations as a Personal Trainer. The next section will provide you with a basic understanding of the cardiorespiratory system.
Cardiorespiratory Physiology:

✔ Roles of the cardiorespiratory system:

- **Ventilation** (movement of air into and out of the body)
- **Delivery** (oxygen and nutrients)
- **Removal** (carbon dioxide and waste products)
- **Transport** (hormones)
- **Maintenance** (acid-base balance – pH and fluid balance)
- **Prevention** (immune function against disease and infection)

✔ The cardiovascular system consists of three components:

- The heart (pump)
  - One way flow-system consisting of 4 chambers (2 atria and 2 ventricles).
  - Blood flows into the atria, then into the ventricles before being ejected back into circulation with high levels of oxygen.

- The blood vessels (system of channels)
  - Arteries and arterioles transport blood away from the heart to the capillaries in a high-pressure system.
  - Veins and venules (very small veins) return blood to the heart from the capillaries in a low-pressure system.
    - Veins contain blood with low oxygen levels.

- The blood (fluid medium)
  - Plasma makes up 55% - 60% of blood and is comprised of water (90%), proteins (7%) and electrolytes, enzymes, fats, etc. (3%).
  - Formed elements make up 36% – 40% (women) / 40% – 45% (men) and comprised of red blood cells (99%) and white blood cells (1%).
  - Hemoglobin is the oxygen-carrying molecule found in red blood cells.
Blood distribution throughout the body:
- Blood enters the right atrium, passes into the right ventricle before being ejected into the pulmonary artery towards the lungs to exchange carbon dioxide (CO$_2$) for oxygen (O$_2$).
- After O$_2$ enters the capillaries in the lungs, venules and veins (pulmonary veins) return blood to the left atrium, passing through the left ventricle before being ejected into circulation to deliver oxygen to the entire body.
- Blood returns to the heart entering the right atrium once again.

Blood pressure is a measure of the outward force exerted by the blood upon the vessel walls.
- During one single heart contraction cycle (approximately 1 second in duration at rest), the pressure within the vessels varies.
  - Coinciding with the heart contraction, the pressure is greatest and measured as Systolic Blood Pressure (SBP).
  - Coinciding with the heart relaxation or refilling phase, the pressure is lowest and measured as Diastolic Blood Pressure (DBP).

Risk Factors for Cardiovascular Disease (Centers for Disease Control and Prevention)
- Genetic
  - Family History
- Lifestyle
  - Diet
  - Obesity
  - Physical Inactivity
  - Cholesterol Levels
  - High Blood Pressure
  - Diabetes
  - Tobacco Use
  - Alcohol Use
The diaphragm, a dome-shaped muscle sits below the lungs and is the key breathing muscle.

- When it contracts, it flattens and allows air to enter the body via the nasal and oral cavities.
- Air passes through the rigid trachea, splits down the left and right bronchi into bronchioles and finally arrives at the alveoli where gas exchange occurs with the blood, exchanging O\textsubscript{2} for CO\textsubscript{2}.

During exercise, the muscle’s demands for O\textsubscript{2} increases and the muscles produce more CO\textsubscript{2} as a result of respiration.

**FUEL + OXYGEN = ENERGY + CARBON DIOXIDE + WATER**

Due to the increased demand for fuel and oxygen during exercise, the following acute adaptations occur:

- **Heart rate** increases to circulate blood more rapidly and increases in proportion to exercise intensity.
- **Stroke volume** (the amount of blood ejected from the heart with each beat) increases to circulate more blood.
- **Systolic Blood Pressure** rises to increase the force of each heart contraction in order to eject more blood and overcome the resistance blood encounters when it reaches the exercising muscles.
- **Diastolic Blood Pressure** changes very slightly or does not change at all as the refilling phase is unaffected by the exercising muscles.
- **Ventilation** increases to deliver more O\textsubscript{2} to the working muscles and remove any excess CO\textsubscript{2} from the body.
  - Ventilation increases first by increases in **tidal volume** (volume of air moved with each breath) and then by an increase in **breath rate** (number of breaths / minute).
Thermoregulation:

✓ Heat generated in the core of body must be transported to the periphery (skin) and is eliminated from the body via five mechanisms:
  
  **Conduction – dry heat exchange**
  o Transfer of heat through direct molecular contact (touching).
  o Heat transferred is dependent upon the temperature gradient (difference) between the two surfaces and the thermal qualities of the surface.

  **Convection – dry heat exchange**
  o Transfer of heat via the movement or removal of hot air blankets away from the skin surface.
  o For example, air currents (wind) remove air blankets from the skin surface.

  **Radiation – dry heat exchange**
  o Transfer of radiant heat energy (heat) via electromagnetic heat waves to cooler, solid objects.
  o Heat moves along the temperature gradient without direct contact.

  **Evaporation**
  o Removal of sweat, which contains heat from the skin surface.
  o While an efficient system, it comes at a cost with dehydration (loss of precious water).

  **Excretion**
  o Heat contained with our breath, urine and feces - contributes insignificantly to heat removal.

✓ Resistance to dry heat exchange is called **insulation**
  
  • In humans, the greatest insulators are fat, number of layers of clothing and the thermal properties of the fabrics we wear.

Table 3: Contributions of the Thermoregulatory Mechanisms at Rest and During Exercise

<table>
<thead>
<tr>
<th>Thermoregulatory Mechanism</th>
<th>Rest</th>
<th>Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduction &amp; Convection</td>
<td>20 % of total</td>
<td>10 – 15 % of total</td>
</tr>
<tr>
<td>Radiation</td>
<td>55 – 60 % of total</td>
<td>5 % of total</td>
</tr>
<tr>
<td>Evaporation</td>
<td>20 % of total</td>
<td>80 % of total</td>
</tr>
<tr>
<td>Excretion / Lungs</td>
<td>5 – 10 % of total</td>
<td>&lt; 2 % of total</td>
</tr>
</tbody>
</table>

✓ As sweating is the key mechanism during exercise and dependent upon hydration, dehydration will compromise our ability to remove heat and increase the likelihood of heat illnesses:

  • Heat Cramps
  • Heat Exhaustion
  • Heat Stroke

Body composition is an important concept to understand as a Personal Trainer since many of your Clients will want to improve their body composition by reducing their bodyfat percentage and increasing their lean muscle mass. Below are some important points to consider when speaking to your Clients about bodyfat percentage.
Body Composition:

✓ The body consists of two basic compartments:
  - Fat mass
  - Fat-free mass (often referred to as lean body mass)

✓ Two types of fat mass:
  - **Essential fat** is needed for normal physiological and biological functions. It is found in the bone marrow, brain, spinal cord, cell membranes, muscles, and other internal organs.
    - *Males: 2% – 4%; Females: 8% – 12%
    - Females may experience a disruption in their menstrual cycle when their body fat drops low, they train intensely for competitions, and they have a condition known as the Female Athlete Triad
  - **Nonessential fat**:
    - Layered below the skin in adipose tissue (*sub-cutaneous fat*) or found surrounding organs in the abdominal cavity (*visceral fat*).
    - Serves three main functions:
      - Insulator to retain body heat
      - Energy substrate during rest and exercise
      - Padding against trauma

✓ *Fat-free mass* is composed of all of the body's nonfat tissue including bone, muscle, organs, and connective tissue

Body Composition Changes:

✓ *Fat Free Mass* peaks in our 20’s – 30’s, then declines steadily at 0.5 pounds per year or approximately 5 % per decade (loss of skeletal muscle mass, bone mineral density, organ mass and total body water).
  - Females gain approximately 0.97 pounds of fat mass per year (ages 18 – 44) and approximately 1.14 pounds of fat mass per year (ages 45 – 65).
  - Males gain approximately 1.25 pounds of fat mass per year (ages 18 – 44) and 0.81 pounds of fat mass per year (ages 45 – 65).

✓ Body composition changes that include an increase of lean tissue and a decrease of fat tissue occur most effectively during an exercise program that contains both cardiovascular exercise and strength training exercise. An increase in muscle tissue will also increase a person’s resting metabolism.
Somatotypes:

✓ Body types developed in the 1940’s by psychologist Dr. William Herbert Sheldon associating personality characteristics with body fat distribution.

✓ There are three body types related to fat distribution:
  • *Endomorphic* has a pear shaped body with wide hips and tends to carry large amounts of body fat.
  • *Mesomorphic* is low in body fat emphasizing lean mass; narrow at the waist and considered athletic.
  • *Ectomorphic* is low in fat, with long and lean muscles with long limbs.

✓ Modern Body Types
  • *Apple* body types tend to carry more weight in the torso with thin legs.
  • *Pear* body types tend to carry more fat in the hips and thighs.
As a Personal Trainer, a fundamental understanding of anatomy and kinesiology, which is the study of the principles of mechanics related to human movement, is important since an understanding of kinesiology will assist with insuring Clients perform strength training exercises safely and effectively.

### Table 4: Anatomical Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior (ventral)</td>
<td>Toward the front</td>
</tr>
<tr>
<td>Posterior (dorsal)</td>
<td>Toward the back</td>
</tr>
<tr>
<td>Superior</td>
<td>Toward the head</td>
</tr>
<tr>
<td>Inferior</td>
<td>Away from the head</td>
</tr>
<tr>
<td>Medial</td>
<td>Toward the midline of the body</td>
</tr>
<tr>
<td>Lateral</td>
<td>Away from the midline of the body</td>
</tr>
<tr>
<td>Proximal</td>
<td>Toward the attached end of the limb, origin of the structure, or midline of</td>
</tr>
<tr>
<td>Distal</td>
<td>Away from the attached end of the limb, origin of the structure, or midline of the body</td>
</tr>
<tr>
<td>Plantar</td>
<td>The sole or bottom of the feet</td>
</tr>
<tr>
<td>Dorsal</td>
<td>The top surface of the feet and hands</td>
</tr>
<tr>
<td>Palmar</td>
<td>The anterior or ventral surface of the hands</td>
</tr>
<tr>
<td>Cervical (Spine)</td>
<td>Regional term referring to the neck</td>
</tr>
<tr>
<td>Thoracic (Spine)</td>
<td>Regional term referring to the portion of the body between the neck and the</td>
</tr>
<tr>
<td></td>
<td>abdomen; also known as the chest (thorax)</td>
</tr>
<tr>
<td>Lumbar (Spine)</td>
<td>Regional term referring to the portion of the back between the abdomen and the pelvis</td>
</tr>
<tr>
<td>Sagittal Plane</td>
<td>An imaginary line that divides the body or any of its parts into right and left sections</td>
</tr>
<tr>
<td>Frontal Plane</td>
<td>An (imaginary line that divides the body into anterior and posterior parts; lies at a right angle to the sagittal plane)</td>
</tr>
<tr>
<td>Transverse Plane</td>
<td>Also known as the horizontal plane; an imaginary line that divides the body or any of its parts into superior and inferior sections</td>
</tr>
</tbody>
</table>
Muscle Terminology:

1. **Prime Movers or Agonists:**
   ✓ Muscles primarily responsible for the given joint movement (*for example*: the Biceps Brachii is the prime mover or agonist for elbow flexion).

2. **Antagonists:**
   ✓ Muscles that produce the opposite joint movement when compared to the agonist (*for example*: the Triceps Brachii is the antagonist to the Biceps Brachii).

3. **Synergistic Muscles:**
   ✓ Muscles that act as secondary movers or generally assist the prime mover (*for example*: the Triceps Brachii is a synergist to the Pectoralis Major during the bench press movement).

4. **Stabilizer Muscles:**
   ✓ Muscles that stabilize one joint to allow for movement at another joint. Stabilizers are usually located more proximally in relation to the agonist (*for example*: the muscles around the scapula act as stabilizers to fixate the scapula to the thorax during arm movements).

5. **Muscle Origin:**
   ✓ Defines the more fixed end of a muscle.

6. **Muscle Insertion:**
   ✓ Defines the more moveable end of a muscle.

7. **Ipsilateral:**
   ✓ Referring to muscles on the same side of the body (*for example*: the left Hamstrings and left Gluteus Maximus).

8. **Contralateral:**
   ✓ Referring to muscles on the opposite side of the body (*for example*: the left Latissimus Dorsi and Right Gluteus Maximus).

