ANATOMY & PHYSIOLOGY ONLINE COURSE - SESSION 3 – CELLS, TISSUES, AND MEMBRANES

Introduction to the Human Body

Human beings are arguably the most complex organisms on this planet. Imagine billions of microscopic parts, each with its own identity, working together in an organized manner for the benefit of the total being. The human body is a single structure but it is made up of billions of smaller structures of four major kinds:

Cells

Cells have long been recognized as the simplest units of living matter that can maintain life and reproduce themselves. The human body, which is made up of numerous cells, begins as a single, newly fertilized cell.

Tissues

Tissues are somewhat more complex units than cells. By definition, a tissue is an organization of a great many similar cells with varying amounts and kinds of nonliving, intercellular substance between them.

Organs

Organs are more complex units than tissues. An organ is an organization of several different kinds of tissues so arranged that together they can perform a special function. For example, the stomach is an organization of muscle, connective, epithelial, and nervous tissues. Muscle and connective tissues form its wall, epithelial and connective tissues form its lining, and nervous tissue extends throughout both its wall and its lining.

Systems

Systems are the most complex of the component units of the human body. A system is an organization of varying numbers and kinds of organs so arranged that together they can perform complex functions for the body. Ten major systems compose the human body:

- Skeletal
- Muscular
- Nervous
- Endocrine
- Cardiovascular
- Lymphatic
- Respiratory
- Digestive
- Urinary
- Reproductive

Body Functions

Body functions are the physiological or psychological functions of body systems. The body's functions are ultimately its cells' functions. Survival is the body's most important business. Survival depends on the body's maintaining or restoring homeostasis, a state of relative constancy, of its internal environment.

More than a century ago, French physiologist, Claude Bernard (1813-1878), made a remarkable observation. He noted that body cells survived in a healthy condition only when the temperature, pressure, and chemical composition of their environment remained relatively constant. Later, an American physiologist, Walter B. Cannon (1871-1945), suggested the name homeostasis for the relatively constant states maintained by the body. Homeostasis is a key word in modern physiology. It comes from two Greek words - "homeo," meaning the same, and "stasis," meaning standing.

"Standing or staying the same" then is the literal meaning of homeostasis. However, as Cannon emphasized, homeostasis does not mean something set and immobile that stays exactly the same all the time. In his words, homeostasis "means a condition that may vary, but which is relatively constant."

Homeostasis depends on the body's ceaselessly carrying on many activities. Its major activities or

functions are responding to changes in the body's environment, exchanging materials between the environment and cells, metabolizing foods, and integrating all of the body's diverse activities.

The body's ability to perform many of its functions changes gradually over the years. In general, the body performs its functions least well at both ends of life - in infancy and in old age. During childhood, body functions gradually become more and more efficient and effective. During late maturity and old age the opposite is true. They gradually become less and less efficient and effective. During young adulthood, they normally operate with maximum efficiency and effectiveness.

Life Process

All living organisms have certain characteristics that distinguish them from non-living forms. The basic processes of life include organization, metabolism, responsiveness, movements, and reproduction. In humans, who represent the most complex from of life, there are additional requirements such as growth, differentiation, respiration, digestion, and excretion. All of these processes are interrelated. No part of the body, from the smallest cell to a complete body system, works in isolation. All function together, in fine-tuned balance, for the well being of the individual and to maintain life. Disease such as cancer and death represent a disruption of the balance in these processes.

The following is a brief description of the life process:

Organization

At all levels of the organizational scheme, there is a division of labor. Each component has its own job to perform in cooperation with others. Even a single cell, if it loses its integrity or organization, will die.

Metabolism

Metabolism is a broad term that includes all the chemical reactions that occur in the body. One phase of metabolism is catabolism in which complex substances are broken down into simpler building blocks and energy is released.

Responsiveness

Responsiveness or irritability is concerned with detecting changes in the internal or external environments and reacting to that change. It is the act of sensing a stimulus and responding to it.

Movement

There are many types of movement within the body. On the cellular level, molecules move from one place to another. Blood moves from one part of the body to another. The diaphragm moves with every breath. The ability of muscle fibers to shorten and thus to produce movement is called contractility.

Reproduction

For most people, reproduction refers to the formation of a new person, the birth of a baby. In this way, life is transmitted from one generation to the next through reproduction of the organism. In a broader sense, reproduction also refers to the formation of new cells for the replacement and repair of old cells as well as for growth. This is cellular reproduction. Both are essential to the survival of the human race.

