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Sample Material

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V-Skills

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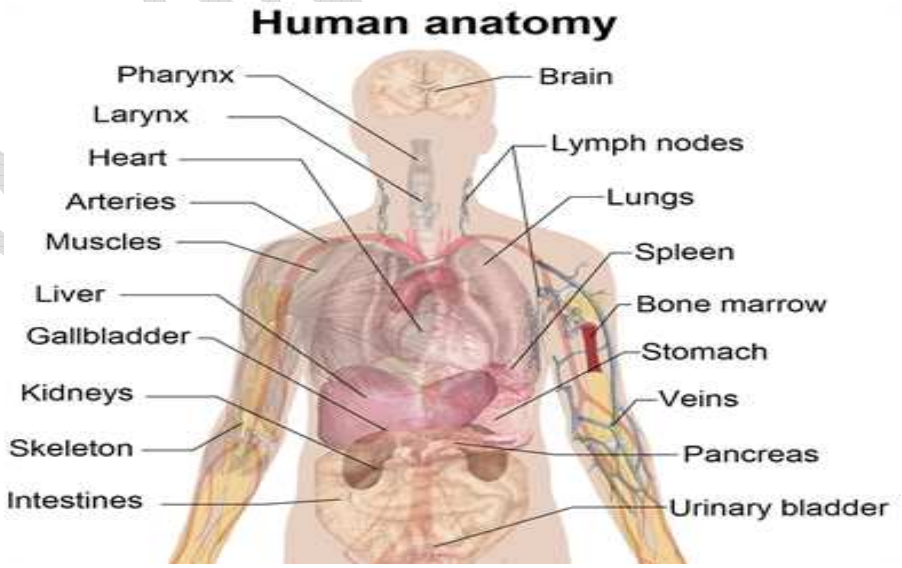
1. HUMAN ANATOMY

Human anatomy is a branch of biology and medicine about the study of structure of body parts and their relationships to one another. It is the study of the biological systems of the body, which consist of organs, tissues and cells. Humans and many other animals are called vertebrates due to a segmented backbone or spine. Some specializations within anatomy are

- ✓ Gross (macroscopic) anatomy focus body parts visible to the eye, like heart or bones.
- ✓ Histology is the study of tissues at the microscopic level.
- ✓ Cytology is the study of cells at the microscopic level.
- ✓ Neurophysiology is the study of how the nervous system functions.

Living systems can be defined from various perspectives, from the broad (looking at the entire earth) to the minute (individual atoms). Each perspective provides information about how or why a living system functions:

- ✓ At the chemical level, atoms, molecules (combinations of atoms), and the chemical bonds between atoms provide the framework upon which all living activity is based.
- ✓ The cell is the smallest unit of life. Organelles within the cell are specialized bodies performing specific cellular functions. Cells themselves may be specialized. Thus, there are nerve cells, bone cells, and muscle cells.
- ✓ A tissue is a group of similar cells performing a common function. Muscle tissue, for example, consists of muscle cells.
- ✓ An organ is a group of different kinds of tissues working together to perform a particular activity. The heart is an organ composed of muscle, nervous, connective, and epithelial tissues.
- ✓ An organ system is two or more organs working together to accomplish a particular task. The digestive system, for example, involves the coordinated activities of many organs, including the mouth, stomach, small and large intestines, pancreas, and liver.
- ✓ An organism is a system possessing the characteristics of living things—the ability to obtain and process energy, the ability to respond to environmental changes, and the ability to reproduce.



1.1. Homeostasis

A characteristic of all living systems is homeostasis, or the maintenance of stable, internal conditions within specific limits. In many cases, stable conditions are maintained by negative feedback.

In negative feedback, a sensing mechanism (a receptor) detects a change in conditions beyond specific limits. A control center, or integrator (often the brain), evaluates the change and activates a second mechanism (an effector) to correct the condition; for example, cells that either remove or add glucose to the blood in an effort to maintain homeostasis are effectors. Conditions are constantly monitored by receptors and evaluated by the control center. When the control center determines that conditions have returned to normal, corrective action is discontinued. Thus, in negative feedback, the variant condition is canceled, or negated, so that conditions are returned to normal.

