HESI A&P Study Guide

**General Information**

Anatomy and physiology are perhaps the most fundamental areas for a nurse to study. Anatomy is the area of study in between biology and medicine that considers the structure of the body. Physiology is the scientific study of how the body and its organs and cells work. Understanding the location of parts of the human body is critical. A nurse must understand how each part of the body works in order to deliver the best patient outcome. Simply knowing where the heart is located is not enough; you must understand how the heart works and how the other systems that depend on it work in conjunction.

Here is a basic review of the different systems of the body, their parts, and function:

**Endocrine**

The endocrine system of the body is made up of glands that secrete hormones into the bloodstream. Through the circulatory system, these hormones travel to work on different target organs in other parts of the body. The hormones the endocrine system produces help regulate many different bodily functions, including growth and development, reproduction, metabolism, and stress response. The endocrine system is considered a “slow” system compared to others (such as the nervous system) in that its initiation and effects are often prolonged and may last hours or days.

**Primary Endocrine Glands and Hormones**

**Hypothalamus**―dopamine, thyrotropin-releasing hormone (TRH)

**Pituitary Gland**:

* *Anterior lobe*―growth hormone, thyroid-stimulating hormone (TSH), adrenocorticotropic hormone (ACTH), prolactin, follicle-stimulating hormone (FSH), luteinizing hormone
* *Posterior lobe*―oxytocin, vasopressin

**Pineal Gland**―melatonin

**Thyroid Gland**―triiodothyronine (T3), thyroxine (T4), calcitonin

**Parathyroid Gland**―parathyroid hormone (PTH)

**Adrenal Gland**:

* *Medulla*―adrenaline, noradrenaline, dopamine
* *Cortex*―androgens, aldosterone, cortisol

**Pancreas**―insulin, glucagon

**Testes (males)**―testosterone

**Ovaries (females)**―estrogen, progesterone

There are also “secondary” endocrine glands that are not considered endocrine glands but do have endocrine functions. They are the kidneys, bone, liver, gonads, and heart.

**Problems with the Endocrine System**

Problems can occur in the endocrine system at any point in the gland-circulatory system-target tissue loop.

* The gland itself may secrete too much or too little hormone, which may cause a decreased or increased response in the body.
* Circulatory issues may cause a delayed or diminished response if the hormones are not brought to the target organ as intended.
* If the receptors on the organs are not fully functional, the organ may not be able to interpret and respond to the “message” the hormone is trying to send.
* Common diseases associated with endocrine dysfunction include diabetes, Addison’s Disease, Graves’ Disease, obesity, and osteoporosis.

**Skeletal**

The skeletal system comprises the bones of the body, as well as the supporting tissues that connect them. Bones are considered living organs and are made up of minerals, cells, and protein fibers. They have several layers, including the hard outside casing referred to as compact bone, the porous, flexible inner layer of spongy bone, and the deepest layer, bone marrow, which produces red blood cells.

Bones serve several purposes, including providing a framework for the body itself, protecting organs, producing red blood cells via the marrow, and storing calcium, iron, and fat.

Human babies are born with around 300 bones, but some fuse together during growth and development, so an adult human has 206 bones. The skeletal system accounts for 30%–40% of the average person’s mass.

**Types of Bones**

There are five types of bones found in the body:

Long―Long bones make up most of the limbs. As their name suggests, they are longer than they are wide. Examples of long bones include the tibia and femur of the legs and radius and ulna of the arms.

Flat―Flat bones are thin bones used by the body for protection or muscular attachment. Examples include the bones of the cranium and pelvis, as well as the sternum and ribs.

Short―Short bones are wider than they are long. They provide stability but little movement. Examples include the carpal bones in the wrist and the tarsals found in the foot.

Sesamoid―Sesamoid bones are found inside tendon or muscle. An example is the patella of the knee.

Irregular―Irregular bones have a unique shape that doesn’t allow them to be classified in any of the other four bone types. Examples include the hyoid bone of the neck, and the vertebrae of the spine.

Supportive Tissues of the Skeletal System:

Tendons―Tendons connect muscle to bone and help aid in movement.

Ligaments―Ligaments connect bone to bone. They are responsible for keeping structures stable.

Cartilage―Cartilage is a firm but flexible connective tissue found between bones. It is located in various locations through the body, including the nose, ears, rib cage, and bronchial tubes.

**Muscular**

The muscular system works in tandem with the skeletal system to allow movement in the body. There are about 700 muscles in the body, grouped into three muscle types:

**Cardiac Muscle**

Cardiac muscle is an involuntary muscle located in the heart. The muscle is striated, meaning it has a striped appearance when examined under a microscope.

**Smooth Muscle**

Smooth muscle is an involuntary, non-striated muscle type found throughout the body in areas such as the blood vessels, uterus, bladder, and eye. It is unique in that it has the ability to stretch much further than the other two muscle types.