Growth

Growth refers to an increase in size either through an increase in the number of cells or through an increase in the size of each individual cell. In order for growth to occur, anabolic processes must occur at a faster rate than catabolic processes.

Differentiation

Differentiation is a developmental process by which unspecialized cells change into specialized cells with distinctive structural and functional characteristics. Through differentiation, cells develop into tissues and organs.

Respiration

Respiration refers to all the processes involved in the exchange of oxygen and carbon dioxide between the cells and the external environment. It includes ventilation, the diffusion of oxygen and carbon dioxide, and the transport of the gases in the blood. Cellular respiration deals with the cell's utilization of oxygen and release of carbon dioxide in its metabolism.

Digestion
Digestion is the process of breaking down complex ingested foods into simple molecules that can be absorbed into the blood and utilized by the body.

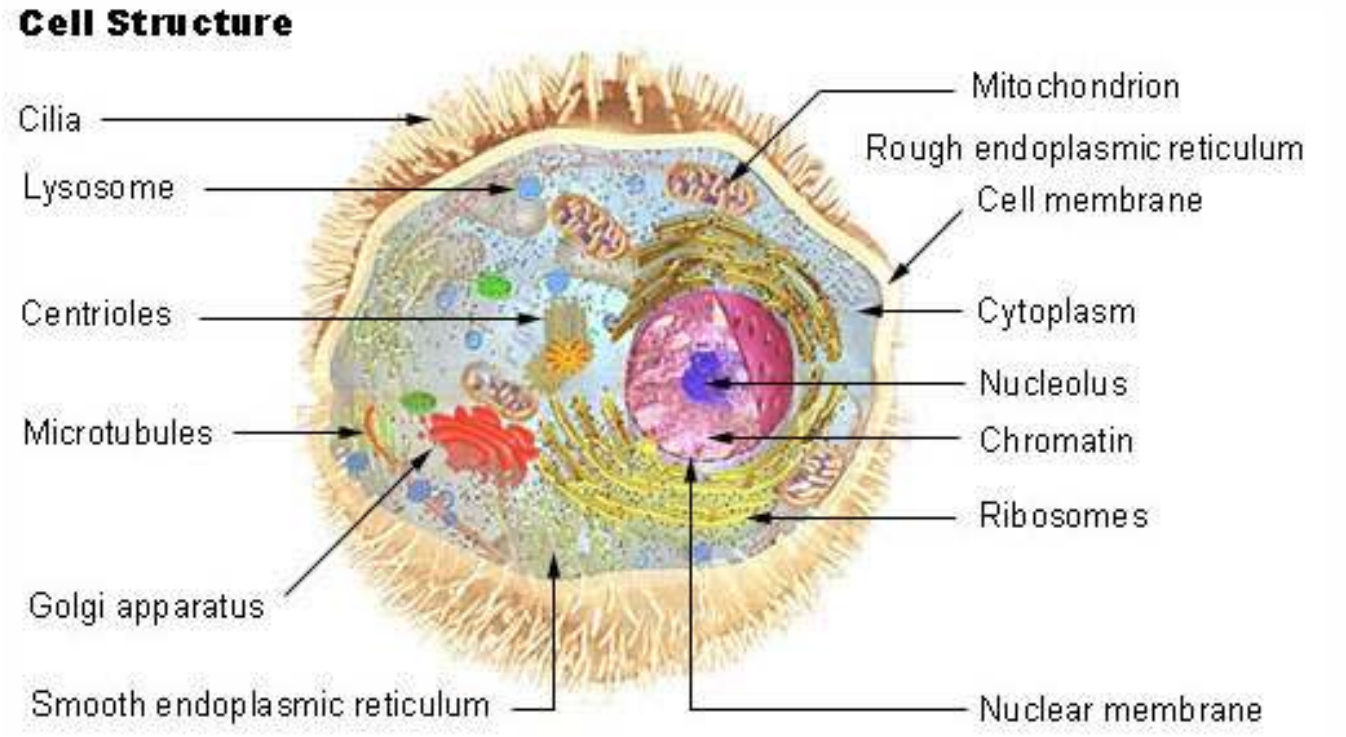
Excretion
Excretion is the process that removes the waste products of digestion and metabolism from the body. It gets rid of by-products that the body is unable to use, many of which are toxic and incompatible with life.

