UNITED STATES MARINE CORPS
FORCE FITNESS READINESS CENTER
THE BASIC SCHOOL
24191 GILBERT ROAD
QUANTICO, VIRGINIA 22134

STUDENT OUTLINE

ANATOMY AND PHYSIOLOGY I

FFIC1020

FORCE FITNESS INSTRUCTOR COURSE

M02MN1T

APPROVED BY: LtCol (Ret) Shusko, J. C. DATE: 20190401 INT:

LEARNING OBJECTIVES

a. TERMINAL LEARNING OBJECTIVES

(1) Given a unit to train, supervise injury prevention to increase Marine and unit readiness. (0919-TRNG-2004)

b. ENABLING LEARNING OBJECTIVES

(1) Without the aid of reference, identify the positions of the human body without error. (0919-TRNG-2004d)

(2) Without the aid of reference, identify the planes of the human body without error. (0919-TRNG-2004e)

(3) Without the aid of reference, identify the movements of the human body without error. (0919-TRNG-2004f)

(4) Without the aid of reference, match the system of the body to its description without error. (0919-TRNG-2004g)

(5) Without the aid of reference, identify major bones of the human body without error. (0919-TRNG-2004h)

(6) Without the aid of reference, define the function of ligaments within the human body without error.(0919-TRNG-200i)

(7) Without the aid of reference, identify the function of the myofascial system without error. (0919-TRNG-2004j)

(8) Without the aid of reference, identify major muscles of the human body without error. (0919-TRNG-2004k)

(9) Without the aid of reference, define the function of tendons within the human body without error. (0919-TRNG-2004k)

(10) Without the aid of reference, describe in writing, human muscle contraction without error without error. (0919-TRNG-2004m)

(11) Without the aid of references, define the different muscle fiber types of the human body without error. (0919-TRNG-2004n)

INTRODUCTION: There are three planes of movement for the human body. The body is comprised of many various systems to support these movements. In this class, you will learn the different

ways the body moves and gain a basic knowledge of bodily systems. This information serves as the foundational information for other classes such as biomechanics, nutrition, and practical application of exercise.

1. REFERENCE POSITIONS AND DIRECTION. When performing a movement or exercise it is critical for the Force Fitness Instructor (FFI) to understand the positions and directions of the human body. The FFI will be better prepared to give specific descriptions and education in exercise.

a. Positions of the Body

(1) Anatomical position. This is the standard position from where all references and directions start: standing upright, legs together and knees straight, toes pointing straight forward, arms by the side, palms facing forward.

(2) Supine. The position of lying down, face up.

(3) Prone. The position of lying down, face down.

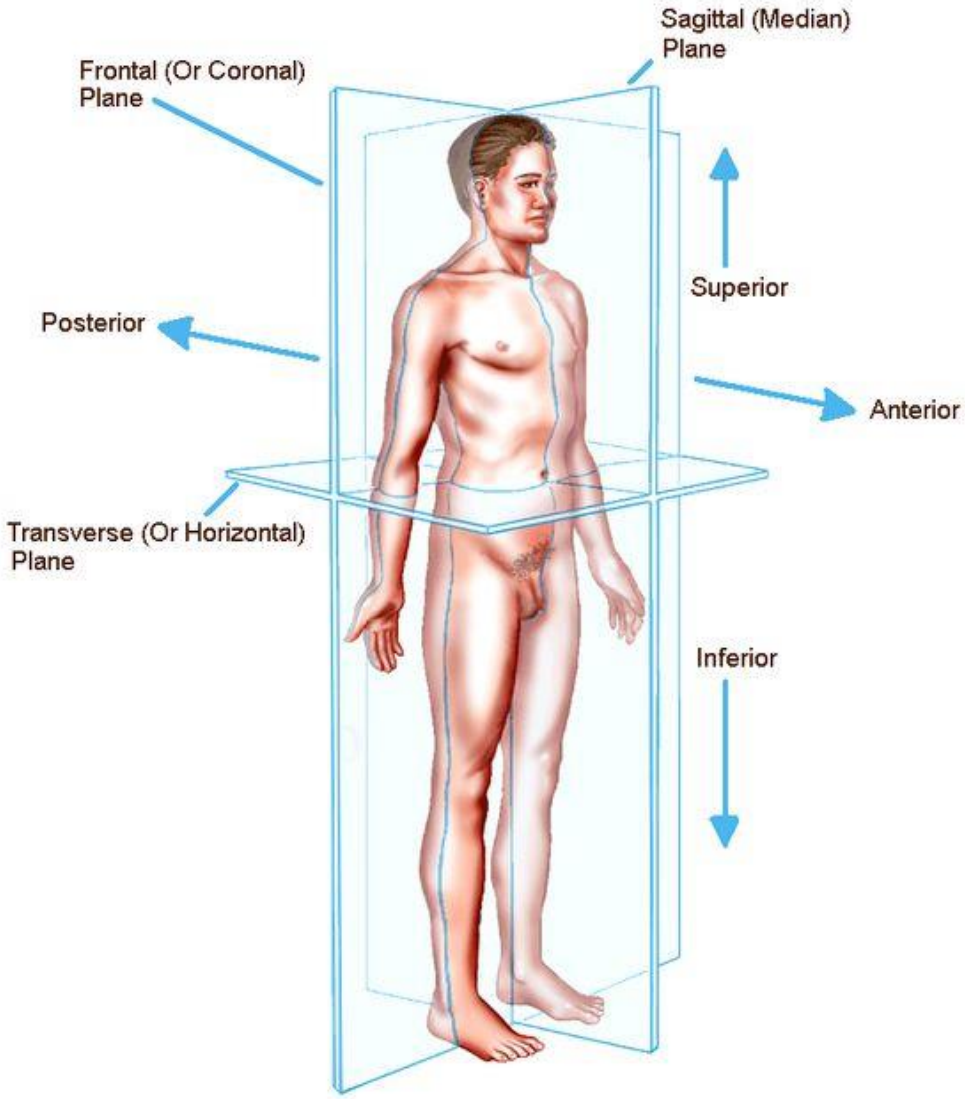
b. Planes and Sections

(1) Sagittal plane. The sagittal plane divides the body into left and right. It passes through the body down the middle. Movements in this plane are the up and down movements like flexion and extension.

(2) Frontal plane. The frontal plane divides the body into front and back. It passes through the side of the body. Movements in this plane are lateral movements like abduction and adduction.

(3) Transverse. This plane divides the body into top and bottom. Movements in this plane are rotational like internal and external rotation, or pronation and supination.

c. Directional Terms



(1) Superior. Definition: above, toward the head or upper part of the structure.

(2) Inferior. Definition: below, away from the head or lower part of the structure.

(3) Anterior. Definition: in front of, front. The sternum (breastbone) is anterior to the heart.

(4) Posterior. Definition: after, behind, nearer to or back of the body.

(5) Medial. Definition: toward the mid-line, middle, away from the side.

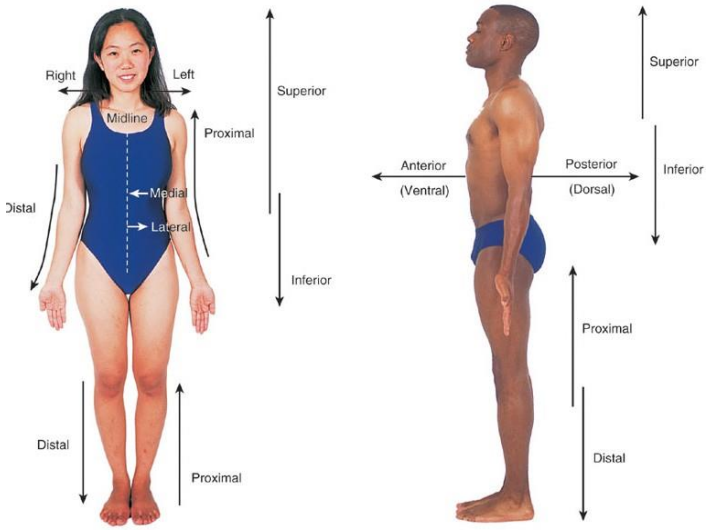
(6) Lateral. Definition: toward the side, away from the mid-line.