**Skeletal Muscle**

Skeletal muscles are voluntary muscles; they can be moved at will. Skeletal muscles are striated and most are attached to bones by tendons. They are typically named because of their location, function, shape, or origin. For example, the trapezius muscle in the back is named because of its trapezium, or diamond, shape. However, the transverse abdominis is so named because of its location in the abdomen.

**Skeletal Muscle Layers**

Muscles have a bundle-within-a-bundle structure. On the outermost level, every muscle in the body is surrounded by fascia, a layer of connective tissue. Underneath this superficial layer of fascia, there are three deeper layers:

Epimysium―The outermost layer of deep fascia surrounds the whole muscle.

Perimysium―This layer of deep fascia surrounds a bundle of skeletal muscle fibers called a fascicle.

Endomysium―This layer of deep fascia surrounds the individual muscle cell.

**Myocyte**

Inside individual myocytes (also called the muscle cell or muscle fiber), there is a fluid called the sarcoplasm, which is the cell’s cytoplasm. Within the myocyte, there are also myofibrils, which are very long chains of sarcomeres. A sarcomere is the basic functional unit of muscle, and it comprises two important proteins, actin and myosin. The actions of these proteins in conjunction with ATP cause muscles to move.

**Nervous**

The nervous system is composed of the central nervous system, which contains the brain and spinal cord, and the peripheral nervous system, which contains the nerves and sensory organs.

The brain is the control center of the nervous system and contains roughly 100 billion neurons. The brain controls both high mental functions, like memory and consciousness, as well as low body functions like digestion and respiration. The spinal cord consists of a bundle of neurons that extends through the spin from the medulla oblongata to the lumbar region.

The nervous tissue is composed of two kinds of cells―neurons or “nerve cells”, which transmit electrochemical signals to the body, and neuroglia which surround and help to maintain the neurons. Neuron cells are composed of bundles of axons called fascicles, which are wrapped in connective tissue called the perineurium. There are 3 kinds of neurons:

Afferent neurons send sensory signals to the central nervous system.

Efferent neurons send signals from the central nervous system to the muscular system.

Interneurons form the network that transmits information from afferent neurons to efferent neurons.

The nerve cells interact with other cells through junctions called synapses. There are two kinds of synapses: chemical synapses and electrical synapses. Chemical synapses cause neurotransmitters to release chemicals by exocytosis, which then stimulate other cells into action. Electrical synapses connect two neurons together and allow them to pass an electric current from one to the other.

**Reproductive**

**Male**

The male reproductive system is composed of the testes, glands, sperm ducts, urethra, and penis. The testes are contained within the scrotum and produce sperm (the male sex cells) and male sex hormones. The sperm exits the testes and travels through the sperm ducts where it is mixed with the nutrient-filled fluid produced by the glands, becoming semen. During sexual intercourse, the semen travels through the penis, in a tube called the urethra.

The primary male sex hormone is testosterone. Testosterone is secreted in males after puberty, stimulating the production of sperm, increasing body hair growth, causing enlargement of the larynx and thickening of the vocal cords, increasing muscle mass, and thickening the skin and bones.

**Female**

The female reproductive system is composed of the ovaries, fallopian tubes, uterus, cervix, and vagina and includes a 28-day cycle of events, known as the menstrual cycle. The ovaries contain hundreds of eggs or ova (the female sex cell). Hormones are released by the ovaries, which cause the lining of the uterus to develop and cause an egg to mature. The mature egg is released from the ovary and travels down the fallopian tube into the uterus.

If the egg is not fertilized, the lining of the uterus breaks down, resulting in menstruation. However, if the egg is fertilized by a sperm cell, the cells start to divide, forming an embryo that attaches to the lining of the uterus. The cervix is a ring of muscle between the uterus and vagina, which dilates when the fetus is mature, enabling passage through the birth canal.

The main female sex hormones are estrogen, progesterone, luteinizing hormone (LH) and follicle-stimulating hormone (FSH). These hormones regulate the menstrual cycle and estrogen in particular, stimulates the changes which occur during puberty.

**Urinary**

The urinary system, or renal system, removes waste from the body and regulates the blood. It is composed of the kidneys, ureters, bladder, and urethra. The kidneys filter the blood, converting waste into urine. The ureters are smooth, muscular tubes, which transport urine from the kidneys to the bladder. Urine is stored in the bladder before being passed through the urethra and expelled.

Within the kidneys, blood is filtered through renal corpuscles into a structure called a nephron, inside which urine is produced. The urine then passes through a system of vessels known as the collecting duct system, forming minor and major calyces. These vessels lead into the pelvis of the kidney, which drains into the ureter.

As well as creating urine, the kidneys also maintain the balance of ions, pH, fluids, and electrolytes, and blood pressure. This is achieved through the production of hormones and enzymes, such as calcitriol, erythropoietin, and renin.

