UNIT 1: CONCEPT OF HUMAN BODY

UNIT STRUCTURE

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1.1 LEARNING OBJECTIVES

After going through this Unit, You will be able to

- Define Anatomy and Physiology
- Understand conceptual knowledge of human body
- Explain the structure and characteristics of human cell
- Discuss about the organelles of human cell and their function
- Describe different types of Tissue

1.2 INTRODUCTION

Now days when we are using yoga for the management of various diseases, it is very much necessary to understand the anatomy and physiology of various organs and systems of our human body. The study of human anatomy and physiology will allow the student to get a basic knowledge about the structure and functions of different body parts.

The human body is like a highly technical and sophisticated machine. It operates as a single entity, but is made up of a number of systems that work interdependently. Biology is a branch of science that deals with living organism

and their vital processes. Biology is divided into two parts, anatomy and physiology. Anatomy and physiology are the scientific study of the body structure and their functions. A single organism is composed of billion and trillion of cells, tissue and organs.

1.3 MEANING OF ANATOMY AND PHYSIOLOGY

Anatomy

The word 'anatomy' is derived from a Greek word "Anatome" meaning to cut up. It is the structures that make up body and how those structures relate with each other. Anatomy is the study of the structure of the body and knowledge of particular organ in our body and also study of location of particular organ and the physical relationship between its constituent parts.

The study of anatomy includes many sub specialities.These are gross anatomy, microscopic anatomy, developmental anatomy,and embryology etc.

- **Embryology-** It is the study of structures that emerge from the time of the fertilized egg through the 8^{th} week in uterus.
- **Developmental anatomy-** It is the study of structures that emerge from the time of the fertilized egg to the adult form.
- **Gross anatomy-** It is the study of body structures that can be examined without using a microscope.
- **Microscopic anatomy (Histology)** requires the use of microscope to study tissues that from the various organs of the body.
- **Systemic Anatomy-** It is the study of the structures of specific systems of the body such as nervous system.
- **Regional Anatomy-** It is the study of the specific regions of the body such as head and chest.
- **Radiographic Anatomy-** It is the study of body structures that can be visualized with x-rays.

- **Pathological Anatomy-** It is the study of structural changes associated with disease.

Physiology

The word 'physiology' is derived from a Greek word'physios' (nature) and 'logia' (study) which means-for study of nature. It is the study of how the body and its part work for function and the ways in which their integrated activities maintain life and health of the individual.

There are many sub-divisions of physiology. They are- neurophysiology, endocrinology, cardio- vascular physiology, respiratory physiology, renal physiology, pathophysiology etc.

- **Neurophysiology**- It is the study of functional properties of nerve cells
- **Endocrinology**- It is the study of hormones and how they control body functions
- **Cardiovascular physiology**- It is the study of functions of the heart and blood vessels
- **Respiratory physiology**- It is the study of the functions of the air passageways and lungs
- **Renal physiology**- It is the study of functions of kidneys
- **Pathophysiology**- It is the study of functional changes associated with disease and aging

Anatomy and Physiology are studied together to give a full appreciation and understanding of human body.

1.4 STRUCTURE AND FUNCTION OF HUMAN CELL

Cell is the body's smallest structural and functional units. Robert Hook discovered the cell in 1665. Human body consists of 10 trillion cells. Size of cell is about 10 micrometer and mass is 1 nanograms. The human body develops from a single cell called the zygote, which results from the fusion of the ovum and the spermatozoon. Cell division follows and as the foetusgrows; cells with different structure and functional specialisation develop, all with the same

genetic make-up as the zygote. Individual cells are too small to be seen with the naked eye.

