Animal Tissue

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Animal tissues are made up of animal cells that have been gathered together. The structure, function, and origin of these tissues are all different. Epithelial, connective, muscular, and nervous tissues are the four types of tissues found in animals.

Epithelial tissue

Epithelial tissue or epithelium forms the skin's outer cover that also lines the cavity of the body. It forms the lining of tracts that are respiratory, digestive, reproductive and excretory. They perform different functions including absorption, secretion, sensation, protection and secretion.

Connective tissue

Connective tissue is a type of tissue as the name suggests, supports, and binds the various body organs and tissues. They are common in any part of the body originate from the embryo's middle germinal layer.
Connective tissue consists of several cells embedded in the intercellular network of cell-secreted protein fibers, called collagen or elastin. The cells secrete a thin gel of polysaccharides that create matrix or ground substance along with fibers.

Muscular tissue

Muscular tissue is a specialized animal tissue that applies force through contraction to various parts of the body. It consists of small, elongated cells called muscle fibers, and it regulates an organism's movement. In the muscle fibers, the cytoplasm is called sarcoplasm. It includes a membrane network called the sarcoplasmic reticulum. The sarcolemma is the membrane that surrounds the muscle fibers.

Nervous tissues

The main tissue of our nervous system is the nervous or nerve tissue. It regulates and monitors the body's functions. Nervous tissue comprises of 2 cells which are named as

- Nerve cells or neurons
- Glial cells

A nerve cell helps to transfer nerve impulses as well as provides nutrients to neurons. Brain, Nerves and spinal cord are made up of nervous tissue, skilled in being stimulated to quickly transfer information from one portion of the body to the other.

Epithelial Tissue

Epithelial tissues form the protective covering and inner lining of the body and organs. These tissues were the first to evolve during evolution and were first formed during embryonic development. They develop from the ectoderm, mesoderm and endoderm of the embryo.

Characteristics of Epithelial Tissues

Following are the important characteristics of epithelial tissues:

1. These can be single-layered or multi-layered.
2. The tissues have the power to regenerate.
3. These are held together by gap junctions, tight junctions, zonula adheren, desmosomes, or interdigitation.
4. The plasma membrane of these cells is specialized into flagella, cilia, and microvilli.

Classification of Epithelial Tissues

The epithelial tissues can be classified as:

Classification	Function

Sensory epithelium	To perceive stimuli
Glandular epithelium	Secretes chemicals
Pigmented epithelium	Imparts colour in retina
Absorptive epithelium	For absorption

Simple Epithelial Tissue

This type of epithelium is composed of a single layer of cells which mainly make up the linings of ducts, tubes and other cavities in the body. Based on the structure of the cell, the simple epithelial tissue is classified into three types viz.:

Squamous epithelium:

- It is a simple single-layered epithelium.
- Structurally, the squamous epithelium is made up of flat cells with irregular boundaries.
- It forms linings of blood vessels and alveoli.

Cuboidal epithelium:

- The tissue is made of cube-shaped cells.
- It forms the lining of kidney tubules and ducts of salivary glands.

Columnar epithelium:

- It is composed of tall and slender, column-shaped
- It forms the lining of the stomach and intestine.

In some organs, cuboidal and columnar epithelial have cilia present on the outer surface which is called the ciliated epithelium. It helps in the directional movement of materials along with the hollow organs like the respiratory tract. The cuboidal or columnar epithelia which are specialized in secretions are called glandular epithelium which includes the exocrine and endocrine glands.

Compound Epithelial Tissue

The compound epithelium is a multilayered (two or more layers of cells) tissue. The key function of compound epithelium is protection and has a limited role in secretion. Skin is a compound epithelium which functions as a barrier against chemical and mechanical stresses.

Muscular Tissue

The muscular tissue develops from the mesoderm of the embryo. It is classified into three types:

- Cardiac
- Smooth
- Skeletal

Muscular tissue performs the following functions:

1. It helps in movement and locomotion.
2. It supports the bones and other structures.
3. It is responsible for peristalsis and parturition.