(7) Proximal. Definition: near, closer to the origin.

(8) Distal. Definition: away from, farther from the origin.

(9) Superficial. Definition: situated near the surface of the body.

(10) Deep. Definition: describes structures that are away from the surface of the body. The ribs are deep to the skin.



d. Movements

(1) Flexion. A movement which decreases the angle at the moving joint. This movement occurs in the sagittal plane.

(2) Extension. A movement which increases the angle at the moving joint. The opposite movement of flexion. This movement occurs in the sagittal plane.

(3) Abduction. Taking the limb away from the central line of the body. This movement occurs in the frontal plane.

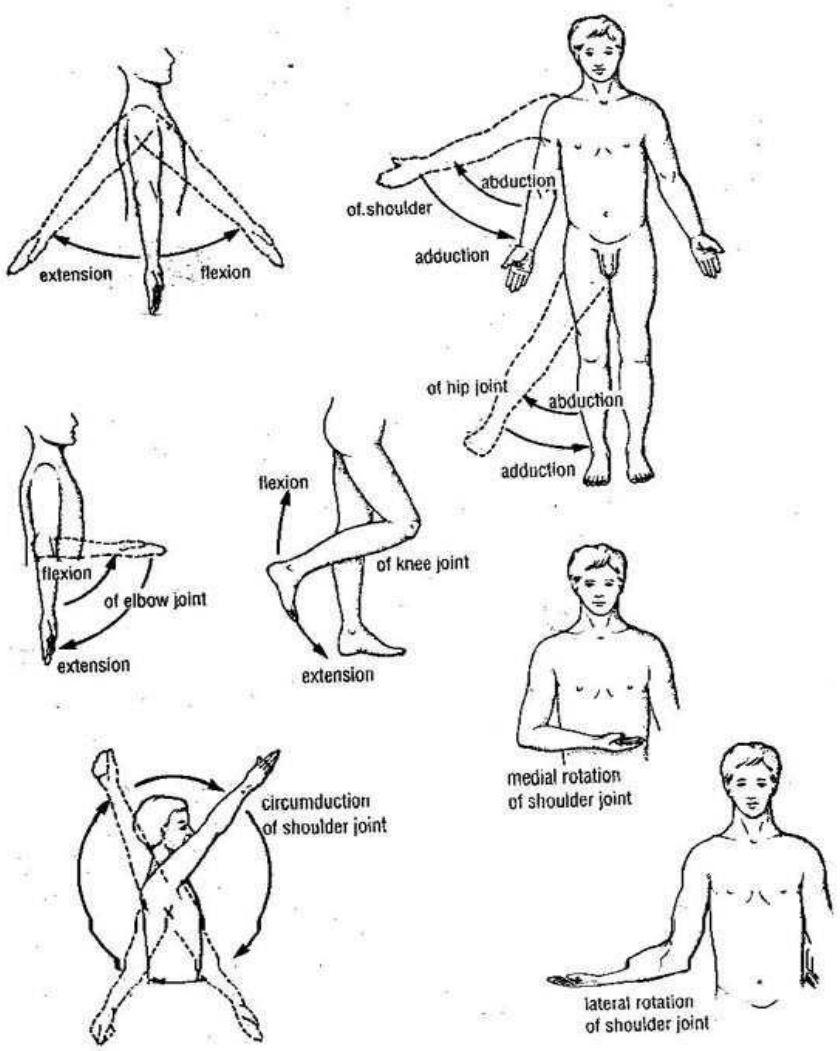
(4) Adduction. Taking the limb towards the central line of the body. This movement occurs in the frontal plane.

(5) Rotation. This movement includes any twisting motion. This movement occurs in the transverse plane. Joints which permit rotation include the shoulder and hip as an example.

(6) Circumduction. A combination of all movements above. It is possible at the ball and socket joint, as if you were to draw a circle with your arm.

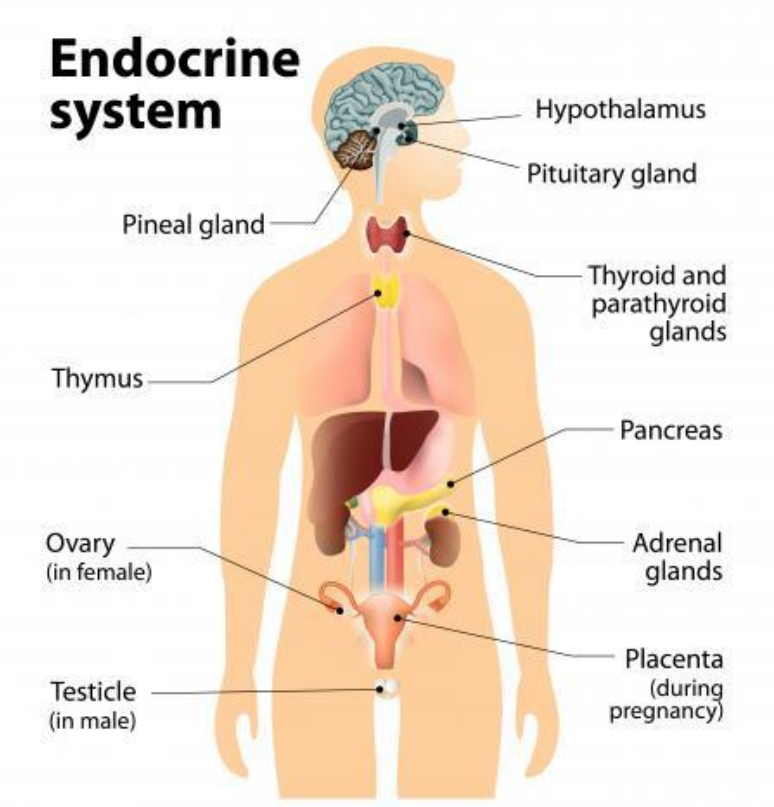
(7) Pronation. Pronation is the movement of turning the palm over to face downwards from the anatomical position.

(8) Supination. Supination is the opposite movement of pronation, of turning the palm up or forwards into an anatomical position.



2. SYSTEMS OF THE BODY. The human body is divided into several systems and each has specific functions. This will become base knowledge of exercise physiology in future classes.

a. Endocrine System. The endocrine system regulates body activities by releasing hormones, which are chemical messengers transported in blood from gland to specific organ.



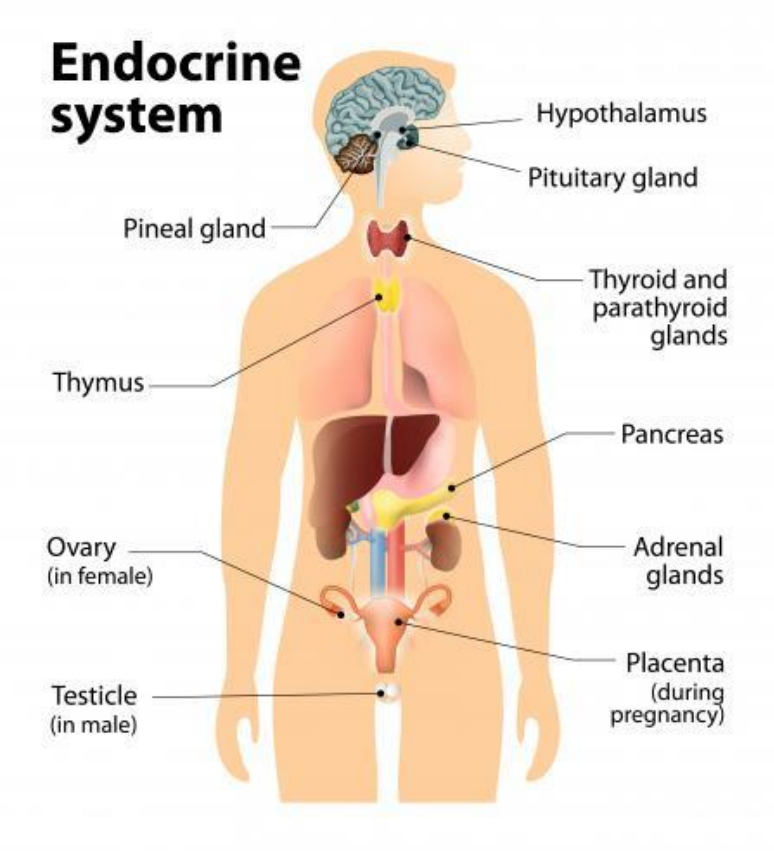
(1) Pituitary Gland. During exercise, the pituitary gland releases human growth hormone, which tells the body to increase bone, muscle, and tissue production.

