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 efferent 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.

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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

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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*

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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

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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

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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.

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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

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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.

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

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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.

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

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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).

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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.

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.

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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. Review of the Properties of Lipids

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

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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.

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***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.

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