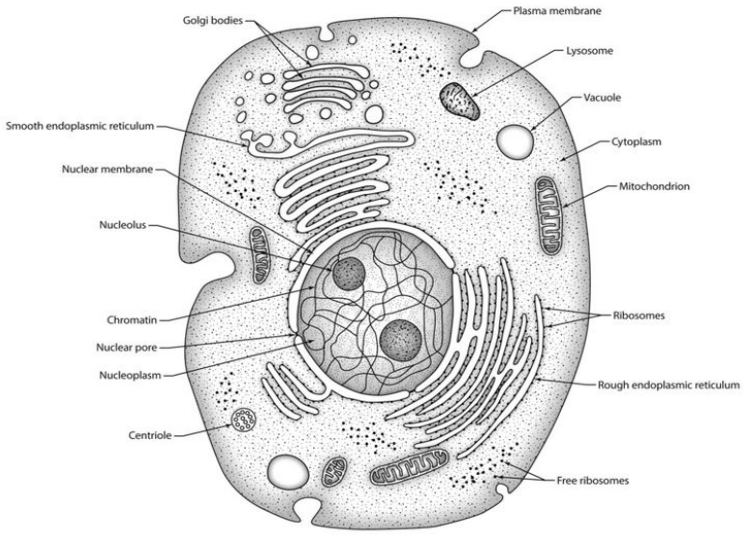


Image: A Typical Human Cell

STRUCTURE OF CELL

There are many different types, sizes, and shapes of cells in the body. All cells share general structure. A cell consists of three parts- 1) the nucleus, 2) the cell membrane and 3) the cytoplasm.

NUCLEUS

The nucleus is the control centre of the cell. It is surrounded by a double nuclear membrane. The nucleus is the largest organelle and is contained within the nuclear envelope, a membrane similar to the plasma membrane but with tiny pores through which some substances can pass between it and the cytoplasm.

The nucleus contains the body's genetic material, in the form of deoxyribonucleic acid (DNA), this directs all its metabolic activities. In a non-dividing cell DNA is present as a fine network of threads called chromatin, but when the cell prepares to divide the chromatin forms distinct structures called chromosomes.

RNA (ribonucleic acid) is also found in the nucleus. There are different types of RNA, not all found in the nucleus, but which are in general involved in protein synthesis.

Within the nucleus is a roughly spherical structure called the nucleus which is involved in synthesis and assembly of the components of ribosomes.

The inner nuclear membrane surrounds the fluid part of the nucleus called nucleoplasm, while the outer nuclear membrane connects with the endoplasmic reticulum.

PLASMA (CELL) MEMBRANE

Every cell of the body is enclosed a with a cell (plasma) membrane. The cell membrane separates the material outside the cell, extra-cellular, 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.

The plasma membrane consists of two layers of phospholipids with proteins and sugars embedded in them. In addition to phospholipids, the lipid cholesterol is also present.

The phospholipids molecules have a head, which is electrically charged and hydrophilic(water loving), and a tail which has no charge and is hydrophobic(water hating). The phospholipids bilayer is arranged like a sandwich with the hydrophilic heads aligned on the outer surfaces of the membrane and the hydrophobic tails forming a central water-repelling layer. These differences influence the transfer of substances across the membrane.

Functions of cell membrane:

- It protect the structure of the cell
- It receive outer sensations
- It transport substances across the cell
- It protect the organelles

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 the functions of for the cell expansion, growth and replication are carried out in the cytoplasm of a cell. The cytoplasm is about 80% water and usually colourless.

Cytoplasmic Organelles

A cell consists of a plasma membrane enclosing a number of organelles suspended in a watery fluid called cytosol. Organelles, literally 'small organs', have individual and highly specialised functions, and are often enclosed in their own membrane within the cytosol. They include the nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, Lysosome and the cytoskeleton.

Cytoplasmic organelles are-

- Mitochondria
- Ribosomes
- Endoplasmic reticulum
- Golgi apparatus
- Lysosomes

Mitochondria

Mitochondria are the power house of the cell. Mitochondria are membranous, sausage-shaped structures in the cytoplasm. They are central to aerobic respiration, the process by which chemical energy is made available in the cell. This is in the form of ATP, which releases energy when the cell breaks it down. The most active cell types have the greatest number of mitochondria, e.g. liver, muscle and spermatozoa.

Ribosome

Ribosomes are small organelles distributed throughout the cytoplasm. These are tiny granules composed of RNA and protein. Ribosome's are not covered by a membrane. When ribosome present in free units or in a small clusters in the cytoplasm, the ribosomes make proteins of use within the cell. These include the enzyme. Ribosomes are also found on the outer surface of the nuclear

envelope and rough endoplasmic reticulum where they manufacture proteins for export from the cell. Ribosomes contain 60% proteins of the cell.