Homework Assignment: Fill in the Blanks

**Figure 8: Planes of Motion of the body**

---

<table>
<thead>
<tr>
<th>Plane</th>
<th>Plane</th>
<th>Plane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 9: Skeletal Anatomy

- Hint: 7 vertebrae
- Hint: 12 vertebrae
- Hint: 5 vertebrae
- Hint: 5 fused vertebrae
- Hint: 4 fused vertebrae

How many pairs? _____
### Table 5: Movements of Human Joints

<table>
<thead>
<tr>
<th>Movement Terminology</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sagittal Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Flexion – Decreasing the angle between two bones</td>
<td>Elbow flexion; knee flexion</td>
</tr>
<tr>
<td>Extension - Increasing the angle between two bones</td>
<td>Elbow extension; knee extension</td>
</tr>
<tr>
<td>Dorsiflexion – Moving the top of the foot towards the shin</td>
<td>Ankle dorsiflexion</td>
</tr>
<tr>
<td>Plantar flexion – Moving the sole of the foot downward</td>
<td>Ankle plantarflexion</td>
</tr>
<tr>
<td><strong>Frontal Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Abduction – Movement away from the midline of the body</td>
<td>Shoulder (arm) abduction; hip (leg) abduction</td>
</tr>
<tr>
<td>Adduction – Movement toward the midline of the body</td>
<td>Shoulder (arm) adduction; hip (leg) adduction</td>
</tr>
<tr>
<td>Elevation – Moving towards a superior position</td>
<td>Scapular elevation</td>
</tr>
<tr>
<td>Depression – Moving towards an inferior position</td>
<td>Scapular depression</td>
</tr>
<tr>
<td>Upward Rotation – Rotational movement to a superior position</td>
<td>Arm rotation upward</td>
</tr>
<tr>
<td>Downward Rotation – Rotational movement to an inferior position</td>
<td>Arm rotation downward</td>
</tr>
<tr>
<td><strong>Transverse Plane</strong></td>
<td></td>
</tr>
<tr>
<td>Rotation – Internal (inward) or external (outward) turning around the axis of a bone or the spine</td>
<td>Spinal rotation</td>
</tr>
<tr>
<td>Internal Rotation – Rotation of the humerus around the long axis</td>
<td>Internal humeral rotation</td>
</tr>
<tr>
<td>External Rotation - Rotation of the humerus around the long axis</td>
<td>External humeral rotation</td>
</tr>
<tr>
<td>Horizontal Flexion – From an abducted arm position, the humerus moves forward towards the midline</td>
<td>Arm movement into horizontal flexion</td>
</tr>
<tr>
<td>Horizontal Extension - From an abducted arm position, the humerus moves backwards</td>
<td>Arm movement into horizontal extension</td>
</tr>
<tr>
<td>Pronation – Rotating the hand and wrist so palm faces downward or foot inward</td>
<td>Forearm pronation; foot pronation</td>
</tr>
<tr>
<td>Supination – Rotating the hand and wrist so palm faces upward or foot outward</td>
<td>Forearm supination; foot supination</td>
</tr>
</tbody>
</table>
Homework Assignment: Fill in the Blanks

Applied Kinesiology

✓ Identify the planes of motion and movement at the joint(s)

Plane: ________
Movement: _______

Plane: __________
Movement: _______

Plane: __________
Movement: _______

Plane: __________
Movement: _______

Plane: __________
Movement: _______

Plane: __________
Movement: _______

Plane: __________
Movement: _______

Plane: __________
Movement: _______
Nutrition

Your Clients will have a difficult time achieving optimal results without utilizing sound nutritional principles. Clients who exercise on a regular basis but have a poor approach to nutrition will become frustrated when they do not see the results they anticipate. The following information will provide you with some general guidelines regarding basic nutrition that can be shared with your Clients.

Carbohydrates:

✓ Carbohydrates serve numerous roles with the most important being that of fuel for the body.

✓ One gram of carbohydrate provides the body with four calories.

✓ 55% to 65% of a person’s diet should consist of carbohydrates.

✓ Examples of carbohydrates include fruits, vegetables, bread, pasta, etc.

✓ Carbohydrate classification depends upon the number of individual sugar units that combine to form the entire carbohydrate structure.
  - **Monosaccharides** – single sugar units
    - Glucose, galactose and fructose
    - Represent the absorbable and usable forms of carbohydrates within the body
  - **Disaccharides** – 2 sugar units
    - Sucrose, lactose and maltose
    - Must be digested to monosaccharides for absorption.
    - Collectively monosaccharides and disaccharides are called *simple sugars*
  - **Oligosaccharides** – 3-10 sugar units
    - Starches comprising short chains of glucose molecules
    - Must be digested to monosaccharides for absorption
  - **Polysaccharides** – ≥ 10 sugar units
    - Starches and fiber comprising long chains of glucose molecules
    - Must be digested to monosaccharides for absorption (except fiber – non-digestable)
    - Collectively oligosaccharides and polysaccharides are called *starches*

• Simple sugars represent 50% of total US carbohydrate consumption (versus recommendation of only 10%).

• Body can store glucose in:
  - Blood (5 – 15 grams)
  - Liver (90-110 grams) as glycogen (storage form of glucose in the body)
  - Muscles (250 – 600 grams +) as glycogen
Protein:

✓ While proteins serve vital roles in tissue synthesis, repair and maintenance, production of hormones, enzymes and antibodies, they do contribute 2% – 5% of the body’s energy needs at rest and up to 5% – 15% during intense or prolonged exercise.

✓ One gram of protein provides the body with four calories.

✓ 15% to 20% of a person’s diet should consist of protein.

✓ Examples of proteins include meat, eggs, cheese, milk, etc.

✓ Amino acids represent the building blocks of proteins and there are approximately 21 nutritionally important amino acids of which nine are essential. Essential amino acids cannot be manufactured by the body but are only attained through our diets.

- The nine essential amino acids are leucine, isoleucine, valine, methionine, tryptophan, lysine, phenylalanine, threonine, and histidine.

- Non-essential amino acids are manufactured in our own body and include alanine, arginine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, tyrosine, asparagine, selenocysteine.

✓ Proteins digest and are broken down from larger molecules (long chain polypeptides - approximately 300 amino acids) to amino acids, di-peptides (pairs) and tri-peptides (triplets) for absorption.

✓ The body stores protein uniquely:
  - 99% of usable protein is found as muscle tissue.
  - 1% of usable protein is found within free amino acid pools located inside cells and within the bloodstream.

Fats:

✓ While fats also serve numerous vital functions within the human body, including protection and insulation, transportation, nerve conduction and steroid manufacture, one key role is their availability as a significant energy source:

  - Fats are capable of storing 90,000 - 110,000 calories worth of energy for the average adult.
  - Stores of fat far exceed the body’s carbohydrate stores (2,000 – 3,000 calories).

✓ One gram of fat provides the body with nine calories.

✓ No more than 30% of a person’s diet should consist of fats, but optimally, 15% to 20% would be ideal.

✓ Examples of fats include butter, milk, oils, etc.
Three kinds of fats exist within the body:

- **Simple or Neutral fats:**
  - Represents ~ 95 - 98% of all fat found within the body.
  - *Triglycerides* are the most abundant form of simple fats.

- **Compound fats:**
  - Structures formed from the combination of a simple or neutral fat (lipid) and a non-lipid molecule to form a more complex structure (e.g.) high density lipoprotein or HDL.

- **Derived fats:**
  - Structures derived from either simple or compound fats (e.g.) testosterone.

Carbohydrates, proteins, and fats are all classified as macronutrients. Vitamins, minerals, and water are also considered to be macronutrients although not covered in this manual. The purpose of this section has been to provide you with basic nutritional information. If you want to learn more about nutrition, you can also review our Sports Nutrition Home Study certification.
Introduction

Figure 1: Stages to Successful Personal Training Client On-Boarding

- Developing a successful professional relationship with a Client involves four stages that occur sequentially, although rapport is continuous.

- These four stages are:
  - Rapport: Personal interaction you establish and maintain with your Clients and your ability to effectively communicate with them.
    - This stage includes making impressions of professionalism, developing trust, demonstrating warmth and genuineness, and exhibiting empathy.
  - Investigation: Collection of all relevant information to identify the comprehensive needs of your Clients.
    - This stage includes identifying readiness to change behavior, stage of behavioral change and personality style, collecting health and safety information, learning about lifestyle preferences, interests and attitudes, understanding previous experiences and conducting assessments.
  - Planning: Collaborative goal-setting with your Client after the investigation is complete in order to design an effective and comprehensive program.
    - This stage includes goal setting, programming considerations, and designing motivational and adherence strategies.
  - Action: Successful implementation of all programming components and providing the appropriate instruction, feedback, progressions and regressions as needed.
    - This stage includes instruction, demonstration and execution of programs, implementing strategies to improve motivation and promote long-term adherence; providing feedback and evaluation, making necessary adjustments to programs and monitoring the overall exercise experience with progression towards goals.

The New Client On-boarding phase involves:

1. The initial meeting of a potential Client where first impressions are made and an early working relationship is explored, the trainer begins **Building Rapport**.

2. When the potential customer becomes an actual new Client, information gathering and health screening begins. This is the **Investigation Phase**.
Building Rapport

✓ Successful Personal Trainers consistently demonstrate excellent communication skills and teaching techniques while understanding the psychological, emotional and physiological needs and concerns of their Clients.

✓ Building rapport is a critical component to effective communication that promotes open, effective communication and the development of trust. This translates into greater levels of participation with Clients.

✓ Three essential attributes are needed to develop rapport:
  - **Empathy**, the ability to experience another person’s world as if it were one’s own.
  - **Warmth**, an unconditional positive regard, or respect for another person regardless of their individuality and uniqueness. This quality conveys a climate that communicates acceptance to the Client.
  - **Genuineness**, the authenticity or ability to be honest and open without putting up a front or façade.

✓ The first impression you make upon a prospective Client is probably the most influential in their decision to hire you as a Personal Trainer.
  - **This impression can be made in person, over the phone or even through an email.**
  - **ALWAYS** make a strong, convincing, and positive first impression, called the **“Moment of Truth.”**
    - It is believed that within the first 11 seconds of meeting a person, they make seven decisions about you (**7-11 rule**).

**Communication Strategies to Build Rapport**

✓ Your immediate objective upon meeting your prospective Client is **NOT** to start gathering information and establish goals, but to build the foundation of a professional, personal relationship.
  - **Take some time to acquaint yourself with your Client while being sensitive to their individual personality traits, which will help determine the appropriate level of rapport needed.**
  - **All too frequently Personal Trainers adopt an approach of “getting down to business” immediately while failing to develop a personal relationship by building trust and a level of comfort with their Client.**
    - **This simply involves taking the time to talk to them and get to know who they are and not just what they seek to achieve through training.**

✓ Attend to the environment where you meet your prospective / current Clients.
  - **Create a nurturing, yet professional environment by meeting in a quiet, comfortable area.**
  - **Avoid high traffic areas, member distractions or attempting to establish rapport with a facility tour or orientation.**
  - **Do not sit behind a desk, but rather sit facing each other to create a level of comfort.**
  - **Be attentive to your own personal appearance (clothing, grooming, jewelry, scent, breath, etc).**
✓ Communicate effectively.
  • Verbal communication translates only part of the message people send. While we hear each other’s words, we often evaluate a speaker’s non-verbal message including posture, facial expressions, gestures, eye contact, etc. This is also known as body language.
  • It is estimated that 55 – 90% of communication is non-verbal.

1. **Distance and orientation (body positioning):**
   o Face your Client squarely and maintain appropriate distance to demonstrate respect for personal space.
   o 1½ - 4 feet is considered ideal while less than 1½ feet is considered intimate space.

2. **Posture and position:**
   o This demonstrates confidence and interest in the conversation.
   o Adopt an open, erect but relaxed posture with a slight forward lean towards your Client.
   o Leaning or stooping suggests boredom and fatigue.
   o Rigid hands placed upon the hips can be interpreted as aggressive behavior.
   o Avoid crossing your arms or legs as it conveys a defensive stance.

3. **Mirroring and Gestures:**
   o S sensitively mimic your Client’s posture, gestures, voice tone, and tempo to help place them at ease and facilitate communication that is more open. People generally feel more comfortable when individuals use relaxed, fluid gestures to convey messages.
   o Reduce distracting movements that may disrupt your Client’s communication, e.g. shifting in your seat, tapping your feet, looking at your phone, etc.

4. **Eye Contact:**
   o Maintain a relaxed look at your Client to help instill comfort, but avoid fixed stares.
   o Looking away while a person speaks conveys disinterest, un-attentive behavior (not listening) or suggests diminished importance of the speaker.

5. **Facial Expressions:**
   o Smile and be genuine and sincere.

6. **Voice quality (tonality and articulation):**
   o A weak, hesitant voice does not inspire confidence, whereas a loud, overbearing voice can make individuals nervous.
   o Speak warmly with compassion. Be clear with your questions, concerns and statements.