(2) Thyroid Gland. When you start exercising, the thyroid gland (located at the base of the neck) sends out hormones that regulate the body's temperature, heart rate and blood pressure. It also regulates the alertness and focus needed to work at a high intensity.

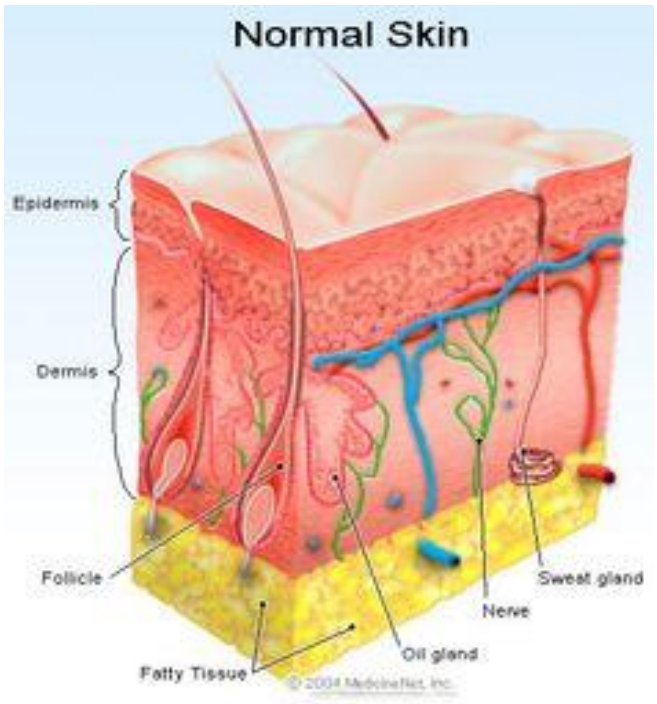
(3) Adrenal Gland. Located at the top of the kidneys, the adrenal glands are responsible for the release of cortisol into the bloodstream. Cortisol levels control blood pressure, glucose and act as an anti-inflammatory agent. The adrenal glands also releases aldosterone, a hormone that regulates

hydration levels, the speed of the heart and the strength of contractions. It also turns stored carbohydrates into energy.

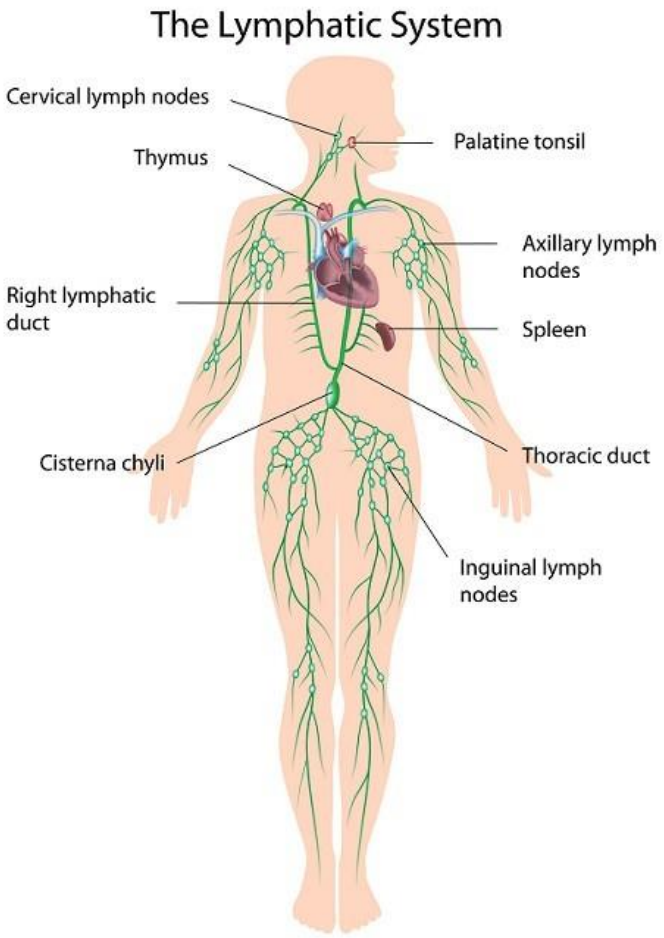
(4) Pancreas. Insulin regulates glucose, or blood sugar, by transporting it to the muscles and tissue that use glucose for energy. Excessive insulin in the blood reduces your sensitivity to insulin and can cause diabetes, which is also linked to overweight and obesity. Exercise improves insulin sensitivity and reduces the reliance on insulin injections.



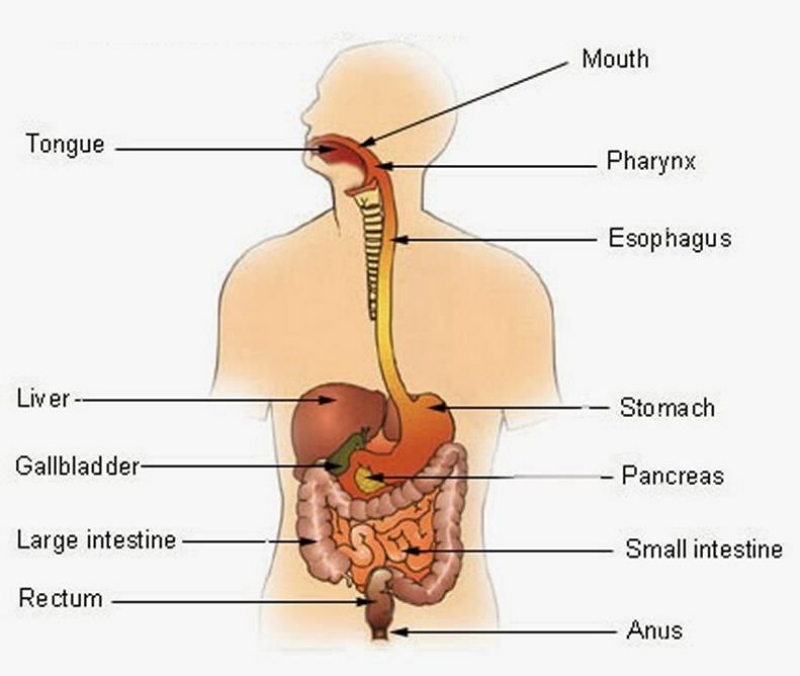
b. Integumentary System. The integumentary system protects the body, detects sensation, and produces vitamin D. Most often we relate this system to sweating (evaporation), skin injuries (blisters) and infections (ringworm, dermatitis) during training.



c. <u>Lymphatic System</u>. The lymphatic system returns proteins and fluid to blood and carries lipids from intestines to blood. The lymphatic system is also involved with fighting bacteria and infection. It is a "return" system of fluid.


The Lymphatic System
Cervical lymph nodes
Thymus
Palatine tonsil
Axillary lymph nodes
Right lymphatic duct
Spleen
Cisterna chyli
Thoracic duct
Inguinal lymph nodes

d. Digestive System. The digestive system achieves physical and chemical breakdown of food, absorbs nutrients, and eliminates waste. Most exercise has a positive effect on the digestive system helping to quell appetite and increase metabolism. Some endurance events sometimes cause competitors to have an upset stomach and diarrhea.