Endoplasmic reticulum

It makes a collection of membrane bound cavities. It is an extensive series of interconnecting membranous canals in the cytoplasm. The endoplasmic reticulum (ER) connects with the outer nuclear membrane and with the cell membrane. There are two types: smooth and rough. Smooth ER synthesises lipids and steroid hormones, and is also associated with the detoxification of some drugs. Some of the lipids are used to replace and repair the plasma membrane and membranes of organelles. Rough ER is studded with ribosome. The function of rough ER is protein synthesis.

Golgi apparatus

It is the collection of flat saclike cisternae. It is present in all cells but is larger in those that synthesise and export proteins. The proteins move from the endoplasmic reticulum to the Golgi apparatus where they are 'packaged' into membrane-bound vesicles. The vesicles are stored and when needed, they move to the plasma membrane and fuse with it. They act like storage or ware houses of the cell.

Lysosomes

Lysosomes are small membranous vesicles pinched off from the Golgi apparatus and it contains powerful digestive enzymes. Lysosomes in white blood cells contain enzymes that digest foreign material such as microbes. They are called the suicide bag of the cell.

Lysosomes function in three different ways-

i) They function with food vacuoles to digest stored food
ii) They function in the maintenance and repair of cellular organelles.
iii) They act as suicide agents in old and weakened cells

FUNCTIONS OF CELL

Cells of different types have different functions because cell structure and functions are closely related. Just as there are many cell types, there are

varied cell functions. The generalized cell function include- provide structure and support, facilitate growth through mitosis, allow passive and active transport, produce energy, create metabolic reactions and aid in reproduction.

1.5 DIFFERENT TYPES OF TISSUES

Tissue is a group of same cells that have similar structure and function together as a unit.Tissue is classified according to the size, shape and functions of their constituent cells.There are four main types of tissue each with subtypes. They are-

1. Epithelial tissue or epithelium
2. Connective tissue
3. Muscle tissue
4. Nervous tissue

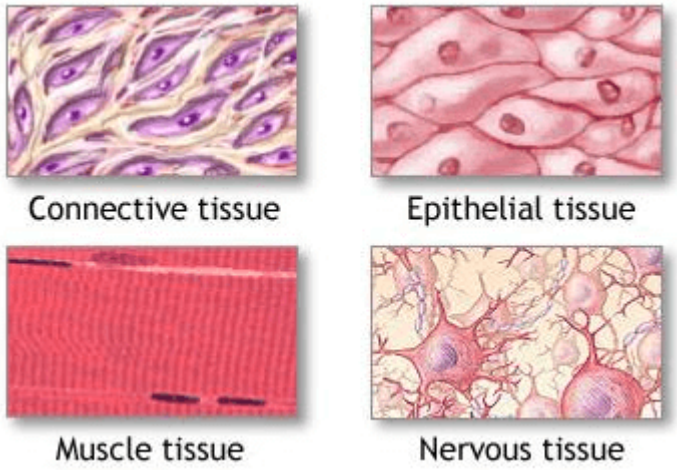


Image: Different types of Tissue

1. EPITHELIAL TISSUE:

Epithelial tissues are covers the body and lines cavities, hollow organs and tubes and also found in glands. The structure of epithelium is closely related to its function, which include:

- Protection of underlying structures from, for example, dehydration, chemical and mechanical damage

- Secretion
- Absorption
- It excretes waste like urea, sweat

Classification of Epithelial tissue-

- ❖ Classification based on shape:
  - i) Squamous
  - ii) Cuboidal
  - iii) Columnar

