NASM NOTES

CHAPTER 1*—The Scientific Rational for Integrated Training*

A. Overview of the Personal Training Industry
   a. The Past
      i. During 50's and 60's, gym members were predominantly men who were training for specific goals.
      ii. During 70's it became more socially acceptable, people looked to the fittest person for advice, personal training was born.
      iii. Clients were better prepared for activity b/c their daily environment demanded more activity.

   b. The Present
      i. Wealth of technology has taken a toll on public health
      ii. 30% of adults obese, 16% of teenagers
      iii. Less active people, aging population
      iv. 80% of 65 or older have one chronic condition, 50% have two.
      v. Evidence of increased muscular dysfunction over last 40 years
         1. Low Back Pain – Affects nearly 80% of adults
         2. ACL injuries – Between 80,000 and 100,000 annually. 70% non-contact, most happen between 15 and 25 years of age.
         3. Chronic Diseases – Chronic diseases responsible for 5 of leading 6 causes of disease—Obesity is one.
         4. Musculoskeletal Injuries – Work-related injures, 40% are strains, sprains. $120 Billion is amount of lost work time.
         5. 54% of US adults did not engage in min. activity levels
         6. Americans older than 55 and younger than 18 are fastest growing groups among health-club members
      vi. Current Training Programs on Sedentary adults

1. 50% to 90% in initial 6 weeks of training
2. Increase in deconditioned adults—a state in which a person may have muscle imbalances, descreased flexibility, or a lack of core and joint stability.
3. Most training programs do not emphasize multiplanar movements through the full muscle action spectrum

vii. Propiceptively-Enriched Environment
1. One that challenges internal balance and stab. Mechanisms of the body
a. Ex. Dumbbell chest press on stability ball.

c. The Future
i. Today's client is not ready to begin physical activity at the same level of a typical client 20 years ago.
ii. Each training program must consider each person, their environment, and the tasks that will be performed.

B. The OPT Model – Process of programming that systematically progresses any client to any goal. 3 blocks of training.
a. **Stabilization Level** – 1 phase of training
i. Phase 1: Stabilization Endurance Training
1. Main focus is to increase muscular endurance and increase neuromuscular efficiency
2. Diff. is increased by introducing more challenge to the balance and stab. system vs. increasing the load.
3. Goal is to increase the client's ability to stabilize their joints and posture.
4. Training strategies:
a. Performing exercises in a proprioceptively enriched environ (controlled, unstable), the body is forced to recruit more muscles to stabilize itself, burning more calories.
b. Corrective flexibility

c. Low loads, high repetitions

b. **Strength Level**—3 phases of training
   - **i. Phase 2: Strength Endurance Training**
     1. Goal is to enhance stab. endurance while increasing prime mover strength
        a. Use supersets with similar joint dynamics to accomplish
     2. Work prime movers predominantly in the first exercise to elicit prime mover strength
     3. Immediately follow with exercise that challenges stabilization muscles.
     4. Training strategy:
        a. Active flexibility
        b. Supersets
        c. Moderate loads and repetitions (8-12)
   - **ii. Phase 3: Hypertrophy Training**
     1. For individuals who want maximal muscle growth.
     2. Training strategy:
        a. Active flexibility
        b. High volume, high loads, mod. or low repetitions (6-10)
   - **iii. Phase 4: Maximal Strength**
     1. Works towards the goal of maximal prime mover strength by lifting heavy loads.
     2. Goals:
        a. Increase motor unit recruitment
        b. Increase frequency of motor unit rec.
        c. Improve peak force
     3. Training strategy:
        a. Active flexibility
        b. High loads, low repetitions (1-5), longer rest periods.

c. Power Level – 1 phase of training
   - i. **Phase 5: Power training**
     1. Emphasizes the development of speed and power by the execution of a traditional strength exercise superset with a power exercise of similar joint dynamics to improve the rate of

force production (how fast a muscle generates force)

2. Goals:
    a. Enhance neuromusc. efficiency
    b. Enhance prime mover strength
    c. Increase rate of force production
    d. Enhance speed strength
3. Training strategy:
    a. Dynamic flexibility
    b. Supersets: strength/power
    c. Perform all power exercises as fast as can be controlled.

A. Introduction to Human Movement
    a. Structure allows for and provides the basic of function
    b. Kinetic Chain—nervous system, skeletal system, and muscular system
        i. If 1 system is not working properly, it affects the other systems and ultimately affects movement.

B. Nervous System

    a. 3 primary functions of the nervous system
        i. Sensory function – ability of nervous system to sense changes in either the internal or external environment
            1. Ex. A stretch placed on muscle (internal)
            2. Ex. The change from walking on sidewalk to walking on sand (external)
        ii. Integrative function – ability of nervous system to analyze and interpret the sensory info. to allow for proper decision making, which produces the proper response
        iii. Motor function – the neuromuscular response to the sensory information
            1. Ex. Causing the muscle to initially contract when stretched
            2. Ex. Changing our walking pattern when in the sand as opposed to the sidewalk.
    b. Thus it becomes important to train the nervous system efficiently to ensure the proper movement patterns are being developed, which enhances performance and decreases the risk of injuries.

C. Anatomy of the Nervous System
    a. The Neuron- Composed of 3 main parts: cell body, axon, dendrites
        i. Cell body (soma) – Contains nucleus and other organelles
        ii. Axon – Cylindrical projection from the cell body that transmit nervous impulses to other neurons or effector sites (muscles, organs, other neurons).
            1. Provides communication from brain and spinal cord to other parts of the body.
        iii. Dendrites – Responsible for gathering info. from other structures back into the neuron.

b. 3 classifications of neurons based on direction of their impulses.
    i. Sensory (afferent) neurons - transmit nerve impulses from effector sites (such as muscles and organs) via receptors to the brain and spinal cord.
    ii. Interneurons – transmit nerve impulses from one neuron to another
    iii. Motor (efferent) neurons – transmit nerve impulses from the brain and spinal cord to the effector sites such as muscles or glands
        1. Ex. – Person touches hot object. Sensory neurons send signal from hand to brain, via interneurons, brain interprets then uses motor neurons to activate muscle to pull hand away.

D. The Central and Peripheral Nervous Systems
    a. Central Nervous System
        i. Consists of Brain and spinal cord
        ii. Serves mainly to interpret information
    b. Peripheral Nervous System
        i. Consists of 12 cranial nerves, 31 pairs of spinal nerves, and sensory receptors
        ii. Provide a connection for the nervous system to activate different effector sites such as muscles (motor function)
        iii. Relay info. from the effector sites back to the brain via sensory receptors (sensory function), thus providing a constant update b/t the body and the environment.
        iv. Sensory receptors transform environmental stimuli into sensory info. that the brain and spinal cord can interpret to produce a response (4 types)
            1. Mechanoreceptors (touch and pressure)
            2. Nociceptors (pain)
            3. Chemoreceptors (smell and taste)
            4. Photoreceptors (vision)
        v. Mechanoreceptors – sensory receptors responsible for sensing distortion in tissues, located in muscles, tendons, ligaments, and joint capsules. Include muscle spindles, Golgi tendon organs, and joint receptors.

1. Muscle spindles – sensitive to change in length and rate of change length
    a. When muscle is stretched, the spindles of muscle are also stretched. Info is transmitted to brain and spinal cord to update the nervous system on status of muscle length and the rate at which it is lengthening. When excited, the muscle spindle will cause the muscle to contract to prevent it from stretching too far or too fast, preventing injury.
2. Golgi tendon organs (GTO) – sensitive to change in tension of the muscle and rate of tension change.
    a. Are located at point where muscle and tendon meet.
    b. When excited, the GTO will cause the muscle to relax to prevent muscle from being placed under excessive stress and sustaining injury.
3. Joint receptors – Respond to pressure, acceleration, and deceleration of the joint.
    a. Act to signal extreme joint positions and thus help to prevent injury. Can also act to initiate a reflexive inhibitory response in the surrounding muscles if there is too much stress place on that joint.
        i. Ex. – Ruffini endings, Pacinian corpuscles

E. The Skeletal System

a. Body's framework, composed of bones and joints
    i. Bones – A resting ground for muscles and protection of vital organs
    ii. Joints – the movable junction where two or more bones meet
        1. These are the sites where movement occurs as a result of muscle contraction.
b. Divisions of the Skeletal System

i. Axial skeleton – skull, rib cage and the vertebral column, 80 bones total.
ii. Appendicular skeleton – Portion of skeletal system that includes the upper and lower extremities, 126 bones.
iii. 177 of 206 bones used in voluntary movement, 300 joints.
iv. 2 functions of bones
    1. Leverage – bones act and perform as levers when acted on by muscles
    2. Support – posture, for efficient distribution of forces acting on the body.

c. Bone Markings – increase the stability of joints and provide attachments for muscles, consist of depressions/processes
    i. Depressions – flattened or indented portion of bone, which can be a muscle attachment site.
        1. Ex. – Sulcus, supraspinous
    ii. Processes – projection protruding from the bone where muscles, tendons, and ligaments can attach.
        1. Ex. – Condyles (femur)

d. Joints – formed by one bone that articulates with another bone
    i. Arthrokinematics – Joint Motion; 3 major motion types:
        1. *Roll movement* – one joint rolls across the surface of another much like the tire of a bicycle roll on the street
            a. Ex- Femoral condyles rolling over the tibial condyles during a squat
        2. *Slide movement* – one joint's surface slides across another much like the tire of a bicycle skidding across the street
            a. Ex – tibial condyles sliding across the femoral condyles during a knee extension
        3. *Spin movement* – one joint surface rotates on another much like twisting the lid of a jar
            a. Ex – head of radius rotating on the end of the humerus during pronation and supination of the forearm

e. Classification of Joints
    i. Synovial joints –joints most associated with movement in the body, 80% of joints in body
    --Greatest capacity for motion
    --Absence of fibrous or cartilaginous tissue directly connecting the bones, loosely held together by a joint capsule and ligaments.
    --produce synovial fluid; egg-white like substance that works like engine oil to reduce excessive wear and nourish cartilage cells that line the joint.
    ii. Types:
        1. *Gliding joint* – nonaxial joint that has the simplest movement of all joints, back and forth or side to side.
            a. *Ex* – Carpals in the hand
        2. *Condyloid joint* – the condyle of one bone fits into the elliptical cavity of another bone to form a joint. Movement predom. In 1 plane
            a. *Ex* – Knee
        3. *Hinge joint* – uniaxial joint allowing movement in only sagittal plane
            a. *Ex* – Elbow, ankle
        4. *Saddle joint* – one point fits like saddle onto another.
            a. *Ex* – ONLY carpometacarptal joint of thumb
        5. *Pivot joint* – move predominantly in one plane (transverse)
            a. *Ex* – Radioulnar
        6. *Ball-and-Socket joint* – Most mobile of all joints, moves in all three planes of motion
            a. *Ex* – Shoulder
    ii. Nonsynovial joint – No joint cavity and fibrous connective tissue; little or not movement.
        1. Ex. – Sutures of skull
f. Joint Connective Tissue
    i. Ligament – Primary connective tissue that connects bone to bone, limits improper joint movement
        1. Primarily made of protein collagen, and 2nd protein elastin

a. Collagen fibers are situated in a more parallel fashion than forces that are place on ligament, provide ligament with ability to withstand tension (tensile strength)
b. Elastin gives ligament flexibility or elastic recoil to withstand the bending and twisting it may have to endure.

--Ligaments are characterized by poor vascularity (blood supply), meaning that they do not heal or repair very well and may be slower to adapt.

F. The Muscular System

a. Structure of Skeletal Muscle

i. Muscle and its Connective Tissue – compilation of many individual muscle fibers that are neatly wrapped together with connective tissue that form different bundles. From outer to innermost:

1. Muscle itself with outer layer called *fascia* and inner layer immediately surrounding muscle called *epimysium.* They are intimately connected with bone, help to form tendon

2. Next bundle is called *fascicle* wrapped by connective tissue called *perimsium*

3. Each fascicle is in turn made up of many individ. muscle fibers wrapped by connective tissue called *endomysium.*

4. These connective tissues play vital role in movement; they allow forces generated by the muscle to be transmitted from the contractile components of the muscle to the bones, creating motion. Each layer of connective tissue extends the length of the muscle helping to form the tendon.

5. Tendon – connective tissues that attach muscle to bone and provide an anchor for muscles to produce force

----also have poor vascularity like ligaments

ii. Muscle Fibers and Their Contractile Elements

1. Have myofibrils that contain myofilaments, the actual contractile components of the muscle tissue

2. Sarcomere – the functional unit of muscle, b/t 2 Z lines, that produces contraction containing actin (thin string-like filaments) and myosin (thick filaments).
3. Two protein structures, tropomyosin & troponin
    a. Tropomyosin is located on the actin filament and blocks myosin binding sites, keeping myosin from attaching to actin while the muscle is in a relaxed state.
    b. Troponin is also located on actin filament, it provides binding sites for calcium and tropomyosin when muscle needs to contract.

iii. Generating Force in a Muscle by these methods
1. Neural Activation – contraction of a muscle generated by neural stimulation
    a. *Motor unit* – a motor neuron and all the muscle fibers it connects with.
    b. Electrical impulses are transported form CNS down axon of neuron, and neurotransmitter acetylcholine (Ach) carries them across synapse to receptor sites on muscle fiber.
2. Sliding Filament Theory
    a. Sarcomere shorts as a result of the Z lines moving closer together.
    b. The Z lines converge as the result of myosin heads attaching to the actin filament and asynchronously pulling (power strokes) the actin filament across the myosin, resulting in shortening of the muscle fiber.
3. Excitation-Contraction Coupling
    a. Begin with neural with neural activation and end with sliding-filament theory through serious of steps.

iv. Muscle Fiber Types—all muscles have combo of both
1. Type I (slow twitch)

a. More capillaries, mitochondria, & myoglobin
b. Increased Oxygen deliver
c. Smaller in size
d. Less force produced
e. Slow to fatigue
f. Long-term contractions (stabilization)

--important for stabilization and postural control, sitting upright for example

2. Type II (fast twitch)
   a. Fewer capillaries, mitochondria, and myoglobin
   b. Decreased oxygen delivery
   c. Larger in size
   d. More force produced
   e. Quick to fatigue
   f. Short-term contractions (force & power)

--sprinting for example

v. Muscles as movers **graph on pg. 35

1. Agonist – prime movers
2. Synergist – assist prime movers during movement
3. Stabilizer – support or stabilize the body while the prime movers and synergists perform the movement patterns
4. Antagonist – Perform the opposite action of the prime mover.