Classification of Muscular Tissue

The muscular tissue can be classified as:

Classification	Function

Cardiac	It helps in blood circulation and keeps the heart pumping
Smooth	These help in peristalsis and other involuntary functions of the body.
Skeletal	Provide support, help in movement and maintain homeostasis

Skeletal Muscle Tissue

- These muscles are attached to the skeleton and help in its movement.
- These muscles are also known as striated muscles because of the presence of alternate patterns of light and dark bands.
- These light and dark bands are sarcomeres which are highly organized structures of actin, myosin, and proteins. These add to the contractility and extensibility of the muscles.
- Skeletal muscles are voluntary muscles composed of muscle fibers.
- 40% of our body mass comprises skeletal muscles.
- Each skeletal tissue contains myofibrils.
- The cells of these tissues are multinucleated.
- These are provided with blood vessels and many elongated mitochondria and glycogen granules.
- They bring about the movement of the organs of the body.

Smooth Muscle Tissue

- These are non-striated, involuntary muscles controlled by the Autonomous Nervous System.
- It stimulates the contractility of the digestive, urinary, reproductive systems, blood vessels, and airways.
- The actin and myosin filaments are very thin and arranged randomly, hence no striations.
- The cells are spindle-shaped with a single nucleus.

Cardiac Muscle Tissue

- These are found only in the heart.
- These are involuntary muscles and the heart pumps the blood through cardiac contractions.
- The cells of the cardiac muscles known as the cardiomyocytes are striated.
- They are single-celled and uninucleated.
- The ends of the cells are joined and the junctions are called intercalated discs. The cells are attached to each other by desmosomes.

Areolar Connective Tissue:

- It is found underneath the skin; also around nerves and blood vessels.
- It is composed of fibroblasts, macrophages and mast cells.
- It provides support and repair tissues.

Connective Tissue

Connective tissues, as the name implies, support and connect different tissues and organs of the body. They are widely distributed in every part of the body. They originate from the mesoderm (the middle germinal layer of the embryo).

Connective tissue is made up of a few cells present in the intercellular framework of protein fibres secreted by the cells, known as collagen or elastin. The cells also secrete a thin gel of polysaccharides, which together with fibres make matrix or ground substance.

The elasticity, flexibility and strength of the connective tissues are due to fibres. The function and types of connective tissues depend on the nature of the intercellular substance present.

Connective tissues contain three types of fibres: collagen, elastic and reticular

Collagen fibres are the most widespread and made up of fibrous protein, collagen. Collagen fibres are flexible and have high tensile strength (comparable to steel).

Elastic fibres form a network and can be stretched like a rubber band. They are made up of protein elastin. They retain their original shape and size once the force is removed.

Reticulate fibres consist of collagen and glycoproteins. They are thin and form a delicate network. They join connective tissues to neighbouring tissues.

There are various kinds of cells present in different types of connective tissues. They secrete different types of fibres and matrices. Fibroblasts or adipose cells are **stationary** and macrophages, mast cells, monocytes, lymphocytes are **migrating** cells.

Fibroblasts are found in developing tissues and play an important part in wound-healing. They are spindle-shaped and present between collagen fibres. They secrete tropocollagen and other substances found in the matrix.

Macrophages are also known as scavenger cells. They wander through connective tissues, clean up debris and remove bacteria and other antigens by phagocytosis.

Types of Connective Tissue

Connective tissues are divided into three groups:

Loose Connective Tissue

Loose connective tissues are present all over the body, where support and elasticity both are needed. Blood vessels, nerves and muscles, all have a loose connective tissue wrapping. They form the subcutaneous layer under the skin along with adipose tissues, attaching muscles and other structures to the skin.

The fibres and cells are loosely arranged in the semi-fluid matrix. They are found between many organs as a filling and act as a shock absorber and reservoir for salt and fluid.

Areolar Tissue: It is present under the skin and supports epithelium. It contains randomly distributed fibres, fibroblasts, mast cells and macrophages. It supports the organs present in the abdominal cavity, fills the space between muscle fibres and wraps around blood and lymph vessels.

Adipose Tissue: They are present under the skin and store fat. It acts as a shock absorber and helps in maintaining body temperature in colder environments.

White adipose tissues protect kidneys and are also found at the back of the eye, in the hump of camels, blubber of whales, etc.

Brown adipose tissue is found in infants, polar bears, penguins and other animals found in cold regions. It contains more mitochondria and generates 20 times more heat as compared to the other fat. It releases metabolic heat.

Reticular Connective Tissue: It is made up of reticular fibres. It supports the internal framework of organs such as liver, lymph nodes and spleen.