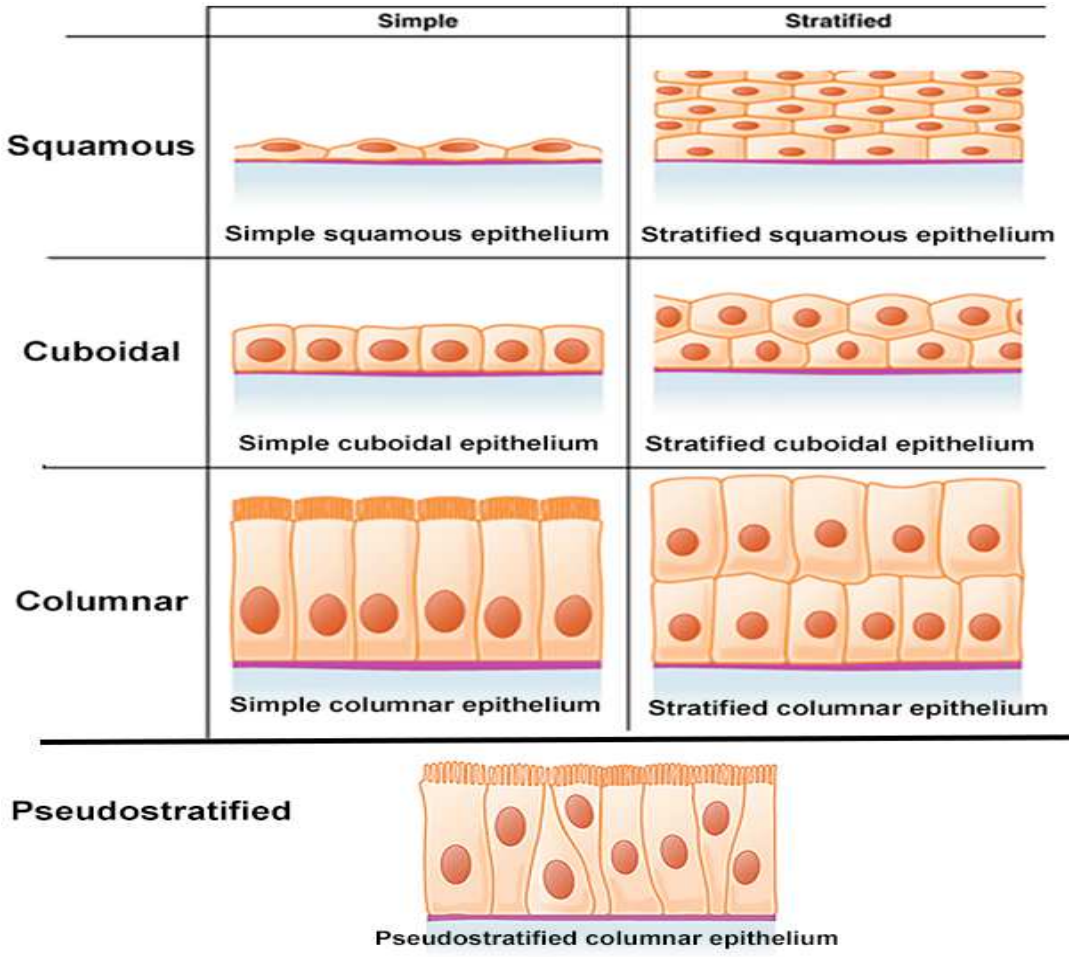


Image: Types of tissues

Squamous Epithelial tissue:

- This is composed of a single layer of flattened cells. The cells fit closely together like flat stones, forming a thin and very smooth membrane.It forms the lining of the heart, blood vessels, lymph vessels, alveoli of the lungs, lining the collecting ducts of nephrons in the kidneys.

Cuboidal Epithelial tissue:

- This consists of cube-shaped cells fitting closely together lying on a basement membrane. It forms the kidney tubules and is found in some glands such as the thyroid. Cuboidal epithelium is actively involved in secretion, absorption and excretion.

Columnar Epithelial tissue:

- This is formed by a single layer of cells, rectangular in shape, on a basement membrane. They function in secretion and absorption. (Ducts and Intestine)

❖ Classification based on arrangement:

i) Simple
ii) Stratified
iii) Pseudo-stratified
iv) Transitional

Simple Epithelial tissue:

- Simple epithelium consists of a single layer of identical cells (Blood capillaries, Alveoli of lungs)

Stratified epithelial tissue:

- Stratified epithelial consists of several layers of the cells of various shapes. Continual cell division in the lower layers pushes cells above nears and nearer to the surface, where they are shed.Main function is to protect underlying structures form mechanical wear and tear.

Pseudo Epithelial tissue:

- This is composed of several layers of cells. They look like it is several layers thick but, in reality all cells extend from the basement membrane to the outer surface. In the deepest layers the cells are mainly columnar and, as they grow towards the surface, they become flattened and are then shed. (Throat, Trachea, Bronchi of lungs)

Transitional Epithelial tissue:

- This is composed of several layers of closely packed, easily stretched cells. When stretched they appear flat, when relaxed they look raged or saw toothed. It lines several parts of the urinary tract including the bladder and allows for stretching as the bladder fills.