EX: CHEST PRESS

--Agonist: Pectoralis major
--Synergist: Anterior deltoid, triceps
--Stabilizer: Rotator cuff
--Antagonist: Posterior deltoid

CHAPTER 3—*The Cardiorespiratory System*

-- System of the body composed of the cardiovascular and respiratory systems

A. **Cardiovascular System**- Composed of the heart, blood, and blood vessles

a. **The Heart**

i. lies anteriorly to the spine and posteriorly to the sternum, flanked by lungs, in area called *mediastinum*

ii. Size of an adult fist, weights roughly 300g (10 ounces)

iii. Heart muscle is termed cardiac muscle, and is involuntary.

iv. Cardiac Muscle Contraction

1. Muscle fibers are shorter and more tightly connected than skeletal muscle, thus enabling the contraction of one fiver to stimulate the others to contract synthronously
2. All cardiac muscle fibers have a built-in contraction rhythm
3. Typical heart rate is between **70 and 80 bpm**
4. *Sinoatrial (SA) node* – located in right atrium and is the pacemaker, initiates heartbeat, where internodal pathway transfer impulse to *AV node*
5. *Atrioventricular (AV) node* – delays impulse b/ moving on to the ventricles. AV bundle passes the impulse to the ventricles for contraction via the left and right bundle branches of the Purkinje fibers

v. Structure of the Heart

1. 4 hollow chambers separated into two pumps
2. *Atrium* – Superior (higher) chamber of the heart that gather blood coming into the heart
    a. Right atrium gathers deoxygenated blood returning to the heart from the entire body, whereas the Left atrium gathers reoxygenated blood coming to the heart from the lungs.
3. *Ventricle* – Inferior (lower) chamber of the heart that receives blood from its corresponding atrium and, in turn, forces blood into the arteries. Main pumps of heart

a. Right ventricle receives the deoxygenated blood from the right atrium and then pumps it to the lungs to be saturated with incoming oxygen. The left ventricle receives the reoxygenated blood from the left atrium and proceeds to pump it to the entire body.
b. Valves prevent backflow or spillage of blood back into chambers

vi. Function of the Heart

1. <u>Stroke volume</u> – The amount of blood that is pumped out with each contraction of a ventricle
    a. Typical adult avg. is **75-80 mL/beat**
2. <u>Heart Rate</u> – The rate with which the heart pumps
    a. Typical adult avg. is **70-80 bpm**
3. <u>Cardiac Output</u> – The combination of how many times the heart beats per minute and how much blood is being pumped out with each beat.
    a. Measured as Q (with dot above)

b. **Blood**

i. fluid that circulates, carries nutrients and oxygen, rids body of waste

ii. thicker and heavier than water

iii. Constitutes **8% of body weight**

iii. Avg. person holds **5 L (roughly 1.5 gallons)**

iv. 3 Mechanisms: Transportation, Regulation, Protection

1. <u>Transportation</u>
    a. Transports oxygen and nutrients to tissues
    b. Transports waste products from tissues
    c. Transports hormones to organs and tissues
    d. Carries heat throughout the body
2. <u>Regulation</u>
    a. Regulates body temperature and acid balance in the body
3. <u>Protection</u>

a. Protects the body from excessive bleeding by clotting. Contains specialized immune cells to help fight disease and sickness

c. **Blood Vessels**

i. Network of hollow tubes that circulates blood throughout the body

1. Arteries – carry blood away from the heart

i. Leaving the heart are large and elastic

ii. Become medium-sized then divide into small branches called *arterioles* which branch into microscopic vessels known as *capillaries,* which connects venules with arterioles. It is in the capillaries that substances such as oxygen, nutrients, hormones and waste products are exchanged between tissues.

2. Veins – carry blood away from the capillaries toward the heart

a. Venules progressively merge with other venules and form veins, which carry blood to heart.

B. The Respiratory System – A system of organs (lungs and respiratory passageways) that collects oxygen from the external environment and transports it to the bloodstream.

a. Respiratory pump – located in thoracic cavity, composed of skeletal structures (bones) and soft tissue (muscles and pleural membranes) ****Table 3.3 pg. 47**

i. Breathing is down in 2 phases:

1. Inspiration – the process of actively contracting inspiratory muscles to move air into the body.

a. Active contraction of inspiratory muscles to increase thoracic cavity volume, which decreases the intrapulmonary pressure, when it decreases below that of the atmospheric pressure (air pressure) air is drawn into the lungs

b. 2 forms

i. *Normal resting state* (quiet) - requires the use of primary respiratory muscles (diaphragm, external intercostals)

ii. *Heavy (deep, forced)* – requires the additional use of secondary respiratory muscles (scalenes, pectoralls minor).

2. Expiration – Can be active or passive

a. During normal breathing it is passive as it results from the relaxation of the contracting inspiratory muscles

b. During heavy or forced breathing, the expiratory ventilation relies on the activity of expiratory muscles to compress the thoracic cavity and force air out

c. Muscles used are internal intercostals and abdominals.

b. Respiratory Passageways – passageways to funnel air in and out of the lungs

i. *Conduction passageway* – all the structures that air travels through before entering the respiratory passageway. These structures also allow incoming air to be purified, humidified, and warmed or cooled to match body temperature

1. Nasal cavity, oral cavity, pharynx, larynx, trachea, right/left pulmonary bronchi, bronchioles.

ii. *Respiratory passageway* – collects the channeled air coming from the conducting passageway

1. At the end of bronchioles sit the *alveoli*, which are made up of clusters of *alveolar sacs.* It is here that gases such as oxygen and carbon dioxide are transported in and out of the bloodstream through a process known as diffusion. This is how oxygen gets from the outside environment to the tissues of the body.

C. Cardiorespiratory System Function – vital support system to provide the kinetic chain with many essential elements (esp. oxygen), while removing waste products that can cause dysfunction in the body.

a. Inhalation through nose and mouth, through the bronchi, to the lungs and alveolar sacs
b. Blood is pumped through the right ventricle of the heart, through the pulmonary arties to the lungs where the blood becomes oxygenated.
c. It is then pumped out through the pulmonary veins to the left atrium of the heart
d. Then pumped to the left ventricle of the heart and pumped to the body's tissues

i. Oxygen Consumption
    1. Capacity to efficiently use oxygen is dependent on the respiratory system's ability to collect oxygen and the cardiovascular system's ability to absorb and transport it to the tissues of the body.
        a. The usage of oxygen by the body is oxygen uptake (or consumption) -VO2 max, the highest rate of oxygen transport and utilization achieved at maximal physical exertion.
            i. At rest, VO2 is estimated to be **3.5 mL of Oxygen per kilogram of bodyweight per minute - -- 1 MET**
            ii. Max values can range from 40-80 mL

ii. Oxygen and Energy
    1. Aerobic – Requires oxygen, more than 30 seconds
    2. Anerobic – Only a few seconds, no oxygen required.
    3. Bioenergetics - the biology of energy transformations and exchanges within the body, and between it and the environment
        a. Energy is gathered from an energy-yielding source (the breakdown of food) by some storage unit and then transferred to a site that can use this energy (muscle contraction). The storage and transfer unit is adenosine triphosphate (ATP)
    4. ATP – a cellular structure that supplies energy for many biochemical cellular processes by undergoing enzymatic hydrolysis.
        a. Composed of adenine, 5-carbon sugar called ribose, and 3 phosphates—large amounts of energy are stored in the chemical bonds of those phosphates, needed for muscle contraction.

b. Supply of ATP in each cell is limited, so cells, so cells need means of producing more.
c. 3 main bioenergetic pathways that produce ATP called bioenergetic continuum

5. Bioenergetic Continuum
    a. ATP-CP
        i. Anaerobic system
        ii. limited b/c it relies on ATP storage and CP storage within cell
        iii. High-Intensity, short-duration activity such as heavy weight training or short sprints
        iv. Up to approx. 10 seconds of activity
    b. Glycolysis
        i. Anaerobic system, 1 glucose molecule produces 2 ATP
        ii. Breakdown of carbs to rapidly produce ATP, lactic acid can develop if pyruvate is not used by muscle fast enough
        iii. Moderate to High-Intensity moderate-duration activities such as a typical set of 8-12 reps
        iv. 30-50 seconds of activity
    c. Oxidative
        i. Aerobic system, 1 glucose molecule produces 38 ATP
        ii. Relies on carbs and fats
        iii. Lower Intensity, longer duration activities such as walking on the treadmill for 20-30 minutes
        iv. Activities greater than 2 minutes

ii. Dysfunctional Breathing
    1. If breathing patterns are shallow, body uses secondary respiratory muscles more than diaphragm, impacting posture

2. Result can create excessive muscular tension, resulting in headaches, lightheadedness, dizziness
3. Short, shallow breaths can also lead to altered CO2 and Oxygen blood content, causing anxiety
4. Inadequate oxygen and retention of metabolic waste within muscles can create stiff muscles and joints.

CHAPTER 4—*Human Movement Science*

A. Biomechanics – study that uses principles of physics to quantitatively study how forces interact within a living body

a. **Anatomic Locations**

i. *Superior* – Positioned above a point of reference

ii. *Inferior* – Positioned below a point of reference

iii. *Proximal* – Positioned nearest the center of the body, or point of reference

iv. *Distal* – Positioned farthest from the center of the body, or point of reference

v. *Anterior (or ventral)* – On the front of the body

vi. *Posterior (or dorsal)* – On the back of the body

vii. *Medial* – positioned near the middle of the body

viii. *Lateral* – Toward the outside of the body

ix. *Contralateral* – Positioned on the opposite side of the body

x. *Ipsilateral* – Positioned on the same side of the body

b. **Planes of Motion, Axes, and Joint Motions**

i. Sagittal Plane – Bisects the body into right and left halves, occurs around a coronal axis.

1. *Flexion* – Bending movement in which the relative angle between two adjacent segments decreases.

a. *Dorsiflexion* is flexion at ankle

2. *Extension* – The straightening of a joint, causing the angle to the joint to increase

b. *Plantarflexion* is extension at ankle

3. EX. – bicep curls, triceps pushdowns, squats, front lunges, calf raises, walking, running, vertical jump, climbing stairs, shooting hoops

ii. Frontal Plane – Bisects the body to create front and back halves, occurs around anterior-posterior axis

1. *Abduction* – a movement of a body part away from the middle of the body.

2. *Adduction* – movement of a body part toward the middle of the body.

3. *Lateral Flexion* – bending of the spine from side to side

4. *Eversion/Inversion* – same principles but relates to tarsals and calcaneus

5. EX. – Side lateral raises, side lunges, side shuffling.

iii. Transverse Plane – Bisects the body to create upper and lower halves, occurs around longitudinal or vertical axis.

1. *Internal Rotation* – rotation of a joint toward the middle of the body
2. *External rotation* – rotation of a joint away from the middle of the body
3. *Pronation*, *Supination* of radioulnar
4. EX. – Trunk rotation, turning lunges, throwing a ball, golfing, swinging a bat

c. **Muscle Actions**

i. Eccentric – exerting less force than is being placed on it, resulting in the lengthening of a muscle

1. Moving in the same direction as the resistance
2. Decelerates or reduces force, a 'negative'

ii. Isometric – exerting force equal to that placed on it, maintaining muscle length

1. No visible movement with or against resistance
2. Dynamically stabilizes force

iii. Concentric – exerting more force than is being placed on it, shortening the muscle

e. Muscular Force

i. Force – an influence applied by one object to another, which results in an acceleration or deceleration of the second object.

1. Magnitude (how much)
2. Direction (which way)

ii. Length-Tension Relationship - the length at which a muscle can produce the greatest force

1. There is optimal muscle length at which the actin and myosin filaments in the sarcomere have the greatest degree of overlap, and thus, force production
2. Lengthening beyond this point reduces overlap, causing reduced force production. Similarly, shortening a muscle too much then stimulating places actin/myosin in maximal overlap

allowing for now movement b/t filaments reducing force output.

3. If muscle lengths are altered as a result of misaligned joints (poor posture), then they will not be able to generate proper force to allow for efficient movement.

iii. Force-Velocity Curve – ability of muscles to produce force with increasing velocity.
   1. As velocity of a concentric muscle contraction increases, its ability to produce force decreases.
   2. With eccentric muscle action, as velocity of muscle action increases the ability to develop force increases.

iv. Force-Couple Relationships – Muscle groups moving together to produce movement around a joint
   1. Each muscle has different attachment sites, pulls at a different angle, and creates a different force on that joint, the motion that results from these forces is dependent on the structure of the joint and the collective pull of each muscle involved.
   2. All muscles working together for the production of proper movement (all muscle actions and all functions)
   3. EX.- Internal & External obliques for trunk rotation, Deltoid & Rotator cuff for shoulder abduction.

v. Muscular Leverage and Arthrokinematics
   1. Amount of force that the kinetic chain can produce is not only dependent on motor unit recruitment and muscle size, but also on the leverage of the muscles and bones.
   2. Rotary motion – Movement of the bones around joints and implies that the levers (bones) rotate around the axis (joints).
   3. Torque – This “turning” effect of the joint, or the force that produces rotation.
   4. The difference between the distance that the weights is from the center of the joint and the muscle’s attachment and line of pull (direction

that the tendon pulls) is from the joint will determine the efficiency with which the muscles will be able to manipulate the movement

a. The closer the weight is to a joint, the less torque it creates, the farther the more torque it creates
b. Can use this principle as a regression to exercises by reducing torque placed on kinetic chain, or progression

f. Motor Behavior

i. The process of the body responding to internal and external stimuli
ii. Motor Control – The study of posture and movements and the involved structures and mechanisms that the central nervous system uses to assimilate and integrate sensory information with previous experiences.
iii. Synergies – Groups of muscles that are recruited by the central nervous system to provide movement
    1. Through practice of proper movement patterns, these synergies become more fluent and automated
iv. Proprioception – The cumulative sensory input to the central nervous system from all mechanoreceptors that sense position and limb movements.
    1. Vital information that CNS uses to gather info. and produce most efficient movement.
    2. Becomes altered after injury
    3. This provides a rationale for core and balance training to enhance one's proprioceptive capabilities, increasing postural control and decreasing tissue overload.
v. Sensorimotor Integration – The ability of the nervous system to gather and interpret sensory information and to select and execute proper motor response, through cooperation of nervous and muscular system.
    1. Only as effective as quality of incoming sensory information

2. If individ. train with improper form, improper sensory info. is delivered to CNS, leading to movement compensations and potential injury.
3. EX. – Individual consistently performs a chest press while rounding and elevating their shoulders, can lead to altered length-tension relationships of muscles (decreased force production), altered force-couple relationships (improper recruitment pattern of muscles), and altered arthrokinematics (improper joint motion). This could lead to shoulder impingement.

vi. Motor Learning – Repeated practice of motor control processes, which lead to a change in the ability to produce complex movements.
    1. Feedback – The use of sensory information and sensorimotor integration to help the kinetic chain in motor learning.
        a. Internal feedback – process whereby sensory information is used by the body to reactively monitor movement and the environment.
            i. Acts as guide to steer kinetic chain to proper force, speed, and amplitude of movement patterns.
        b. External feedback – information by some external source, such as a health and fitness professional, videotape, mirror, or heart rate monitor to supplement the internal environment.
            i. *Knowledge of results* – inform the client of the outcome of their performance, so they become involved, and increase their awareness and augment the other forms of sensory feedback. Improves neuromuscular efficiency

ii. *Knowledge of performance* – provides info. about the quality of the movement during the exercise.

iii. Client must not completely depend on external feedback, rather it should augment their internal sensory input.