**Circulatory**

The circulatory, or cardiovascular, system is composed of the heart, blood vessels, and blood. Its function is to transport blood cells and nutrients around the body. Blood contains plasma, red blood cells, white blood cells and platelets. Plasma is the fluid, which carries hormones, carbon dioxide and waste. Red blood cells carry oxygen and white blood cells produce antibodies. Platelets, or thrombocytes, form clots to stop bleeding.

There are two circuits through which blood travels: pulmonary and systemic. The pulmonary circuit carries blood to the lungs where carbon dioxide is removed and oxygen binds to the hemoglobin in the red blood cells. The oxygenated blood is then taken back to the heart, where it can be circulated by the systemic circuit to deliver oxygenated blood to the rest of the body, as well as transporting nutrients and waste.

The human heart is composed of four chambers; the left and right atriums, and left and right ventricles. The atria receive blood and the ventricles pump it out. The heart also contains valves to stop the blood from flowing backward.

Deoxygenated blood is received by the right atrium via large veins called the venae cavae. It is then transferred to the right ventricle through the tricuspid valve and subsequently exits the heart through the semilunar valve and is transferred to the pulmonary artery, where it is pumped toward the lungs for oxygenation.

Oxygenated blood is received by the left atrium and transferred to the left ventricle through the mitral valve. It is then pumped through the aorta and to the rest of the body, via another semilunar valve.

The arteries transport blood away from the heart under high pressure and have strong muscular walls. The veins carry blood to the heart under low pressure and are thinner, but contain valves to prevent backflow. Capillaries are the smallest blood vessels. They are incredibly thin, enabling efficient gas exchange between blood and tissues in the muscles and lungs, where oxygen is transferred from blood to tissue and carbon dioxide from tissue to blood.

The pulse rate is the number of heartbeats per minute and a normal pulse rate for a healthy adult should fall between 60 and 100 beats per minute.

There are two types of blood pressure―systolic and diastolic. Systolic pressure is the pressure inside the arteries when the heart contracts and should be less than 120 mm Hg. Diastolic pressure is the pressure in the arteries when the heart relaxes and a normal value is under 80 mm Hg.

**Respiratory**

The respiratory system consists of the lungs, trachea, bronchi, and diaphragm. Its function is to receive and deliver oxygen and remove carbon dioxide. The diaphragm is a sheet of muscle that enables breathing.

During inhalation, the diaphragm contracts pulling downwards and expanding the lungs. This increase in volume causes the pressure in the lungs to decrease with respect to the air outside the body, which results in oxygen-rich air being sucked through the trachea and bronchi. The intercostal muscles and accessory muscles can also be used to enable greater expansion, i.e., when deep breaths are needed.

Inside the lungs, oxygen and carbon dioxide are exchanged between the air and blood via diffusion. This process occurs through the alveoli. These are small hollow structures, around 200 micrometers in diameter, with a large surface area for efficient gas exchange.

Upon exhalation, the diaphragm relaxes and the volume of the lungs decreases, and the carbon dioxide-rich air is forced out.

The rate at which gas enters or leaves the lungs is called ventilation and is controlled by the autonomic nervous system, specifically by the medulla oblongata and pons. If the level of carbon dioxide in the blood increases, this is detected by receptors in the aorta, carotid artery, and medulla. A signal is then sent to increase the rate of breathing to remove excess CO2.

**Digestive**

The digestive system is a large system of organs, composed of the mouth, esophagus, stomach, small intestine, large intestine, pancreas, liver, gallbladder, rectum, and anus. Its function is to break down food and absorb nutrients.

Food is passed from the mouth and digestion begins with chewing and the secretion of enzymes in saliva. The chewed food, or bolus, travels down the esophagus to the stomach via a series of muscular contractions known as peristalsis. Inside the stomach, gastric acid and more enzymes are secreted to further break down the stomach contents.

After the food has been sufficiently broken down in the stomach, the contents are passed into the small intestine. Peristalsis again moves food through the small intestine, firstly through the duodenum where it continues to be broken down by bile created by the liver and more enzymes secreted by the pancreas. Nutrients are then absorbed into the bloodstream through the jejunum and ileum, leaving a liquid residue.

After nutrient extraction, the waste contents, or stool, are passed to the large intestine or colon, which is composed of five sections―the cecum, the ascending colon, the transverse colon, the descending colon, and the sigmoid colon. As the stool passes through the colon, water is extracted and it solidifies. When the descending colon is full, the contents are transferred to the rectum and then the anus for evacuation.

During digestion, the body secretes several enzymes that help to break down food. These include pepsin, which acts on proteins; lipase, which acts on fat; and amylase, which acts on carbohydrates.

As well as secreting enzymes, the pancreas also produces insulin. The liver processes the nutrients absorbed by the small intestine and uses them to produce chemicals required by the body. It also breaks down harmful chemicals and creates bile, which aids the digestion of fat. The bile is stored in the gallbladder and then released into the small intestine.