7. **Listen effectively:**
   o Listening is the primary non-verbal communication skill. Being an effective communicator involves listening more than speaking. While humans can speak at 125 – 250 words / minute, we are capable of listening to up to 500 words / minute.
   o Effective listening implies listening to both the content and emotions behind the speaker’s words.
   o Listening occurs at different levels:
     a) **Indifferent listening** where one is not really listening and is “checked” out.
     b) **Selective listening** where one listens only to key words.
     c) **Passive listening** where one gives the impression of listening by using minimal non-committal agreements (e.g. head nods, “ah huhs”, etc.)
     d) **Active listening** where one is empathetic and listens as if in the speaker’s shoes. This form is the key to effective listening.
Investigation:
Health Risk and Fitness Assessments

Purpose of a Health Risk Appraisal (HRA)/Health Screening:

✓ The health screening is a vital **FIRST** step in the Personal Trainer/Client relationship.
  - It identifies the presence or absence of known cardiovascular, pulmonary and/or metabolic disease, or signs or symptoms suggestive of cardiovascular, pulmonary and/or metabolic disease.
  - It identifies individuals at increased risk who should:
    1. First undergo medical evaluation and exercise testing before initiating an exercise program.
    2. Be excluded from exercise or physical activity until those conditions are corrected or are under control.

✓ HRA questionnaires are designed to provide information regarding existing risks for participation in activity and need for a medical clearance.
  - A pre-participation screening **MUST** be performed on all new participants (regardless of age) in any facility that offers exercise equipment or services.
  - The screening procedure should be valid, simple, cost- and-time efficient and appropriate for the target population.
  - Screening procedures range from self-administered questionnaires to elaborate tests:
    1. For individuals participating in self-guided or directed activity, they should minimally complete an HRA.
    2. The **Physical Activity Readiness Questionnaire (PAR-Q)** has been used successfully when a short, simple medical/health questionnaire is needed.

✓ Experts recognize the PAR-Q as a **minimal**, yet safe pre-exercise screening measure for low-to-moderate, but not vigorous exercise training.
  - It serves as a minimal HRA prerequisite.
  - It is quick, easy and non-invasive to administer.
  - It is limited by its lack of detail and may overlook important health conditions, medications and past injuries.

✓ Ultimately, when working with Clients, you will need to learn how to conduct a more complex health risk assessment than the simple PAR-Q presented here. The **ACSM/AHA Health/Fitness Facility Pre-participation Screening Questionnaire** investigates one’s history, symptoms, cardiovascular risk factors and other health issues in greater detail. This is important in determining if a Client should initiate an exercise program or contact their physician for a more detailed evaluation.
  - The basis for recommending physical activity / exercise, a medical examination, exercise testing, or physician supervision is based on the risk stratification of the HRA.
    - Individuals are identified as a low, moderate or high risk.

1. **Identifying Coronary Artery Disease (CAD) Risk Factors**
2. **Performing Risk Stratification**
3. **Determining Need for a Medical Exam / Clearance and Medical Supervision**
PAR-Q & You
(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly:

YES NO
☐ ☐ 1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐ ☐ 2. Do you feel pain in your chest when you do physical activity?
☐ ☐ 3. In the past month, have you had chest pain when you were not doing physical activity?
☐ ☐ 4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐ ☐ 5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐ ☐ 6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐ ☐ 7. Do you know of any other reason why you should not do physical activity?

If you answered YES to one or more questions:

Talk with your doctor by phone or in person BEFORE you commence any physically active program or BEFORE your fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those that are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.
If you answered NO honestly to all PAR-Q questions:

You can be reasonably sure that you can:

- Start becoming much more physically active — Begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal — this is an excellent way to determine your base fitness level so that you can plan the best way for you to live actively.

Delay becoming much more active:

- If you are not feeling well because of a temporary illness such as cold or a fever — Wait until you feel better; or
- If you are or may be pregnant — Talk to your doctor before you start becoming more active.

Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire consult your doctor prior to physical activity.

You are encouraged to copy the PAR-Q but only if you use the entire form.

Note: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

I have read, understood, and completed this questionnaire. Any questions I had were answered to my full satisfaction.

Name: 

Signature: ___________________________ Date: ______

Signature of Parent or Guardian (for under-age participants): ___________________________

Witness: ___________________________

Physical Readiness Questionnaire – PAR-Q © Canadian Society for Exercise Physiology
Fitness Assessment Overview

A fitness assessment is important during the early stages of the personal training process as it:

1. **Collects baseline data** in order to develop personalized programs and allow program evaluation (progress) using follow-up data.

2. **Identifies areas of health / injury risk** for possible referral to the appropriate health professional(s).

3. **Educates** Clients about their present physical condition by allowing comparisons to normative data for age and gender.

4. **Motivates** individuals by helping them establish realistic goals.

Physiological assessments you should be familiar with and competent to administer include the following (* = see end of this section for more details on administering these assessments):

- ✔ Resting vital signs (heart rate and blood pressure).
- ✔ Static posture and range of movement screens* (Thomas Test, Overhead Squat, Postural Screening).
- ✔ Joint flexibility and muscle length.*
- ✔ Balance and core function.
- ✔ Cardiorespiratory fitness* (VO2 Max, Rockport Walking Test).
- ✔ Body composition (skin fold calipers, bio-impedance, tape measure).
- ✔ Muscular endurance and strength.
- ✔ Skill-related parameters of fitness (agility, coordination, power, reactivity, speed, etc.).

Be aware that not all Clients need or desire assessments initially. Regardless, remember that the one mandatory component to conduct is the health-risk assessments to determine your Client’s cardiovascular risk and readiness for activity.

- ✔ Some assessments may be de-motivating to some individuals as they may feel uncomfortable, intimidated, overwhelmed or embarrassed by their current physical condition or by the complexity of the protocols.
  - Fitness testing/assessments in this case, may prove to be counterproductive to the success of an exercise program.
    - For example; if you have a Client that is obviously over-fat in their body composition, it would be unnecessary and likely counterproductive to do a skin-fold caliper or bio-impedance assessment. Tape measurements may be more appropriate and motivating to the Client, as the Personal Trainer can still take advantage of an initial assessment, but one that is more likely to encourage the Client and support their potential & goals.
Normative Data may be useful in helping guide Clients in the interpretation of test results, which may assist them with seeing where they fit in the larger picture* (Body Mass Index, Waist to Hip Ratio)*.

- Published norms for fitness assessments are generally based on group averages and the range of scores around the mean. Comparing test results to these norms will give the Client a perspective in understanding where they fall based on published average data.

Before and after pictures are also very helpful in demonstrating the changes that have occurred through the fitness process. Again, suggest these with care, since many Clients will be too shy.

- “Before and after” pictures may also be useful in marketing your services and programs.

Good Personal Trainers, therefore; always consider the need, appropriateness, type and time for conducting assessments on each Client on a case-by-case basis and prioritize their timelines in which to conduct tests.

The following fitness assessments over the next pages are examples of ones that can be used with your Clients.
Heart Rate Assessment

✓ Purpose: Assess resting and exercise heart rate. Generally, a lower resting heart rate is indicative of having a more efficient cardiorespiratory system and a higher level of cardiorespiratory fitness.

✓ Equipment:
- Stop watch.

✓ Resting Heart Rate (RHR):
- Keep in mind that true resting heart rate is measured just before the client gets out of bed in the morning.
  - Heart rate changes by 7 - 15 beats per minute (bpm) when individuals transition from lying to standing due to the effects of gravity and the action of the postural muscles.
  - Personal Trainers need to consider in which position to measure RHR – ideally measured in the position in which the client will exercise.
- Your pulse is generated by the left ventricle hitting the chest wall near the 5th rib on the left side of the thorax.
  - This beat can be quite prominent in leaner individuals.

✓ Measurement:
- The client should be resting comfortably for several minutes prior to obtaining resting heart rate.
- The resting heart rate may be measured indirectly by placing the fingertips on a pulse site (palpation), or directly by listening through a stethoscope (auscultation).
- Place the tips of your index and middle fingers (not the thumb, which has a pulse of its own) over the artery and lightly apply pressure.
- Commonly used pulse sites to palpate resting heart rate:
  1. Radial pulse: Palpated with two fingers on the wrist at the base of the thumb.
  2. Carotid pulse: Palpated by placing the fingertips on the neck, just to the side of the larynx (heavy pressure should be avoided because the carotid arteries contain baroreceptors that sense increases in pressure and respond by slowing the heart rate).
- To determine the resting heart rate, count the number of beats for 60 seconds.
- It is important to remember that you are counting cardiac cycles, thus the first pulse measured should commence with the number “zero”.

✓ Exercising Heart Rate Measurement:
- Measuring for 60 seconds is difficult; therefore, exercise heart rates are normally measured for shorter periods of time.
- Generally, a 10 – 15-second count is recommended over a 6-second count given the larger potential for error with a 6-second count.
- Count the first pulse beat as “zero” at the start of the time interval, then multiply the counted score by either six (for a 10-second count) or by four (15-second count) to determine beats per minute.
- The exercising heart rate should be taken as soon as possible after the individual stops exercising (within 5 seconds).

\[
HR \ (bpm) = \ (\text{beats counted / count time}) \times \text{time interval to 60 seconds}
\]

- For example, Joe’s 10-second count was 22 beats = 22 x 6 = 132 bpm
Aerobic Fitness Assessment: Rockport Walk Test (VO₂ Max)

✓ **Purpose:** Predict maximal oxygen consumption (VO₂ max) using a 1 mile walk test.
  - VO₂ max is defined as the maximum amount of oxygen that one can consume while exercising, which is a valid indicator of cardiorespiratory fitness. Individuals with a higher VO₂ max have a more efficient cardiorespiratory system and a higher level of cardiorespiratory fitness.
  - This test will under-predict VO₂ max for fit individuals and is therefore not appropriate for that group.
  - This test determines aerobic fitness by estimating VO₂ max from an exercise heart rate.

✓ **Equipment:**
  - ¼-mile track.
  - A treadmill can be used as an alternative although this test is truly only validated for the track.

✓ **Procedure:**
  - **Warm-up:**
    - Allow your client adequate time to warm-up (at a low-intensity) and stretch if necessary.
  - **Test:**
    - The goal of this test is for your Client to complete the distance as quickly as possible while measuring their steady state heart rate during the event.
    - Instruct your client to walk as briskly as possible to complete the 1-mile distance.
      1. Pacing is necessary, as this is not intended to be an all-out test.
      2. No jogging is permitted.
    - Steady state heart rate should be recorded during the last ¼ mile of the walk.
      1. Use a heart rate monitor.
      2. If measuring heart rate via palpation, collect a 10-second count immediately following the completion of the walk and correct to 60-seconds (10-sec count x 6).
Test Interpretation:

Table 6: Normative Values for the Rockport Walking Test

<table>
<thead>
<tr>
<th>Rating</th>
<th>Males (Age 31 – 69)</th>
<th>Females (Age 31 – 69)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (minutes : seconds)</td>
<td>Time (minutes : seconds)</td>
</tr>
<tr>
<td>Excellent</td>
<td>&lt; 10:12</td>
<td>&lt; 11:40</td>
</tr>
<tr>
<td>Above Average</td>
<td>11:43 – 12:13</td>
<td>13:09 – 14:36</td>
</tr>
<tr>
<td>Average</td>
<td>12:14 – 14:44</td>
<td>14:37 – 16:04</td>
</tr>
<tr>
<td>Fair</td>
<td>14:45 – 16:23</td>
<td>16:05 – 17:31</td>
</tr>
<tr>
<td>Poor</td>
<td>&gt; 16:24</td>
<td>&gt; 17:32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Males (Age 18 – 30)</th>
<th>Females (Age 18 – 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 %</td>
<td>11:08</td>
<td>11:45</td>
</tr>
<tr>
<td>75 %</td>
<td>11:42</td>
<td>12:49</td>
</tr>
<tr>
<td>50 %</td>
<td>12:38</td>
<td>13:15</td>
</tr>
<tr>
<td>25 %</td>
<td>13:38</td>
<td>14:12</td>
</tr>
<tr>
<td>10 %</td>
<td>14:37</td>
<td>15:03</td>
</tr>
</tbody>
</table>

Body Mass Index Calculation (BMI)

✔ Purpose: Estimate body composition by calculating a height-normalized index against body weight.