CHAPTER 5—*Fitness Assessment*

A. Systematic problem-solving method that provides the health and fitness professional with a basis for making educated decisions about exercise and acute variable selection

i. Subjective Information – General and medical history (Occupation, Lifestyle, Medical, and Personal Information)

ii. Objective Information – Physiological assessments, body composition testing, cardiorespiratory assessments, static/dynamic postural assessments, and performance assessments.

B. **Subjective Information**

i. General and Medical History

1. *Par-Q* (Physical Activity Readiness Questionnaire) directed toward detecting any possible cardiorespiratory dysfunction. If client answers 'yes' to any question refer to medical professional

2. *Extended periods of sitting* – hips are flexed, can lead to tight hip flexors and postural imbalances. Shoulders and head can fatigue under constant force of gravity, leading to rounding of the shoulders and head

3. *Repetitive Movements* – Can create pattern overload to muscles and joints, leading to tissue trauma and eventually kinetic chain dysfunction

4. *Dress Shoes* – shoes with heel puts ankle in a plantarflexion position for extended periods of time.

5. *Mental Stress* – dysfunctional breathing

ii. Lifestyle

1. *Recreation* – Design to fit needs of ski, golf, etc.
2. *Hobbies* –

iii. Medical History

1. *Past Injuries* – decreased neural control
2. *Past Surgeries* – surgery will cause pain and inflammation that can alter neural control to the affected muscles and joints if not rehabilitated properly
3. *Chronic Conditions* – 75% of Americans do not partake of 30 mins. of physical activity, daily.
4. *Medications**Table 5.2*

D. Objective Information

a. Measurable data about a client's physical state such as body composition, movement, and cardiovascular ability.

i. *Physiologic Assessments*

1. Heart rate – Can be taken on inside of the wrist (radial) or windpipe (carotid), get resting heart rate three mornings in a row from client
   a. Avg. resting rate for Males is 70 bpm
   b. Avg. resting rate for Fem. is 75 bpm
2. *To Calculate Heart Training Zone*
   a. (220 – age)
   b. *Zone 1* – Max. heart rate x .65 and Max. heart rate x .75
   c. *Zone 2* – Max. heart rate x .80 and Max heart rate x .85
   d. *Zone 3* – Max heart rate x .86 and Max heart rate x .90
3. Blood Pressure
   a. *Systolic pressure* – reflects the pressure produced by the heart as it pumps blood to the body
   b. *Diastolic pressure* – signifies the minimum pressure within the arteries through a full cardiac cycle
   c. Systolic is top number over diastolic. Normal is 120-130 mm Hg over 80-85 mm Hg.
   d. To take blood pressure inflate cuff to 20 to 30 mm Hg above point when pulse can no longer be felt at wrist. Release pressure at 2 mm Hg per second. Systolic is first observation of pulse. Diastolic is when pulse fades away.

ii. *Body Composition*

1. Body fat measurements
   a. Skin-fold calipers measure subcutaneous fat
      i. Durnin formula – measures biceps, triceps, subscapular (left of lat on

back), and lilac crest (just inside love handle)
ii. Body fat % X scale weight = fat mass
iii. Scale weight – fat mass = lean body mass

b. Bioelectrical impedance uses current to measure fat

c. Underwater weighing can measure fat to lean tissue.

d. Circumferences Measurements:
i. Neck, Chest, Waist, Hips, Thighs, Calves, Biceps

e. Waist-to-Hip Ratio
i. Divide waist by hip
ii. Ratio above .80 for women above .95 for men at risk for diseases

f. BMI
i. Weight divided by height
ii. Mild – 25-30
iii. Moderate – 30-35
iv. Severe - >35

E. **Cardiorespiratory Assessments**

a. <u>3 minute-step test</u> –

i. *Step one* – Determine Max heart rate zones

ii. *Step two* - 24 steps per minute on an 18-inch step. Rest for 1 minute, then measure for 30 seconds to get recovery pulse.
1. Duration of exercise (sec) x 100/ Recovery pulse X 5.6 = cardiovascular efficiency

iii. *Step three* –
1. 28-38 – Poor
2. 39-48 – Fair
3. 49-59 – Average
4. 60-70 – Good
5. 71-100 – Very good

iv. *Step four* –
1. Poor – Zone one
2. Fair – Zone one
3. Average – Zone two

4. Good – Zone two
5. Very Good – zone three

b. Rockport Walk Test
   i. *Step One* – Determine client's max heart rate
   ii. *Step Two* – Record client's weight, have them walk 1 mile as fast possible, record time it took and heart rate and use formula for Vo2 score
   iii. *Step Three* – Locate the Vo2 in one of categories
   iv. *Step Four* – Find starting program category

F. Posture and Movement Assessments

a. Posture – the alignment and function of all components of the kinetic chain at any given moment, under control of central nervous system. Posture is the position from which all movement begins and ends
   i. Main purpose of proper posture is to maintain enough structural efficiency to overcome constant forces placed on the body
      1. *Structural efficiency* is the alignment of the musculoskeletal system, which allows our center of gravity to be maintained over a base of support
   ii. Any deviation from proper postural alignment can cause a change in the body's center of gravity, affecting functional efficiency of the kinetic chain
      1. *Functional efficiency* is the ability of the neuromuscular system to monitor and manipulate movement during functional tasks using the least amount of energy, creating the least amount of stress on the kinetic chain
   iii. *Postural equilibrium* is maintaining a state of balance in the alignment of the kinetic chain

b. Importance of Posture
   i. Allows optimum *neuromuscular efficiency*
   ii. Ensures muscles of body are aligned at proper length-tension relationships necessary for force-couple, allowing for proper joint mechanics (arthrokinematics) and effective absorption of forces throughout the kinetic chain, alleviating excess stress on joints.

iii. Allows high levels of *functional strength,* or the ability of the neuromuscular system to perform dynamic eccentric, isometric, and concentric muscle actions in all 3 planes of motion.
iv. Altered movement patterns result from muscle imbalances, which can place unusual stresses on the joints. This affects other joints and muscles in the kinetic chain, which can cause tissue stress throughout the body, called *postural distortion patterns.*

c. **Dynamic Postural Assessments**- observation process should search for any imbalances in anatomy, physiology, or biomechanics that may decrease a client's results and possibly lead to injury.
    i. Overhead Squat Assessment – designed to assess dynamic flexibility on both sides of the body as well as integrated total body strength.
        1. *Position*
            a. Client stands with feet shoulder-width apart and pointed straight ahead. Foot and ankle complex should be in a neutal position
            b. Have client raise his or her arms overhead, with elbow full extended, upper arm should bisect the torso
        2. *Movement*
            a. Instruct client to squat to roughly the height of a chair and return to the start position
            b. Have the client repeat the movement five repetitions in each position (anterior and lateral)
        3. *Views*
            a. View feet, ankles, and knees from front
            b. View the lumbo-pelvic-hip complex, shoulder, and cervical complex from side
    ii. Single-Leg Squat Assessment – The observation is designed to assess ankle proprioception, core strength, and hip joint stability
        1. *Position*

a. Client should stand with hands on the hips and eyes focused on an object straight ahead
b. Feet should be pointed straight ahead, and the foot, ankle, and knee and the lumbo-pelvic-hip complex should be in a neural position

2. *Movement*
   a. Instruct client to raise one leg and place it parallel to the stance leg
   b. Have client squat to a comfortable level and return to the start position
   c. Perform up to 5 reps before switching sides
3. *Views*
   a. View the knee from the front.

iii. <u>Pushing Assessment</u>
1. *Position*
   a. Instruct client to stand with abdomen drawn inward, feet in a split stance, and toes pointing forward
2. *Movement*
   a. Instruct client to press handles forward and return slowly
   b. Perform up to 20 reps in controlled fashion
   c. Use checklist to record movement faults

iv. <u>Pulling Assessment</u>
1. *Position*
   a. Instruct client to stand with abdomen drawn inward, feet shoulder-width apart, and toes pointing forward
2. *Movement*
   a. Instruct client to pull handles toward their body and return slowly
   b. Perform 20 reps in a controlled fashion
   c. Use checklist to record movement faults

v. <u>Overview</u>
1. Performance assessments:

a. Davies: Assesses upper extremity stability
b. Shark skill: Assesses overall athletic ability
c. Upper extremity strength: Advanced assessment that estimates one-rep max and upper extremity strength
d. Lower extremity strength: Same but for lower

2. Dynamic Postural Assessment Techniques
    a. Overhead squat: Assesses dynamic flexibility and integrated total body strength
    b. Single-Leg Squat: Assesses ankle proprioception, core strength, and hip joint stability
    c. Pushing and pulling: Assesses upper extremity neuromuscular efficiency

d. **Basic Performance Assessments**

i. Davies Test – observation to assess upper extremity agility and stabilization, not suitable for individ. who lack shoulder stability.

1. Position
    a. Place 2 pieces of tape on floor, 36 inches apart
    b. Have client in push-up position, one hand on each piece of tape

2. Movement
    a. Instruct client to quickly move his or her right hand to touch the left hand
    b. Perform alternating touching on each side for 15 seconds
    c. Repeat for three trials
    d. Reassess in the future to measure improvement of number of touches
    e. Record # of lines touched by both hands

ii. Shark Skill Test – observation designed to assess lower extremity agility and neuromuscular control. **It is a progression from single-leg squat.**

1. *Position*

a. Position client in the center box of a grid, with hands on hips and standing on one leg.

2. *Movement*
    a. Instruct client to hop to each box in a designated pattern, always returning to the center box, consistent with patterns
    b. Perform 1 practice run through the boxes with each foot
    c. Perform test twice with each foot, keep track of time
    d. Record times
    e. Add .10 seconds for each of these faults:
        i. Nonhopping leg touches ground
        ii. Hands come off hips
        iii. Foot goes into wrong square
        iv. Foot does not return to center square

iii. <u>Upper Extremity Strength Assessment, Bench Press</u> – observation is designed to estimate 1-rep max for training intensity purposes. Advanced assessment for strength-specfic goals

1. *Position*
    a. Position client on bench, feet pointed ahead, low back in neutral position
2. *Movement*
    a. Instruct client to warm up with light resistance that can be easily performed for 8-10 reps
    b. Take a 1 minute rest
    c. Add 10-20 pounds (5-10%) and perform 3-5 reps
    d. Take 2 minutes rest
    e. Repeat steps 4 & 5 until individ. fails at 3-5 reps
    f. Use 1-rep max est chart in appendix.

iv. <u>Lower Extremity Strength Assessment, Squat</u> – observation is designed to estimate the one-rep squat maximum, for training intensity purposes, advanced assessment for strength

1. *Position*
    a. Feet should be shoulder-width apart, pointed straight ahead, and with knees in line with the toes, low back in neutral position
2. *Movement*
    a. Instruct client to warm up with light resistance easily performed 8-10 reps
    b. Take 1 minute rest
    c. Add 30-40 pounds (10-20%) and perform 3-5 reps
    d. Take 2 minute rest
    e. Repeat steps 4-5 until individ. fails at 3-5 reps
    f. Use 1-rep max chart in appendix.

CHAPTER 6—*Flexibility Training Concepts*

A. **Flexibility** – the normal extensibility (capability to be stretched) of all soft tissues that allow the full range of motion of a joint.

a. *Dynamic range of motion* – combo of flex. And the nervous system's ability to control this range of motion efficiently

i. For soft tissue to achieve efficient extensibility there must be this optimum control.

b. *Neuromuscular efficiency* – ability of the nervous system to properly recruit the correct muscles to produce force, reduce force, and dynamically stabilize the body's structure in all planes of motion.

c. *Dynamic functional flexibility* – Multiplanar soft tissue extensibility with optimal neuromuscular efficiency through the full range of motion

i. Flexibility requires extensibility, which requires dynamic range of motion, which requires neuromuscular efficiency.

B. **Review of Kinetic Chain**

a. *Postural distortion patterns* – predictable patterns of muscle imbalances

i. Muscle imbalances>poor posture>improper movement>injury

b. *Relative Flexibility* – tendency of body to seek the path of least resistance during functional movement patterns

i. Poor flexibility can lead to this

ii. EX.- Squat with externally rotated feet, b/c they don't have proper dorsiflexion in ankles, to do it right, so they compensate

iii. EX.- Overhead shoulder press with excessive lumbar extension, individ. with tight latissimus dorsi have decreased sagittal-plane shoulder flexion, so they must compensate for lack of range of motion.

C. **Muscle Imbalance** – Alternation of muscle length surrounding a joint, in which some are overactive (forcing compensation to occur) and others may be underactive (allowing for the compensation to occur

a. Results from altered reciprocal inhibition, synergistic dominance, arthrokinetic dysfunction, and overall decreased neuromuscular control

i. Altered Reciprocal Inhibition – the concept of muscle inhibition caused by a tight agonist, which decreases neural drive of its functional antagonist

1. EX.- Tight psoas (hip flexor) would decrease the neural drive of the gluteus maximus (hip extensor)

ii. Synergistic Dominance – phenomenon when synergists take over for a weak or inhibited prime mover.

1. EX.- Tight psoas leads to reciprocal inhibition of the gluteus maximus. The results is increased force output of synergists for hip extension (hamstrings, adductor magnus, erector spinae) to compensate for weakened gluteus, leading to arthrokinetic dysfunction, altered force-couples, etc.

iii. Arthokinetic Dysfunction – altered forces at the joint that result in abnormal muscular activity and impaired neuromuscular communication at the joint. Causes poor movement efficiency.

1. EX.-Externally rotating feet when squatting forces tibia/femur to externally rotate. Alters length-tension relationships of muscles at knees and hips, putting the gluteus maximus (agonist) in a shortened pos. decreasing ability to generate force. This causes the biceps femoris to become synergistically dominate, altering joint motion, leading to increasing stress on knee and back, over time stress can lead to pain, which can further alter muscle recruitment and joint mechanics.

D. Neuromuscular Efficiency

a. Mechanoreceptors located in the muscles and tendons help to determine muscle balance or imbalance.

i. *Muscle Spindles*

1. When a muscle on one side of a joint is lengthened (owing to a shortened muscle on the other side), the spindles of the lengthened muscles are stretched.

2. This info. is transmitted to the brain and spinal cord, exciting the muscle spindle, causing the muscle fibers to contract, resulting in spasms or a feeling of tightness

ii. *Golgi Tendon Organs*

1. When excited the Golgi tendon causes the muscle to relax, preventing the muscle from being placed under excessive stress, which could result in injury

2. Prolonged Golgi tendon organ stimulation provides an inhibitory action to muscle spindles, this neuromuscular phenomenon is called *autogenic inhibition, and occurs when the neural impulses sensing tension are greater than the impulses causing muscle contraction. "Autogenic" b/c contracting muscle is being inhibited by its own receptors*

3. Static stretching for example. Holding a stretch creates tension in the muscle. This tension stimulates the Golgi tendon organ, which overrides muscle spindle activity in the muscle being stretched, causing relaxation in the overactive muscle and allowing for optimal lengthening of the tissue.