Dense Connective Tissue

In the dense connective tissue, fibroblast cells and fibres are compactly packed. Their main function is to support and transmit mechanical forces. They are somewhat less flexible than loose connective tissue. On the basis of the arrangement of collagen fibres, they are divided into two types:

Dense regular tissue: In this type of tissue, the orientation of fibres are regular. The collagen fibres are present between the parallel running bundles of fibres. The regular arrangement enhances tensile strength and poses resistance to stretching in the direction of the orientation of fibre. Examples of dense regular tissue are tendons and ligaments.

Tendons and Ligaments: Tendons attach bones to skeletal muscles. Ligaments attach two bones together.

Dense irregular tissue: There are many fibres including collagen, which are oriented irregularly or randomly. The irregular arrangement gives uniform strength in all directions. Fibres may form a mesh-like network. This type of tissue is present in the dermis of the skin.

Specialised Connective Tissue

Other than these, there are supportive connective tissues, that help in maintaining correct posture and support internal organs, e.g. cartilage and bone.

Blood and lymph are fluid connective tissues that circulate in the body and help in interaction and communication among all the organs.

Cartilage: Cartilage is mostly present in the embryonic stages and works as a supporting skeleton. Most of the cartilage is replaced by bones in adults, however, it supports some structures in adults too. In humans, cartilage is present between the bones of the vertebral column, in the external ear, nose and hands.

The cartilage consists of **chondrocytes** cells, which are enclosed in a hard, rubbery matrix, secreted by them. They secrete collagen fibres also, which provide additional strength. Chondrocytes lie in the cavities known as **lacunae,** in a group of 2-4 cells or singly. Cartilage possesses elasticity, but is firm too. They lack nerves, blood and lymph vessels.

Bones: Bone is the hardest connective tissue and helps in maintaining the shape and posture of the body, it protects internal organs. They are rich in collagen fibres and calcium, which give strength.

The cells of the bone are known as **osteocytes.** They are present in lacunae and secrete the matrix. There is substantial blood supply in bony tissues. The cytoplasmic extension of osteocytes makes tiny channels known as **canaliculi.** These channels help in communication among osteocytes and capillaries.

Spongy bone is present in the core surrounded by the compact bone. **Osteons** is the spindle-shaped unit present in the compact bone. Osteocytes are present in the concentric layers of the matrix in each osteon, called **lamellae.** Capillaries and nerves pass through a central channel known as **Haversian canals.** Haversian canals are surrounded by lamellae.

There is a central marrow cavity made up of spongy tissues (marrow). The yellow marrow contains fat, whereas red marrow produces blood cells.

Blood: Blood is made up of various cells present in the plasma. The blood contains red blood cells (RBCs), white blood cells (WBCs) and platelets.

RBCs have haemoglobin and transport oxygen.

WBCs form a defence system and protect from foreign antigens.

Platelets are important for blood clotting.

Plasma contains proteins, water, hormones, salts, etc. to transport to different parts of the body.

Lymph: Lymph drains into the blood and transports absorbed fat to the blood, which cannot enter the bloodstream directly. Lymph has white blood cells in the liquid matrix. They help in getting rid of toxins and waste materials. They contain WBCs, which help in fighting infection.

Tendons and Ligaments

Tendons and Ligaments are an integral part of locomotion in all higher organisms.

Tendons

A tendon is a tough fibrous connective tissue that connects muscle to bone. They are a bundle of inelastic fibrous tissues. They appear like a tough high-tensile-strength band.

Ligaments

A ligament is a fibrous connective tissue that connects bones to other bones. They are elastic with an insufficient blood supply. They appear as criss-cross bands.

Difference between Bone and Cartilage

Bones and cartilage differ by structure, types and function. The main difference between bone and cartilage are listed below.

Bones	Cartilage
Bones are the hard, inelastic and a tough organ that forms part of the vertebral skeleton.	Cartilage is a soft, elastic and flexible connective tissue that protects the bone from rubbing against each other.
Bones are of two types: compact or spongy.	Cartilage is of three types: Hyaline cartilage, fibrocartilage and elastic cartilage.

