

# Human Machine

## General Anatomy and Physiology

### Study Guide/Outline

*This study guide is intended to help coaches understand the topics the event will cover and the level of comprehension expected for those topics. It is recommended and expected that additional materials, websites and activities be used to help prepare the teams for this event.*

#### I. Introduction

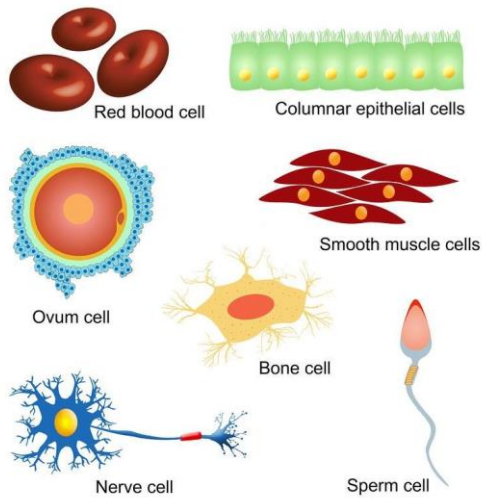
The human body is a complex machine. From eating breakfast, to running, to sleeping, everything your body does requires multiple systems carrying out specialized tasks. Each system has a focus but they must also communicate and work together.

In order to understand how the machine works, we must understand both the human anatomy and physiology. **Anatomy** is the study of the body's structure. That means the "parts". **Physiology** is the study of how the individual organs and systems function. This event will focus more on the anatomy with a general overview of the physiology of the major human organ systems.

#### II. Body Basics - Organization of the Body

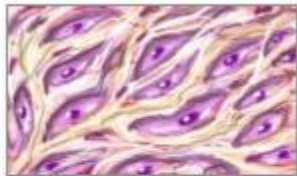
- **Fluids** - The human body is about  $\frac{2}{3}$  water. The different substances dissolved in this water make up the fluids of the human body. Body fluids include those found within cells (intracellular), around the body tissues (interstitial), blood, lymph, sweat, saliva, digestive juices and urine.
- **Cells** - Cells are the smallest living units in the human body. Different types of cells carry out different functions in the body. There are more than 200 different cell types in the human body and an adult human has around 37 trillion cells. (Teams will not be asked to visually identify cell types.)

# ANATOMY OF HUMAN CELLS

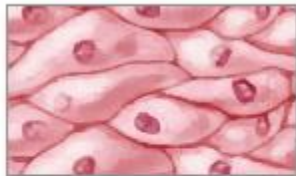


- **Tissues** - Cells performing similar functions are grouped together to form tissues. There are four main tissue types: Nervous, Epithelial, Muscle and Connective

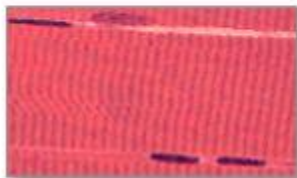
## Four types of tissue



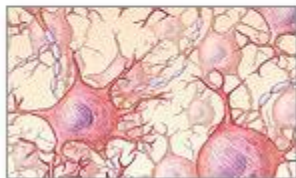
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

- **Nervous Tissue** - nerve cells form nervous tissue which make up the brain, spinal cord and all nerves throughout the body. Nervous tissue forms the high-speed communication system of the human body.

- **Epithelial Tissue** - epithelial cells are tightly connected to each other forming a sheet of epithelial tissue that lines and covers the inside and outside surfaces in the body
  - **Muscle Tissue** - long thin muscle cells form muscle fibers which have the ability to contract and relax. Several different types of muscle tissue are responsible for tasks like moving bones, or moving food through the digestive system.
  - **Connective Tissue** - There are several different types of connective tissue all of which provide protection and support to the other tissues and organs in the body. Connective tissue also fills the space between organs and holds them together. Blood is an example of a connective tissue.
- **Organs** - All of these types of tissues combine together to form organs. Almost all organs in the human body contain all four major tissue types but must contain at least two different tissue types. Each organ works like an individual machine to carry out a specific function or role in the body. For example, your heart is an organ which has the specific function of pumping blood throughout your body.
  - **Organ Systems** - Groups of organs work together to carry out a specific function in the human body. These groups of organs form a specific body system. For example, the digestive system is comprised of many organs like the mouth, stomach, pancreas and colon all of which work together to take in and break down food so that your body will have building blocks and energy in order for you to grow and function. Some organs can play multiple roles in more than one system. For example, your kidneys are primarily involved in the excretory system but also have a role in the endocrine system. All the systems are interconnected and play a role in maintaining a fully functioning human body.