(1) Stomach. The stomach acts as a reservoir for the food where it may remain between 2 and 6 hours. Here, the food is churned over and mixed with various enzymes, hydrochloric acid, and other chemicals; all of which are secreted further down the digestive tract. The stomach has an average capacity of 1 liter and is capable of considerable distension. When expanding, stimuli is sent to the hypothalamus which is the part of the brain and nervous system which controls hunger. The wall of the stomach is impermeable to most substances, although does absorb some water, electrolytes, certain drugs, and alcohol.

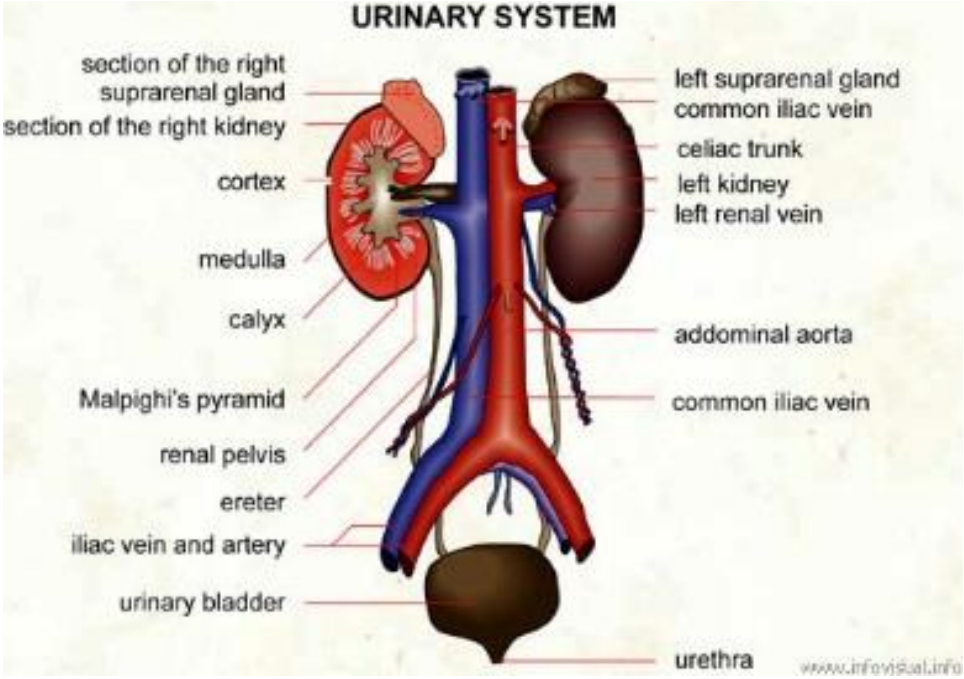
(2) Small intestine. The small intestine measures about 7 meters. Both the bile (from the liver) and pancreatic (from pancreas) ducts open into the small intestine together. The small intestine provides a vast surface area where further absorption takes place. There is a large blood supply to this area, ready to transport nutrients to the rest of the body.

(3) Pancreas. The pancreas has two main functions: to produce enzymes to aid the process of digestion and to release

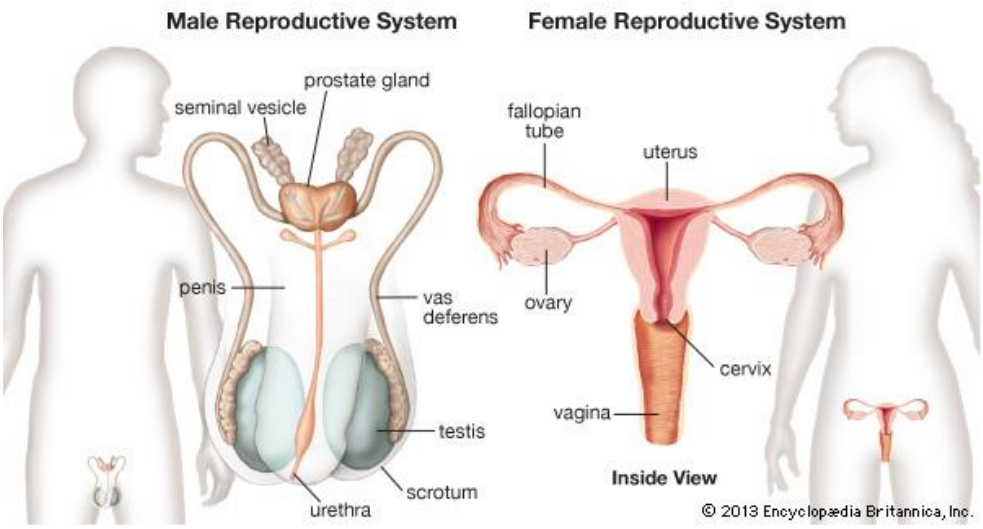
insulin directly into the blood stream for the purpose of controlling blood sugar levels.

(4) Liver. The liver, which acts as a large reservoir and filter for blood, has several important functions: secretion of bile to the gall bladder (break down fats), metabolism of carbohydrates, protein and fat, storage of glycogen ready for conversion into glucose when energy is required, and the storage of vitamins.

e. Urinary System. The urinary system has multiple functions, such as excreting toxins and metabolic by-products, maintaining the body's fluid and acid-base balance; regulating electrolyte levels, and secreting several important hormones.



f. Reproductive System. The reproductive system releases hormones and creates human life.



3. SKELETAL SYSTEM IN DEPTH.

a. Functions. The skeletal system supports and protects vital organs, provides attachment, stores minerals, and gives rise to blood cells.

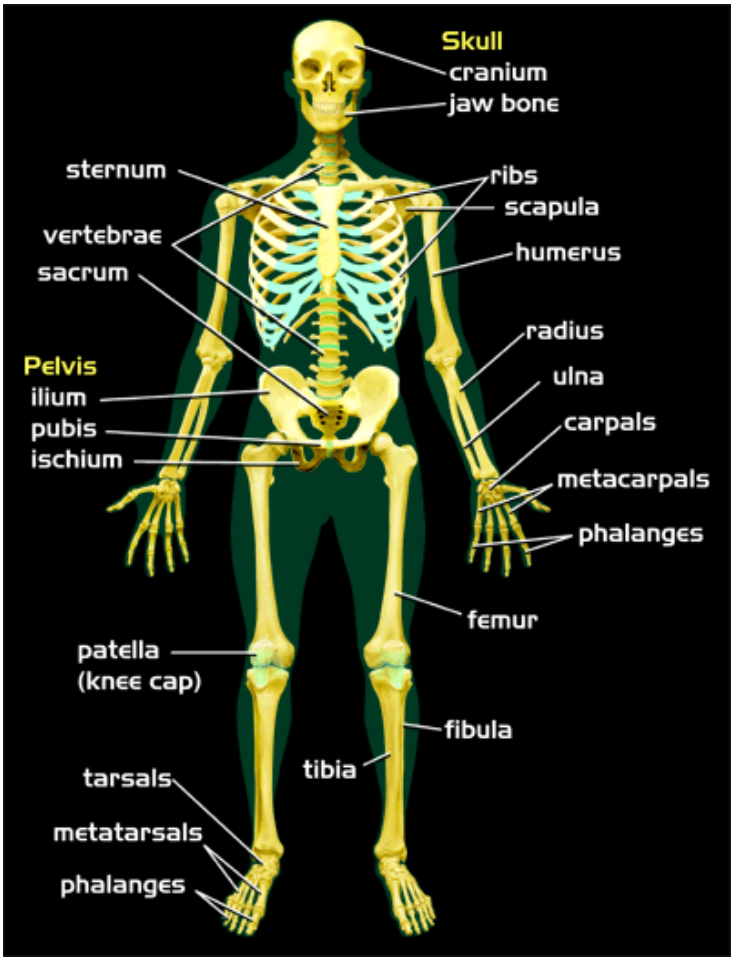
(1) Protects vital organs. For example, the rib cage will protect the vital organs of the heart and lungs. Your cranium protects the brain.