2. CONNECTIVE TISSUE:

Connective tissue is one of the most widely distributed tissues in the body. It is made up of cells with lots of intercellular material called matrix. They occur throughout the body.

Functions-

- It bind structure together
- Form a framework and support for organs and the body as a whole
- Store fat
- Transport substances
- Protect against diseases
- Helps to repair tissue damage

Classification and types-

i) Loose connective tissue
   i) Areolar
   ii) Adipose
   iii) Reticular
ii) Dense connective tissue
   i) Regular
   ii) Irregular

iii) Specialized connective tissue

i) Cartilage

ii) Bone

iii) Liquid

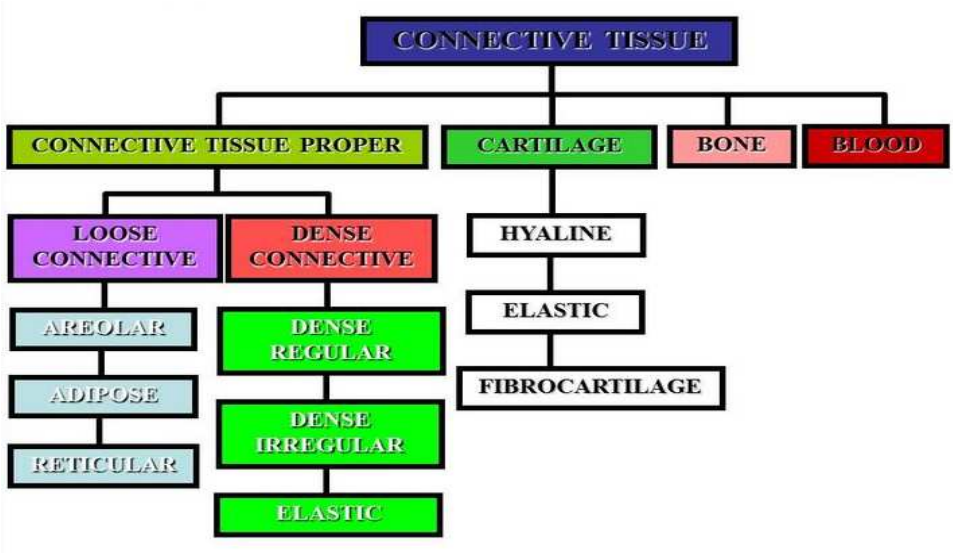


Image: Types of Connective Tissue

Loose connective Tissue

The fibres of loose connective tissue are loosely intertwined between cells. In this tissue the matrix is semisolid with many fibroblasts and some fat cells, mast cells and macrophages widely separated by elastic and collagen fibres. It is found in almost every part of the body. It provides elasticity and tensile strength. It connects and supports other tissues.

There are three types of loose connective tissue-

- Areolar tissue
- Adipose tissue
- Reticular tissue

Areolar tissue:

Areolar loose connective tissue are one of the most wide distributed in our body. It contains several types of cells like fibroblast, macrophages, plasma cells, mast cells. It combine with adipose tissue, areolar connective tissue forms the subcutaneous layer, the payer of tissue that attaches the skin to underlying tissues and orange.

Adipose tissue:

This tissue consists of fat cells called adipocytes, containing large fat globules, in a matrix of areolar tissue. It is good insulator and therefore it can reduce heat loss thorough the skin. Example-eyelids.

Reticular tissue:

Reticular tissue has a semisolid matrix with fine branching reticulin fibres. It contains reticular cells and white blood cells(monocytes and lymphocytes). This tissue is found in lymph nodes and all organs of the lymphatic system. It forms the framework of the liver, spleen, lymph nodes and bone marrow. Reticular fibres in the spleen filter blood and remove worn out blood cells. Reticular fibres in the lymph nodes filter lymph and remove bacteria.

Dense connective tissue:

Dense connective tissue contains more, thicker and denser fibres but considerably fewer cells than loose connective tissue. There are two types of dense connective tissue.

i) Regular
ii) Irregular

Regular dense connective tissue:

This type of tissues embedded fibres are regularly arranged that provide the tissue with great strength. Example – Tendons (attach muscles to bone) and ligaments (attach bone to bone)

Irregular dense connective tissue:

In this, embedded fibres are casually irregularly arranged. Often occurs in muscle sheaths (covering of muscle), joint capsules, fascia (tissue beneath skin and around muscles and other organs).