### III. Human Body Systems (function, organs involved)

#### 1. Muscular System

- **Function(s)** - The function of the muscular system is to move your body and everything in your body. Sometimes you move your muscles consciously like when you walk down the stairs and other times your muscles move unconsciously like when your heart muscles beat or when food passes through your body.
- **Major Structures/Organs:**
  - **Skeletal** - Skeletal muscle is found in your arms and legs and anywhere else in your body that you can control and move.

- **Smooth** - Smooth muscle is found in the digestive system, airways and other organs where it functions to keep those other systems working properly. Smooth muscle moves involuntarily.
- **Cardiac** - Cardiac muscle is specifically found in the heart and contracts (beats) continuously.

## 2. Skeletal System

- **Function(s)** - The skeletal system supports the overall structure of the body and provides protection for the internal organs. It is comprised of bones, ligaments and tendons. The skeletal system and the muscular system work together to help you move.
- **Major Structures/Organs:**
  - **Bones** - 70% of bone is made up of hard minerals like calcium. It also contains blood vessels and many bones have a soft center section called marrow. Blood cells are made in the bone marrow.
  - **Ligaments** - Bands of tissue made of collagen that attach bones to other bones
  - **Tendons** - Bands of tissue made of collagen that attach bones to muscles
  - **Cartilage** - Dense connective tissue that cushions bones near each other such as in a joint.

## 3. Integumentary System

- **Function(s)** - The integumentary system acts as a protective covering. It protects the internal body from infection and damage from the sun. It also helps regulate the body temperature.
- **Major Structures/Organs:**
  - **Skin** - Consists of three layers, the outer epidermis made of dead skin cells, the lower dermis which contains blood vessels, nerves and glands and the inner most hypodermis which is a layer of fat.
  - **Hair** - Made of keratin. Helps provide warmth and extra protection. Fine hairs all over the body help with the sense of touch.
  - **Nails** - Made of keratin. Protects the tips of the fingers and toes.
  - **Sweat and oil glands** - produce sweat and oil to help keep the body cool and soften the skin and hair.

## 4. Nervous System

- **Function(s)** - The nervous system controls all the high speed communications in the body. Electrical signals are sent and received

coordinating the body's response to changes in the internal and external environment.

- **Major Structures/Organs:**
  - **Brain** - The control center. Responsible for processing and relaying information.
  - **Spinal Cord** - The communication highway. Serves as the main communication link between the brain and the rest of the body
  - **Nerves** - Bundles of fibers made up of nerve cells.
- **The Senses** - Nerves and structures that allow you to receive information from the outside world and send it to your brain
  - **Touch, Taste, Smell, Hearing, Vision**

## 5. Digestive System

- **Function(s)** - The digestive system breaks down food so that we can use the nutrients and energy in that food. The nutrients are absorbed and the left over waste is eliminated.
- **Major Structures/Organs:**
  - **Mouth** - Food is taken in and chewed into smaller pieces.
  - **Pharynx** - Area connecting the mouth to the esophagus
  - **Esophagus** - Muscular tube that pushes the food to the stomach
  - **Stomach** - Muscular sac that turns the food further breaking it down and mixes it with stomach acids and other substances that break it down even more.
  - **Small Intestine** - Most of the chemical digestion and absorption of food takes place in the small intestine.
  - **Large Intestine** - Water is reabsorbed and feces are formed.
  - **Rectum** - Area where feces are held before elimination

## 6. Endocrine

- **Function(s)** - The endocrine system produces the hormones act as messengers to all the other organ systems in the body. These hormones control growth and development and are also responsible for metabolism (building up or breaking down of energy molecules) and homeostasis (maintaining a constant internal environment).
- **Major Structures/Organs:**
  - **Pancreas** - Releases hormones involved in controlling blood sugar levels.
  - **Hypothalamus** - Located in the brain, links the nervous and endocrine system.

- **Pituitary** - Also, located in the brain, makes hormones that control many other endocrine glands.
- **Thyroid** - Releases hormones involved in controlling metabolism
- **Adrenals** - Produces hormones that help your body respond to stress.
- **Testes and Ovaries** - Both produce gender specific hormones needed for reproductive development.

## 7. Circulatory (Cardiovascular)

- **Function(s)** - The circulatory system moves blood throughout the body. Blood contains, oxygen, hormones, and nutrients that cells need and removes cell waste.
- **Major Structures/Organs:**
  - **Heart** - Powerful pump made up of cardiac muscle pushes blood throughout the body
  - **Blood** - Contains plasma (water carrying hormones, nutrients and other important compounds), red blood cells (carry oxygen), white blood cells (defend against infection) and platelets (blood clotting factors).
  - **Blood Vessels** - Arteries carry blood from the heart to tissues. Capillaries are the smallest vessels and serve as the area where oxygen and nutrients diffuse into the tissues and cellular waste is picked up by the blood. Veins return the blood to the heart.