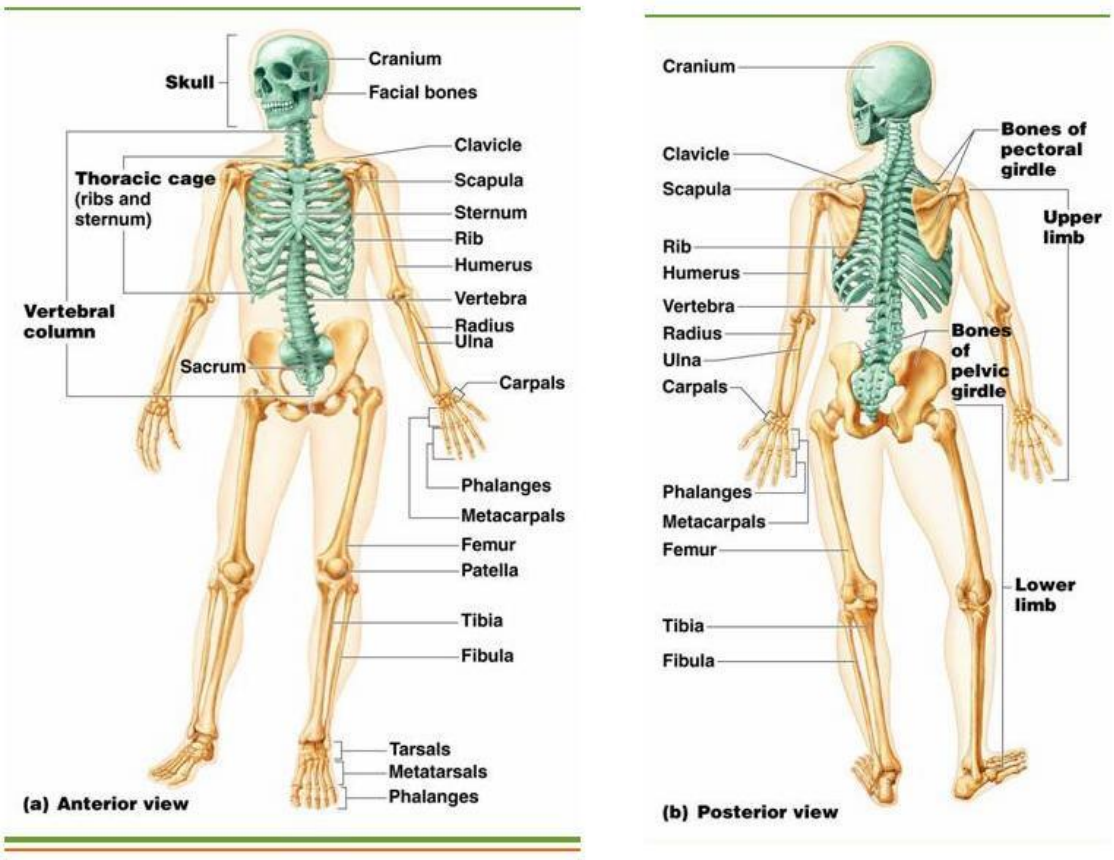
(2) Provides attachment and structure. Muscles attach to the bone to create movement. Bones give the human body shape and the base frame work.

(3) Stores minerals. Bones store key minerals such as calcium and magnesium.

(4) Ligaments. While "ligaments" are considered a type of tissue and not classified in the skeletal system, it is worth noting that bones are jointed together using ligaments. A common knee ligament is the ACL or Anterior Cruciate Ligament. More will follow in the Common Injuries lecture.

b. Anatomy. The major bones of the body are labeled in the second diagram below: skull, cranium, jaw bone, ribs, scapula, humerus, radius, ulna, carpals, metacarpals, phalanges, vertebrae, sacrum, pelvis, femur, patella, tibia, fibula, tarsals, metatarsals, phalanges.





(1) Axial. The axial skeleton has three main parts.

(a) Skull. The skull holds the brain in a liquid suspension.

(b) Spine. The spine is composed of individual bones separated by disc cartilage, and protects the spinal cord.

(c) Rib cage. The ribs protect vital organs with 12 pairs of ribs.

(2) Appendicular. The appendicular skeleton includes the body's limbs and girdles.

(a) Arms. The arms are used for lifting and carrying.

(b) Legs. The legs are used for movement and propulsion.

4. MYOFACIAL SYSTEM IN DEPTH. The myofascial system includes all the muscles of the body and the fascia (encasement tissue) that surrounds it. It will be necessary to identify the major muscles of the body.

a. Functions. There are several main functions of the myofascial system.

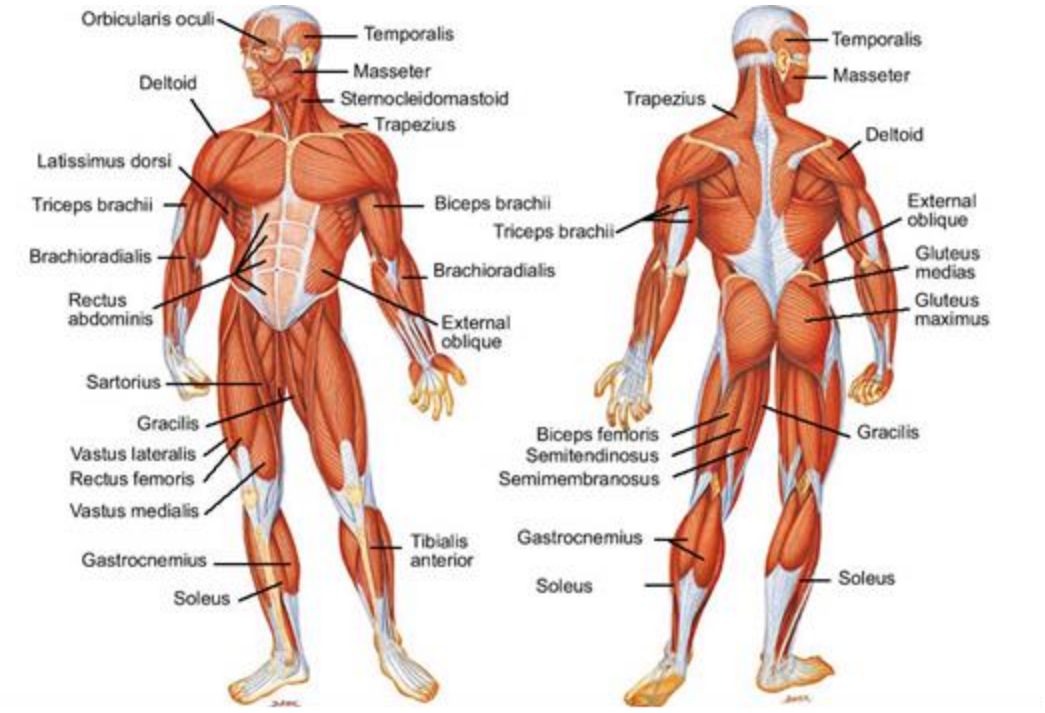
(1) Body movements. This system coordinates total body movements such as running and walking. Also, localized motions such as writing or nodding the head.

(2) Stabilizing body positions. The myofascial system increases the stability of joints and maintains body positions such as sitting. The myofascial system help keep joints within their intended space and stabilize the joint during motion.

(3) Moving substances in the body. Cardiac muscle moves blood through the body. Smooth muscles move food and substances in the gastrointestinal tract. Skeletal muscle contractions promote blood flow.