E. Scientific Rational for Flexibility Training

a. Pattern Overload – consistently repeating the same pattern of motion, which may place abnormal stresses on the body.

b. Cumulative Injury cycle - Poor posture and repetitive movements create dysfunction within the connective tissue of the kinetic chain. This is treated by the body as an injury, and as a result body will initiate repair process.

i. Tissue trauma > Inflammation > Muscle spasm >Adhesions > Altered neuromuscular control > Muscular imbalance

ii. Tissue trauma creates inflammation, which leads to microspasms and decreases normal elasticity of the soft tissue. Left unchecked, these adhesions can begin to form permanent structural changes in the soft tissue that is evident by Davis's law

iii. *Davis's Law* – states that soft tissue models along the lines of stress

1. Soft tissue rebuilds itself in a random fashion with an inelastic collagen matrix that usually does not run in the same direction as the muscle fibers

2. If the muscle fibers are lengthened, these inelastic connective tissue fibers act as roadblocks, preventing the muscle fibers from moving properly

3. This creates alterations in normal tissue extensibility and causes relative flexibility

F. The Flexibility Continuum – Corrective, Active, and Functional Flexibililty.

a. Corrective Flexibility - designed to improve muscle imbalances and altered joint motion appropriate for Phase 1 of OPT model.

i. ***Self-myofascial release*** *– Stretching that focuses on the neural system and fascial system of the body. By applying gentle force to an adhesion or 'knot,' the elastic muscle fibers are altered from a bundled position into a straighter alignment with the direction of the muscle or fascia. At pressure 20-30 seconds, Golgi tendon organ is stimulated, creating autogenic inhibition, decreasing muscle spindle excitation and releasing the hypertonicity of the underlying musculature. With foam roll*

ii. ***Static Stretching*** *– the process of passively taking a muscle to the point of tension and holding the stretch for a minumum of 20 seconds. Low force with longer duration. Before or after activity.*

1. Mechanism of Action – Autogenic Inhibition
2. Acute Variables – 1-3 sets, 20-30 seconds per stretch
3. Examples – Gastrocnemius stretch, kneeling hip flexor stretch, standing adductor stretch, pectoral wall stretch

b. Active Flexibility – designed to improve the extensibility of soft tissue and increase neuromuscular efficiency by using reciprocal inhibition. Allow for agonists and synergist muscles to move a limb through a full range of motion while the functional antagonists are being stretched, appropriate for Phase 2,3,and 4 of OPT model

i. ***Self-myofascial release (above)***

ii. ***Active-isolated stretching*** *– the process of using agonists and synergists to dynamically move the joint into a range of motion. Preactivity warm-up as long as no postural distortion patterns are present.*

1. Mechanism of Action – Reciprocal inhibition
2. Acute Variables – 1-2 sets, hold each 1-2 seconds for 5-10 reps

3. Examples – Active supine biceps femoris stretch, active kneeling quadriceps stretch, active standing adductor stretch, active pectoral wall stretch.

c. Functional Flexibility – integrated, multiplanar soft tissue extensibility with optimum neuromuscular control through full range of motion, movement without compensations, appropriate for Phase 5 of OPT model

i. ***Self-myofascial release (above)***

ii. ***Dynamic stretching*** *– the active extension of a muscle, using force production and momentum to move the joint through the full available range of motion.*

1. Mechanism of action – Reciprocal inhibition

2. Acute Variables – 1 set, 10 reps, 3-10 exercises

3. Examples – Prisoner squats, multiplanar lunges, single-leg squat touchdowns, tube walking, medicine ball chop/lift

CHAPTER 7—*Cardiorespiratory Training Concepts*

A. Uses of Cardiorespiratory Training

a. **Warm Up**

i. <u>General Warm-Up</u> – Low-intensity exercise consisting of movements that do not necessarily relate to the more intense exercise that is to follow

1. EX.- treadmill, stationary bike

ii. <u>Specific Warm-Up</u> – Low-intensity exercise consisting of movements that mimic those that will be included in more intense exercise that is to follow

1. EX. – body-weight squats, push-ups
   **every warm-up should include both. First time clients may spend half the time warming up the first 1-3 workouts

iii. <u>Benefits/Effects</u>

1. *Increased heart and respiratory rate* – increases cardioresp. System's capacity to perform work, increases blood flow to active muscle tissue, and increases oxygen exchange capacity
2. *Increased tissue temperature* – increases rate of muscle contraction, efficiency of opposing muscle contracting and relaxation, metabolic rate, and soft tissue extensibility
3. *Increased psychological preparation for bouts of exercise* – increases the mental readiness of an individual

iv. <u>Other Benefits</u>

1. Speculation between whether warm-up is helpful in prevention of musculoskeletal injury, some studies show it does, other don't.
2. May be beneficial for enhancing performance of kinetic chain
3. Possible inhibitory effect on the accumulation of intercellular acidosis during subsequent exercise bouts. Acidosis is accumulation of excessive hydrogen that causes acidity of the blood and muscle that is related to lactic acid.

v. Warm-up for Stabilization Level Client (Phase 1)
    1. Self-myofascial release (5-10 mins)
    2. Static stretching (5-10 mins)
    3. Cardiorespiratory exercise (5-10 mins)
    4. **Clients should do this before workout**

vi. Warm-up for Strength Level Client (Phase 2,3,4)
    1. Self-myofascial release (5-10 mins)
    2. Active-isolated stretching (5-10 mins)
    3. Cardiorespiratory exercise (5-10 mins)

vii. Warm-up for Power Level Client (Dynamic, Functional)
    1. Self-myofascial release (5-10 mins)
    2. Dynamic stretching (10 reps of each for 5-10 mins)

b. **Cool Down – 40-50% of max heart rate for 5-10 mins, corrective stretching to bring muscles back to original resting length**

i. Benefits
    1. Improved flexibility
    2. Removes waste by-products, via blood
    3. Minimizes muscle soreness
    4. Allows cardio system to respond to lower demand
    5. Avoids dizziness or possible fainting
    6. Provides an emotional balance after exercise stress.

ii. It is views that activity levels that may not necessarily produce significant improvements in fitness may have marked effects on health. Benefits accrue as result of many physiological adaptations to cardio training.

Variable> Response
    1. Vo2>Increase
    2. Stroke volume>Increase
    3. Cardiac output> Increase
    4. Oxidative capacity of muscle> Increase
    5. Resting heart rate>Decrease
    6. Exercising heart rate>Decrease

B. General Guidelines for Cardiorespiratory Training

a. **F.I.T.T.E. (Frequency, Intensity, Time, Type, Enjoyment)**

i. Frequency - # of training sessions in a given time frame.

ii. Intensity – The level of demand the activity places on the body, usually measured by heart rate or maximal oxygen consumption (VO2 Max)

iii. Time – The length of time engaged in the activity.

iv. Type – the mode of physical activity that individual is engaged in.

v. Enjoyment – The amount of pleasure derived from performing the physical activity.

b. **General Health Activity Recommendations**

i. *Frequency* – 5-7 days a week

ii. *Intensity* – Moderate (enough to increase heart and respiration rates)

iii. *Time* – 30 minutes per day

iv. *Type* – General activities (walking, stairs, gardening)

v. *Enjoyment* – the greater, the better

c. **Improved Fitness Recommendations**

i. *Frequency* – 3-5 days a week

ii. *Intensity* – 40-85% VO2 max, or 60-90% HR max

iii. *Time* – 20-60 minutes per day

iv. *Type* – Any activity

v. *Enjoyment* – the greater, the better

C. The Myth of the Fat-Burning Zone

a. Law of Thermodynamics – body fat reduction can only take place when there is more energy being burned than consumed.

i. Fat and glucose are major sources of fuel for exercise. For them to be used more efficiently, the body was be able to receive enough Oxygen, burning fat and glucose as ‘fuel’, producing waste products of carbon dioxide and water.

ii. RER – Respiratory exchange ratio. The ratio of CO2 produced to the volume of oxygen consumed. Normally, CO2 and oxygen exchanged in the lungs equals that used and released in body tissues, so we can use these to estimate caloric expenditure.

iii. Percentages of Calories derived from Fats and Carbs

1. RER of .71 – body at rest, 100% from Fat
2. RER of .85 – 50.7% from Carbs, 49.3% from Fat
3. RER of .95 – 84% from Carbs, 16% from Fat
4. RER of 1.00 – 100% from carbs, 0% from Fat

iv. How much fat an individual burns that ultimately dictates body fat reduction, instead, it is how many calories are burned

v. Excess Postexercise Oxygen Consumption (EPOC)

1. The elevation of the body's metabolism after exercise

a. The body is designed to expend as little energy as possible. This can be avoided by maximizing the caloric expenditure of a training session, and thus, the EPOC. The body will continue to burn more calories after exercise than before exercise was initiated. Increased intensity (percentage of VO2 max or % of HR max) and splitting training sessions into multiple sessions will both result in higher EPOC.

D. Cardiorespiratory Training Methodologies

a. *Translating RER Into Heart Rate Zones*

i. **Zone 1 (.80-.90 RER) – 65-75% HR max.**

1. "Recovery zone" Great zone to start in to improve blood's ability to deliver oxygen throughout the body and remove waste.
2. Fits into beginning phase of OPT model in which goal is to increase blood supply to tissue for recovery

ii. **Zone 2 (.95-1.0 RER) – 80-85% HR max.**

1. Near anaerobic threshold (the point at which body can't produce enough energy for muscles with normal oxygen intake), so higher levels of lactic acid
2. Will burn more calories with higher percentage coming form fat.
3. Main goal of cardio is to increase anaerobic threshold, appropriate for Strength level of OPT model

iii. **<u>Zone 3</u> (1.1 RER) 80-85% of HR max.**

1. True high-intensity workout that cannot be maintained more than 10-60 seconds
2. Just using Zones 1 & 2 will cause clients to plateau. Use Zone 3 once a week in conjuntion with the other zones.
3. Just like staying at low-level all the time will cause clients to plateau, staying at Zone 3 too often will cause clients too overtrain and overload without sufficient recovery.

b. *Translating Heart Rate Zones Into Stages*

i. <u>Stage 1 (Stabilization Level)</u>

1. Will use heart rate Zone 1.
2. Zone 1 (5 minutes warm-up)
3. Zone 1 (30-60 mins)

ii. <u>Stage 2 (Strength Level)</u>

1. Will use heart rate Zones 1 & 2 (interval training)
2. Zone 1 (5 minutes warm-up)
3. *Zone 2 (1 minute)*
4. Zone 1 (5 minutes)
5. *Zone 2 (1 minute)*
6. Zone 1 (5 minutes)
7. *Zone 2 (1 minute)*
8. Zone 1 (2-3 minutes)
9. Cool-down
10. In stage 2, it is important to alternate with stage 1, rotating stages.

iii. <u>Stage 3 (Power Level)</u>

1. Zone 1 (5-10 mins)
2. Zone 2 (2 mins)
3. Zone 3 (1 min)
4. Zone 2 (1 min—reducing workload to keep HR in AT zone without burning out the legs)
5. Zone 1 (10 mins) recovery, cool down.
6. Rotate all three zones to increase EPOC

c. *Circuit Training*

i. Just as beneficial as traditional forms of cardio exercise for improving fitness levels

ii. Produced greater levels of EPOC and strength

iii. Produced near-identical caloric expenditure for the same given time span, when compared with walking at a fast pace.

F. **Postural Considerations in Cardiorespiratory Training**
   a. <u>Clients who possess a rounded shoulder or forward head posture</u>
      i. During use of stationary bicycles, treadmills, etc, watch for rounding of shoulders and protruding head
      ii. On steppers and treadmills, watch for grasping of handles, which will cause elevated and protracted shoulders and a protracted head.
      iii. Watch for excessive cervical extension or rotation to watch TV
   b. <u>Clients who possess an anteriorly rotated pelvis (low back arches)</u>
      i. Initial use of bicycles or steppers may not be warranted, as hips are placed in a constant state of flexion, adding to a shortened hip flexor complex. If they are used, emphasize hip flexor stretches before and after use.
      ii. Treadmill speed should be kept to a controllable pace, to avoid overstriding. The hips will not be able to properly extend and will cause the low back to overextend, placing increased stress on the low back. Hip flexor stretches should be emphasized before and after use
   c. <u>Clients whose feet turn out and/or knees move in</u>
      i. Use of all cardio equipment that involves lower extremities will require proper flexibility of the ankle joint. Emphasize foam rolling for calves, adductors, iliotibial (IT) band, tensor fascia latae (TFL), and latissiums dorsi as well as hip flexor stretches.
      ii. Using the treadmill and steppers that require climbing (or aerobics classes) may initially be too extreme for constant repetition, especially if clients are allowed to hold on to the rails and speed up the pace. If these modalities are used, emphasize the foam roll protocol and keep the pace at a controllable speed.

CHAPTER 8*—Core-Training Concepts*

A. Core Musculature

a. **Core –** The lumbo-pelvic-hip complex and the thoracic and cervical spine, where the body's center of gravity is located consisting of 29 muscles & 2 categories:

i. Stabilization System – responsible for stability of complex. An efficient core is necessary for maintaining proper muscle balance throughout the entire kinetic chain.

ii. Movement System – responsible for movement, force reduction, and force reductioin of the core.

iii. The core operates as an integrated functional unit, whereby the stabilization system must work in concert with the movement system. Must work from inside (stabilization system) to the outside (movement system) to provide foundation for movement.

B. Importance of Properly Training the Stabilization System

a. If the movement system musculature of the core is strong and the stabilization is weak, the kinetic chain senses imbalance and forces are not transferred or used properly. This leads to compensation, synergistic dominance, and inefficient movements.

i. EX.- performing a lunge, squat, or overhead press with excessive spinal extension

C. Scientific Rationale for Core Stabilization Training

a. Individuals with lower back pain (85% of adults) have decreased activation of muscles and stabilization endurance.

b. Traditional abdominal exercises, and traditional low back hyperextension exercises without proper lumbo-pelvic hip stabilization has been shown to increase pressure on disks to dangerous levels

c. Thus crucial to incorporate systematic progressive approach when training the core, ensuring the muscles that stabilize the spine (stabilization system) are strengthened before the musculature that moves the spine (movement system)

D. Solutions for Stabilization

a. Drawing-in maneuver – The action of pulling the belly button in toward the spine.

i. Also, maintaining the cervical spine in a neutral position during core training improves posture, muscle balance, and stabilization

ii. Increased EMG activity and pelvic stabilization

iii. If sternocleidomastoid muscle is hyperactive and extends the upper cervical spine, the pelvis rotates anteriorly to realign the eyes, leading to muscle imbalances and decreased pelvic stabilization.