## 8. Respiratory

- **Function(s)** - The respiratory system brings in oxygen which is essential for every cell in the body and expels carbon dioxide, the waste product of energy production.
- **Major Structures/Organs:**
  - **Nose** - Organ where air enters and exits the body. The nose filters, moistens and warms the air.
  - **Larynx** - Top part of the trachea which contains the vocal cords
  - **Trachea** - Tube of muscle and cartilage also known as the windpipe. Carries air from the larynx to the lungs.
  - **Bronchi and bronchioles, alveoli** - The branching network of tubes that run throughout the lungs
  - **Lungs** - The site of oxygen and carbon dioxide exchange between red blood cells and the air.

## 9. Immune/Lymphatic

- **Function(s)** - The lymphatic system collects and moves excess fluid lost from blood vessels and returns it to the circulatory system. The infection fighting cells of the immune system travel through the lymphatic system.
- **Major Structures/Organs:**
  - **Lymph** - The fluid portion of the blood that is not reabsorbed into capillaries but enters into lymphatic vessels
  - **Lymph vessels** - A system of tubes throughout the body that transport the lymph
  - **Lymph nodes** - Sites where the lymph is cleaned by white blood cells
  - **White blood cells** - An army of several cell types who guard against infection, fight parasites and attack bacteria and viruses.
  - **Spleen** - Cleans out germs and debris from the blood

## 10. Reproductive

- **Function(s)** - The reproductive system is responsible for producing the specialist cells needed to create a new human. In females, additional organs, protect and nurture the developing baby.
- **Major Structures/Organs:**
  - **Testes** - In males, the organ responsible for production of the male gametes (sperm).
  - **Ovaries** - In females, the organ responsible for production of the female gametes (eggs).
  - **Uterus** - In females, the stretchy muscular sac that supports the developing embryo.

## 11. Excretory (Urinary)

- **Function(s)** - The excretory system produces urine which contains cellular waste and excess fluid. Urine is eliminated from the body through the excretory system.
- **Major Structures/Organs:**
  - **Kidneys** - This organ filters the blood removing excess water, urea and other metabolic waste and forming urine.

- **Bladder** - Urine is stored here until it is ready to be released.
- **Urethra** - The tube that carries urine out of the body.

#### IV. **System Cooperation and Homeostasis**

All of the individual organ systems have a primary role but none of them can operate on their own. All the systems working together, allow your body to maintain homeostasis. **Homeostasis** means your body has a stable internal environment even when there are changes to the internal or external environment. For example, your body will not let your temperature get too high or too low or it will not be able to function. Your nervous system monitors the temperature on your skin and the temperature of your organs. If it is too low or high, it enlists the endocrine system to release hormones that act on other systems such as the muscular system to make you shiver producing heat or the integumentary system to produce sweat that will cool the body when it evaporates.

Why is homeostasis so important? Think about what you might need to successfully do your homework or take a test. You might need a specific set of conditions like a quiet room, comfortable temperature and good lighting. Well, all the cells that make your body function need a certain set of conditions too. These conditions include your internal body temperature, pH (acidity of your body fluids) and oxygen levels. These and many other conditions must be strictly regulated in order for the machine to run and it takes all the systems working together to achieve this.

In addition to working together, some organs have multiple roles in different organ systems. The kidneys are part of the excretory system producing urine but they also have specialized cells that make up the adrenal glands that are a main part of the endocrine system.

#### V. **Vocabulary**

- Anatomy
- Physiology
- Homeostasis
- Metabolism
- Fluids
- Cells
- Tissues
- Organ
- System



**VI. Sample Questions** - Below are a sample of the types of questions teams may see during the first part of the event. Questions will not be limited to these examples.

- **Multiple Choice**

1. Which is the correct order of components (parts) needed to build an organ system from simplest to most complex:
  - a. Organs, tissues, cells
  - b. Tissues, cells, organs
  - c. Cells, tissues, organs
  - d. Organs, cells, tissues
2. This tissue type is often found covering the surface of organs:
  - a. Epithelial
  - b. Nervous
  - c. Muscle
  - d. Connective

- **Name That System** - Please identify the organ system which would be primarily responsible for carrying out the following activities. (Teams would be given a list of the organ systems)

1. You eat an apple and your body breaks it down to provide you energy.
2. This system protects your body from UV rays when you go to the beach on a sunny day.
3. Your friend comes to school with a cold and coughs on you but you don't get sick.

- **What's my system?** - Identify the organ system that these individual organs or structures belong to (primary system).

1. Nose
2. Skin
3. Large Intestine

**VII. References**

Claybourne, A., Farndon, J., Friend, J., Temple, N., Lewis, A., & Parkin, M. (2017). *Human body!* NY, NY: DK Publishing.

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