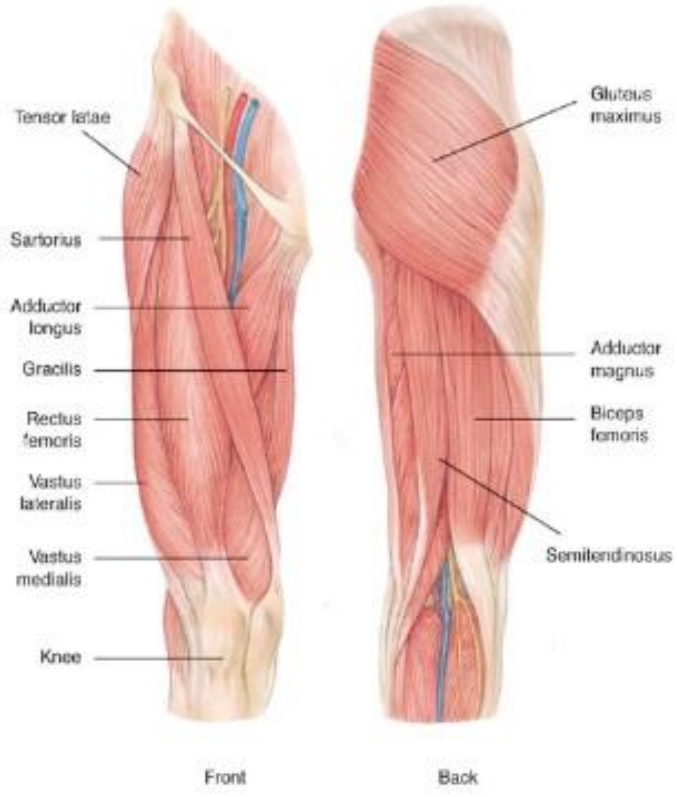
(4) Providing heat. As muscle contracts, it produces heat. As temperature increases, muscles help release the heat. Involuntary muscle contractions such as shivering can increase rate of heat production.

(5) Tendons. It is worth noting that muscles attach to bones using tendons. A common knee tendon is the patella tendon. It is the same tendon doctors use to test the knee reflex. More will follow in the Common Injuries lecture.

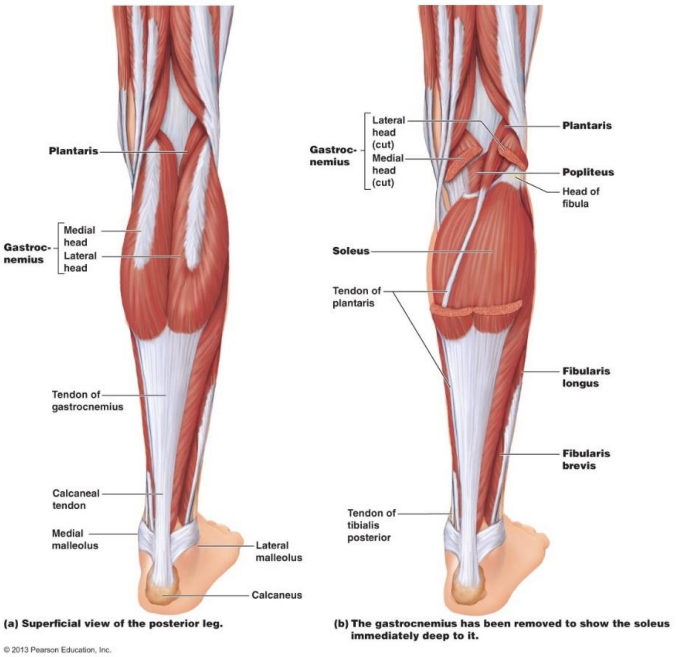


b. <u>Anatomy.</u> There are numerous muscles in the human body, the picture below serves as a reference of the individual muscles. For the purpose of this class we will group the major muscles together.

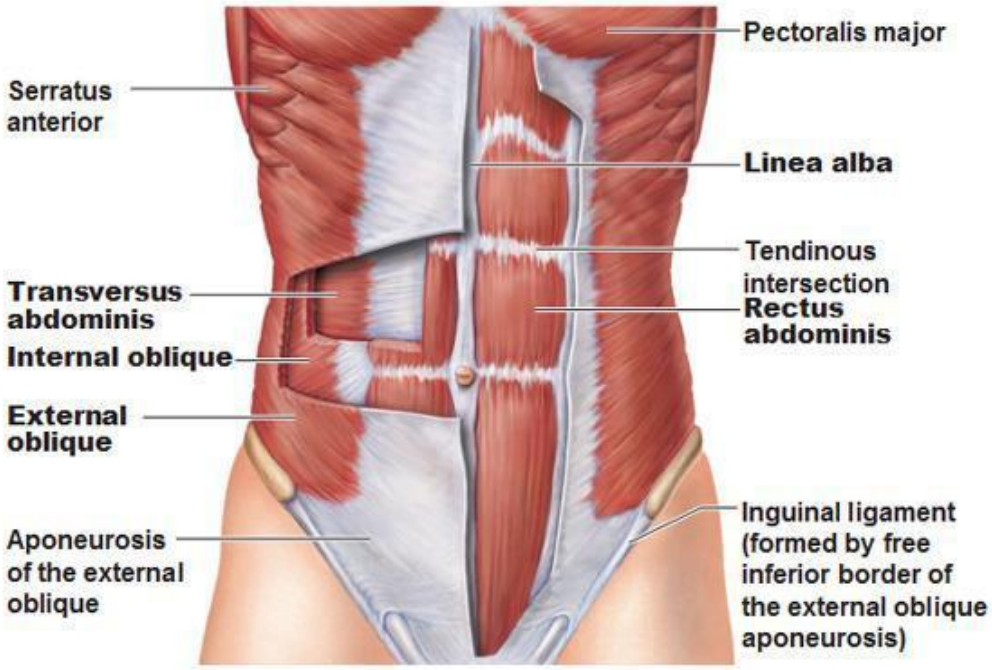
(1) <u>Major muscles of the lower body:</u> The major muscles of the lower body are: hamstrings, quadriceps, gluteus maximus, gastrocnemius, and soleus muscles.

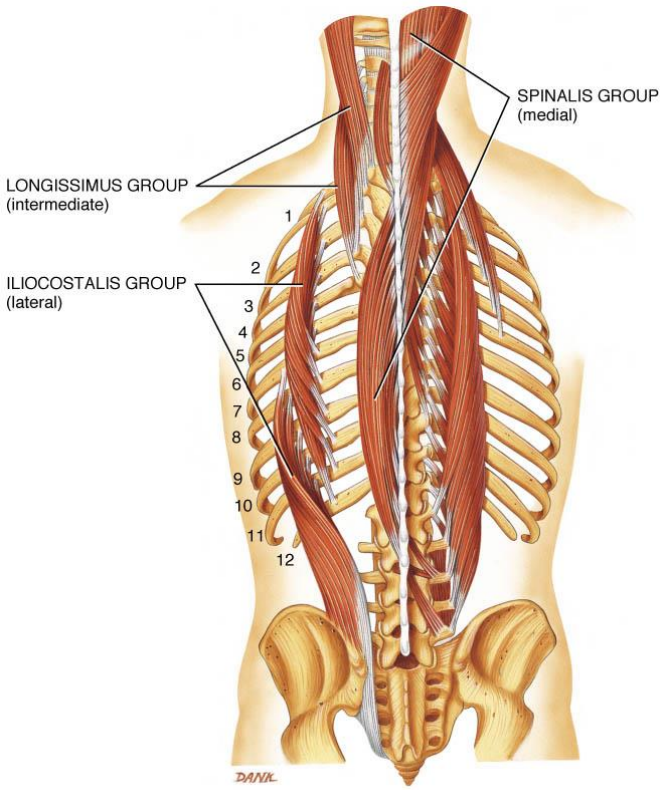


The muscles of the thigh region.