Specialized connective tissue-

- **Cartilage:**

The cells of cartilage are called chondocytes. Cartilage is firmer than other connective tissues. The cells are sparse and lie embedded in matrix reinforced by collagen and elastic fibres. Cartilage scan endure considerably more stress than loose and dense connective tissue. Cartilage has no blood supply so; it heals poorly following an injury.

There are three types of cartilage:

i) Hyaline cartilage
ii) Fibrocartilage
iii) Elastic cartilage

Hyaline Cartilage: it is the most abundant cartilage in the body. It provides flexibility and support and at joints reduces friction and absorbs shock. It is the weakest of the three types of cartilage. Example- costal cartilage

Fibro cartilage: This cartilage is strongest of the three types of cartilage. This consists of dense masses of white collagen fibres in a matrix similar to that of hyaline cartilage with the cells widely dispersed. It is a tough, slightly flexible, supporting tissue found. Example- intervertebral discs

Elastic cartilage: this flexible tissue consists of yellow elastic fibres lying in a solid matrix with chondrocytes lying between the fibres. It provides support and maintains shape of, e.g. the pinna or lobe of the ear, the epiglottis and part of the tunica media of blood vessel walls.

- **Bone specialized connecting tissue-**

Bone cells are called osteocytes. Bone tissue is classified as either compact or spongy, depending on how its extra cellular matrix and cells are organised.

Bone cells are embedded in a matrix of calcium and phosphorus, the mineral salts responsible for the hardness of bone.

- **Liquid specialized connecting tissue-**

Blood tissue: it is composed of a liquid extra cellular matrix called blood plasma and blood cells. Blood cells are formed in red bone marrow.

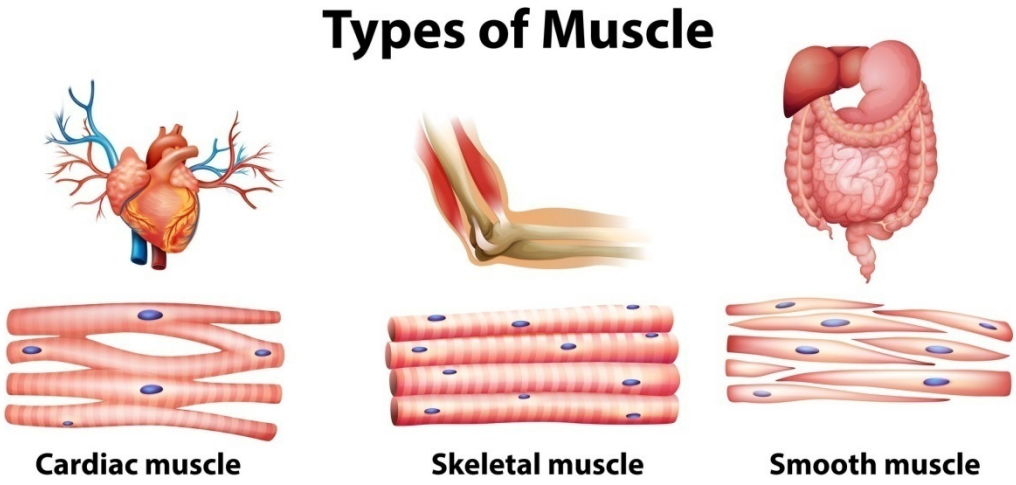
Lymph: lymph is the extra cellular fluid that flows in lymphatic vessels. It makes up lymph glands, thymus, spleen, tonsils. It produces the plasma cells that produce antibodyes.

3. MUSCLE TISSUE:

Muscle tissue is a specialized tissue in the body responsible for movement, posture and various physiological functions. It is made up of thin and elongated cells called muscle fibres which helpto contract and relax, providing movement within the body and of the body itself. Muscle contraction requires a blood supply that will provide sufficient oxygen, calcium and nutrients and remove waste products.The cells are long and slender so they are sometimes called muscle fibres.