The ten life processes described above are not enough to ensure the survival of the individual. In addition to these processes, life depends on certain physical factors from the environment. These include water, oxygen, nutrients, heat, and pressure.

Cells
Cells, the smallest structures capable of maintaining life and reproducing, compose all living things, from single-celled plants to multibillion-celled animals. The human body, which is made up of numerous cells, begins as a single, newly fertilized cell.

Almost all human cells are microscopic in size. To give you an idea how small a cell is, one average-sized adult body, according to one estimate, consists of 100 trillion cells!

Cell Structure
Ideas about cell structure have changed considerably over the years. Early biologists saw cells as simple membranous sacs containing fluid and a few floating particles. Today's biologists know that cells are infinitely



more complex than this.

There are many different types, sizes, and shapes of cells in the body. For descriptive purposes, the concept of a "generalized cell" is introduced. It includes features from all cell types. A cell consists of three parts: the cell membrane, the nucleus, and between the two, the cytoplasm. Within the cytoplasm lie intricate arrangements of fine fibers and hundreds or even thousands of miniscule but distinct structures called organelles.

Cell membrane
Every cell in the body is enclosed by a cell (Plasma) membrane. The cell membrane separates the material outside the cell, extracellular, from the material inside the cell, intracellular. It maintains the integrity of a cell and controls passage of materials into and out of the cell. All materials within a cell must have access to the cell membrane (the cell's boundary) for the needed exchange.

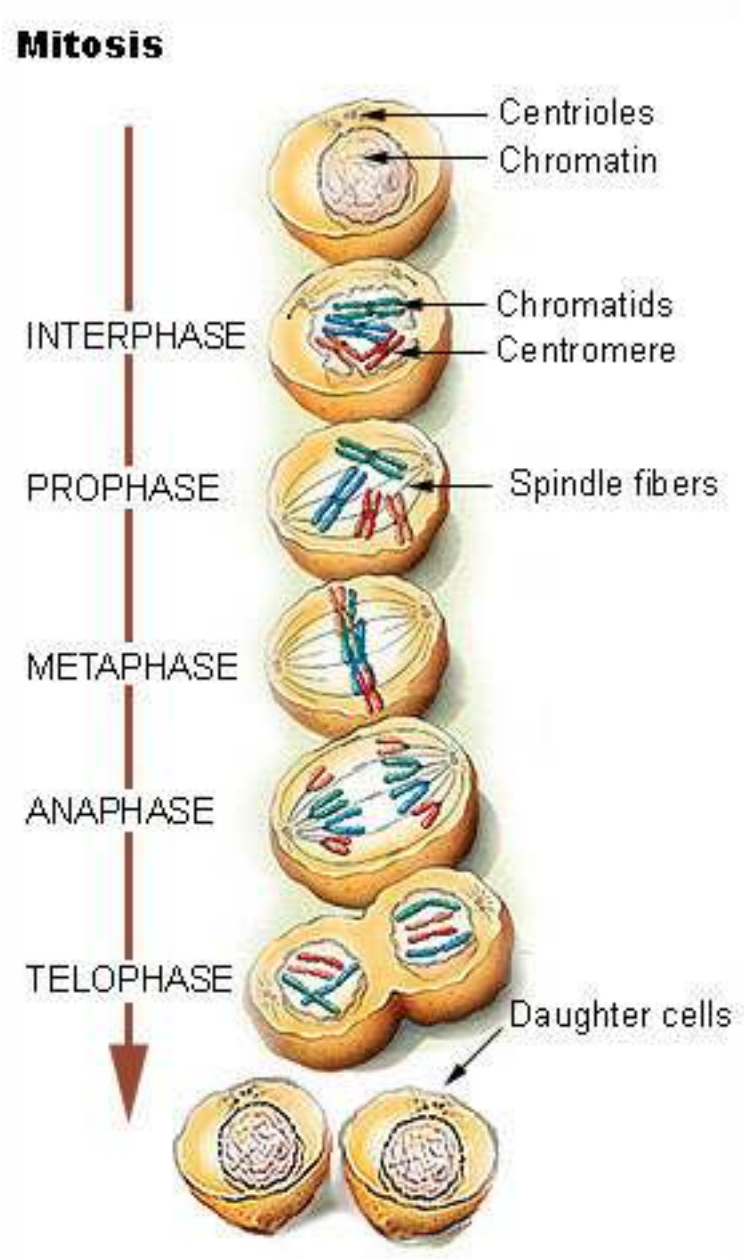
The cell membrane is a double layer of phospholipid molecules. Proteins in the cell membrane provide structural support, form channels for passage of materials, act as receptor sites, function as carrier molecules, and provide identification markers.