E. Requirements for Core Training

a. Core stabilization system consists primarily of slow-twitch, type I muscle fibers, which respond best to time under tension.

b. Intramuscular coordination – The ability of the neuromuscular system to allow optimal levels of motor unit recruitment and synchronization within a muscle

i. Need sustained contractions (6 to 20 seconds) to improve this, enhances static and dynamic stabilization of lumbo-pelvic-hip complex.

c. Intermuscular coordination – The ability of the neuromuscular system to allow all muscles to work together with proper activation and timing between them.

i. Core-movement system is primarily geared toward movement of the lumbo-pelvic-hip complex

F. Designing a Core-Training Program

a. *Stabilization (Phase 1)* – designed to improve the functional capacity of the stabilization system

i. EX.- Marching, Floor bridge, Floor prone cobra, Prone iso-ab

b. *Strength (Phase 2, 3, and 4)* – designed to improve dynamic stabilization, concentric strength (force production), eccentric strength (force reduction), and neuromuscular efficiency

i. EX. – Ball crunch, Back extension, Reverse crunch, Cable rotations

d. *Power (Phase 5)* – designed to improve the rate of force production of the core musculature.

i. EX.- Rotation chest pass, Ball medicine ball (MB) pullover throw, Front MB oblique throw, Woodchop throw.

CHAPTER 9*—Balancing-Training Concepts*

A. Importance of Balance Training

a. Adequate force reduction and stabilization are required for optimum force production, the ability to reduce force at the right joint, at the right time, and in the right plane of motion requires optimum levels of functional balance and neuromuscular efficiency.

b. *Balance threshold* – the distance outside of the base of support that one can go without losing control of his or her center of gravity.

i. Training functional movements in a proprioceptively enriched environment (unstable, yet controllable) with appropriate progressions/technique/progressions facilitates max sensory input to CNS, resulting in selection of the proper movement pattern.

ii. <u>Progressions</u>

1.**Floor>Half foam roll>Airex pad>Dyna Disc**

2. **2 legs stable>1 leg stable>2 legs unstable>1 leg unstable**

B. Benefits of Balance Training

a. <u>Dynamic joint stabilization</u> – The ability of the kinetic chain to stabilize a joint during movement.

i. EX.- rotator cuff stabilizing the head of humerus on the glenoid fossa while performing a push-up.

b. <u>Multisensory condition</u> – Training environment that provides heightened stimulation to proprioceptors and mechanoreceptors

i. EX.- Balancing on half foam roll, while squatting down and reaching across body, toward the floor.

c. <u>Controlled instability</u> - Main goal of balance training, a training environment that is as unstable as can safely be controlled by an individual

C. Balance and Joint Dysfunctions

a. Individ. with altered neuromuscular control like have specific kinetic chain imbalances, that affect the quality of movement, create faulty movement patterns, and lead to lowered neuromuscular efficiency. This may contribute to synergistic dominance, which can cause joint dysfunction and pain elsewhere, creating muscle inhibition, altered balance which can lead to tissue overload and injury.

D. Designing a Balance-Training Program

a. Stabilization Level (Phase 1) – Designed to improve reflexive joint stabilization contractions to increase joint stability, which means when the body is placed in unstable environments, it must react by contracting the right muscles at the right time to maintain balance

i. EX.- Single-leg balance, Single-leg balance reach, Single-leg hip internal and external rotation, Single-leg lift and chop

b. Strength Level (Phase 2-4) – more dynamic eccentric and concentric movement of the balance leg through full range of motion. Movements require dynamic control in mid-range of motion, with isometric stabilization at the end-range of motion.

i. EX.- Single-leg squat, Single-leg squat touchdown, Single-leg Romanian deadlift, Step-up to balance, Lunge to balance

c. Power Level (Phase 5) – designed to develop high levels of eccentric strength, dynamic neuromuscular efficiency, and reactive joint stabilization

i. EX.- Multiplanar hop with stabilization, Box hop-up with stabilization, Box hop-down with stabilization.

CHAPTER 10*—Reactive (Power) Training Concepts*

A. **Reactive Training –** Exercises that use quick, powerful movements involving an eccentric contraction immediately followed by an explosive concentric contraction.

a. Accomplished through the use of plyometric exercises and defines the stretch-shortening cycle of the integrated performance paradigm (to move with precision, forces must be reduced (eccentrically), stabilized (isometrically), and then produced (concentrically).

b. Exercises enhance reactivity of the neuromuscular system and increase the rate of force production (power), motor-unit recruitment, firing frequency (rate coding), and synchronization.

c. **Rate of force production** – Ability of muscles to exert maximal force output in a minimal amount of time through muscle spectrum (eccentric deceleration, isometric stabilization, concentric acceleration)

i. Ultimate goal of reactive training is to increase this

ii. Body will only move within a range of speed that the Nervous System has been programmed to allow, reactive training improves this.

iii. Only incorporate once proper flexibility, core strength, and balance capabilities have been achieved.

B. Levels of Reactive training

a. **Stabilization Level (Phase 1)** – designed to establish optimum landing mechanics, postural alignment, and reactive neuromuscular efficiency, stabilizing/landing 3 to 5 seconds before repeating

i. EX.- Squat jump w/ stab., Box jump-up w/ stab., Box jump-down w/stab., Multiplanar jump w/stab.

b. **Strength Level (Phase 2-4)** – exercises require greater specificity, speed, and neural demand, involve more dynamic eccentric and concentric movement through entire range of motion, designed to improve dynamic joint stabilization, eccentric strength, rate of force production, performed in a more repetitive fashion (short amount of time on ground)

i. EX.- Squat jump, Tuck jump, Butt kick, Power step-up

c. **Power Level (Phase 5)** – exercises involve the entire muscle action spectrum and contraction-velocity spectrum used during integrated, functional movements, performed as fast and explosively

as possible, improve rate of force production, reactive strength, dynamic neuromuscular efficiency, and optimum force production.

i. EX. – Ice Skater, Single-Leg power stepup, Proprioceptive plyometrics: cones & hurdles

CHAPTER 11*—Speed, Agility, and Quickness Training*

A. Speed Training

a. **Speed –** The ability to move the body in one intended direction as fast as possible

i. Stride Rate – # of strides taken in a given amount of time (or distance)

ii. Stride Length – the distance covered in one stride

1. Optimum stride length at max. velocity has a high correlation to leg length **(2.1 to 2.5 times leg length)

iii. Proper Sprint Mechanics

1. Frontside mechanics – the emphasis on triple flexion of the front leg
    a. Ankle dorsiflexion
    b. Knee flexion
    c. Hip flexion
    d. Keeping the lumbar spine neutral
2. Backside mechanics – emphasis on triple extension of the back leg
    a. Ankle plantarflexion
    b. Knee extension
    c. Hip extension
    d. Keeping lumbar spine neutral

B. Agility Training

a. **Agility** – The ability to accelerate, decelerate, stabilize, and change direction quickly, while maintaining proper posture.

i. Can enhance neuromuscular control, dynamic flexibility, dynamic postural control, functional core strength, and proprioception

ii. Can help to prevent injury by enhancing body's ability to effectively control eccentric forces in all planes of motion as well as by improving the structural integrity of the connective tissue

C. Quickness Training

a. **Quickness** – The ability to react and change body position with the maximum rate of force production, in all planes of motion, from all body position, during functional activities.

i. Involves the ability to react to visual, auditory, and kinesthetic feedback during functional activities with minimal hesitation.

CHAPTER 12*—Resistance-Training Concepts*

A. Adaptation

a. **General Adaptation Syndrome –** The kinetic chain's ability to adapt to stresses placed on it, Hans Selye showed 3 stages of response to stress

i. Alarm Reaction Stage – the alarm reaction is the initial reaction to a stressor

1. Person undergoing resistance training places his or her body under stress of increased amounts of force on bones/muscles/joints etc.

2. Creates need for increased oxygen and blood supply & increased neural recruitment to muscles

3. Initially inefficient, the body was increase ability to meet these new demands

ii. Resistance Development Stage – The body increases its functional capacity to adapt to the stressor

1. Increased functional capacity to adapt to stressor such as increasing motor unit recruitment, more efficiently recruiting muscle fibers.

iii. Exhaustion – Prolonged stress or stress that is intolerable and will produce exhaustion of distress to the system

1. When stressor is too much for system to handle, stress fractures, muscle strains, joint pain, and emotional fatigue can occur
2. *Periodization* – Division of a training program into smaller, progressive stages will help avoid this

b. **SAID principle (specific adaptation to imposed demands)** – Principle that states the body will adapt to the specific demands placed on it.

i. Mechanical specificity – Refers to the weight and movements placed on the body.

ii. Neuromuscular specificity – Refers to the speed of contraction and exercise selection

1. EX.- low-weight, high-velocity contractions performed in a plyometric manner to develop power in legs

iii. Metabolic specificity – Refers to the energy demand placed on the body

1. For endurance, limited time b/t sets, for power/strength, more time between sets for higher intensity.

B. Progressive Strength Adaptations From Resistance Training

a. **Strength –** The ability of the neuromuscular system to produce internal tension to overcome an external force

i. Requires internal tension or *strength adaptaion*

b. **Stabilization Level Resistance Training (Phase 1)**

i. Type I muscle fibers and connective tissue are maximized by using high-repetition schemes with low to moderate volume/intensity in a postural position that challenges stability of the body, emphasis is on nervous system

ii. Type I motor unit types (smaller) are recruited before Type II (larger) b/c they are recruited by size, new clients have not established an ability to recruit a high percentage of motor units

iii. *Muscular Endurance* – The ability of the body to produce low levels of force and maintain them for extended periods

1. The ability to overcome gravity, ground reaction forces, and momentum on a continual basis is vital in the prevention of injury and allows proper kinetic chain alignment and performance

iv. *Stability* – The ability of the body to maintain postural equilibrium and support joints during movement

1. Training with controlled, unstable exercises increases the body's ability to stabilize or balance itself.

2. Arguably the most important adaptation b/c it increases the ability of the kinetic chain to stabilize the lumbo-pelvic-hip complex and joints during movement, allowing the arms and legs to work more efficiently

c. **Strength Level Resistance Training (Phases 2-4)**

i. Type II muscle fibers are predominantly recruited to increase body's capacity to produce internal tension.

ii. Heavy weights, and higher volumes of training are used to increase the recruitment, synchronization, and firing rate of motor units, while placing necessary mechanical stress on the muscles to increase their size and strength.

d. **Strength Endurance (Phase 2)**

i. Strength Endurance – The ability of the body to repeatedly produce high levels of force for prolonged periods

ii. Higher levels of force with lower reps (6 to 12) more sets, with minimal rest, often with supersets

e. **Hypertrophy (Phase 3)**

i. Hypertrophy – Enlargement of skeletal muscle fibers in response to overcoming force from high volumes of tension.

ii. Increase in the cross-sectional area of individual muscle fibers and is believed to result from an increase in the myofibril proteins (myofilaments)

iii. Nervous system must establish the proper connection to effectively communicate with each muscle fiber.

iv. Not externally visible for 4 to 8 weeks

f. **Maximal Strength (Phase 4)**

i. Maximal strength – The maximum force that a muscle can produce in a single, voluntary effort, regardless of velocity.

ii. All the muscle's motor units must be recruited for maximal force, one way to increase strength is to increase recruitment ability

iii. Max. strength can be improved through stab. training. This type of training improves the ability of the neuromuscular system to better recruit motor units within a muscle (intramuscular coordination) and in synergy with many other muscles (intermuscular coordination), allowing nervous system to appropriately use muscles to stabilize a joint while other muscles are lifting maximal loads.

g. **Power Level Resistance Training (Phase 5)**

i. Power – Ability of the neuromuscular system to produce the greatest force in the shortest time.

ii. Focus is on rate of force production, an increase in either force or velocity will produce an increase in power.

iii. Power training allows for increased rate of force production by increasing the number of motor units activated, the synchronization between them, and the speed at which they are activated.

C. Resistance-Training Systems

a. *Single-Set System* – 8 to 12 reps, 2 times per week, may be good for beginning clients

b. *Multiple-Set System* – Many sets, reps, etc. to work towards goals

c. *Pyramid System* – progressive or regressive step approach that either increases weight with each set or decreases weight with each set

1. Light-to-heavy system – individ. performs 10 to 12 reps with a light load and increases the resistance for each following set, until individual can perform 1 to 2 reps, usually in 4-6 sets

2. Heavy-to-light system – start with 1-2 reps works other way

d. *Superset System* – uses a couple of exercises performed in rapid succession of one another, features use of independent subsystems with similar systems

1. Compound sets – The performance of 2 exercises for antagonistic muscles, for example bench presses followed by cable rows, allowing for better recovery

2. Tri-sets – 3 exercises in rapid succession for the same muscle group or body part

e. *Circuit-Training System* – Acute variables are 1-3 sets of 8 to 15 reps with 15-60 seconds between exercises.

f. *Peripheral Heart Action System* – Variation of circuit training that alternates upper and lower body exercises throughout the circuit, 8-20 reps per exercise

g. *Split-Routine System* – Breaking body into parts trained on separate days

h. *Vertical Loading* – Alternating body parts from set to set, starting from the upper extremity and moving to the lower extremity

EX. Doing 1 set of chest, then back, then shoulders, then biceps, then legs,

i. *Horizontal Loading* – Performing all sets of an exercise or body part before moving on to the next exercise or body part

EX. Doing all sets of chest, then all sets of back, then all sets of shoulders, then all sets of biceps, then all sets of legs.

***CHAPTER 13**—Program Design Concepts*

A. Program Design

a. **Program Design –** A purposeful system or plan put together to help an individual achieve a specific goal.

B. Acute Variables of Training

a. **Acute variables** – Important components that specify how each exercise is to be performed

i. *Repetitions* – One complete movement of a single exercise

****1.** Power adaptations require 1 to 10 reps at 30-45% of the 1RM, or approximately 10% of body weight

****2.** If maximal strength adaptations are desired, the repetition range is 1-5 at 85-100% of the 1RM.

****3.** Hypertrophy is best achieved using 8-12 reps at 70-85% of the 1RM

****4.** Endurance is best achieved by performing 12-25 reps at 50-70% of the 1RM

ii. *Sets* – A group of consecutive repetitions

****1.** For power adaptations, 3-6 sets b/t 1-10 reps at intensity of 30-45% of 1RM or approx. 10% of body weight.

****2.** For maximum strength adaptations, 4-6 sets b/t 1-5 reps at an intensity of 85-100% of 1RM

****3.** Hypertrophy adaptations require 3-4 sets of 8-12 reps at 70-85% of 1RM

****4.** Endurance is best developed with 1-3 sets of 12-25 reps at 50-70% of 1RM

iii. *Training Intensity* – An individual's level of effort, compared with their maximal effort, which is usually expressed as a percentage

****1.** Power (high velocity) adaptations are best attained with 30-45% of 1RM when using conventional weight training, or approx. 10% of body weight when using medicine balls.

****2.** Max Strength adaptations require training with 85-100% of 1RM

****3.** Hypertrophy is best achieved by training with 70-85% of 1RM

****4.** Endurance is best developed with a training intensity of 40-70% of 1RM

iv. *Repetition Tempo* – The speed with which each repetition is performed.

****1.** Power – (x/x/x) Explosive

****2.** Strength – (2/0/2) Moderate

****3.** Stabilization – (4/2/1) Slow

v. *Rest Interval* – The time taken to recuperate between sets. Primary type of energy used during training depends on the training phase, intensity, and goal.