There are three types of muscle tissue:

i) Skeletal muscle tissue
ii) Smooth muscle tissue
iii) Cardiac muscle tissue



Skeletal muscle tissue- Skeletal muscles are attached to bone by tendons and helps in the movements of the body. It has alternating light and dark bands. It is striated, voluntary as it is under conscious control. These fibres are cylindrical contain several nucleus (Multinucleated) and can be up to 35 cm long. Skeletal muscle provides protection and support to internal organs, nerves and blood vessels of the body and generates significant body heat generations during contraction.Speed of contraction is fast. The contraction is stimulated by motor nerve impulses originating in the brain or spinal cord and ending at the neuromuscular junction.

Smooth muscle tissue- Smooth muscle is described as non-striated, visceral or involuntary. It is spindle shaped with only one central nucleus and does not have striations and is not under conscious control. They are also called as non-striated involuntary muscle. Some smooth muscle has the intrinsic ability to initiate its own contraction, e.g. peristalsis. Smooth muscle is only completely relaxed for short periods. Contraction of smooth muscle is slower and more sustained than skeletal muscle. It is found in the walls of hollow organs such as oesophagus, Stomach, Small and Large intestines of the digestive tract etc.

Cardiac muscle tissue- Cardiac muscle is found only in the wall of the heart.Its contraction pumps blood and accounts for the heart beat. It is involuntary, striated and uni-nucleated. Each fibre has a nucleus and one or more branches. The ends of the cells and their branches are in very close contract with the ends and branches of adjacent cells. Cardiac muscle fibres do not need to be stimulated individually.

4. NERVOUS TISSUE

The nervous tissue is the main tissue component of nervous system. It regulates and controls body functions and activity. Nervous tissue is made up of cells and supportive materials. The main cells are highly specialized for carrying messages in the form of electrical signals.It stimulates muscle contraction, creates an awareness of the environment, and plays an important role in emotions, memory and reasoning. These cells are called neurons and they generate and transmit nerve impulses. The supporting cells called neuroglia cells which help neurons function properly.

There are three types of matters in nervous tissue. They are-

Grey matter- Forming nerve cells

White matter- Forming nerve fibres

Neuroglia- Holding nerve cells and fibres together and supporting them

There are two types of nervous tissue:

- Neuron
- Neuroglia

Neuron- The nervous system consists of neurons, which conduct nerve impulses and are supported by unique connective tissue cells known as neuroglia. Nerve cells (Neuron) are the functional units of the nervous system that generate and transmit nerve impulses. Each neuron consists of a cell body and its processes, one axon and many dendrites. Neurons are commonly referred to as nerve cells. Bundles of axons bound together are called nerves.

Function: The nerve cell or neuron acts as the mediator and is the basic signalling unit of the nervous system. The human nervous system is a complex network of neurons specialized to carry messages. The main functions of the nerve cell are-

- To respond to stimuli
- To control the metabolic actions
- Regulation of physiological functions
- To carry messages from other neurons to the cell body
- To receive stimuli and send signals to the brain and spinal cord

Location: Brain, Spinal cord and Nerve

Neurons have three main parts:

- Dendrite
- Cell body
- Axon

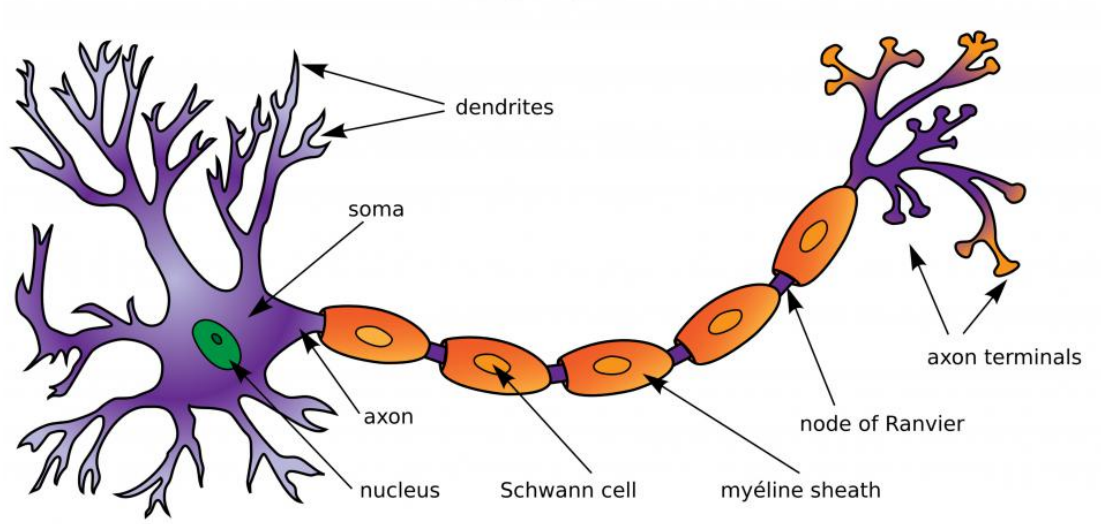


Image: Neuron/ Nerve Cell

Dendrite: A branch like structure that functions by receiving messages from other neurons and allows the transmission of messages to the cell body.