- The validity of this index has been challenged for senior populations or athletic populations. Athletic populations tend to have more body mass and lean tissue.
  - Additionally, BMI tables do not apply to children and adolescents under age 18.
  - Use standard height-to-weight tables:
    1. A child’s weight that is in the 85th – 95th percentile classifies him or her as overweight.
    2. A child’s weight that is ≥ 95th percentile classifies him or her as obese.

✔ Equipment:

- BMI tables.
- Calculator.
- Tape measure and scale (if needed).

Procedure: Trainers can utilize any of the three methods provided:

1. BMI Table (table 7)

2. Metric Formula: BMI = Weight (kg) ÷ Height² (m²)

   o Metric Formula: BMI = Weight (kg) ÷ Height² (m)
     1. Obtain your client’s body weight and convert it from pounds to kilograms.
        ✓ 1 kg = 2.2 lbs
     2. Obtain your client’s height and convert it from feet and inches to meters.
        ✓ 1 inch = 2.54 cm
        ✓ 1 meter = 100 cm
     3. Example: Mary stands 5’7” at 160 lbs
        ✓ 160 lbs ÷ 2.2 = 72.7 kg
        ✓ 5 foot 7 inches = 67 inches x 2.54 = 170.18 cm
        ✓ 170.18 cm ÷ 100 = 1.70 m
        ✓ 72.7 kg ÷ 1.70² m = 72.7 kg ÷ (1.70 m x 1.70 m) = 72.7 kg ÷ 2.90 m = 25.07

3. Standard Formula: BMI = Wt (lbs) x 703 ÷ Ht (inches) ÷ Ht (inches)

   o Procedure: Standard Conversion: BMI = Wt (lbs) x 703 ÷ Ht (inches) ÷ Ht (inches)
     1. Example: Mary stands 5’7” at 160 lbs
        ✓ 160 lbs x 703 = 112,480
        ✓ 112,480 ÷ 67 = 1,678.81
        ✓ 1,678.81 ÷ 67 = 25.06
Table 7: BMI Computation Table

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>19</th>
<th>20</th>
<th>21</th>
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<td>Height (in.)</td>
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<td>238</td>
<td>246</td>
<td>287</td>
</tr>
</tbody>
</table>


Test Interpretation:

- Using the reference table presented below, categorize your client’s score.

Table 8: BMI Score Classifications

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI Score (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5 – 24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0 – 29.9</td>
</tr>
<tr>
<td>Obese</td>
<td>30.0 – 40.0</td>
</tr>
<tr>
<td>Extremely Obese</td>
<td>&gt; 40.0</td>
</tr>
</tbody>
</table>

Waist to Hip Ratio (WHR)

✓ **Purpose:** Assess body fat distribution to evaluate the risk for cardiovascular disease.

✓ **Equipment:**
  - Cloth tape measure.

✓ **Procedure:**
  - Measurements are taken at the following locations:
    1. **Waist:** Narrowest point of the torso below the rib cage and above the iliac crest.
    2. **Hips:** Largest circumference around hips or buttocks region, above the gluteal fold.

✓ **Measurement instructions:**
  1. Take both measurements as close to the skin as possible.
  2. Insure that the tape runs horizontally around the entire body circumference.
  3. Keep the tape flat and avoid any twisting.
  4. The tape should be pulled snugly but not to the point of causing an indentation in the skin.
  5. Take the waist measurement at end-tidal volume (following normal expiration).
  6. Record scores to nearest millimeter or 1/16”.

✓ **Test Interpretation:**
  - Calculate waist-to-hip ratio by dividing the waist measurement by the hip measurement:
  - **Waist (inches or cm) ÷ Hips (inches or cm)**

\[
\text{Waist to Hip Ratio (WHR)} = \frac{\text{Waist Measurement}}{\text{Hips Measurement}}
\]

Table 9: Waist-to-Hip Ratio (WHR) Norms

<table>
<thead>
<tr>
<th>Gender</th>
<th>Excellent</th>
<th>Good</th>
<th>Average</th>
<th>At Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>&lt; 0.85</td>
<td>0.85 – 0.89</td>
<td>0.90 – 0.95</td>
<td>≥ 0.95</td>
</tr>
<tr>
<td>Females</td>
<td>&lt; 0.75</td>
<td>0.75 – 0.79</td>
<td>0.80 – 0.86</td>
<td>≥ 0.86</td>
</tr>
</tbody>
</table>

Flexibility, Muscle Length and Range of Motion (ROM) Assessments

Assessing your Clients using movement screens can be an effective way to observe and document patterns of movement that are key to normal function. The ability to assess and document abnormal movement patterns can aid Personal Trainers in identifying exercises that will be most effective in restoring proper muscle function.

Thomas Test:

✓ **Purpose:** Assess the length of the major hip flexor muscles.
  - Hip flexors or iliopsoas.
  - Rectus femoris (one of the quadriceps muscles).

**Note:** This test should not be conducted on Clients suffering from low back pain unless cleared by their physician.

✓ **Equipment:**
  - Stable table.

✓ **Procedure:**
  - Explain the purpose of the test and provide a brief demonstration.
  - Allow for warm-up and active ROM if needed.
  - Instruct your Client to sit at the end of a table with their mid-thigh aligned with the edge of the table.

1. Ask your Client to lift both knees gently towards their chest as you slowly assist them; roll back onto the table to touch their back and shoulders to the tabletop.
2. In the supine position, their low back and sacrum should lay flat against the table.
3. Instruct your Client to pull one thigh (hip) deeper towards their chest while reaching with both hands to grasp the backside of the thigh without raising or moving their torso from the table.
4. Ask them to relax the opposite leg slowly allowing that knee to fall towards the table - this positions the hip of the lowered leg into extension (~ 10°) while stretching the hip flexors.

- Given the nature of the movement associated with this test, Personal Trainers may want to consider placing a towel over the clients groin area.

✓ **Test Interpretation:**
  1. The back of the lower thigh should touch the table.
  2. The knee should demonstrate about 80° of flexion.
  3. The knee should remain aligned and straight.

- **Tightness in all muscles:**
  - With the back and sacrum flat, check to see that the back of the lower leg does not touch the table and the knee doesn’t flex to 80°. This indicates that it is reasonable to assume tightness in all four hip flexor muscles.

- **Tightness in the hip flexors:**
  - With the back and sacrum flat, if the back of the lower leg does **not** touch the table, but the knee **does** flex to 80°, then suspect tightness in the iliopsoas.
• **Tightness in the Quadriceps:**
  o With the back and sacrum flat, if the back of the lower leg **does** touch the table, but the knee **does not** flex to 80°, then suspect tightness in the rectus femoris.

![Image of a person performing a Passive Straight Leg Raise]

**Passive Straight Leg Raise:**

✓ **Purpose:** Assess the flexibility of the hamstrings.

✓ **Equipment:**
  - Stable table or exercise mat.

✓ **Procedure:**
  - Explain the purpose of the test and allow for some warm-up.
  - Instruct your Client to lie supine with their legs extended and their low back and sacrum flat on the mat or table.
    1. Place one hand under the calf on one leg and place the other hand on the top of the thigh on the opposite leg in order to passively restrain it from moving or rising during the test.
    2. Advise your Client to plantar flex their ankles (point toes away from body) to avoid test limitations that occur due to a tight gastrocnemius muscle.
    3. Additionally, a straight leg raise with dorsi flexion may increase tension within the sciatic nerve and create some low-back discomfort.
  - Slowly raise the non-restrained leg, instructing your Client to keep the knee loosely extended throughout the movement.
    1. Throughout the movement, ask the Client to maintain extension in the opposite leg and keep the sacrum and low back flat against the mat or table.
    2. If the test is performed with the opposite hip in slight flexion (bend in the knee), this allows the pelvis more freedom to move into a posterior tilt, allowing a greater range of motion and falsely increasing the evaluation of hamstrings flexibility.

✓ **Test Interpretation:**
  - Normal hamstring flexibility is indicated by passively moving the extended leg to 80°.
  - A lack of flexibility in the hamstrings is indicated by an increased flattening of the low back during the movement or any visible signs of lifting the back of the opposite leg off the mat or table.
**Other Important Flexibility Markers:**

Table 10: Average Range of Motion at Specific Joints (Healthy Adults)

<table>
<thead>
<tr>
<th>Joint and Movement</th>
<th>ROM (°)</th>
<th>Joint and Movement</th>
<th>ROM (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shoulder:</strong></td>
<td></td>
<td><strong>Thoraco-lumbar Spine</strong></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>150 – 180°</td>
<td>Rotation</td>
<td>30 – 45°</td>
</tr>
<tr>
<td>Extension</td>
<td>50 – 60°</td>
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<td></td>
</tr>
<tr>
<td>Medial Rotation</td>
<td>70 – 80°</td>
<td>Extension</td>
<td>30°</td>
</tr>
<tr>
<td>Lateral Rotation</td>
<td>90°</td>
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<td></td>
</tr>
<tr>
<td><strong>Cervical Spine:</strong></td>
<td></td>
<td><strong>Knee</strong></td>
<td></td>
</tr>
<tr>
<td>Rotation</td>
<td>65 – 75°</td>
<td>Flexion</td>
<td>125 – 145°</td>
</tr>
<tr>
<td><strong>Hip</strong></td>
<td></td>
<td><strong>Ankle</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dorsiflexion</td>
<td>20°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plantar Flexion</td>
<td>45 – 50°</td>
</tr>
</tbody>
</table>
Section Three: Program Planning

Goal Setting and Motivation

The experience Clients have with their fitness programs is the ultimate motivator to continue to participate. Therefore, take the time to explore Client interests and preferences before beginning any new program.

✓ Clients may have many goals with respect to what they want to achieve in their training program. As part of starting a program with your Client, establish goals that follow the S.M.A.R.T acronym:

- **Specific**:
  o Set specific goals that can be quantified.
  o If there are many goals, try to narrow them down to no more than three specific goals.
  o Goals such as getting into shape or toning up are too generic and not specific enough.
  o Record goals to indicate what is desired (e.g., lose 5 lbs, run a 5K in 30 minutes)

- **Measureable** (objective and subjective):
  o Goals should be measureable (e.g. number of pounds lost, distance ran, time on the treadmill, etc.).
  o Consider the importance and the value of subjective measurements (e.g. how you feel while running, etc.).

- **Adjustable**:
  o While some use the word “attainable”, adjustable is another option to describe a realistic goal. While programs need to have some degree of rigidity to promote adherence, they cannot be inflexible. For example, a program that elicits guilt and punishment when a workout is missed is too rigid and unrealistic.
  o The long-term program needs to have some adjustability built in so unexpected events can be accommodated (e.g., doing a modified workout when you run short of time or having a workout plan available for travel times, etc.).

- **Realistic**:
  o Goals should be attainable, which means you should consider the skill and conditioning level of the individual.
  o Also consider the Client’s genetic make-up, current health status, previous injuries, age and the ability of the Client to spend time and energy on a particular goal or goals.

- **Timeframe**:
  o Identify the timeframe needed to achieve the outcome(s), and then set short-term goals within time lines to establish specific progress markers along the way.
  o Setting outcome goals too far in the future can cause individuals to lose sight of their long-term goals.
Motivational Strategies:

✓ Identify appropriate motivational strategies that precede and follow behavior.
  • Extrinsic (or external) forms of motivation (e.g. rewards, recognition) are more effective to use during the first six months of starting a program since they work best in the beginning.
  • Intrinsic (or internal) motivational strategies (e.g. self-gratification, feelings, experience, and accomplishment) are more effective to use beyond six months of training.
    o Extrinsic motivation favors short-term compliance.
    o Intrinsic motivation favors long-term adherence.
  • Transition your Client towards more intrinsic forms of motivation within the first six months of training.

A balanced workout program for a Client should address the five health-related components of fitness: cardiorespiratory endurance, muscular strength, muscular endurance, flexibility and body composition. Clients will have specific goals that they want to focus on, but Personal Trainers should insure Clients understand that all five health-related components of fitness are important and interrelated.
Cardiorespiratory Programming for Clients  
(2010 ACSM General Exercise Guidelines)

Fitness programming, no matter which modality is being addressed (strength, endurance, flexibility, etc.), follows an easy-to-remember acronym called F.I.T.T.e. Let’s apply the F.I.T.T.e. principle to Cardiorespiratory Programming:

1. Frequency
2. Intensity
3. Type (modality)
4. Time (duration)
5. Enjoyment

✓ Exercise is usually monitored by intensity and progressed by manipulating frequency, intensity and duration of exercise.