Nucleus and Nucleolus

The nucleus, formed by a nuclear membrane around a fluid nucleoplasm, is the control center of the cell. Threads of chromatin in the nucleus contain deoxyribonucleic acid (DNA), the genetic material of the cell. The nucleolus is a dense region of ribonucleic acid (RNA) in the nucleus and is the site of ribosome formation. The nucleus determines how the cell will function, as well as the basic structure of that cell.

Cytoplasm

The cytoplasm is the gel-like fluid inside the cell. It is the medium for chemical reaction. It provides a platform upon which other organelles can operate within the cell. All of the functions for cell expansion, growth and replication are carried out in the cytoplasm of a cell. Within the cytoplasm, materials move by diffusion, a physical process that can work only for short distances.



Cytoplasmic organelles

Cytoplasmic organelles are "little organs" that are suspended in the cytoplasm of the cell. Each type of organelle has a definite structure and a specific role in the function of the cell. Examples of cytoplasmic organelles are mitochondrion, ribosomes, endoplasmic reticulum, golgi apparatus, and lysosomes.

Cell Functions

The structural and functional characteristics of different types of cells are determined by the nature of the proteins present. Cells of various types have different functions because cell structure and function are closely related. It is apparent that a cell that is very thin is not well suited for a protective function. Bone cells do not have an appropriate structure for nerve impulse conduction. Just as there are many cell types, there are varied cell functions. The generalized cell functions include movement of substances across the cell membrane, cell division to make new cells, and protein synthesis.

Movement of substances across the cell membrane

The survival of the cell depends on maintaining the difference between extracellular and intracellular material. Mechanisms of movement across the cell membrane include simple diffusion, osmosis, filtration, active transport, endocytosis, and exocytosis.

Simple diffusion is the movement of particles (solutes) from a region of higher solute concentration to a region of lower solute concentration. Osmosis is the diffusion of solvent or water molecules through a selectively permeable membrane. Filtration utilizes pressure to push substances through a membrane. Active transport moves substances against a concentration gradient from a region of lower concentration to a region of higher concentration. It requires a carrier molecule and uses energy. Endocytosis refers to the formation of vesicles to transfer particles and droplets from outside to inside the cell. Secretory vesicles are moved from the inside to the outside of the cell by exocytosis.

Cell division

Cell division is the process by which new cells are formed for growth, repair, and replacement in the body. This process includes division of the nuclear material and division of the cytoplasm. All cells in the body (somatic cells), except those that give rise to the eggs and sperm (gametes), reproduce by mitosis. Egg and sperm cells are produced by a special type of nuclear division called meiosis in which the number of chromosomes is halved. Division of the cytoplasm is called cytokinesis.

Somatic cells reproduce by mitosis, which results in two cells identical to the one parent cell. Interphase is the period between successive cell divisions. It is the longest part of the cell cycle. The successive stages of mitosis are prophase, metaphase, anaphase, and telophase. Cytokinesis, division of the cytoplasm, occurs during telophase.

Meiosis is a special type of cell division that occurs in the production of the gametes, or eggs and sperm. These cells have only 23 chromosomes, one-half the number found in somatic cells, so that when fertilization takes place the resulting cell will again have 46 chromosomes, 23 from the egg and 23 from the sperm.