The regulation of glucose concentration in the blood illustrates how homeostasis is maintained by negative feedback. After a meal, the absorption of glucose (a sugar) from the digestive tract increases the amount of glucose in the blood. In response, specialized cells in the pancreas (alpha cells) secrete the hormone insulin, which circulates through the blood and stimulates liver and muscle cells to absorb the glucose. Once blood glucose levels return to normal, insulin secretion stops. Later, perhaps after heavy exercise, blood glucose levels may drop because muscle cells absorb glucose from the blood and use it as a source of energy for muscle contraction. In response to falling blood glucose levels, another group of specialized pancreatic cells (beta cells) secretes a second hormone, glucagon. Glucagon stimulates the liver to release its stored glucose into the blood. When blood glucose levels return to normal, glucagon secretion stops.

Compare this with positive feedback, in which an action intensifies a condition so that it is driven farther beyond normal limits. Such positive feedback is uncommon but does occur during blood clotting, childbirth (labor contractions), lactation (where milk production increases in response to an increase in nursing), and sexual orgasm.

1.2. Anatomic terminology

In order to accurately identify areas of the body, clearly defined anatomical terms are used. These terms refer to the body in the anatomical position—standing erect, facing forward, arms down at the side, with the palms turned forward. Terms often used are summarized

Term	Definition	Example
Superior	Above another structure.	The heart is superior to the stomach.
Inferior	Below another structure.	The stomach is inferior to the heart.
Anterior/ventral	Toward the front of the body.	The navel is anterior to the spine.
Posterior/dorsal	Toward the back of the body.	The spine is posterior to the navel.
Medial	Toward the midline of the body. (The midline divides the body into equal right and left sides.)	The nose is medial to the eyes.
Lateral	Away from the midline of the body (or toward the side of the body).	The ears are lateral to the nose.
Ipsilateral	On the same side of the body.	The spleen and descending colon

Term	Definition	Example
		are ipsilateral.
Contralateral	On opposite sides of the body.	The ascending and descending portions of the colon are contralateral.
Intermediate	Between two structures.	The knee is intermediate between the upper leg and lower leg.
Proximal	Closer to the point of attachment of a limb.	The elbow is proximal to the wrist.
Distal	Farther from the point of attachment of a limb.	The foot is distal to the knee.
Superficial	Toward the surface of the body.	The skin is superficial to the muscle.
Deep	Away from the surface of the body.	The skeleton is deep to the skin.

1.3. Human Kinetics

Human movement is accomplished through the functional integration of three systems within the human body, the nervous, skeletal, and muscular systems. The nerves, muscles, and joints must work together, or be linked (chain) to produce motion (kinetic) or human movement. The three systems responsible for human movement are also referred to as the kinetic chain. All components of the human movement system must work together to produce movement. If one component of the human movement system is not working properly, it will affect the other systems and ultimately affect movement. Therefore, it is important that personal trainers understand the systems involved in human movement and how they work together, forming a kinetic chain to produce efficient movement.

1.4. The Nervous System

The nervous system is one of the main organ systems of the body and consists of a network of specialized cells called neurons that transmit and coordinate signals, providing a communication network within the human body. It is the fast-acting control system of the body and responds to stimuli by activating muscles and glands. The nervous system is divided into two parts, the central and peripheral nervous systems. The central nervous system (CNS) is composed of the brain and spinal cord. The peripheral nervous system (PNS) contains only nerves and connects the brain and spinal cord (CNS) to the rest of the body.

The three primary functions of the nervous system include sensory, integrative, and motor functions. Sensory function is the ability of the nervous system to sense changes in either the internal or external environment, such as a stretch placed on a muscle (internal) or the change from walking on the sidewalk to walking on sand (external). Integrative function is the ability of the nervous system to analyze and interpret the sensory information to allow for proper decision making, which produces an appropriate response. Motor function is the neuromuscular (or nervous and muscular systems) response to the sensory information, such as causing a muscle to contract when stretched too far, or changing one's walking pattern when walking in the sand as opposed to the sidewalk.