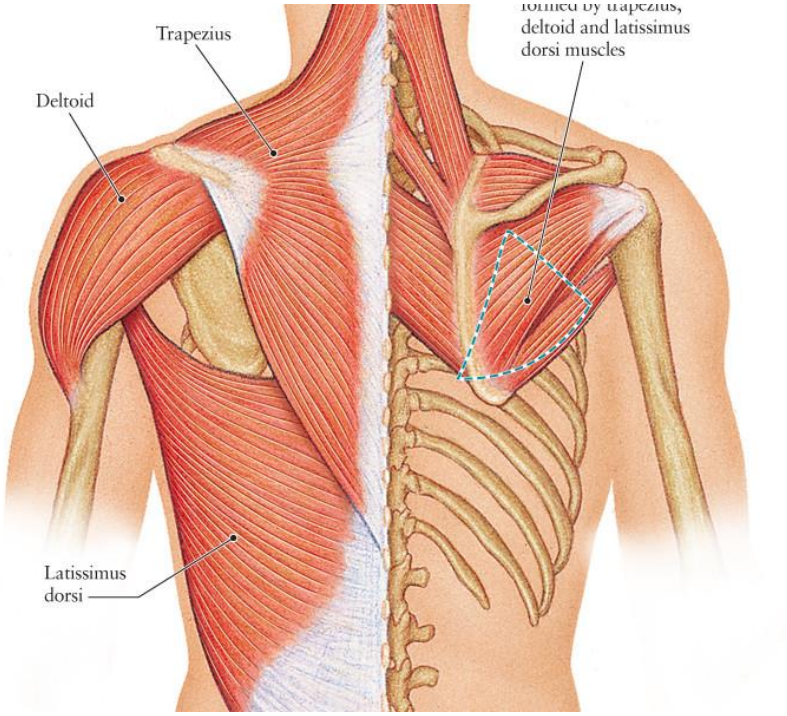


(2) Major muscles of the trunk: The major muscles of the trunk body are: external oblique, internal oblique, transverse abdominis, and rectus abdominis. You can see the pectoralis major at the top of the picture. The deep muscles of the back (posterior view) can be grouped as the erector spinae muscle group. The more superficial muscles of the back are latissimus dorsi and trapezius. The deltoid muscle is better viewed from the lateral view but the posterior muscle fibers can be seen here.

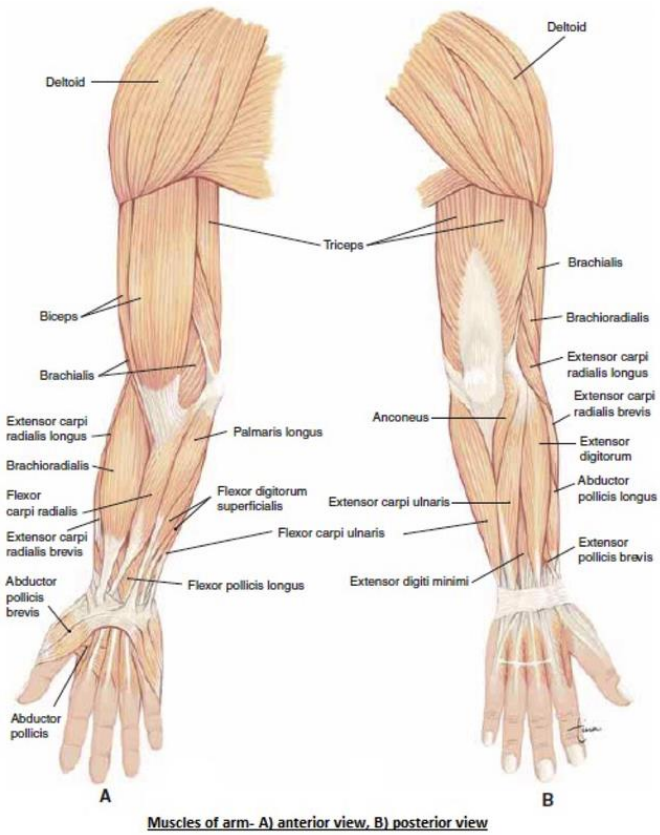




Posterior view of erector spinae muscles



(3) Major muscles of the upper body. The main muscle of the upper arm are the biceps (anterior) and triceps (posterior). The main muscles of the lower are going to be generalized in the forearm. The distal anterior arm muscles are the "wrist flexors," and the distal posterior arm muscles are the "wrist extensors."



Muscles of arm- A) anterior view, B) posterior view

c. Connective Tissue. Connective tissue (fascia) surrounds and protects muscle tissue.

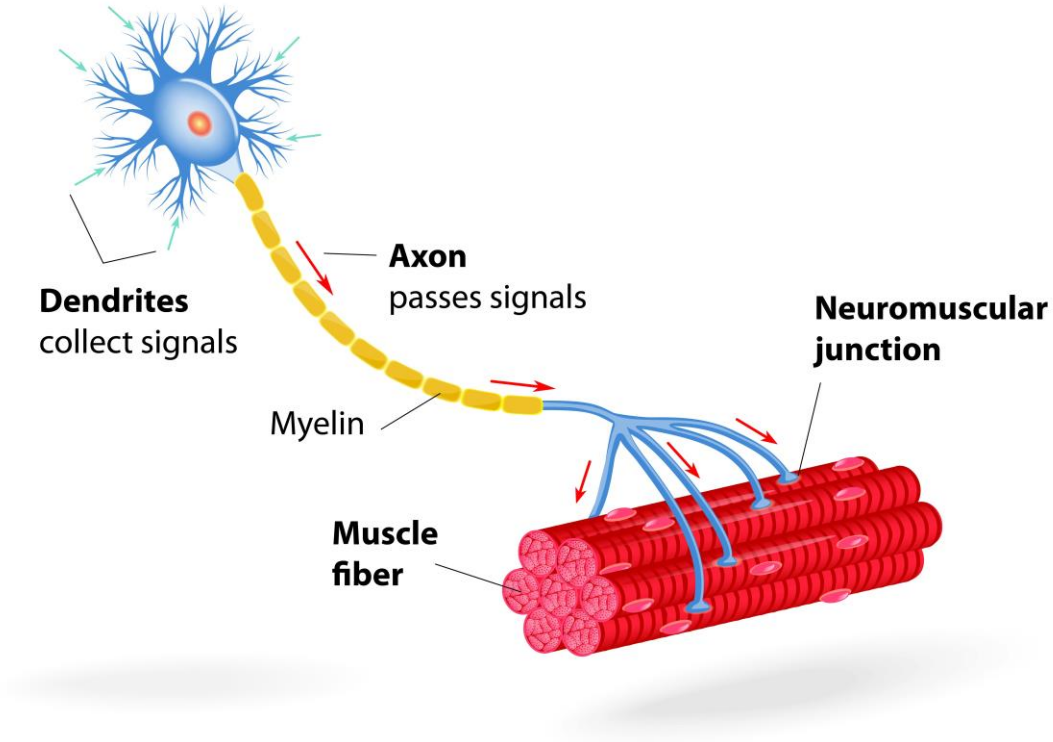
(1) Fascia. Fascia is defined as a sheet or broadband of fibrous tissue deep to the skin, and surrounds muscles and other types of organs in the body.

(2) Fascia in Muscle. Fascia separates muscle from skin and provides a pathway for nerves and blood vessels to enter and exit the muscles. It allows free movement of muscles, carries nerves, blood and lymphatic vessels, and fills the space between muscles. Adhesions may occur naturally with use, disuse,

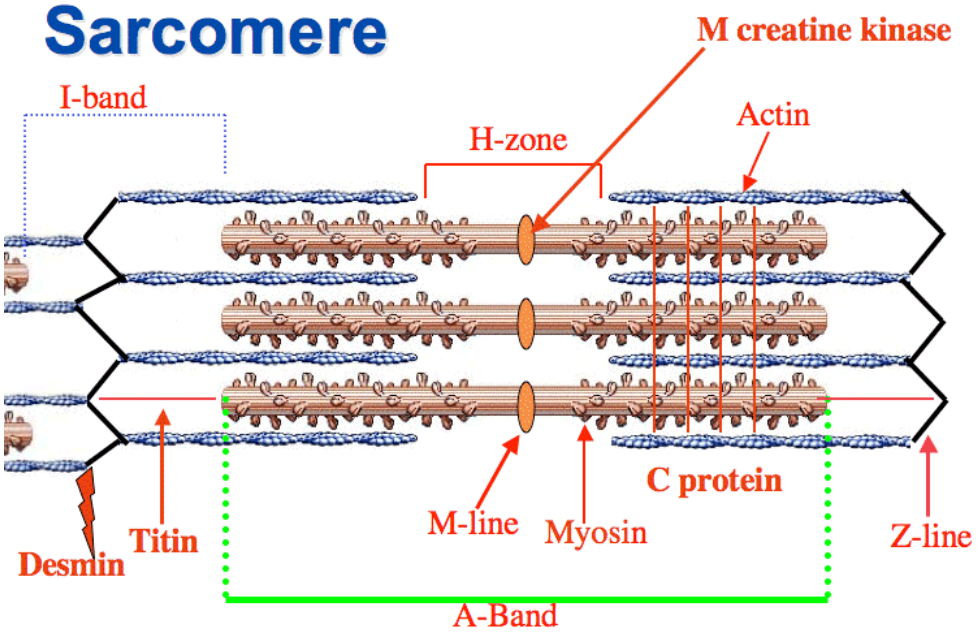
exercise, or injury. Fascia can restrict overall mobility and be a part of force production in muscle strength.

d. Muscle contractions

(1) Motor unit. A motor unit is the nerve fiber and all the muscle fibers it innervates. A single motor unit has an average of 150 muscle fibers. Force production = recruitment of more motor units.