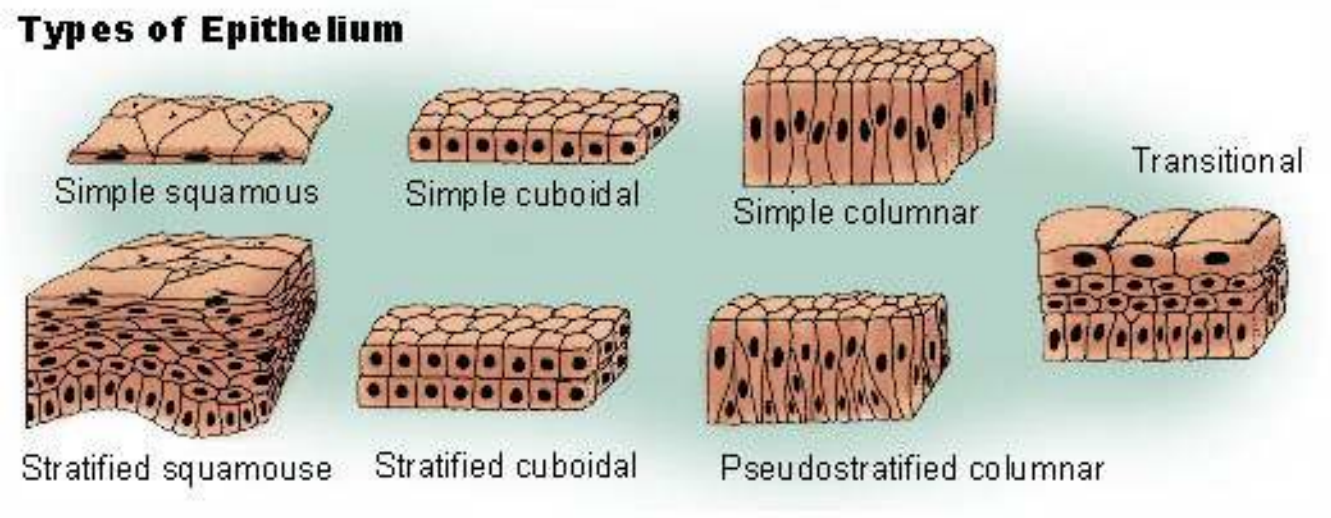
DNA replication and protein synthesis

Proteins that are synthesized in the cytoplasm function as structural materials, enzymes that regulate chemical reactions, hormones, and other vital substances. DNA in the nucleus directs protein synthesis in the cytoplasm. A gene is the portion of a DNA molecule that controls the synthesis of one specific protein molecule. Messenger RNA carries the genetic information from the DNA in the nucleus to the sites of protein synthesis in the cytoplasm.

Tissues

Tissue is a group of cells that have similar structure and that function together as a unit. A nonliving material, called the intercellular matrix, fills the spaces between the cells. This may be abundant in some tissues and minimal in others. The intercellular matrix may contain special substances such as salts and fibers that are unique to a specific tissue and gives that tissue distinctive characteristics. There are four main tissue types in the body: epithelial, connective, muscle, and nervous. Each is designed for specific functions.

Epithelial Tissues



Epithelial tissues are widespread throughout the body. They form the covering of all body surfaces, line body cavities and hollow organs, and are the major tissue in glands. They perform a variety of functions that include protection, secretion, absorption, excretion, filtration, diffusion, and sensory reception.

The cells in epithelial tissue are tightly packed together with very little intercellular matrix. Because the tissues form coverings and linings, the cells have one free surface that is not in contact with other cells. Opposite the free surface, the cells are attached to underlying connective tissue by a non-cellular basement membrane. This membrane is a mixture of carbohydrates and proteins secreted by the epithelial and connective tissue cells.

Epithelial cells may be squamous, cuboidal, or columnar in shape and may be arranged in single or multiple layers.

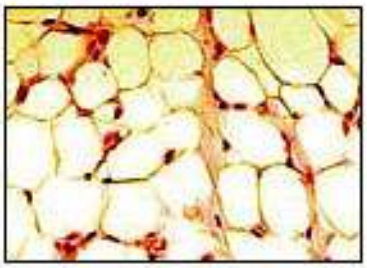
Simple cuboidal epithelium is found in glandular tissue and in the kidney tubules. Simple columnar

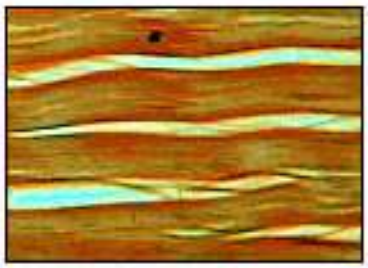
epithelium lines the stomach and intestines. Pseudostratified columnar epithelium lines portions of the respiratory tract and some of the tubes of the male reproductive tract. Transitional epithelium can be distended or stretched. Glandular epithelium is specialized to produce and secrete substances.