The nervous system is responsible for the recruitment of muscles, learned patterns of movement, and the functioning of every organ in the human body. Proprioception is the body's ability to sense

the relative position of adjacent parts of the body. For example, when we walk or run our feet give us proprioceptive feedback about the type of surface or terrain we are on. Training the body's proprioceptive abilities will improve balance, coordination, and posture, and enable the body to adapt to its surroundings without consciously thinking about what movement is most appropriate for any given situation. Thus, it becomes important to train the nervous system efficiently to ensure that proper movement patterns are being developed, which enhances performance and decreases the risk of injury

In the early stages of training the majority of performance improvements likely result from changes in the way the central nervous system controls and coordinates movement. This appears to be particularly so for resistance training. When we perform an activity, our senses provide constant feedback regarding limb position, force generation, and the performance outcome (i.e., was the movement successful?). Unsuccessful or poor performances can be cross-referenced with other sensory input, and a new movement strategy can be tried. Regular training and practice cause adaptations in the CNS, allowing greater control of movements. Thus movements become smoother and more accurate, and performance improves.

1.5. The Skeletal system

The skeletal system serves many important functions; it provides the shape and form for our bodies in addition to supporting, protecting, allowing bodily movement, producing blood for the body, and storing minerals. It is important to note that the growth, maturation, and functionality of the skeletal system are greatly affected by posture, physical activity, and nutrition status. For example, poor nutrition and physical inactivity contribute to osteoporosis, which has a negative effect on skeletal health and human movement. It is composed of bone, cartilage, and ligaments and protects and supports body organs. It also provides the framework for muscles. Muscles are connected to bones by tendons. Bones form junctions that are connected by muscles and connective tissue. These junctions are known as joints. Joints are the sites where movement occurs as a result of muscle contraction.

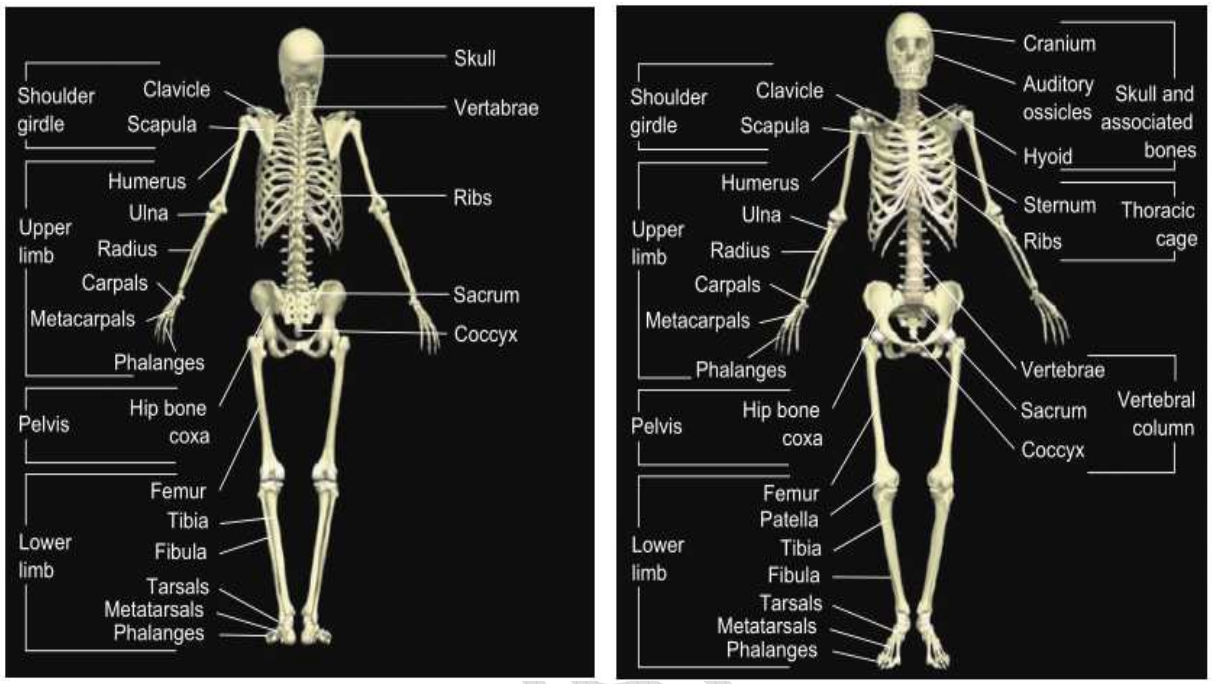
The skeletal system is divided into two divisions: the axial and appendicular skeletal systems. The axial skeleton is made up of the skull, the rib cage, and the vertebral column. There are approximately 80 bones in the axial skeleton. The appendicular skeleton is made up of the upper and lower extremities as well as the shoulder and pelvic girdles. The pelvic girdle is often considered a component of either the axial or appendicular system and is actually a link between the two systems. The appendicular skeleton encompasses approximately 126 bones. There are 206 bones in the skeletal system, of which approximately 177 are used in voluntary movement. The bones in the human body form more than 300 joints.