✓ There is a difference between *Estimating Training Zones* and a *Max Heart Rate* (MHR) measure.
  - We use sub maximal testing to estimate training zones.
  - As Personal Trainers, we do not perform maximal fitness testing within our scope of practice.
  - Intensity is monitored by:
    - Heart rate, usually as a percentage of maximal heart rate (% MHR) or by percentage of heart rate reserve (% HRR).
    - Ratings of Perceived Exertion (RPE).

✓ While percentage of Maximal Heart Rate (% MHR) is still popular, we no longer use the 220 – age formula to *estimate* MHR. Instead we use more accurate formulas:
  - **Tanaka formula:** $208 - (0.7 \times \text{age})$.
    - *Example:* A 20-year old has a MHR of $208 - (0.7 \times 20) = 208 - 14 = 194 \text{ bpm}$

✓ Ratings of Perceived Exertions (RPEs) are used to quantify a participant’s personal sensations regarding the stress of physical activity subjectively: 1 = not at all exerted, 5 = moderate exertion but feels fine & can converse, 10 = Maximal exertion which should be avoided. RPEs are also useful for special populations.

**Frequency:**
✓ Moderate exercise = 50% – 60% HRR or 60% – 75% MHR and should be performed ≥ 5 x /week.
  - **OR**
✓ Vigorous exercise = > 60% HRR should be performed ≥ 3 x / week.
  - **OR**
✓ Perform a combination of either 3 – 5 x / week.
   - Obese individuals should strive to achieve 5 – 7 x / week due to lower tolerance for activity.
     - Research has demonstrated that de-conditioned individuals can benefit significantly from participating in shorter, more frequent exercise segments.
       - Segments can occur in intervals of 5 - 10 minutes, three to five times daily.
       - Exercise selection should be low-intensity.
         - For example, walking, Elliptical trainer, recumbent cycle, etc. to improve cardiorespiratory endurance.
       - Therefore, understanding the effectiveness of short-duration exercise segments can be very motivating for de-conditioned individuals.
Intensity:
✓ When using % MHR, aim for a range between 64% and 74% up to 94% of MHR.

✓ When using % HRR, aim for a range between 30 – 85% of Heart Rate Reserve (HRR).
  - When using this formula, complete the following steps:
    1. Calculate the HRR.
    2. Calculate the percentage of the HRR.
    3. Add the RHR back to this value to determine your training or target HR.

  - Example: Calculate the target heart rate for a 25 year old with a resting HR of 60 who will exercise at 65% HRR?
    - MHR = 208 – (0.7 x 25) = 191 bpm
    - HRR = 191 – 60 = 131 bpm
    - % HRR = 65% of 131 bpm = 131 x 0.65 = 85 bpm
    - Target HR = % HRR + RHR = 85 + 60 = 145 bpm

✓ Heart Zones Training (HZT)
  - Developed by Sally Edwards in 1993.
  - It is important to train in all the zones, but establishing a Base Zone before moving into the more challenging zones is an important.
  - Zone training refers to cardiorespiratory exercise that occurs in a variety of heart rate zones.
  - There are five heart rate zones:
    - Zone 1 is 50% to 60% of your MHR.
      - “Healthy Heart” zone or “Base” zone as well as the warm-up and cool down zone.
    - Zone 2 is 60% to 70% of your MHR.
      - “Fat Burning” zone because the majority of energy used comes from fat.
    - Zone 3 is 70% to 80% of your MHR.
      - “Aerobic” zone improves your physiological and functional capacity.
    - Zone 4 is 80% to 90% of your MHR.
      - “Anaerobic Threshold” zone challenges the body sub-maximally, but approaches and frequently crosses the anaerobic threshold.
    - Zone 5 is 90% to 100% of your MHR.
      - “Red Line” zone is an all-out effort not sustainable for greater than several seconds at a time. Frequently used in HIIT protocols.
Type (Modality):

<table>
<thead>
<tr>
<th>Exercise Description</th>
<th>Recommend for</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endurance activities</strong> requiring minimal skill or fitness</td>
<td>All adults</td>
<td>Walking, slow-dancing, water fitness</td>
</tr>
<tr>
<td>Vigorous-intensity endurance activities requiring minimal skill</td>
<td>Adults participating in regular exercise or having ≥ average fitness</td>
<td>Jogging, rowing, spinning, elliptical, stepping</td>
</tr>
<tr>
<td><strong>Endurance activities</strong> requiring higher skill levels</td>
<td>Adults with acquired skill and fitness levels</td>
<td>Swimming, cross-country skiing, running races, etc.</td>
</tr>
<tr>
<td><strong>Recreational sports</strong> that require intensity with skill</td>
<td>Adults participating in regular training with acquired fitness levels</td>
<td>Soccer, basketball, racquet sports</td>
</tr>
</tbody>
</table>

Time (Duration):

<table>
<thead>
<tr>
<th>Physical Fitness Classification</th>
<th>Weekly Calorie Expenditure</th>
<th>% MHR</th>
<th>% HRR</th>
<th>Duration / day</th>
<th>Weekly Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>500 – 1,000</td>
<td>57 – 67 %</td>
<td>30 – 45 %</td>
<td>20 – 30 min</td>
<td>60 – 150 min</td>
</tr>
<tr>
<td>Poor-fair</td>
<td>1,000 – 1,500</td>
<td>64 – 74 %</td>
<td>40 – 55 %</td>
<td>30 – 60 min</td>
<td>150 – 200 min</td>
</tr>
<tr>
<td>Fair-average</td>
<td>1,500 – 2,000</td>
<td>74 – 84 %</td>
<td>55 – 70 %</td>
<td>30 – 90 min</td>
<td>200 – 300 min</td>
</tr>
<tr>
<td>Average-good</td>
<td>&gt; 2,000</td>
<td>80 – 91 %</td>
<td>65 – 80 %</td>
<td>30 – 90 min</td>
<td>200 – 300 min</td>
</tr>
<tr>
<td>&gt; Good-excellent</td>
<td>&gt; 2,000</td>
<td>84 – 94 %</td>
<td>70 – 85 %</td>
<td>30 – 90 min</td>
<td>200 – 300 min</td>
</tr>
</tbody>
</table>

Enjoyment:

✔ Activity or exercise needs to be engaging and must be a positive experience.

Progression:

✔ Increase by 10 % per week or 5 – 10 minutes every 1 – 2 weeks over the initial 4 – 6 weeks.

✔ Progressions thereafter should aim to meet the recommended guidelines.

✔ While intensity offers the MOST effective method to improve conditioning, it is also associated with the highest rate of attrition since it can create poor experiences, injury and burnout.

✔ Generally, before progressing intensity, plan to progress duration first (until Clients reach their optimal time frame for a training session), and then progress frequency of exercise.

✔ Advanced clients may also participate in interval training, which involves multiple short segments of high intensity work alternating with short recovery periods
Recovery:

- Adequate recovery between workouts is essential for gaining the physiological and psychological benefits of exercise.
  - Allowing the body time for recovery is one of the most important ways in which to gain fitness benefits as the body requires time to change and improve (principle of adaptation).
- Too few rest days between workouts results in inadequate recovery.
  - Recovery consists of both active and passive recovery.
  - 24-72 hours is the recommended recovery time between workouts depending on the intensity of training.
- Symptoms of inadequate recovery include:
  - Injury
  - Burnout
  - Sleep disturbances
  - Lack of performance gains

Homework for Cardiorespiratory Programming:

**Fill in the blanks on the chart below.**

- Only change one element at a time; either duration OR frequency OR intensity.
- Develop your own formula for each Client on an individual basis.
- Remember, there is **ALWAYS** more than one correct progression for your program. Identify what works best for your Client.

<table>
<thead>
<tr>
<th>Week</th>
<th>Frequency</th>
<th>Duration</th>
<th>Intensity (% HRR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>2 x / week</td>
<td>20 min</td>
<td>55 % HRR</td>
</tr>
<tr>
<td>Week 2</td>
<td>-----------</td>
<td>--------</td>
<td>55 % HRR</td>
</tr>
<tr>
<td>Week 3</td>
<td>-----------</td>
<td>25 min</td>
<td>60 % HRR</td>
</tr>
<tr>
<td>Week 4</td>
<td>-----------</td>
<td>--------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Week 5</td>
<td>-----------</td>
<td>--------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Week 6</td>
<td>3 x / week</td>
<td>25 min</td>
<td>65 % HRR</td>
</tr>
</tbody>
</table>
Resistance Training Programming for Clients

Principles of Resistance Training

The resistance training program is planned around the needs, goals and current condition of the Client (information collected during the assessment process).

✓ Effective, long-term adaptation to a resistance training is guided by key principles that enable the body to adapt to the stress response from resistance training:

- **Principle of Specificity (“SAID” Principle):**
  - *Specific Adaptations to Imposed Demands (SAID):* The body will adapt to the stresses applied through the variables of program design.
  - A specific stress stimulus will create a specific physiological response (e.g., training with light resistance and high repetitions will improve muscular endurance).

- **Principle of Overload:**
  - To enhance physiologic improvement and stimulate adaptations to training, the variables of program design must be manipulated to create a physical overload to the system (i.e. exercises are performed at intensities greater than those the muscles are accustomed to producing).

- **Principle of Progression:**
  - To apply overload safely, the intensity of training stress must gradually increase over time.
  - Allow an initial 2 – 3 weeks for neuromuscular adaptations, along with another 2 – 3 weeks for connective tissue strengthening and expect muscular strength increases of 5% – 10% within the first six to eight weeks of the onset of a training stimulus.

The Variables of Exercise Program Design

✓ Application of the training variables is dependent on the Client’s current condition, movement skills, trainability (commitment to training) and most importantly, their training goals.

✓ Manipulate application of variables to control training stress and allow Clients time to adapt to the imposed demands of the workout. Use only 5% – 10% a week increases to avoid injury.

✓ **Intensity:**
  - Intensity defines the specific amount of resistance or external load applied to muscles.
  - If the same resistive force is consistently applied, then the muscle will not be stimulated to produce greater levels of force and a training overload will not be created.
  - Intensity is written as a % of the maximum amount of weight lifted for one repetition (e.g., one repetition max is written as 1RM).
  - Greater intensities increase motor unit recruitment and muscle force production, which translates into gains in **strength** and **power**.

✓ **Volume:**
  - Volume defines the total amount of work performed (weight lifted) during an exercise session.
  - It is generally expressed as a product of (intensity) X (sets) X (number of repetitions).
  - The total volume of a workout should be dictated by training experience and training goals.
  - Volume increases time under tension, which translates to increases in muscle size and mass (**hypertrophy**).
**Sets:**
- A set is defined as a group of repetitions.
- 1 set x 10 – 12 repetitions to muscle fatigue is sufficient to create initial strength improvements for Clients with little-to-no training experience. However, once a Client experiences initial strength gains, the number of sets needs to be increased to create the desired overload and training effect.
- Personal Trainers must remember that increasing the number of sets also requires additional time.

**Repetitions:**
- Repetition (reps) refers to the consecutive number of times a particular exercise movement is performed before resting.
- The number of repetitions that can be performed is inversely proportional to the intensity.
  - The greater the intensity, the fewer number of repetitions that can be completed.
  - The lighter the intensity, the greater number of repetitions that can be completed.

**Table 11: Relationship between Intensity (% 1RM) and Repetitions**

<table>
<thead>
<tr>
<th># Repetitions</th>
<th>% 1 RM</th>
<th># Repetitions</th>
<th>% 1 RM</th>
<th># Repetitions</th>
<th>% 1 RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>5</td>
<td>87</td>
<td>9</td>
<td>77</td>
</tr>
<tr>
<td>2</td>
<td>95</td>
<td>6</td>
<td>85</td>
<td>10</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>93</td>
<td>7</td>
<td>83</td>
<td>11</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>90</td>
<td>8</td>
<td>80</td>
<td>12</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>65</td>
</tr>
</tbody>
</table>

**Rest Interval:**
- A rest interval is the period of rest between sets in a particular workout session and is needed to enable muscles to replenish energy stores (ATP) and allow the nervous system to recover from fatigue.
- During a workout, the heavier the load, the longer the inter-set rest interval needed.

**Table 12: Rest Period as Determined by Training Intensity**

<table>
<thead>
<tr>
<th>Training Goal</th>
<th>Rest Interval Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular Endurance</td>
<td>≤ 30 seconds</td>
</tr>
<tr>
<td>Hypertrophy</td>
<td>30 - 90 seconds</td>
</tr>
<tr>
<td>Strength</td>
<td>2 - 5 minutes</td>
</tr>
<tr>
<td>Power (single multiple-event effort)</td>
<td>2 - 5 minutes</td>
</tr>
</tbody>
</table>

Training Frequency / Recovery:

- Frequency refers to the number of training sessions completed within a specific time period and can be viewed as a recovery period or the amount of time between consecutive workouts.