Connective Tissue

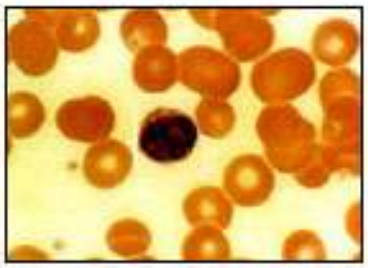
Connective tissues bind structures together, form a framework and support for organs and the body as a whole, store fat, transport substances, protect against disease, and help repair tissue damage. They occur throughout the body. Connective tissues are characterized by an abundance of intercellular matrix with relatively few cells. Connective tissue cells are able to reproduce but not as rapidly as epithelial cells. Most connective tissues have a good blood supply but some do not.

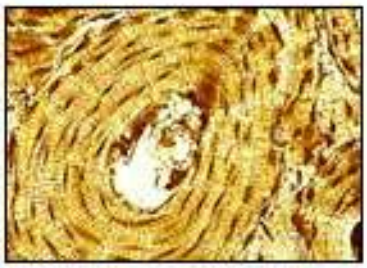

Areolar connective tissue

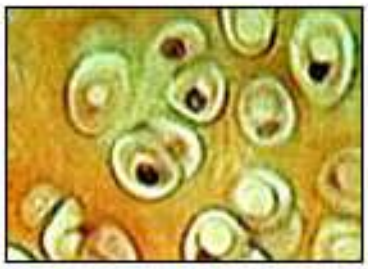

Adipose tissue


Fibrous connective tissue

Numerous cell types are found in connective tissue. Three of the most common are the fibroblast, macrophage, and mast cell. The types of connective tissue include loose connective tissue, adipose tissue, dense fibrous connective tissue, elastic connective tissue, cartilage, osseous tissue (bone), and blood.


Blood


Osseous tissue

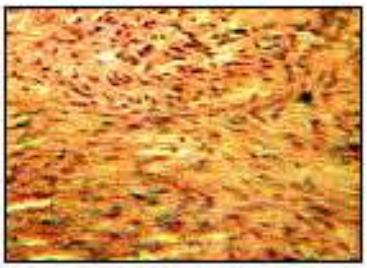

Hyaline cartilage

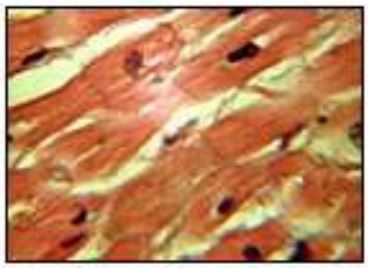
Muscle Tissue

Muscle tissue is composed of cells that have the special ability to shorten or contract in order to produce movement of the body parts. The tissue is highly cellular and is well supplied with blood vessels. The cells are long and slender so they are sometimes called muscle fibers, and these are usually arranged in bundles or layers that are surrounded by connective tissue. Actin and myosin are contractile proteins in muscle tissue.

Muscle tissue can be categorized into skeletal muscle tissue, smooth muscle tissue, and cardiac muscle tissue.


Skeletal muscle

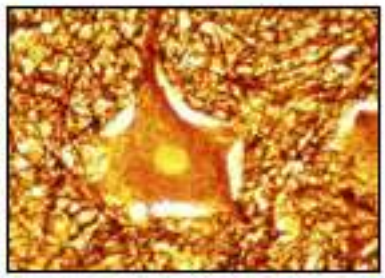

Smooth muscle


Cardiac muscle

Skeletal muscle fibers are cylindrical, multinucleated, striated, and under voluntary control. Smooth muscle cells are spindle shaped, have a single, centrally located nucleus, and lack striations. They are called involuntary muscles. Cardiac muscle has branching fibers, one nucleus per cell, striations, and intercalated disks. Its contraction is not under voluntary control.

Nervous Tissue

Nervous tissue is found in the brain, spinal cord, and nerves. It is responsible for coordinating and controlling many body activities. It stimulates muscle contraction, creates an awareness of the environment, and plays a major role in emotions, memory, and reasoning. To do all these things, cells in nervous tissue need to be able to communicate with each other by way of electrical nerve impulses.



Neuron (Nervous tissue)

The cells in nervous tissue that generate and conduct impulses are called neurons or nerve cells. These cells have three principal parts: the dendrites, the cell body, and one axon. The main part of the cell, the part that carries on the general functions, is the cell body. Dendrites are extensions, or processes, of the cytoplasm that carry impulses to the cell body. An extension or process called an axon carries impulses away from the cell body.

Nervous tissue also includes cells that do not transmit impulses, but instead support the activities of the neurons. These are the glial cells (neuroglial cells), together termed the neuroglia. Supporting, or glia, cells bind neurons together and insulate the neurons. Some are phagocytic and protect against bacterial invasion, while others provide nutrients by binding blood vessels to the neurons.