Bone Growth

Throughout life, bone is constantly renewed through a process called remodeling. This process consists of resorption and formation. During resorption, old bone tissue is broken down and removed by special cells called osteoclasts. During bone formation, new bone tissue is laid down to replace the old. This task is performed by special cells called osteoblasts.

During childhood through adolescence, new bone is added to the skeleton faster than old bone is removed. As a result, bones become larger, heavier, and denser. For most people, bone formation continues at a faster pace than removal until bone mass peaks usually by the time individuals reach their thirties. It is also worth noting that remodeling tends to follow the lines of stress placed on the

bone. Exercise and habitual posture, therefore, have a fundamental influence on the health of the skeletal system. Incorrect exercise technique, coupled with a generally poor alignment, will lead to a remodeling process that may reinforce the predominating bad posture.



There are five major types of bones in the skeletal system. Their shape, size, and proportion of bone tissue determine their classification as

Bone Type	Characteristic	Example
Long	Long, cylindrical shaft and irregular or widened ends	Humerus, femur
Short	Similar in length and width and appear somewhat cubical in shape	Carpals of hand, tarsals of feet
Flat	Thin, protective	Scapulae, patella
Irregular	Unique shape and function	Vertebrae
Sesamoid	Small often round bones embedded in a joint capsule or found in locations where a tendon passes over a joint	Patella

Like muscle, bone is living tissue that responds to exercise by becoming stronger. Individuals who exercise regularly generally achieve greater peak bone mass (maximal bone density and strength) than those who do not. Exercising allows us to maintain muscle strength, coordination, and balance, which in turn help to prevent falls and related fractures. This is especially important for older adults and people who have been diagnosed with osteoporosis.

Weight-bearing exercise is the best kind of exercise to help strengthen bones because it forces bones to work against gravity, and thus react by becoming stronger. Examples of weight-bearing exercises include resistance training, walking, body weight squats, push-ups, jogging, climbing stairs, and even dancing. Examples of exercises that are not weight-bearing include swimming and bicycling. Although these activities help build and maintain strong muscles and have excellent cardiovascular and weight control benefits, they are not the best way to exercise your bones.

1.6. The Muscular System

The body uses the muscular system so that the nervous system can command to move the skeletal system. Muscles generate internal tension that, under the control of the nervous system, manipulates the bones of our body to produce movements. Muscles are the movers and stabilizers of our bodies. It is composed of muscles and tendons to allow manipulation of the environment, locomotion, and facial expression. It also helps to maintain posture and produces heat.

Skeletal muscle is one of three major muscle types in the body; the others are cardiac and smooth muscle. Skeletal muscle is made up of individual muscle fibers, and the term muscle refers to multiple bundles of muscle fibers held together by connective tissue. Bundles of muscle fibers can be further broken down into layers from the outer surface to the innermost layer.

Tendons are the structures that attach muscles to bone and provide the anchor from which the muscle can exert force and control the bone and joint. They are very similar to ligaments in that they have poor vascularity (blood supply), which leaves them susceptible to slower repair and adaptation.

As with ligaments, the tendon's poor vascularity will be important to remember when considering the number of days' rest taken and the structure of your daily exercise programming plan when performing high-intensity exercise to ensure you do not develop overuse injuries.