- Adequate recovery is important to allow the trained muscles sufficient time to adapt, repair and restore energy reserves before being trained again.
  - Strength gains (adaptations) occur during recovery and NOT during the actual training session.
  - Insufficient rest and recovery between workouts can lead to injury or overtraining and affect your Client’s ability to achieve their goals.

- The frequency of training a muscle group is dependent upon the individual’s training goals, experience, conditioning level and available time.

- Appropriate recovery intervals for endurance training programs are 24 – 36 hours between workouts. Appropriate recovery intervals for hypertrophy and strength training programs are 48 hours or greater between workouts for the same muscle or muscle group.

- For example, if your Client performs chest exercises on a Monday for hypertrophy, do not schedule another workout for chest exercises until at least Wednesday, which will allow for sufficient time to recover and adapt.

Exercise Order and Selection:

- The order of exercises refers to the sequence of performing resistance training exercises.

- Basic guidelines include:
  - Power and max-strength exercises should be performed at the beginning of the workout session when the Client has the highest levels of energy.
    - If power exercises are performed later in the workout, the Client may experience neural fatigue, which increases the risk of injury.
  - Train the muscles proximal to distal.
  - Primary exercises that include multi-joint, compound movements for the hips, trunk and shoulders (e.g. squats) should also be performed at the beginning of a workout.
  - Assistance exercises that include single-joint, isolated movements (e.g. biceps curls) can be performed later in the workout.

- During circuit training, alternate lower and upper extremity exercises to allow recovery time for muscle groups.

- While Personal Trainers may be tempted to change exercises frequently to keep the program interesting, consider the need for consistency to promote success. Mastery of the exercises and development of confidence will lend themselves to the development of self-efficacy.

- In light of all the modern “functional” equipment available in clubs today, Personal Trainers should also carefully select exercises that are appropriate for their Client’s current conditioning level and recognize how and when to progress the exercises based on skill level, competency and individual needs.

- “More is Not Better”
  - Insist that your Clients use excellent form and technique.
    - Excellent lifting techniques require practice and genuine, accurate feedback from you as the Personal Trainer.
Equipment Options
- Free weights
- Body weight
- Portable equipment
- Machines

Program Design
- There are five components of fitness including cardio-respiratory, muscle strength, muscle endurance, flexibility and body composition.
- With respect to improving lean mass using resistance training techniques, Personal Trainers need to consider exercises for muscular endurance, strength, power and hypertrophy.

Training Outcomes

- The purpose of exercise program design is to manipulate the variables that produce desired adaptations.
- Make sure that Clients are working in pain-free ranges of motion.
- Duration is inversely proportional to intensity.
  - The heavier the weight or the higher-intensity the exercise, the shorter duration the Client will be able to perform that movement.

Table 13: Training Load and Repetition (Volume) Based on the Training Goal

<table>
<thead>
<tr>
<th>Training Goal</th>
<th>Repetitions (per set)</th>
<th>Sets (per exercise)</th>
<th>Intensity (% 1RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular Endurance</td>
<td>≥ 12</td>
<td>2 – 3</td>
<td>≤ 67%</td>
</tr>
<tr>
<td>Hypertrophy</td>
<td>6 - 12</td>
<td>3 – 6</td>
<td>67 - 85%</td>
</tr>
<tr>
<td>Strength</td>
<td>≤ 6</td>
<td>2 – 6</td>
<td>≥ 85%</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-repetition event</td>
<td>1 - 2</td>
<td>3 - 5</td>
<td>80 - 90%</td>
</tr>
<tr>
<td>Multiple-repetition event</td>
<td>3 - 5</td>
<td>3 - 5</td>
<td>75 - 85%</td>
</tr>
<tr>
<td>Offload</td>
<td>Reduce volume</td>
<td>Reduce volume</td>
<td>Reduce intensity</td>
</tr>
</tbody>
</table>

Homework for Resistance Training Programming:

✓ Fill in the blanks for a Client who has purchased a six session training package, and is meeting you two times weekly for three weeks. Each session is 60-minutes in duration.

✓ This individual has a goal to build muscle size and lose body fat.
  o Remember, there is ALWAYS more than one correct progression for your program. Identify what works best for your Client.

<table>
<thead>
<tr>
<th>Week and Session#</th>
<th>Muscle/Groups</th>
<th>Exercises How many exercises for each body part?</th>
<th>Training Technique</th>
<th>Sets How many sets of each exercise?</th>
<th>Reps How many reps in each set?</th>
<th>% 1 RM How heavy is each set?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1, Session 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 1, Session 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2, Session 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2, Session 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 3, Session 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 3, Session 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Flexibility Programming

What is Flexibility?

✓ Flexibility refers to the degree of soft tissue extensibility at a joint that allows for a functional range of motion (ROM).
✓ It is dependent upon muscle properties and the nervous system’s ability to control movement throughout the ROM efficiently.

Benefits of Flexibility

✓ Numerous benefits are associated with consistent flexibility training and include:
  • Improved posture.
  • Increased ROM and restored muscle balance.
  • Decreased muscle tension, anxiety and improved mental state.
  • Reduced joint stress.
  • Improved performance and movement efficiency.
  • May decrease the injury risk if performed consistently.
    o There is little evidence to support that stretching reduces the incidence of DOMS (delayed onset muscle soreness).

✓ Flexibility training at the start of a workout should be limited to movements that facilitate:
  • Increased range of motion.
  • Increased core body temperature.
  • Preparation for the upcoming activities.

✓ Static stretching should not typically be included in the warm up, but is most appropriate at the end of a workout session. Stretch to a point of mild tension. Also, remember that flexibility may be naturally increased on a warm day.
Figure 2: Stretching Modalities Within a Workout Session

- **De-conditioned Client** with Poor Flexibility and Muscle Imbalances
- **Conditioned Client** with Good Flexibility and Muscle Balance
- **Performance Athlete** with Great Skill and Flexibility

**Pre-Workout**
- Warm-up
- Myofascial Release

**During Workout**
- Myofascial Release
- AIS
- Dynamic
- Dynamic Ballistic

**Post-Workout**
- Myofascial Release
- PNF
- Static
<table>
<thead>
<tr>
<th>Modality</th>
<th>Variables</th>
<th>Notes</th>
<th>Demonstration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static</strong></td>
<td>✓ 2 – 4 reps x 15 – 30 sec</td>
<td>✓ After ~ 5 sec of stretch tension, muscles may experience decreased localized blood flow (ischemia, lactic acid accumulation) which may increase fatigue</td>
<td>Passive straight leg raise (hamstrings)</td>
</tr>
<tr>
<td></td>
<td>✓ Target major muscle groups for a total of 15 - 20 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ More muscle specific, not intended for whole body stretching</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Proprioceptive Neuromuscular Facilitation (PNF)</strong></td>
<td>✓ 2 – 3 reps with:</td>
<td>✓ Partner-assisted.</td>
<td>Partner-assisted supine hamstrings stretch</td>
</tr>
<tr>
<td></td>
<td>- 3 – 15 second contractions</td>
<td>✓ “Hold- Relax” (simplest technique)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- &gt; 10 second stretches</td>
<td>✓ Passive movement to end-ROM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ More muscle specific, not intended for whole body stretching</td>
<td>✓ Mild (20-70% of maximal effort) isometric contraction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓ Progressively increasing intensity in range very effective</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓ Deeper static stretch immediately following</td>
<td></td>
</tr>
<tr>
<td><strong>Myofascial Release</strong></td>
<td>✓ Apply constant pressure back and forth rolling 3 – 6” for 30 – 45 sec (&gt; 30 reps)</td>
<td>✓ A “knot” represents fibers not in alignment</td>
<td>Roller: thigh - posterior compartment</td>
</tr>
<tr>
<td></td>
<td>✓ Continue until client experiences noticeable decrease in tenderness or tension</td>
<td>✓ Relaxes and aligns fibers in the direction of the healthy fibers of the muscle or fascia</td>
<td></td>
</tr>
<tr>
<td><strong>Active Isolated Stretching (AIS)</strong></td>
<td>✓ 1 – 2 sets x 5- 10 reps, holding the end ROM for 1-5 seconds</td>
<td>✓ Involves activating agonists to shut down tight antagonists</td>
<td>Active straight leg raise (hamstrings)</td>
</tr>
<tr>
<td></td>
<td>✓ 10-15 minutes targeting areas of concern</td>
<td>✓ Involves isolated joint movement (single joint) in a more-supported environment with limited ROM</td>
<td></td>
</tr>
<tr>
<td><strong>Dynamic Movement</strong></td>
<td>✓ 1 set x 10 reps at a controlled tempo</td>
<td>✓ Integrated movement that relies on force production and momentum created in body to move joints through functional ROM</td>
<td>Standing single-leg into an inverted flyer</td>
</tr>
<tr>
<td></td>
<td>✓ Progressively increase movement complexity, mimicking forthcoming activities</td>
<td>✓ Requires greater core stability, movement control, dynamic balance and coordination</td>
<td></td>
</tr>
</tbody>
</table>
Weight Management Coaching

Ten Easy Steps to Helping Clients Manage Their Weight and Improve Body Composition

1. **Avoid setting your Client up for failure - set realistic weight loss goals of no more than 1 – 2 lbs / week after weeks 2 – 4.**
   
   ✓ 1 lb = 3,500 kcal, thus in order to lose 1 lb, your Client needs to create a daily caloric deficit of 500 kcal daily.

   ✓ 2 lbs = 7,000 kcal, thus in order to lose 2 lbs, your Client needs to create a daily caloric deficit of 1,000 kcal daily.

   ✓ These values are unrealistic for new exercisers given their poor tolerance for exercise and activity.
     • They will realistically only burn 75 – 150 kcal in an exercise session and follow that routine 2 – 3 x / week.

   ✓ Focus your initial 2 – 4 weeks on the exercise experience, building their self-efficacy and tolerance for more exercise and greater caloric expenditures.

2. **Set a goal to lose 5 - 10 % of body weight initially.**

   ✓ Maintain this weight loss for approximately four weeks to readjust your metabolism before attempting to lose more weight.

   ✓ Great initial rates of weight loss can lower your resting metabolic rate by 10 – 20%, making it extremely difficult to lose weight.

3. **Incorporate strategies to increase overall activity throughout the day.**

   ✓ The average adult consumes ~ 14,000 calories per week and exercise may only burn 600 – 800 calories per week on average, which means exercise is a small percentage of total calories consumed.

   ✓ An estimated 2,000 calories per week, spent through exercise and activity, is needed to achieve weight loss.

   ✓ Finding ways to be more active throughout the day can significantly increase your caloric contribution towards total daily energy expenditure.

   ✓ This involves strategies to get your Client out of their chair, reduce their reliance on certain technologies (e.g. escalators, internet grocery shopping, etc.) and move around more. Visit www.smallstep.gov for more ideas.
4. **Reduce caloric and fat intake.**

✓ Aim to reduce total daily caloric intake by 15% initially. More drastic reductions in caloric intake result in:
  - Starvation states that reduce resting metabolic rate by 10% – 20%.
  - Poor exercise adherence.
  - Compromised nutritional quality.
✓ Aim to reduce total fat intake to < 30% of total calories.

5. **Exercise portion control and make healthier choices.**

✓ Use appropriate education and progression to empower your Client to making healthier choices.

✓ Focus initially on:
  - Portion control.
  - Eating more fruits, vegetable, grains and leaner dairy and meat products.
  - Selecting healthier choices on menus.
  - Reading food labels.

✓ Tracking portions and portion sizes is challenging, so utilize simple tools to help guide you:
  - For example, at dinner aim for:
    - ½ plate vegetables - fill ½ the plate with a colorful assortment of different vegetables.
    - ⅛ plate health (lean) proteins - baked, broiled or grilled.
    - ⅛ plate starches - aim for healthier whole-grain starches.
• To help your client understand basic portion sizes, use commonly-utilized household items:
  o **Baseball** = 1 cup
  o **Standard light bulb** = ½ cup
  o **Racquet ball** = ¼ cup
  o **Golf ball** = 1 oz. or 2 tbsp
  o **Poker chip** = 1 tbsp
  o **Deck of cards** = 3 oz meat or chicken
  o **DVD** = 1 oz lunch meat / cheese slice
  o **Cassette** = slice of bread

6. **Teach your Clients how to read food labels.**

  ✓ Reduce intake of simple sugars.
  ✓ Reduce intake of cholesterol, saturated and trans-fats.
  ✓ Reduce intake of sodium.