****1.** Power/Max Strength adaptations may require up to 5 mins.

****2.** Hypertrophy adaptations 45-90 secs of rest

****3.** Stability/Endurance 30 to 90 seconds

4. By adjusting rest interval, energy supplies can be regained according to goal.

i. 20-30 secs. Approx. 50% recovery of ATP and CP

ii. 40 secs. Approx. 75% recovery

iii. 60 secs., Approx. 85-90% recovery

iv. 3 mins., Approx 100% of recovery

vi. *Training Volume* – Amount of physical training performed within a specific period.

1. Power – 6 sets of 30 reps
2. Strength – 8 sets of 36 reps
3. Stabilization – 36 sets of 75 reps

vii. *Training Frequency* – the number of training sessions performed during a specific period (usually 1 week)

viii. *Training Duration* – The timeframe of a workout (including warm-up and cool-down) or the length of time spent in one phase of training.

1. Timeframe from start to finish (programs that exceed 60-90 minutes associated with declining energy levels)
2. Length of time (# of weeks) spent in one phase (or period) of training (a phase of training will last b/t 4-8 weeks as usually time it takes for body to adapt to given stimulus.

ix. *Exercise Selection* – The process of choosing appropriate exercises for a client's program

****1.** Power level – Total body; multijoint (explosive)

****2.** Strength level – Total body; multijoint or single joint

****3.** Stabilization level – total body; multijoint or single joint; controlled unstable.

C. Periodization and the OPT Model (Planned fitness Training)

a. **Training plan** – The specific outline, created by a fitness professional to meet a client's goals, that details the form of training, length of time, future changes, and specific exercises to be performed.

i. Plan is broken down into annual (macroscycle), monthly (mesocycle), weekly (microcycle)

D. The OPT Model**

a. Stabilization (anatomic adaptation) focuses on

i. Correcting muscle imbalances

ii. Improving stabilization of the core musculature

iii. Preventing tissue overload by preparing muscles/tendons/ligaments/joints for the upcoming imposed demands of training

iv. Improving overall cardiorespiratory & neuromuscular condition

v. Established proper movement patterns or exercise technique

vi. Accomplished through low-intensity, high-repetition

b. Stabilization Endurance Training (Phase 1) focusing on

i. Increasing stability

ii. Increasing muscular endurance

iii. Increasing neuromuscular efficiency of core musculature

iv. Improving intermuscular & intramuscular coordination

v. 4-week duration, challenging proprioception and endurance of core muscles

c. Strength focuses on:

i. Increase ability of core musc. to stabilize the pelvis and spine under heavier loads, through more-complete ranges of motion

ii. Increase the load-bearing capabilities of muscles/tendons/ligaments/joints

iii. Increase the volume of training w/ more reps, sets, intensity

iv. Increasing metabolic demand by taxing the ATP and CP and glycolysis energy systems to induce cellular changes in muscle (weight loss or hypertrophy)

v. Increase motor unit recruitment, frequency of motor unit recruitment, and motor unit synchronization (maximal strength)

d. Strength Endurance Training (Phase 2)

i. Hybrid form of training that promotes increased stabilization endurance, hypertrophy, and strength, using superset techniques in which a more-stable exercise is immediately followed by stabilization exercise using same biomechanical motions

e. Hypertrophy Training (Phase 3)

i. Specific for the adaptation of maximal muscle growth, focusing on high levels of volume with minimal rest periods to force cellular changes resulting in increase muscle size

f. Maximal Strength Training (Phase 4)

i. Focused on increasing the load placed upon the tissues of the body, improving:

1. Recruitment of more motor units
2. Rate of Force production
3. Motor unit synchronization
4. Can help increase the benefits of forms of power training used in Phase 5.

g. Power

i. defined as force multiplied by velocity (P = F x V)

ii. Therefore increase in force or velocity will increase power, accomplished by either increasing the load (or force) or increasing speed with which you move the load (velocity)

iii. Train with both heavy loads (85 to 100%) and light loads (30 to 45%) at high speeds, focus is to increase rate of force production by increasing the # of motor units activated, the synchrony between them, and the speed at which they are excited.

h. Power Training (Phase 5)

i. Accomplished by combining strength exercise with a power exercise for each body part (barbell bench press with medicine ball chest pass)

ii. Heavy loads increase the force side of the power equation

iii. Speed exercises (30-45% intensity) & 10% intensity medicine ball training affect velocity side of power equation.

E. Applying the OPT Model

a. Applying the Model for the goal of Body Fat Reduction

i. Annual plan consists of cycling between Phases 1 & 2, 4 weeks spent at each, 3 workouts per week

b. Applying the Model to increase Lean Body Mass

i. Annual plan consists of cycling 4 weeks a piece as follows: Phase 1, 2, and 3, Phase 2, 3, 4, Phase 1, 2, 3, and Phase 4, 3, 2,

ii. For Phases 1 & 2, MWF, for Phases 2 & 4, MTTHF

c. Applying the Model to Improve General Performance

i. Undulating Periodization

ii. Annual plan:

1. 4 Weeks @ Phase 1
2. 4 Weeks @ Phase 2
3. 4 Weeks @ Phase 1,2,5
4. 4 Weeks @ Phase 2,5
5. Cycle through #3 & #4 and end with 4 weeks at Phase 2

iii. Monthly plan

1. For Phases 1 & 2, MWF
2. For March, M (Phase 2), W (Phase 1), F (Phase 5)

CHAPTER 14—*Specific Populations*

A. Age Considerations

a. Youth Training (between 11-21 years old)

i. Should engage in moderate to vigorous activity for min. of 20 minutes, 3 or more days of the week

ii. Elementary children should have physical activity of at least 30-60 minutes on most or all days of the week.

b. Physiological differences Between Children and Adults

i. The term 'maximum oxygen uptake' should not be used in children b/c they do not exhibit a plateau in oxygen uptake at maximum exercise, peak oxygen consumption is similar for young and mature males, and slightly higher for young females, similarity in peak oxygen uptake between children and adults means children perform endurance-related tasks fairly well (Phase 1)

ii. *A Higher Submaximal oxygen demand – economy of movement, combined with lower sweating rate means children have less tolerance to higher temperatures.*

iii. *Lower Glycolytic enzymes – enzymes used in the glycolysis energy pathway decrease their ability to perform higher intensity (anaerobic) tasks for prolonged periods of time (10 to 90 seconds), so they need adequate rest intervals when training at high intensities.*

c. Resistance Training in the Youth Population

i. Resistance training in the youth population is associated with decrease in the number of common injuries

ii. Positive effects on motor skills (sprinting and jumping), body composition, and bone mineral density.

d. Seniors

i. Decrease in following functions: Max attainable heart rate, cardiac output, muscle mass, balance, coordination (neuromuscular efficiency), connective tissue elasticity, bone mineral density

ii. Emphasis on stabilization & core (Phases 1 and 2)

B. **Obesity –** The condition of subcutaneous fat exceeding the amount of lean body mass.

a. 33% of adult population & 15% of children ages 6 and older

b. BMI - Total body weight in kilograms divided by the height in meters squared.

i. 18.5-24.9 normal, 25-29.9 overweight, >30 obese

ii. More than 2/3s of adult population has BMI above 25

c. Causes of obesity – Fundamental problem is energy balance. Adults not involved in exercise will lose 5 pounds of muscle per decade,

while adding 15 pounds of fat. 15% decrease if fat-free mass between ages of 30 and 80.

d. Obesity and Training – use exercises in standing or seated position

i. Calorie expenditure should approximate 200-300 kcal, with minimum weekly output of more than 1250 kcals, increasing to 2000 thourgh exercise.

ii. Walking is recommended, dumbbell, cable, and tubing exercises, not machines b/c of the difficulty getting in and out.

iii. Self-myofascial should be done with caution as many clients will not feel comfortable rolling or lying on the floor.

C. **Diabetes** – Chronic metabolic disorder, caused by insulin deficiency, which impairs carbohydrate usage and enhances usage of fat and protein. The body's ability to produce insulin (a hormone secreted by the pancreas to help deliver glucose to cells) or to utilize glucose (blood sugar) is altered.

a. Nearly 6% of US population with diabetes, expected to double in next 15 to 20 years

b. Type 1 (insulin-dependent diabetes) – as a result of insulin, blood sugar is not optimally delivered into the cells (particularly muscle and fat cells), resulting in *hyperglycemia* (high levels of blood sugar). To control this high level of blood sugar, insulin may be injected to compensate for what their pancreas cannot produce. Important b/c exercise increases the rate at which cells use glucose

i. If they do not control their glucose levels before, during, and after exercise, blood sugar levels can drop rapidly and cause a condition called *hypoglycemia* (low blood sugar) leading to weakness, dizziness, and fainting.

c. Type 2 (adult-onset diabetes) – associated with obesity, particularly abdominal obesity. They produce adequate amounts of insulin, however their cells are resistant to the insulin (that is, they do not allow insulin to bring adequate amounts of blood sugar into the cell). Can lead to *hyperglycemia.*

i. Chronic hyperglycemia is associated with a number of diseases associated with damage to the kidneys, heart, nerves, eyes, and circulatory system.

d. Exercise and Diabetes

i. Exercise training is effective in that regard, because it acts much like insulin by enhancing the uptake of circulating glucose by skeletal muscle, substantial positive effect on type 2 diabetes.

ii. Care must be taken to prevent blisters and foot microtrauma that could result in foot infection.

iii. Low impact exercise, Phases 1 & 2

D. **Hypertension** – raised systemic arterial blood pressure, which, if sustained at a high enough level, is like to induce cardiovascular or end-organ damage.

a. Systolic greater than or equal to 140 mm Hg and Diastolic reading greater than or equal to 90 mm Hg. (Normal is 120/80 mm Hg)

b. Should engage in low-intensity aerobic exercise, but may wan tot avoid heavy resistance training. Measure clients' heart rate response to exercise.

c. Monitor body position is very important. Supine or prone positions (especially when the head is lower in elevation than the heart) may be avoided. Most exercises should be performed in a seated or standing position. Full flexibility continuum can be used, avoid self-myofascial release. Reactive training with care, Phases 1 and 2 are appropriate

d. Medication (Beta Blockers) are used, but cardio, diet changes can have effect. High-intensity cardio has same effect as low-intensity.

E. **Coronary Heart Disease**

a. 40% of deaths annually, 18 million individuals have coronary artery disease or chronic heart failure, with another 50 million diagnosed with high blood pressure.

b. Plaque accumulation in the coronary arteries, and the eventual obstruction of the artery, resulting in a myocardial infarction (or heart attack)

c. Use 'rate of perceived exertion' to assess exercise intensity

d. Heart disease may be slowed (ore even reversed) when a multifactor intervention program of intensive education, exercise, counseling, and lipid lowering medications are used.

e. Perform exercises in a seated or standing position. Avoid reactive training. Flexibility limited to static/active in seated position. Self-myofascial must be approved by physican. Programs should be performed in circuit style or using Peripheral Heart Action (PHA) training system.

f. Weekly caloric expenditure goal of 1500-2000 kcal, resistance training should not be attempted until client has been exercising without problems for 3 months.

F. **Osteoporosis**

a. Osteopenia - a decrease in the calcification or density of bone as well as reduced bone mass

b. Osteoporosis – Condition in which there is a decrease in bone mass and density as well an increase in the space between bones, resulting in porosity and fragility.

i. Erodes core, affects more than 25 million people each year, and 1.5 million hip fractures (only 20% return to normal functional status)

ii. Peak bone Mass – the highest amount of bone mass a person is able to achieve in a lifetime.

1. New bone formation (remodeling) occurs as the result of stress placed on the musculoskeletal system. To maintain consistent bone remodeling, people must remain active enough to ensure adequate stress is being placed on their bodies.

iii. Risk factors: lack of physical activity, smoking, excess alcohol consumption, & low dietary calcium intake.

iv. Resistance training improves bone mineral density by no more than 5%, not necessarily high enough to risk fracture. 20% increase is necessary to offset fractures.

v. Flexibility limited to static and active in seated position. Avoid self-myofascial release. Cardio on phase I, progress to II with physician's advice. Care should be taken with crunches or movements with a lot of spinal flexion. Reactive Training not recommended. Resistance training in seated or standing position. 6 months of consistent exercise at high intensities, progressed appropriately will be required to have an effect on bone mass.

vi. Use circuit style or PHA train system, focusing on hips, thighs, back, and arms and progressing to exercises in standing position

G. **Arthritis** – Chronic inflammation of the joints
   a. Most common chronic condition, effects 50% of persons older than 65 and more than 15% of American population.
   b. Osteoarthritis – Arthritis in which cartilage becomes soft, frayed, or thins out, as a result of trauma or other conditions
      i. Lack of cartilage creates a wearing on the surfaces of articulating bones, causing inflammation and pain at the joint.
   c. Rheumatoid arthritis – Arthritis primarily affecting connective tissues, in which there is a thickening of articular soft tissue, and extension of synovial tissue over articular cartilages that have become eroded. Body's immune system mistakenly attacks its own tissue, causing inflammatory response in multiple joints, leading to pain and stiffness.

d. Pain persisting for more than 1 hour after exercise should be modified or eliminated from the routine.
e. Higher intensity or higher repetitions should be avoided to decrease joint aggravation, so circuit program or multiple session is suitable.
f. Oral corticosteroids may lead to osteoporosis. Steroids can increase fracture risk.
g. People with osteroarthritis have a decrease in strength and proprioception, and those with arthritis have a decreased ability to balance while standing.
h. They can't activate knee-extensor musculature to optimal levels. Improving muscle strength and enhancing flexibility through exercise can assist in decreasing symptoms associated with arthritis.
i. Static/active of stretching, use of self-myofascial release can be used if tolerated, cardio training can being in stage I and progress to stages II and III. Core and balance exercises are very important, No reactive training. Phase 1 of OPT model with modified reps (10 to 12) to avoid heavy, repetitive joint loading that increases stress to the affected joints.

H. **Cancer –** any of various types of malignant neoplasms, most of which invade surrounding tissues, may metastasize to several sites, and are likely to recur after attempted removal and to cause death of the patient unless adequately treated
   a. 2nd leading cause of death, behind cardiovascular disease. American men have a 44% probability and women have a 38% probability of developing cancer during their lifetime.
   b. Exercise can improve exercise tolerance, reduce the cellular risks associated with cancer, and improve the quality of life.
   c. Moderate level exercise has positive effect on immune system, moderate to high levels seem to be associated with decreased incidence and mortality rates for certain forms of cancer.
   d. Flexibility active/static, self-myofascial stretching is okay, cardio is important and can progress to stages II and III with physician consent. Core and balance exercises are essential. Reactive training not recommended until client progressed to three phase 1 workouts a week. Resistance training will include Phases I and II of OPT, and can be progressed with physician approval.