(2) Sarcomere. A sarcomere is the smallest functional unit of a muscle fiber. Characterized from Z-line to Z-line (below). The sarcomere is made up of thick and thin filaments. Thick and thin filaments form cross bridges to shorten the muscle fiber.



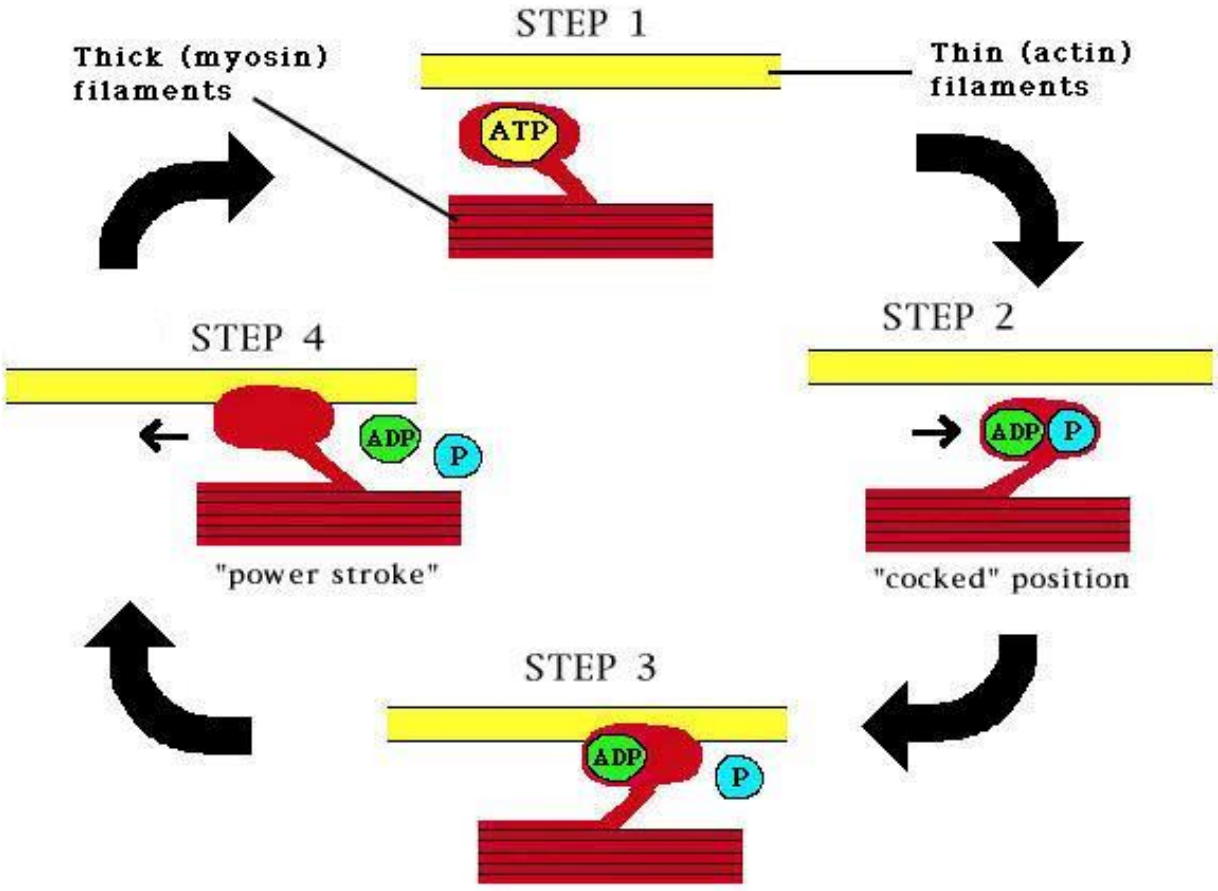
(3) Contraction step 1 (release & energize). The first step, in the cycle involves the binding of a molecule of adenosine triphosphate (ATP) to the myosin head. When the ATP binds, the myosin head releases from the thin filament and is ready to undergo the contraction cycle.

(4) Contraction step 2 (slide forward). In the second step, the myosin head breaks down the bound ATP molecule into ADP and P, but instead of releasing the products, the myosin head holds onto the ADP and P. This causes the myosin head to make its first change in shape. It enters the "cocked" position as it slides forward.

(5) Contraction step 3 (bind & excited). The third step is when the excited myosin head binds to the actin strand (thin filament). When this occurs, the P that was bound to the myosin head is released. When it is released, the actin binding site on the myosin molecule is exposed. The actin and myosin head are tightly held together for the remainder of the cycle. While

the release of the P molecule causes a change in shape of the myosin head, it is still in the excited cocked state in this step.

(6) Contraction step 4 (power stroke). The final step is when the myosin head releases the bound ADP. When this happens, the myosin head leaves its excited state and returns to the position where it began. But this time, the myosin head is tightly bound to the thin filament, so when the myosin head shifts, it pulls the thin filament with it. This shift of the actin and myosin is called the "power stroke". In this step, the energy that was generated by breaking down ATP, and stored in the excited "cocked" position of the myosin head is finally used to contract the muscle. After the "power stroke", the cycle is completed when the myosin head binds to a new ATP molecule, if ATP is available, causing the myosin head to let go of the actin strand.



e. Muscle fiber types

(1) Slow Twitch. Slow twitch fibers develop force slowly and relax slowly.

(a) Type I. Type I fibers (slow twitch) are described as the following: slow, withstands fatigue, efficient, aerobic capacity. Limited in maximum force development and has low anaerobic power. Example: a professional marathon runner has more Type I fibers.

(2) Fast twitch. Fast twitch fibers develop force quickly and relax quickly.

(a) Type IIa. Type IIa fibers are described as: fast, inefficient and fatigable with *moderate* aerobic power. They create rapid force development and have high anaerobic power. You can summarize this fiber type as an "in between" muscle fiber not truly fast or slow. Type IIa fibers have a higher capacity for aerobic power compared to IIx due to an increase of capillaries surrounding the muscle. Example: Running the (800M) will use the type IIa fibers.

(b) Type IIx. Type IIx fibers are described as: fast, inefficient and fatigable with *low* aerobic power. They create rapid force development and have high anaerobic power. These are considered "true" fast twitch fibers.

	Type I fibers	Type II a fibers	Type II x fibers
Contraction time	Slow	Moderately Fast	Fast
Size of motor neuron	Small	Medium	Large
Resistance to fatigue	High	Fairly high	Intermediate
Activity Used for	Aerobic	Long-term anaerobic	Short-term anaerobic
Maximum duration of use	Hours	<30 minutes	<5 minutes
Power produced	Low	Medium	High
Mitochondrial density	High	High	Medium
Capillary density	High	Intermediate	Low
Oxidative capacity	High	High	Intermediate
Glycolytic capacity	Low	High	High
Major storage fuel	Triglycerides	Creatine phosphate, glycogen	Creatine phosphate, glycogen

SUMMARY: While reviewing the systems individually, you can see how each system is integrated with other systems. You may now be able to see how nutrition and supplements can affect the human body's system. Finally, the basic understanding of anatomy and physiology will be the basis of kinesiology and biomechanics.

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