7. **Eat breakfast.**

  ✓ Breakfast helps control appetite, food cravings and helps avoid binging later in the day.
  ✓ Breakfast helps controls blood sugar and increases energy levels and work productivity throughout the day.

8. **Establish support systems.**

  ✓ Suggest your Client share their documented goals with significant others (family and friends) who will be supportive of their efforts.
  ✓ Encourage Clients to surround themselves with individuals who will always offer their support, especially during difficult times.
  ✓ Help Clients evaluate the efficacy of their support systems on an ongoing basis especially if their goals change.

9. **Apply strategies for stimulus control and antecedent control (both precede behavior).**

  ✓ This implies remove triggers to undesirable behavior to avoid temptation (stimulus control) and utilizing prompts, cues, etc. to influence desirable behavior (antecedent control).

10. **Develop coping strategies for obstacles.**

    ✓ Help your Client anticipate and identify potential triggers that may raise barriers or obstacles to maintaining desirable behaviors.
    ✓ Increase Clients’ awareness to these early warnings and develop plans to assist them cope with these potential obstacles.
Section Four: Training in Action

Exercise Coaching

When instructing Clients on how to perform exercises, the following two basic teaching methodologies may be effectively utilized:

**The explain-demonstrate-execute (“tell-show-do”) format:**
- Briefly explain the objective of the exercise – “tell”.
- Continue to explain (coach) the technique points while providing a visual demonstration for your Client to observe – “show”.
- Allow your Client the opportunity to perform the exercise and offer immediate (positive and corrective) feedback to facilitate learning – “do”.

**The M.O.V.E Coaching Approach**

<table>
<thead>
<tr>
<th>MOVEMENT</th>
<th>Identify the desired movements at the specific joint(s).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Example: sagittal plane extension of the hips.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBSERVE</th>
<th>Ask your client to perform the movement.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>VALIDATE</th>
<th>Analyze their ability to maintain proper form and alignment between their body segments.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Example: Is there a compromise to their technique?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EDUCATE</th>
<th>Provide various forms of feedback to correct, reinforce, and help self-correct.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Example: kinesthetic, visual and verbal cues and feedback.</td>
</tr>
</tbody>
</table>

- Briefly explain the objective of the exercise.
- As a Personal Trainer, identify (in your mind) which movements you are striving to achieve (e.g., which joints should move, which joints should remain stable, which planes of motion are we targeting).
- Instruct the exercise with explanations and demonstrations.
- Allow your client the opportunity to perform the exercise (observe).
✓ Identify where compromises may occur and try to understand (validate) why the compromises are occurring.

✓ Offer immediate (positive and corrective) feedback to facilitate learning (educate).

✓ Hands On Cueing Techniques

1. Always get permission from your Client before touching him/her.
2. When using hands-on cuing techniques, touch bony prominences when possible.
   - For example, touch the shoulder joint, elbow joint, the wrist, the ankle joint or the knee as opposed to the fleshy parts of the arm, torso or leg.
3. If ever in doubt, touch your own body in order to visibly demonstrate a particular area of the body you wish to highlight.
4. Never forcibly move a bone or a joint for a client.
5. When using hands-on cues, be aware of your body placement, voice volume, pressure of touch, breath, etc.
Exercise Instruction and Review

Refer to 100% Hands On Personal Training Videos with Douglas Brooks, MS for explanations of the following exercises.

Table 1: List of Commonly Used Exercises

<table>
<thead>
<tr>
<th>Exercise</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lower Body</strong></td>
<td></td>
</tr>
<tr>
<td>Dumbbell Squats / Deadlifts</td>
<td></td>
</tr>
<tr>
<td>Back Squats</td>
<td></td>
</tr>
<tr>
<td>Leg Press</td>
<td></td>
</tr>
<tr>
<td>Lunges</td>
<td></td>
</tr>
<tr>
<td>Glute Exercises</td>
<td></td>
</tr>
<tr>
<td>Leg Extensions</td>
<td></td>
</tr>
<tr>
<td>Leg Curls</td>
<td></td>
</tr>
<tr>
<td>Hip Abduction / Adduction</td>
<td></td>
</tr>
<tr>
<td>Standing Calf Raises</td>
<td></td>
</tr>
<tr>
<td>Seated Calf Raises</td>
<td></td>
</tr>
<tr>
<td>Crunches</td>
<td></td>
</tr>
<tr>
<td>High Pulley Crunches</td>
<td></td>
</tr>
<tr>
<td>Torso Rotations</td>
<td></td>
</tr>
<tr>
<td>Front Planks</td>
<td></td>
</tr>
<tr>
<td>Side Planks</td>
<td></td>
</tr>
<tr>
<td>Push-ups</td>
<td></td>
</tr>
<tr>
<td>Barbell Bench Press</td>
<td></td>
</tr>
<tr>
<td>Incline Press</td>
<td></td>
</tr>
<tr>
<td>Decline Press</td>
<td></td>
</tr>
<tr>
<td>Dumbbell Fly’s</td>
<td></td>
</tr>
<tr>
<td>Cable Crossovers (Fly’s)</td>
<td></td>
</tr>
<tr>
<td>Dumbbell Shoulder Press (Military Press)</td>
<td></td>
</tr>
<tr>
<td>Seated Front Press</td>
<td></td>
</tr>
<tr>
<td>Dumbbell Lateral Raises</td>
<td></td>
</tr>
<tr>
<td>Dumbbell Front Raises</td>
<td></td>
</tr>
<tr>
<td>Reverse Fly’s</td>
<td></td>
</tr>
<tr>
<td>Chin-ups / Pulls-ups</td>
<td></td>
</tr>
<tr>
<td>Lat Pull Downs</td>
<td></td>
</tr>
<tr>
<td>Straight-arm Lat Pulldowns</td>
<td></td>
</tr>
<tr>
<td>Seated Rows</td>
<td></td>
</tr>
<tr>
<td>One-arm Dumbbell Rows</td>
<td></td>
</tr>
<tr>
<td>Low Back Extensions</td>
<td></td>
</tr>
<tr>
<td>Upright Rows</td>
<td></td>
</tr>
<tr>
<td>Shrugs</td>
<td></td>
</tr>
</tbody>
</table>
### Conclusion

Now that you have learned the basics of exercise science, how to on-board your Clients, how to plan a program, and how to teach a Client how to effectively exercise, you are ready to start your career as a Personal Trainer. We sincerely hope that the journey will be a successful one for you and your Clients and wish you the best of luck along the way!
Appendix I
Nutrition

Macronutrients – Carbohydrates:

✓ Carbohydrates serve numerous roles with the most important being that of a fuel for the body.

✓ Carbohydrate classification depends upon the number of individual sugar units that combine to form the entire carbohydrate structure.

  • **Monosaccharides** – single sugar units
    o Glucose, galactose and fructose
    o Represent the absorbable and usable forms of carbohydrates within the body

  • **Disaccharides** – 2 sugar units
    o Sucrose, lactose and maltose
    o Must be digested to monosaccharides for absorption

✓ Collectively monosaccharides and disaccharides are called **simple sugars**.

  • **Oligosaccharides** – 3-10 sugar units
    o Starches comprising short chains of glucose molecules
    o Must be digested to monosaccharides for absorption

  • **Polysaccharides** – ≥ 10 sugar units
    o Starches and fiber comprising long chains of glucose molecules
    o Must be digested to monosaccharides for absorption (except fiber, which is non-digestable)

✓ Collectively, oligosaccharides and polysaccharides are called **starches**.

  • Simple sugars represent 50 % of total US carbohydrate consumption (vs. recommendation of 10 %)

✓ Body can store glucose in:

  • Blood (5 – 15 g)
  • Liver (90-110 g) as glycogen (storage form of glucose in the body)
  • Muscles (250 – 600 g+) as glycogen

Macronutrients – Proteins:

✓ While proteins serve vital roles in tissue synthesis, repair and maintenance, production of hormones, enzymes and antibodies, they do contribute 2 – 5 % of the body’s energy needs at rest and up to 5 - 15 % during intense or prolonged exercise.
✓ Amino acids represent the building blocks of proteins and there are approximately 20 nutritionally important amino acids of which nine are essential, which implies we cannot manufacture them in our body and they can only be obtained through our diets
  o The nine essential amino acids are leucine, isoleucine, valine, methionine, tryptophan, lysine, phenylalanine, threonine, and histidine
  o Non-essential amino acids are manufactured in our own body and include alanine, arginine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine, tyrosine, asparagine, selenocysteine

✓ Proteins digest from bigger molecules (long chain polypeptides - approximately 300 amino acids) to amino acids, di-peptides (pairs) and tri-peptides (triplets) for absorption

✓ The body stores protein uniquely:
  o 99 % of usable protein is found as muscle tissue
  o 1 % of usable protein is found within free amino acid pools located inside cells and within the bloodstream

Macronutrients - Fats:

✓ While fats also serve numerous vital functions within the human body, including protection and insulation, transportation, nerve conduction and steroid manufacture, one key role is their availability as a significant energy source:
  • Fats are capable of storing 90,000 - 110,000 kcal worth of energy for the average adult.
  • Stores of fat are exceed the body’s carbohydrate stores (2,000 – 3,000 kcal)

✓ Three kind of fats exist within the body:
  • Simple or Neutral fats:
    o Represent ~ 95 - 98 % of all fat found within the body
    o Triglycerides are the most abundant form of simple fats
  • Compound fats:
    o Structures formed from the combination of a simple or neutral fat (lipid) and a non-lipid molecule to form a more complex structure (e.g. high density lipoprotein or HDL)
  • Derived fats:
    o Structures derived from either simple or compound fats (e.g. testosterone)
Energy Balance:

✓ Weight management is influenced by energy intake and expenditure

Total Daily Energy Expenditure (TDEE)

✓ It is influenced by three factors:
  • Resting / Basal Metabolic Rate represents 60 – 75 % TDEE
  • Thermic Effect of Food represents 10 % TDEE
    o Represents the energy cost to digest, absorb, transport and store food in the body
    o Food consumption increases metabolism (peaking within one hour after a meal – digestion and absorption)
  • Physical Activity, Recovery and NEAT (non-exercise activity thermogenesis) represents 15 – 30 % TDEE

✓ Lowest ideal caloric intake:
  o For Men = ≥1600 kcals
  o For Women = ≥1200 kcals

✓ Calculate TDEE using the Mifflin-St. Jeor Equation
  • Two steps:
    o Step One: Calculate RMR
    o Step Two: Calculate Energy of Activity – includes TEF
      ▪ After estimating your RMR you need to determine the additional calories burned by activity and digestion (TEF)

STEP 1: Calculate RMR

✓ Women: RMR = (9.99 x kg) + (6.25 x cm) – (4.92 x age) – 161
✓ Men: RMR = (9.99 x kg) + (6.25 x cm) – (4.92 x age) + 5
STEP 2: Calculate TDEE using a Standard Activity Factor (Institutes of Medicine Method)

✓ To calculate TDEE, multiply the calculated RMR score by a standard activity factor score

Activity Factor Scores for TDEE

<table>
<thead>
<tr>
<th>Category</th>
<th>Physical Activity</th>
<th>Activity Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>&lt; Dept. of HHS/US Surgeon General’s guidelines (54% US population)</td>
<td>1.0</td>
</tr>
<tr>
<td>Low Active</td>
<td>30 – 60 minutes of moderate activity daily</td>
<td>1.12</td>
</tr>
<tr>
<td>Active</td>
<td>≥ 60 minutes of moderate activity daily</td>
<td>1.27</td>
</tr>
<tr>
<td>Very Active</td>
<td>≥ 60 minutes of moderate activity daily + 60 minutes of vigorous activity daily or 120 minutes of moderate activity daily</td>
<td>1.45</td>
</tr>
</tbody>
</table>

✓ Example: A low active female (~ 30 – 45 minutes of moderate activity daily), 35-year old female who stands 5’5” (165 cm), weighs 155lbs (70.45 kg) with 28 % body fat.