Muscle Types

Muscles provide the human body with a variety of functions that allow for the manipulation of forces placed on the body and to produce and slow down movement. These muscle functions categorize the muscle as an agonist, synergist, stabilizer, or antagonist.

- ✓ Agonist muscles are muscles that act as prime movers, or, in other words, they are the muscles most responsible for a particular movement. For example, the gluteus
- ✓ maximus is an agonist for hip extension.
- ✓ Synergist muscles assist prime movers during movement. For example, the hamstring complex and the erector spinae are synergistic with the gluteus maximus during
- ✓ hip extension.

- ✓ Stabilizer muscles support or stabilize the body, whereas the prime movers and the synergists perform the movement patterns. For example, the transversus abdominis,
- ✓ internal oblique, and multifidus (deep muscles in the low back) stabilize the low back, pelvis, and hips (lumbo-pelvic-hip complex) during hip extension.
- ✓ Antagonist muscles perform the opposite action of the prime mover. For example, the psoas (a deep hip flexor) is antagonistic to the gluteus maximus during hip extension.

Muscle Type	Muscle Function	Exercise
Agonist	Prime mover	Chest press, Overhead press, Row, Squat
Synergist	Assist prime mover	Chest press, Overhead press, Row, Squat
Stabilizer	Stabilize during workout	Chest press, Overhead press, Row, Squat
Antagonist	Oppose prime mover	Chest press, Overhead press, Row, Squat

1.7. The Endocrine System

The endocrine system is a system of glands that secrete hormones into the bloodstream to regulate a variety of bodily functions, including the control of mood, growth and development, tissue function, and metabolism. The endocrine system consists of host organs (known as glands), chemical messengers (hormones), and target (receptor) cells. Once a hormone is secreted from a gland, it travels through the bloodstream to target cells designed to receive its message. The target cells have hormone-specific receptors ensuring that each hormone will communicate only with specific target cells.

Hormones produced by the endocrine system virtually affect all forms of human function including triggering muscle contraction, stimulating protein and fat synthesis, activating enzyme systems, regulating growth and metabolism, and determining how the body will physically and emotionally respond to stress. The primary endocrine glands are the hypothalamus, pituitary, thyroid, and adrenal glands. Several other organs contain discrete areas of endocrine tissue that also produce hormones, including the pancreas and reproductive organs. Exercise programming has a significant impact on hormone secretion. Health and fitness professionals should become familiar with how pertinent hormones respond to exercise to maximize programming strategies and avoid overtraining

Research has indicated that testosterone and growth hormone levels increase after strength training and moderate to vigorous aerobic exercise. The presence of cortisol in the bloodstream is often taken to be indicative of overtraining. This is perhaps a little simplistic as cortisol is a necessary part of maintaining energy levels during normal exercise activity and may even facilitate recovery and repair during the post exercise period. Problems may arise, however, as a result of extremely intense or prolonged bouts of endurance training, which have been found to lower testosterone levels while raising cortisol levels.

1.8. The Cardio Respiratory system

The cardio-respiratory system is composed of the cardiovascular system and the respiratory system. Together, they provide the body with oxygen, nutrients, protective agents, and a means to remove waste products. The cardiovascular system is composed of the heart, blood, and blood vessels. The heart is located in the mediastinum and is made up of involuntary cardiac muscle, which contracts according to a built-in rhythm to regularly pump blood throughout the body. It is

divided into four chambers: two atria (which gather blood from the body) and two ventricles (which pump blood out to the body) on each side.

The heart rate and the stroke volume make up the overall performance of the heart. Cardiac output is the combination of how many times the heart beats per minute and how much blood is being pumped out with each beat. Heart monitoring can be manual or by a heart rate monitor.

Blood acts as a medium to deliver and collect essential products to and from the tissues of the body, providing an internal transportation, regulation, and protection system. The blood vessels that transport blood away from the heart are called arteries (which have smaller components called arterioles). The vessels that bring blood back to the heart are called veins (which have smaller components called venules). Capillaries are the smallest blood vessels and connect venules with arterioles.