Cell body: Cell body is also receptive to stimuli and serves as the synthesizing centre for the whole nerve.

Axon: It is a tube like structure which functions by carryingelectrical impulses from the cell body to the axon terminals and by transmitting the impulses to another neuron.

Nucleus: Each neuron or a nerve cell has a cell body with a nucleus and other cell organelles including the endoplasmic reticulum, Golgi apparatus, mitochondria and other components.

Myelin sheath: It is present in the exterior region of the nerve cell. In neuron, it works as a protective layer of the nerve cell by surrounding the nerve fibres.

Neuroglia-Nervous tissue also includes cells that do not transmit impulses, but instead support the activities of the neurons.They are collectively known as neuroglia, which is formed from different types of glia cells.Glia carry nutrients, speed repair, provide myelin for axons, support the blood-brain barrier and may form their own communication network. Some are phagocytic and protect against bacterial invasion.

1.6 LET US SUM UP

- Anatomy is the study of body structures and their relations, derived from the Greek word “Anatome” meaning to cut up. The Study of Anatomy includes many sub-specialities. i.e. Gross anatomy, Microscopic anatomy and Embryology.
- Physiology derived from the Greek word ‘physios’ (nature) and ‘logia’ (study) which means-for study of nature. It is the study of how the body and its part work or function.
- Human cells are the basic building blocks of life, forming tissues, organs and systems in the body.

  Cell membrane, a protective layer controlling the entry and exit of substances. Cytoplasm, a jelly like fluid containing organelles, Nucleus, the control centre holding DNA and regulating cell activities.
- Other cell organelles present in the cell are Mitochondria, the powerhouse producing energy (ATP). Ribosome helps in Protein synthesis. Smooth endometrium Reticulum (ER) helps in synthesizes lipids; Rough ER has ribosome for protein production. Golgi apparatus modifies packages and transports proteins and lipids. Lysosomes help in digestion.
- Tissue is a group of cells working together to perform specific function. There are four primary types of tissues in the human body, which are epithelial tissue, Connective tissue, Muscle tissue and Nervous tissue. Epithelial tissue helps in the protection, secretion, absorption and filtration.

Connective tissue supports binds and protects other tissue and organs. Muscle tissue enables movements through contraction. Nervous tissue signals for communication, coordination and control.

1.7 FURTHER READINGS

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4. Guyton, Arthur C. *Textbook of Medical Physiology*, W.B.Saunders Co. Philadelphia
5.

✓ 1.8 ANSWERS TO CHECK YOUR PROGRESS

Que. 1 Who had discovered the cell?

Answer: Robert Hook discovered the cell.

Que. 2 What is nucleus?

Answer: The nucleus is the control centre of the cell.

Que. 3 What is the meaning of hydrophilic?

Answer: Water loving

Que. 4 What is the powerhouse of a cell?

Answer: Mitochondria are the power house of the cell.

Que. 5 List the three types of cartilages.

Answer: Hyaline, Elastic and Fibro-cartilage

? 1.9 MODEL QUESTIONS

Que.1 Describe the structure and functions of Human Cell in details.

Que.2 Describe the epithelial tissue in details.

Que.3 Explain the connective tissue in details.

Que. 4 Define Anatomy and Physiology and explain in the study of the muman body.

Que. 5 Describe the structural and functions of plasma membram C in detail.

Que. 6 Explain the structure and functions of Cytoplasm and it's role in cell activities.

Que. 7 Describe the role and functions of Mitochondria, ribosomes and endoplasmic reiticulam.

Que. 8 Explain the structure and classifications of Connective tissue with suitable examples.

Que. 9 Describe the structure of neuron and it's role in neorones system.

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