I. Women and Pregnancy

a. May continue with moderate levels of exercise until the third trimester, when a logical reduction in activity is recommended.
b. Gradual growth of fetus can alter posture, making flexibility and core-stabilization training important. After 12 weeks , avoid prone or supine positions, and decreased work capacity in cardiovascular and cardiorespiratory systems.
c. A return to exercise post-pregnancy should not be rushed, as changes during pregnancy can persist for another 4 to 6 weeks after birth. Flexibility in seated/standing position esp. in 2nd and 3rd trimesters. Static/active stretching, self-myofascial release ok, but not on varicose veins that are sore, or areas where there is swelling. Cardio in stage I progressing to stage II with doctor's approval. No reactive training. Phases 1 and 2 in 1st trimester, Phase 1 only in 2nd and 3rd trimester.

J. Lung disease

a. Restrictive lung disease – The condition of a fibrous lung tissue, which results in a decreased ability to expand the lungs.
b. Obstructive lung disease – The condition of altered airflow through the lungs, generally caused by airway obstruction as a result of mucus production.
c. Problems during exercise include decreased ventilation and decreased gas exchange ability, fatigue at low levels and shortness of breath. Those with emphysema are frequently underweight and may have hypertrophied neck muscles (that assist in heavy breathing.)
d. Lower body cardiorespiratory and resistance training exercises seem to be best tolerated. Upper extremity exercises place an increased stress on the secondary respiratory muscles that are involved in stabilized upper extremities.
e. Use of PHA is advised. Inspiratory muscle training can improve work associated with breathing.

K. **Intermittent Claudication/Peripheral Arterial disease**

a. Intermittent claudication – the manifestation of the symptoms caused by peripheral arterial disease

        i. Characterized by limping, lameness, or pain in the lower leg during mild exercise resulting from a decrease in blood supply (oxygen) to the lower extremties
    b. Peripheral arterial disease – A condition characterized by narrowing of the major arteries that are responsible for supplying blood to the lower extremities.
    c. Exercise for PAD should induce symptoms, causing a stimulus that increases local circulation, must differentiate between true intermittent claudication versus similar leg complaints associated with deconditioning.
    d. Exercise in intermittent format, rest as necessary between exercise bouts. Physician clearance for exercise is necessary for PAD client.
    e. # of repetitions for assessment may have to be decreased to 5 to 10.
    f. Static/Active stretching should be used, no self-myofascial release. Phase 1 and 2 of the OPT model should be used. Reps may need to start at 8 to 12 and slowly progress 12 to 20. Exercise bouts may initially start with 5 to 10 minutes of activity and progress slowly to 20 to 30 minutes.

CHAPTER 15—*Nutrition*

A. Nutrition and Body Composition

a. **Nutrition –** The sum of the processes by which an animal or plant takes in and uses food substances.

B. **Protein** – Amino acids linked by peptide bonds, whose primary function is to build and repair body tissues and structures. Also involved in synthesis of hormones, enzymes, and other regulatory peptides, and can be used for energy if calories or carbohydrate are insufficient in the diet.

a. 20 amino acids to build proteins, 2 classes of amino acids, essential and nonessential

b. *Essential amino acids* – can't be manufactured by the body (or are manufactured in insufficient amounts). **8 essential amino acids.**

c. *Nonessential amino acids* – body is able to manufacture them from dietary nitrogen and fragments of carbohydrates and fat.

d. *Semiessential amino acids* – because of their rate of synthesis within the body, arginine and histidine are semiessential, they can't be manufactured by the body at a rate that will support growth (especially in children)

e. Digestion, Absorption, and Utilization

i. Proteins must be broken down into constituent amino acids before the body can use them.

ii. As ingested proteins enter the stomach, they encounter hydrochloric acid, which uncoils (denatures) the protein so the digestive enzymes can begin dismantling the peptide bonds

iii. The enzyme pepsin begins to cleave the protein strands into smaller polypeptides (strands of several amino acids) and singular amino acids

iv. The resulting dipeptides, tripeptides, and singular amino acids are then absorbed through the intestinal wall into the enterocytes and released into the blood supply to the liver.

g. Amino acids for immediate Energy

i. If carb or total energy intake is too low, the body can use amino acids (from dietary or body proteins) to provide energy.

ii. Amino acids are first deaminated (or stripped of the amine group) allowing the remaining carbon skeleton to be used for the production of glucose or ketones to be used for energy.

iii. Removed amine group produces ammonia, which is converted to urea in the liver and excreted as urine by the kidneys.

h. Amino acids for potential energy (fat)
   i. If protein intake exceed need for synthesis, carbon fragments may be stored as fat

i. Protein in Foods

i. If food supplies all of the essential amino acids in appropriate ratios, it is called a *complete protein*, if food source is low or lacking in one ore more essential amino acids, it is called an *incomplete protein*.

ii. The essential amino acid that is missing or present in the smallest amount is called the *limiting factor* of the protein.

iii. Because the process of protein synthesis works on an all-or-none principle, all amino acids must be present at the site of protein manufacture, or synthesis will be reduced to the point where the cell runs out of the limiting amino acid.

iv. (PER) – Protein efficiency ratio, (NPU) – net protein utilization, (BV) – biological value

v. Biological value – a measure of protein quality, or how well it satisfies the body's essential amino acid needs

1. Consuming only high BV proteins will cause amino acid requirements would be met with less protein

2. A diet composed of mostly lower BV protein sources, total protein requirements will increase.

j. Factors affecting protein requirements

i. *Exercise* – Both anaerobic & aerobic exercise effect protein requirements in different ways. Exercise increases the oxidation of amino acids as well as the rate of protein turnover in lean body mass during recovery, an individual participating in both types may have a need for protein greater than someone involved in only one.

ii. *Caloric Intake* – majority of energy needs should be met with carbs and fat, if one does not have enough, protein will be used when it should be spared for tissue repair and muscle growth

iii. *Negative Energy Balance* – during this, amino acids are used to assist in energy production (called gluconeogenesis). An increase

in protein in the diet during negative energy balance can reduce amount of lean body mass lost

iv. *Protein and the Bodybuilder* – protein intake could be dramatically increased (during cut/contest phase) to theoretically lessen the obligatory loss of lean tissue during these drastic measures. Carbs, not protein, consumed within an hour after heavy resistance training inhibits muscle-protein breakdown, resulting in a positive protein balance.

k. Protein's effect on Satiety – protein can have more of an effect than fats or carbs

l. Protein-intake recommendations

i. RDA is .0g/kg per day or 15 to 30% of total caloric intake

ii. Minimum acceptable intake – bodybuilder & active recreational athlete (1.0 g/kg per day), Endurance athlete (1.4 g/kg per day)

iii. Adaptation period – Bodybuilder (1.6-2.0 g/kg per day), Active recreational athlete (1.2-1.8 g/kg per day), Endurance athlete (1.6-2.0 g/kg per day)

iv. *Negative side effects associated with chronic use of high-protein diets*

1. More than 30% of total caloric intake, associated with higher intake or saturated fat and low fiber intake, both of which are risk factors for heart disease and some types of cancer, also kidneys have to work harder to eliminate the increased urea produced.
2. Calcium is excreted with high-protein diet, and need for fluids is increased, protein requires **7 times the water for metabolism than carbs and fats.**
3. Low-carb consumption typically accompanies high-protein diets (esp. for weight loss) which can lead to decreased glycogen stores, which inhibit performance and contribute to dehydration.

v. *Protein supplementation*

1. Enhanced recovery after exercise – research has shown that the use of protein and carbs supplements before and after weight training can enhance anabolic hormones.

2. Weight production programs – replace whole-food proteins, eliminating unwanted calories to maintain equal or positive nitrogen balance during body-fat reduction for competitive cosmetic athletes.

3. Convenience

4. Cost – whey protein has an amino acid profile very high in branched-chain amino acids for easy absorption.

m. Review of Properties of Protein:

i. 1 gram yields 4 calories

ii. Used for synthesizing body-tissue protein, providing glucose for energy, providing nitrogen in the form of amine groups to build nonessential acids, contributing to fat stores.

iii. Amino acids are not used to build protein under following conditions: not enough available energy from carbs and fat, consistently low or lacking essential dietary amino acids owing to the exclusive consumption of incomplete proteins, an excess of necessary protein

iv. These must be met for body to synthesize endogenous protein: availability of all essential & nonessential amino acids in proper groups, adequate supply of exogenous protein (supplying amine groups, which synthesize the nonessential amino acids), adequate energy-yielding carbs and fats (sparing the protein),

v. Recommended protein intake for athletes and exercises: 1 to 2.0 g/kg depending on goal, activity, protein source, and total caloric intake, falls in range of 15-30% of total caloric intake

vi. Chronic high-protein intake (greater than 2.5 times the RDA) diets can lead to:

1. Calcium depletion
2. Fluid imbalance
3. Eventual hunger
4. Slower metabolism
5. Weight rebound
6. Energy Loss

C. Carbohydrates – neutral compounds of carbon, hydrogen, and oxygen (such as sugars, starches, and celluloses), which make up a large portion of animal foods.

a. Monosaccharide – single sugar unit, many of which are connected to make starches (the storage form of carbohydrates in plants) and glycogen (the storage form of carbohydrates in humans).

1. EX.- Glucose (blood sugar), fructose (fruit sugar), and galactose.

b. Disaccharides – two sugar units

1. EX.- Sucrose (common sugar), lactose (milk sugar) and maltose

c. Chief source of energy for all body functions, also help to regulate the digestion and utilization of protein and fat.

d. *Digestion, Absorption, and Utilization*

i. Principal carbs present in food occur in the form of simple sugars, starches, and cellulose

1. Simple sugars are easily digested (honey, fruits)
2. Double sugars, (table sugar) require some digestive action
3. Starches (whole grains), require prolonged enzymatic action to be broken down into simple sugars (glucose) for utilization.
4. Cellulose (found in skins of fruits and vegetables) is largely indigestible by humans and contributes little energy level, but provide the bulk necessary for intestinal motility and aids in elimination (of DUMP).

ii. Glycemic index (GI) – the rate at which ingest carbohydrates raise blood sugar and its accompanying effect on insulin release.

1. Determined when the particular food is consumed by itself on an empty stomach, mixed meals of proteins, etc can alter GI effect.
2. Foods lower on the glycemic index are good sources of complex carbohydrates, as well as being high in fiber and overall nutritional value.
3. Through processes of digestion and absorption, all dissaccarides and polysaccarides are ultimately converted into simple sugars such as glucose or fructose. Fructose must be converted to glucose in the liver before it can be used for energy.
4. Small portion of glucose is converted to glycogen after meal within liver and muscles, excess is converted to fat and stored throughout the body as a reserve source of energy.

iii. Fiber and its role in health

1. Lower incidence of heart disease and certain cancers
2. Increases satiety value of foods, delays emptying of stomach
3. Prevents constipation, establishes regularity
4. Retains health and tone of digestive tract muscles, preventing diverticulosis, which causes the weakening of intestinal walls, then causing them to swell and distend
5. Aids in prevention of appendicitis
6. Lowers risk of colon cancer
7. Reduces risks of heart/artery disease, by lowering blood cholesterol
8. Regulates body's absorption of glucose
9. High-fiber meals exert regulatory effects on blood glucose levels up to 5 hours after eating.

iv. Carbohydrate and Performance

1. When performing high-intensity, short-duration activity (anaerobic), muscular demand for energy is dependent on muscle glycogen.
2. During endurance exercise (aerobic) performed at a moderate intensity (60% of maximal oxygen consumption), muscle glycogen provides approx. 50% of energy needs
3. During high-intensity aerobic exercise (>79% of VO2 max), it yields nearly all of energy needs
4. As duration of activity increases, available glucose and glycogen diminish, increasing reliance of fat as a fuel source.
5. Max fat utilization can't occur without sufficient carbohydrate to continue Krebs cycle activity, when an endurance athlete hits the wall, it is a result of fatigue caused by severely lowered liver and muscle glycogen, even though there is an abundance of potential energy from fat stores.

v. Recommendations

1. *Endurance Exercise*

i. High-carb diet increases use of glycogen as fuel, whereas high-fat diet increases the use of fat as fuel, however high-fat diet results in lower glycogen synthesis.

ii. diet containing between 6-10 g/kg per day of carbohydrate, or approximately 60% of caloric intake is recommended.

iii. Complex carbs (whole grains, fresh fruits and vegetables) b/c of their nutrient dense nature.

2. *Before Exercise*

i. Consume a high-carb meal 2 to 4 hours before exercising for more than an hour, esp. for morning workouts when glycogen stores are lowered by as much as 80%

ii. Some research intake of 1 to 4.5 g/kg, 4 hours before exercise saw performance improved by 15%

3. *Carbohydrate Loading*

i. Can double muscle glycogen stores before endurance event

ii. Week-long program, 4 days of glycogen depletion (through low-carb diet and exhaustive exercise), followed by 3 days of rest and high-carb diet, but this method can have drawbacks (hypoglycemia, increased susceptibility to injury)

4. *During Exercise*

1. For exercise more than 1 hour, can help supply glucose to working muscles as well as maintain blood glucose levels.

2. Endurance athletes should have between 30-60 g of carbohydrates every hour to accomplish this, sports beverages can help as well

3. NASM concurs that consuming 500-1200 mL (20 to 40 oz) per hour of fluid that contains between 4-8% carb will contribute to better performance.

5. *After Exercise*

1. Consuming 1.5 g/kg of carbs within 30 minutes of completing exercise is recommended to maximize glycogen replenishment.

2. Delaying carb intake by even 2 hours can decrease total muscle glycogen synthesis by 66%

3. Additional meals of 1.5 g/kg of carbs every 2 hours are recommended to completely restore muscle glycogen

5. *For Altering Body Composition*

1. Carb intake of between 50% and 70% is recommended.

2. No need to reduce carb % to lose fat. Weight lost on low-carb diet can be attributed to two factors: lower caloric intake, and loss of fat-free mass (FFM)

3. Added to the caloric reduction in low-carb diets, are dwindling glycogen stores. For every gram of glucose taken out of glycogen, it brings with it 2.7 g of water. This adds to weight loss in first week, but long-term success is not easily maintained.

6. *Carbohydrates and Weight Gain: The Facts*

1. At the turn of century, carbohydrate intake as a percentage of total energy was higher, fat as a percentage was lower. Only during the last two decades has there been a significant increase in obesity because of 2 factors: increased energy intake, and reduction in energy expenditure.

vi. <u>Review of properties of carbohydrates</u>

1. 1 gram of carbohydrate yields 4 calories
2. Satiety by keeping glycogen stores full and adding bulk to diet
3. Proper cellular fluid balance, maximizing cellular efficiency
4. Proper blood sugar levels with intake of low-glycemic carbohydrates
5. 'Spares' protein for building muscle

vii. <u>Body needs carbohydrates because</u>

1. Perfect and preferred form of energy
2. Constantly need to be replaced, causing craving that must be satisfied.
3. Parts of the CNS rely exclusively on carbs
4. They efficiently burn and use fat and protein

viii. <u>Recommended carbohydrate intake</u>

1. Daily diet should include 25g of fiber
2. Carb intake should be between 50-70% of total caloric intake according to preference, performance, and satiety
3. Carb recommendations should be estimated after protein and fat requirements are met
4. Fruits, whole grain, and vegetables, are all excellent sources of fiber.