Membranes

Body membranes are thin sheets of tissue that cover the body, line body cavities, and cover organs within the cavities in hollow organs. They can be categorized into epithelial and connective tissue membrane.

Epithelial Membranes

Epithelial membranes consist of epithelial tissue and the connective tissue to which it is attached. The two main types of epithelial membranes are the mucous membranes and serous membranes

Mucous Membranes

Mucous membranes are epithelial membranes that consist of epithelial tissue that is attached to an underlying loose connective tissue. These membranes, sometimes called mucosae, line the body cavities that open to the outside. The entire digestive tract is lined with mucous membranes. Other examples include the respiratory, excretory, and reproductive tracts.

Serous Membranes

Serous membranes line body cavities that do not open directly to the outside, and they cover the organs located in those cavities. Serous membranes are covered by a thin layer of serous fluid that is secreted by the epithelium. Serous fluid lubricates the membrane and reduces friction and abrasion when organs in the thoracic or abdominopelvic cavity move against each other or the cavity wall. Serous membranes have special names given according to their location. For example, the serous membrane that lines the thoracic cavity and covers the lungs is called pleura.

Connective Tissue Membranes

Connective tissue membranes contain only connective tissue. Synovial membranes and meninges belong to this category.

Synovial Membranes

Synovial membranes are connective tissue membranes that line the cavities of the freely movable joints such as the shoulder, elbow, and knee. Like serous membranes, they line cavities that do not open to the outside. Unlike serous membranes, they do not have a layer of epithelium. Synovial membranes secrete synovial fluid into the joint cavity, and this lubricates the cartilage on the ends of the bones so that they can move freely and without friction.

Meninges

The connective tissue covering on the brain and spinal cord, within the dorsal cavity, are called meninges. They provide protection for these vital structures.

Session Review
Here is what we have learned from this unit:

- Basically, a cell consists of three parts: the cell membrane, the nucleus,and between the two, the cytoplasm.
- The cell nucleus contains genetic material and regulates activities of the cell. It determines how the cell will function, as well as the basic structure of that cell.
- All of the functions for cell expansion, growth and replication are carried out in the cytoplasm of a cell.
- Tissue is a group of cells that have similar structure and that function together as a unit. Primary types of body tissues include epithelial, connective, muscular, and nervous tissues.
- Epithelial tissues form the covering of all body surfaces, line body cavities and hollow organs, and are the major tissue in glands.
- Connective tissues bind structures together, form a framework and support for organs and the body as a whole, store fat, transport substances, protect against disease, and help repair tissue damage.
- Muscle tissue is composed of cells that have the special ability to shorten or contract in order to produce movement of body parts.
- Nervous tissue is responsible for coordinating and controlling many body activities.
- Body membranes are thin sheets of tissue that cover the body, line body cavities, and cover organs within the cavities in hollow organs.
- Two main categories of body membranes are epithelial and connective tissue membranes. Sub-categories include mucous membranes, serous membranes, synovial membranes, and meninges.

ANATOMY AND PHYSIOLOGY ONLINE COURSE - SESSION 3 - QUESTION & ANSWERS

NAME: _____

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Please be sure to fill out the information above, complete the test and e-mail or fax it back to us at iridology@netzero.net or 530-878-1119. We will grade your question & answer session and will let you know if we have questions or comments.

1. These are T/F questions. Please put a T or F after each question below.
2. A human life begins as a single, newly fertilized cell. _____
3. One average-sized adult body may consist of 100 million cells. _____
4. Intricate arrangements of fine fibers and thousands of organelles exist within the cell nucleus. _____
5. The nucleus determines how the cell will function, as well as the basic structure of that cell. _____
6. All of the functions for cell expansion, growth and replication are carried out in the cytoplasm of a cell. _____
7. Epithelial tissue consists of tightly packed cells with little intercellular matrix, having one free surface. _____
8. Connective tissue cells are able to reproduce twice as rapidly as epithelial cells. _____
9. The cells in muscle tissue that generate and conduct impulses are called neurons. _____
10. Mucous membranes line the body cavities that open to the outside. _____
11. Synovial fluid lubricates the membrane and reduces friction and abrasion when organs in the thoracic or abdominopelvic cavity move against each other or the cavity wall. _____