- Calculating RMR:
  - RMR = (9.99 x kg) + (6.25 x cm) – (4.92 x age) – 161
  - = 703.8 + 1,031.2 – 172.2 – 161
  - = 1,402 Kcal

<table>
<thead>
<tr>
<th>Equation</th>
<th>RMR</th>
<th>IOM Activity Factor</th>
<th>TDEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mifflin-St. Jeor</td>
<td>1,402 kcal</td>
<td>x 1.12</td>
<td>= 1,570 kcal</td>
</tr>
</tbody>
</table>
Appendix II

Assessment of Body Mass Index (BMI)

✓ **Purpose:** Estimate body composition by calculating a height-normalized index against body weight
  - The validity of this index has been challenged for senior populations and athletic populations
    - Additionally, BMI tables do not apply to children and adolescents under age 18
    - Use standard height-to-weight tables:
      1. A child’s weight that is in the 85th – 95th percentile classifies him or her as overweight
      2. A child’s weight that is ≥ 95th percentile classifies him or her as obese

✓ **Equipment:**
  - BMI tables
  - Calculator
  - Tape measure and scale (if needed)

**Procedure:** Personal Trainers can utilize any of the three methods provided:

1. **BMI Table** (table 1)

2. **Metric Formula:** \( BMI = \frac{\text{Weight (kg)}}{\text{Height}^2} \) (m²)
   - **Metric Formula:** \( BMI = \frac{\text{Weight (kg)}}{\text{Height}^2} \) (m)
     1. Obtain your client’s body weight and convert it from pounds to kilograms
        ✓ 1 kg = 2.2 lbs
     2. Obtain your client’s height and convert it from feet and inches to meters
        ✓ 1 inch = 2.54 cm
        ✓ 1 meter = 100 cm
     3. Example: Mary stands 5’7” at 160 pounds
        ✓ 160 lbs ÷ 2.2 = 72.7 kg
        ✓ 5 foot 7 inches = 67 inches x 2.54 = 170.18 cm
        ✓ 170.18 cm ÷ 100 = 1.70 m
        ✓ 72.7 kg ÷ 1.70² m = 72.7 kg ÷ (1.70 m x 1.70 m) = 72.7 kg ÷ 2.90 m = **25.07**

3. **Standard Formula:** \( BMI = \frac{\text{Wt (lbs) x 703}}{\text{Ht (inches) x Ht (inches)}} \)
   - **Procedure: Standard Conversion:** \( BMI = \frac{\text{Wt (lbs) x 703}}{\text{Ht (inches) x Ht (inches)}} \)
     1. Example: Mary stands 5’7” at 160 pounds
        ✓ 160 lbs x 703 = 112,480
        ✓ 112,480 ÷ 67 = 1,678.81
        ✓ 1,678.81 ÷ 67 = **25.06**
BMI Computation Table

<table>
<thead>
<tr>
<th>Height (in.)</th>
<th>Weight (lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>91 96 100 105 110 115 119 124 129 134 138 143 167 191</td>
</tr>
<tr>
<td>59</td>
<td>94 99 104 109 114 119 124 128 133 138 143 148 173 198</td>
</tr>
<tr>
<td>60</td>
<td>97 102 107 112 118 123 128 133 138 143 148 153 179 204</td>
</tr>
<tr>
<td>61</td>
<td>100 106 111 116 122 127 132 137 143 148 153 158 185 211</td>
</tr>
<tr>
<td>62</td>
<td>104 109 115 120 126 131 136 142 147 153 158 164 191 218</td>
</tr>
<tr>
<td>63</td>
<td>107 113 118 124 130 135 141 146 152 158 163 169 197 225</td>
</tr>
<tr>
<td>64</td>
<td>110 116 122 128 134 140 145 151 157 163 169 174 204 232</td>
</tr>
<tr>
<td>65</td>
<td>114 120 126 132 138 144 150 156 162 168 174 180 210 240</td>
</tr>
<tr>
<td>66</td>
<td>118 124 130 136 142 148 155 161 167 173 179 186 216 247</td>
</tr>
<tr>
<td>67</td>
<td>121 127 134 140 146 153 159 166 172 178 185 191 223 255</td>
</tr>
<tr>
<td>68</td>
<td>125 131 138 144 151 158 164 171 177 184 190 197 230 262</td>
</tr>
<tr>
<td>69</td>
<td>128 135 142 149 155 162 169 176 182 189 196 203 236 270</td>
</tr>
<tr>
<td>70</td>
<td>132 139 146 153 160 167 174 181 188 195 202 207 243 278</td>
</tr>
<tr>
<td>71</td>
<td>136 143 150 157 165 172 179 186 193 200 208 215 250 286</td>
</tr>
<tr>
<td>72</td>
<td>140 147 154 162 169 177 184 191 199 206 213 221 258 294</td>
</tr>
<tr>
<td>73</td>
<td>144 151 159 166 174 182 189 197 204 212 219 227 265 302</td>
</tr>
<tr>
<td>74</td>
<td>148 155 163 171 179 186 194 202 210 218 225 233 272 311</td>
</tr>
<tr>
<td>75</td>
<td>152 160 168 176 184 192 200 208 216 224 232 240 279 319</td>
</tr>
<tr>
<td>76</td>
<td>156 164 172 180 189 197 205 213 221 230 238 246 287 328</td>
</tr>
</tbody>
</table>

Bodyweight in pounds according to height and body mass index


✔ Test Interpretation:

Using the reference table presented below, categorize your client’s score

Table 2: BMI Score Classifications

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI Score (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5 – 24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0 – 29.9</td>
</tr>
<tr>
<td>Obese</td>
<td>30.0 – 40.0</td>
</tr>
<tr>
<td>Extreme Obese</td>
<td>&gt; 40.0</td>
</tr>
</tbody>
</table>

Appendix III

Assessment of Waist-to-Hip Ratio (WHR)

✓ **Purpose:** Assess bodyfat distribution to evaluate the risk for cardiovascular disease

✓ **Equipment:**
  - Cloth tape measure

✓ **Procedure:**
  - Measurements are taken at the following locations:
    1. **Waist:** Narrowest point of the torso below the rib cage and above the iliac crest
    2. **Hips:** Largest circumference around hips or buttocks region above the gluteal fold

✓ **Measurement instructions:**
  1. Take both measurements as close to the skin as possible
  2. Insure that the tape runs horizontally around the entire body circumference
  3. Keep the tape flat and avoid any twisting
  4. The tape should be pulled snugly but not to the point of causing an indentation in the skin
  5. Take the waist measurement at end-tidal volume (following normal expiration)
  6. Record scores to the nearest millimeter or 1/16”.

✓ **Test Interpretation:**
  - Calculate waist-to-hip ratio by dividing the waist measurement by the hip measurement:
  - \( \text{Waist (inches or cm)} \div \text{Hips (inches or cm)} \)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Excellent</th>
<th>Good</th>
<th>Average</th>
<th>At Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>&lt; 0.85</td>
<td>0.85 – 0.89</td>
<td>0.90 – 0.95</td>
<td>≥ 0.95</td>
</tr>
<tr>
<td>Females</td>
<td>&lt; 0.75</td>
<td>0.75 – 0.79</td>
<td>0.80 – 0.86</td>
<td>≥ 0.86</td>
</tr>
</tbody>
</table>

**Table 3: Waist-to-Hip Ratio (WHR) Norms**

Appendix IV

Assessments for Flexibility
Thomas Test for Hip Flexion / Quadriceps Length
Passive Straight Leg Raise

Screening your clients using movement can be an effective way to observe and document patterns of movement that are key to normal function. The ability to assess and document abnormal movement patterns can aid Personal Trainers in identifying exercises that will be most effective with regards to restoring proper movements.

✓ **Purpose:** Assess the length of the major hip flexor muscles
  - Hip flexors or iliopsoas
  - Rectus femoris (one of the quadriceps muscles)

**Note:** This test should not be conducted on clients suffering from low back pain unless cleared by their physician

✓ **Equipment:**
  - Stable table

✓ **Procedure:**
  - Explain the purpose of the test and provide a brief demonstration
  - Allow for warm-up and active ROM if needed
  - Instruct your client to sit at the end of a table with their mid-thigh aligned with the table edge

1. Ask your client to lift both knees gently towards their chest as you slowly assist them; roll back onto the table to touch their back and shoulders to the tabletop
2. In this supine position, their low back and sacrum should lay flat against the table
3. Next, instruct your client to pull one thigh (hip) deeper towards their chest, reaching with both hands to grasp the backside of the thigh without raising or moving their torso from the table
4. Ask your client to relax the opposite leg slowly, allowing that knee to fall towards the table - this positions the hip of the lowered leg into extension (~ 10°), stretching the hip flexors

  - Given the nature of the movement associated with this test, Personal Trainers may want to consider placing a towel over the client’s groin area

✓ **Test Interpretation:**
  1. The back of the lower thigh should touch the table
  2. The knee should demonstrate about 80° of flexion
  3. The knee should remain aligned and straight
• **Tightness in all muscles:**
  o With the back and sacrum flat, check to see that the back of the lower leg does not touch the table and the knee *doesn’t* flex to 80°, then it is reasonable to assume tightness in all four (4) hip flexor muscles

• **Tightness in the hip flexors:**
  o With the back and sacrum flat, if the back of the lower leg *does not* touch the table, but the knee *does* flex to 80°, then suspect tightness in the iliopsoas

• **Tightness in the Quadriceps:**
  o With the back and sacrum flat, if the back of the lower leg *does* touch the table, but the knee *does not* flex to 80°, then suspect tightness in the rectus femoris
Passive Straight Leg Raise

✓ **Purpose:** Assess the length of the hamstrings

✓ **Equipment:**
  - Stable table or exercise mat

✓ **Procedure:**
  - Explain the purpose of the test and allow some warm-up and ROM
  - Instruct your client to lie supine with their legs extended and their low back and sacrum flat on the mat or table

1. Place one hand under the calf on one leg and place the other hand on the top of the thigh of the opposite leg in order to passively restrain it from moving or rising during the test
2. Advise your client to plantar flex their ankles (point toes away from body) to avoid test limitations that occur due to a tight gastrocnemius muscle
3. Additionally, a straight leg raise with dorsiflexion may increase tension within the sciatic nerve and create some low back discomfort

  - Slowly raise the non-restrained leg, instructing your client to keep the knee loosely extended throughout the movement

1. Throughout the movement, ask the client to maintain extension in the opposite leg and keep the sacrum and low back flat against the mat or table
2. If the test is performed with the opposite hip in slight flexion (bend in the knee), this allows the pelvis more freedom to move into a posterior tilt, which allows a greater range of motion and falsely increases the evaluation of hamstrings length

✓ **Test Interpretation:**
  - Normal hamstring length is indicated by passively moving the extended leg to 80°
  - Shortness in the hamstrings is indicated by increased flattening of the low back during the movement or any visible signs of lifting the back of the opposite leg off the mat or table

---

**Other Important Flexibility Markers**

**Table 3: Average Range of Motion at Specific Joints (Healthy Adults)**

<table>
<thead>
<tr>
<th>Joint and Movement</th>
<th>ROM (°)</th>
<th>Joint and Movement</th>
<th>ROM (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shoulder:</strong></td>
<td></td>
<td><strong>Thoraco-lumbar Spine</strong></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>150 – 180°</td>
<td>Rotation</td>
<td>30 – 45°</td>
</tr>
<tr>
<td>Extension</td>
<td>50 – 60°</td>
<td>Hip</td>
<td>30°</td>
</tr>
<tr>
<td>Medial Rotation</td>
<td>70 – 80°</td>
<td>Knee</td>
<td>125 – 145°</td>
</tr>
<tr>
<td>Lateral Rotation</td>
<td>90°</td>
<td>Flexion</td>
<td>125 – 145°</td>
</tr>
<tr>
<td><strong>Cervical Spine:</strong></td>
<td></td>
<td>Dorsiflexion</td>
<td>20°</td>
</tr>
<tr>
<td>Rotation</td>
<td>65 – 75°</td>
<td>Plantar Flexion</td>
<td>45 – 50°</td>
</tr>
</tbody>
</table>
Exam Instructions

After you complete the course, you will be ready to take the exam. Please follow these simple instructions:

1. To take your exam click on the following link: http://www.scwfit.com/ptexam
2. After you click on the link above, you will be asked to create a log-in and password to access your exam, results and certificate
3. Keep your log-in and password in a safe place and do not lose it
4. Begin your exam.
5. There is no time limit for the exam - you can even start and stop your exam with the ability to resume later. The exam will be available for 60 days after the date of your purchase.
6. You must obtain a score of 80% or greater to pass. You have two attempts to pass the exam.
7. Once you pass your exam, you can print your customized certificate by clicking on the certificate link on the bottom right hand corner of the page

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Upon successful completion of your examination you will be SCW certified for two years. To renew your certification you must complete 15 continuing education credit hours. Three of these 15 credit hours must be from SCW Fitness Education. All SCW, ACE, AFAA, AEA, ACSM, NASM and academic courses in the fitness field from accredited colleges and universities count toward SCW Fitness Certification renewal.

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