D. Lipids

a. Lipids – A group of compounds that includes triglycerides (fats and oils), phospholipids, and sterols. 95% are fats and oils. In the body, 99% of stored lips are also triglycerides. Structurally, triglycerides are three fatty acids attached to a glycerol backbone. Either saturated or unsaturated.

i. *Unsaturated* – are associated with increases in good cholesterol (HDL) and decreased risk of heart disease.

1. Monounsaturated (found in olive and canola oils) – if fatty acid has 1 double bone in its carbon chain

2. Polyunsaturated (such as omega-3 found in cold-water fish) – if there is more than one point of unsaturation

i. Polyunsaturated provide important essential acids (fats that can't be manufactured by the body but are essential for proper health and functioning.

3. Both have favorable effects on blood lipid profiles and may play a roll in the treatment and prevention of heart disease, hypertension, arthritis, and cancer.

ii. *Saturated* – are implicated as a risk factor for heart disease because they raise bad cholesterol levels (LDL)

iii. *Trans-fatty acids* – the result of hydrogenation (the process of adding hydrogen to unsaturated fatty acids to make them harder at room temperature and increase food shelf-life)

1. Increase LDL cholesterol and decrease HDL cholesterol, much like saturated fats.

b. Function of Lipids

1. Most concentrated form of energy, 1 gram yields 9 calories when oxidized
2. Act as carriers for fat-soluble vitamins A, D, E, and K
3. Involved in cellular membrane structure and function
4. Precursors to hormones
5. Regulation and excretion of nutrients in the cells
6. Surrounding, protecting, and holding in place organs
7. Insulating the body from environmental temperature changes and preserving body heat
8. Prolonging the digestive process by slowing stomach's secretions of hydrochloric acid, creating a longer-lasting fullness feeling
9. Initiating the release of the hormone cholecystokinin (CCK), which contributes to satiety.

c. Digestion, absorption, and utilization

1. Starts in mouth, move to stomach, and is completed in small intestine

2. In intestine, fat interacts with bile to become emulsified so that pancreatic enzymes can break the triglycerides down into 2 fatty acids and a monoglyceride

3. Absorption occurs through intestinal wall in blood.

4. In intestinal wall, they are reassembled into triglycerides that are then released into the lymph in the form of a lipoprotein called chylomicron.

5. Chylomicrons from lymph move to the blood where triglyceride content of chylomicron is removed by the action of the enzyme lipoprotein lipase (LPL) and the released fatty acids are taken up by the tissues

6. Throughout the day, triglycerides are constantly cycles in and out of tissues including muscles, organs, and adipose

d. Recommendations

1. Between 10-30% of calories from fat.

2. Fat has lower *thermic effect (TEF)* than other macronutrients. This is the rise in metabolic rate after food is ingested. As fat % increases, amount of heat given off (TEF) decreases. As carb % increases, TEF increases.

3. Metabolically inexpensive to convert dietary fat to body-fat stores. Only 3% of calories in fat are required to store it as fat. It takes 23% of calories in carbohydrates to convert it to body fat

4. Dietary fats stimulate release of CCK, hormone that signals satiety.

5. Diets containing more than 30% of calories from fat lose the volume of food provided by higher-carb diets.

e. Fat Supplementation during Exercise

1. LCT –long-chain triglycerides which make up majority of fatty acids, take longer to be absorbed than MCTs (medium-chain), however insufficient evidence exists to recommend MCT supplementation as a exogenous energy source during endurance exercise.

f. Insulin resistance and obesity

1. Metabolic syndrome is a cluster of symptoms characterized by obesity and insulin resistance. However, IR alone will not allow for weight gain w/o energy intake in excess of

expenditure. Obesity itself is a risk factor for development of IR, not other way around.

2. If one constantly overeats, excess calories are stored in fat, fat cells then increase in size. The growing fat cell itself becomes insulin resistant and resulting prevalence of FFA causes body to favor use of fat as energy at expense of glucose, blood sugar levels rise, insulin levels rise, as well as cholesterol TG, and blood pressure.

3. Impaired ability of glucose to enter muscle cells keeps glycogen stores lower, which can increase appetite, causing vicious cycle, etc.

g. <u>Review of the Properties of Lipids</u>

1. 1 gram of fat yields 9 calories

2. fat is generally insoluble in water, and is present in all cells: high in adipose and nerve tissue, low in epithelial and muscle tissue.

3. Body needs fats for:

i. Energy

ii. Structure and membrane function

iii. Precursors to hormones

iv. Cellular signals

v. Regulation of uptake and excretion of nutrients in cells

4. Recommended fat intake:

i. Fat intake can range from 10-30%, according to performance, satiety, and palatability

ii. A high polyunsaturated-to-saturated fat ratio is desirable.

iii. Average American's fat consumption is between 30-42% of total calric intake

iv. More than 30% leads to overeating (lack of food volume) and often slows metabolism

E. Water – individual should consume 96 ounces of water per day. Those participating in fat-loss program should drink an additional 8 ounces of water for every 25 pounds they carry above ideal body weight.

a. Importance of Water

1. 60% of adult human body be weight

2. Endocrine gland function improves

3. Fluid retention is alleviated

4. Liver functions improve, increasing % of fat used for energy

5. Appetite decreases, metabolic function improves

6. Nutrients distributed throughout the body

7. Body-temperature regulation improves

8. Blood volume is maintained

b. Water and Performance

1. Fluid loss of even 2% of body weight will adversely affect circulatory functions and decrease performance levels.

2. Consume 16 oz of fluid 2 hours before exercise, additional 8-16 oz may be needed in warmer weather

3. Drink 20 to 40 oz for every hour of exercise

4. Fluids should be cold b/c of more rapid gastric emptying

5. If exercise exceeds 60 minutes, use of a sports drink (containing up to 8% carbohydrate) can replace both fluid & dwindling muscle stores

6. If exercise is less than 60 minutes, water is experts choice for fluid replacement

7. Goal is to replace sweat and urine losses

8. Ingest 20 oz of fluid for every pound of body weight lost after an exercise bout

F. Altering Body Composition

a. For Fat Loss:

1. Distribute protein, carb, & fat throughout the day and at each meal

2. Whole Grains and fresh vegetables over refined grains and simple sugars

3. 4-6 meals a day.

4. Avoid empty calories and highly processed foods

5. Lots of water (8-12 cups per day)

6. Clients should weigh and measure food for at least 1 week, making them more aware of caloric values and serving sizes

b. For Lean Body Mass Gain:

1. 4-6 meals a day – insulin response to a meal stimulates protein synthesis

2. Spread protein throughout the day to take advantage of previous tip

3. Ingestion of protein and carbs within 90 minutes of a workout will increase recovery and protein synthesis, maximizing gains, liquid supplement is best.

4. do no neglect the importance of carbohydrate and fat, it takes more than protein to increase lean body mass.

CHAPTER 16—*Supplementation* – Sales of $3.3 billion to $17.7 billion in 2002. Dietary Supplement Health and Education Act (DSHEA) passed in 1994, providing detailed legal definition of the term 'dietary supplement'

A. Dietary supplement – A substance that completes or makes an addition to daily dietary intake.

a. A dietary supplement is:

i. A product (other than tobacco) intended to supplement the diet and contains 1 or more of the following: a vitamin, a mineral, an herb or other botanical, an amino acid

ii. A dietary substance for use by man to supplement the diet by increasing the total daily intake

iii. A concentrate, metabolite, constituent, extract, or combinations of these ingredients

iv. Intended for ingestion in pill, capsule, tablet, or liquid form

vi. Not represented for use as a conventional food or as the sole item of a meal or diet

vii. Labeled as a 'dietary supplement'

b. Rationale for the use of Dietary Supplements

i. Specific health problems, enhancing physical/mental performances, altering body composition, stimulating metabolism, controlling appetite, or dealing with age-related changes in body structure and function

ii. Can help older people get all nutrients they need, can help pregnant women, can reduce chronic diseases in people

B. Supplementation Guidelines (Dietary Reference Intakes (DRI's))

a. Estimated Average Requirement (EAR) – The average daily nutrient intake level that is estimated to meet the requirement of half the healthy individuals who are in a particular life stage and gender group

b. Recommended Dietary Allowance (RDA) – The average daily nutrient intake level that is sufficient to meet the nutrient requirement of nearly all (97-98%) healthy individuals who are in a particular life stage and gender group.

c. Adequate Intake (AI) – A recommended average daily nutrient intake level, based on observed (or experimentally determined) approximations or estimates of nutrient intake that are assumed to be adequate for a group(s) of healthy people. This measure is used when an RDA cannot be determined.

d. Tolerable Upper Intake Level (UL) – The highest average daily nutrient intake level likely to post no risk of adverse health effects to almost all individuals in a particular life stage and gender group. As intake increases above the UL, the potential risk of adverse health effects increases.

C. Dietary Reference Intake Values and Guidelines

a. Excess Vitamin Intake Examples:

i. Excess intake of Vitamin A can cause birth defects

ii. Excess intake of Vitamin D can result in the calcification of blood vessels and eventually damage the function of the heart, kidneys, and lungs

iii. Excess intake of vitamin B6 can cause permanent damage to sensory nerves

b. Excess Mineral Intake Examples:

i. Excess (and inadequate) calcium intake can increase the risk of developing kidney stones

ii. Excess intake of iron can interfere with the absorption of other minerals (such as zinc) and can cause gastrointestinal irritation.

c. A drug or illness may increase or decrease the need for vitamins/minerals.

d. Nutrient levels that are perfectly safe for normal, healthy people can be life threatening to those with specific health problems

i. EX.- supplementation with Vitamins E and K can complicate conditions for people on blood thinners

e. Also, use of various drugs can contraindicate the use of specific nutrient supplements

f. When no UL has been established, doesn't mean there are no adverse effects for high intake, just no info. available to establish UL value.

g. Safe Upper Levels (SULs) provides safe upper levels for 8 nutrients and guidance levels for 22 vitamins and minerals, for which data were inadequate to set an SUL

D. Labels of Dietary Supplements

a. Units of Measure used on Dietary Supplement Labels

i. Based on 1968 RDAs for adults

ii. Most are still fairly accurate, however recommendations today for A, D, E, and iron are different

E. Vitamin and Mineral Supplements

a. Most commonly used supplement is a multi-Vit/Min)

b. Deficiencies of vitamins and minerals can impair ability and desire to perform physical activity and also cause mental and emotional problems

c. Most nutrients in a multi-vitamin should be around 100% of DV except for the following:

1. Vitamin A (present only as retinol) should be less than 100% of the DV, high intake is associated with hip fracture in older women and increases risk of birth defects

2. B-Carotene is contraindicated in smokers

3. Calcium should be at low levels or absent, is better to have throughout the day, if taken all at once can decrease the absorption of other minerals.

d. People are more likely to consume excessive amounts of the following nutrients from supplementation and fortified foods combined:

1. Vitamin A, D, Iron, and Zinc

CHAPTER 17—Behavior Modification

A. Five Steps to help clients achieve more:

a. **Step One - Vision –**

i. Those who are certain about what they want to accomplish are up to **6 times more likely** to successfully make life changes

ii. Root cause analysis – A method of asking questions on a step-by-step basis to discover the initial cause of a fault

1. Just keep asking 'why?'

2. Uncovers motivations behind superficial answers

iii. What would you try to accomplish if you knew you couldn't fail? What would you do if you won the lottery? Who are you role models? What kinds of experiences do you find so engrossing that, when you engage in them, you forget about everything around you?

b. **Step Two – Strategy –**

i. 6 useful principles of goal setting (SCAMPI)

1. S – Specific goals result in better performance

2. C – Challenging goals tend to accomplish more than modest goals

3. A – Approach to goal setting should be on desired ends to move toward

4. M- Measurable goals let a client know whether the strategy is working

5. P – Proximal, short-term goals raise sense of confidence and determination

6. I – Inspirational goals should be consistent with ideals and ambitions

c. **Step Three – Belief –**

i. Can be fostered by having clients start with modest attainable goals, increasing them in small increments

ii. Should have visualizations of success, as well as proper form

iii. Possibly schedule negativity, or make it location specific.

d. **Step Four – Persistance** -

i. For example, people who successfully maintain New Year's resolutions after 2 years, report 14 slips, but use setbacks as motivation.

ii. Reward success, facilitate networks of excellence, and have a strategy for setbacks, such as calling a friend in the event of a slip-up or to carry a ‘reminder card.’

e. **<u>Step Five – Learning</u> -**

i. Self-monitoring – keeping records of eating and exercise, enhances accountability and keeps clients focused on their ultimate objectives.

ii. Share past data with clients and review progress, create charts/date of progress.

iii. Go further, focus on ‘controllable behaviors,’ have clients wait to weight themselves, analyze data for course corrections.

CHAPTER 18—*Professional Development*

A. Customer Service

a. **<u>Uncompromising customer service</u> –** being adamant about providing an experience and level of assistance that is rarely, if ever experienced anywhere else

B. The Customer

a. Avoid the following when approaching a club member doing an exercise

1. May I make a suggestion? Can I recommend a better way of doing that? Can I show you a different technique? Let me show you the right way? Can I help you with that? What's your goal for that exercise?

2. Rather, ask them if they want to know how to maximize the exercise.

C. The READ system

a. **R**apport – Aspect of a relationship characterized by similarity, agreement, or congruity.

1. Effective communication- **only 7% is verbal; 38% is tone of voice; 55% is physiology (the way a person stands, whether or not they smile, degree of contact**.

2. Confidence, Enthusiasm, Professionalism

b. **E**mpathy – Action of awareness, understanding, and sensitivity of the thoughts, emotions, and experience of another without personally having gone through the same.

1. All decisions and actions are the result of motivation.

2. 4 initial questions: What are you trying to achieve? How long has this been your goal? What is the most important to you about achieving that? What has prevented you from achieving it in the past?

3. This 3rd question determines why the client's goal motivates him or her.

4. Clients may be motivated either to alleviate discontent, or to experience satisfaction (or combo).

c. **A**ssessment – A process of determining the importance, size, or value of something.

1. Nondirective questions – Can't be answered with 'yes' or 'no.' In other words, open-ended questions

2. Directive questions – Answered with 'yes' or 'no'

3. Paraphrasing – shows a client that health professional is listening and understand what the client is saying.

d. **D**eveloping Solutions – the program that best meets needs

4. Features vs. Benefits – *features* of personal training and products are the number of sessions, what materials come with product, assessments that will be taken, etc. *benefits* are how the features help a client get to their goals. Every time a feature is explained to a client, be sure to correlate it back to answering his or or her mental question, 'What's in it for me'

D. Asking for the Sale

a. Most sales are lost b/c they are not asked for. Failure to close comes down to following:

1. There was not enough value built into the sale

2. An insufficient level of rapport makes the potential client hesitant to go ahead.

3. The health and fitness professional did not affirmatively ask for the sale

4. The potential client legitimately does not have the ability to pay.

b. No today is not a No indefinitely. Contacts help sales grow