Bone cells are known as osteocytes.	Cartilage cells are known as chondrocytes.
Presence of blood vessels.	Absence of blood vessels (nutrients are obtained through diffusion)
The matrix is both organic and inorganic.	The matrix is completely organic.
Has deposits of calcium salts.	May or may not have deposition of calcium salts.
The bones have a rich blood supply.	Lacks blood supply (hence repair is slower)
The growth pattern of the bone is bidirectional.	The growth pattern of the cartilage is unidirectional.
Presence of calcium phosphate in the matrix.	Has no calcium phosphate in the matrix.
Haversian canal system is present.	Haversian canal system is absent.
Volkmann canal is present.	Volkmann canal is absent.
Protect the body from mechanical damage, provide a framework and shape for the body, helps in the movement of the body, store minerals, and produce both RBC – red blood cells and WBC – white blood cells.	Supports the respiratory tract, acts as shock absorbers between weight-bearing bones, maintains the shape and flexibility of fleshy appendages and reduces friction at joints.

Lymphatic system

The lymphatic system is part of the immune system. It also maintains fluid balance and plays a role in absorbing fats and fat-soluble nutrients.

The lymphatic system is a network of lymph nodes connected by lymphatic vessels. This system transports lymph throughout the body. The whole body is encompassed with the lymph vessels similar to the blood vessels and has a complex nature. The cells of the body are supported really well by them as it receives oxygen and nutrients from the same. The lymph gets recirculated through the vessels themselves as they have no endpoint.

Functions of the lymphatic system

The three main functions of lymphatic system are given below

- Maintains the balance of fluid between the blood and tissues, also called fluid homeostasis.
- Forms a vital part of the body's immune system and helps defend against bacteria and other intruders.
- Facilitates the absorption of fats and fat-soluble nutrients in the digestive system.

Nervous Tissue

Nervous or the nerve tissue is the main tissue of our nervous system. It monitors and regulates the functions of the body. Nervous tissue consists of two cells: nerve cells or neurons and glial cells, which helps transmit nerve impulses and also provides nutrients to neurons. Brain, Spinal Cord, and nerves are composed of nervous tissue, they are specialized for being stimulated to transmit stimulus from one to another part of the body rapidly.

Structure Of Nervous Tissue

- It is made of nerve cells or neurons, all of which consists of an axon. Axons are long stem-like projections emerging out of the cell, responsible for communicating with other cells called the Target cells, thereby passing impulses

- The main part is the cell body which contains the nucleus, cytoplasm and cell organelles. Extensions of the cell membrane are referred to as processes.
- Dendrite is a highly branched processes, responsible for receiving information from other neurons and synapses (specialized point of contact). Information of other neurons is provided by dendrites to connect with its cell body.
- Information in a neuron is unidirectional as it passes through neurons from dendrites, across the cell body down the axon.

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Centrosome

Centrosome is a micCentrosome Structurerotubule-organizing centre in animal cells.
The centrosome is made up of two perpendicular centrioles, a daughter centriole, and a mother centriole, linked together by interconnecting fibers. It consists of a complex of proteins that helps in the formation of additional microtubules. An amorphous pericentriolar matrix surrounds the centrioles. It is involved in the nucleation and anchoring of cytoplasmic microtubules.

Centrosome in the animal cells is very much like DNA. During cell division, one centrosome from the parent cell is transferred to each daughter cell. In proliferating cells, the centrosome starts dividing before the S-phase begins. The newly formed centrosomes participate in organizing the mitotic spindles. During Interphase, the centrosome organizes an astral ray of microtubules that help in intracellular trafficking, cell adhesion, cell polarity, etc.

In post-mitotic cells, the centrosome consists of a mature centriole and an immature centriole, known as the mother centriole and daughter centriole respectively.

The centrosome cycle consists of four phases:

1. **G1 phase** where the duplication of centrosome takes place.
2. **G2 phase** where the centrosome maturation takes place.
3. **The mitotic phase** where the centrosome separation takes place.
4. **A late mitotic phase** where the chromosome disorientation takes place

Centrosome Function

The major functions of centrosome are listed below:

- The centrosomes help in cell division.
- They maintain the chromosome number during cell division.
- They also stimulate the changes in the shape of the cell membrane by phagocytosis.
- In mitosis, it helps in organizing the microtubules ensuring that the centrosomes are distributed to each daughter cell.
- They regulate the movement of microtubules and cytoskeletal structures, thereby, facilitating changes in the shapes of the membranes of the animal cell.

Centrosome in Animal Cells

In most animal cells, centrosomes are not required in the cell division process even though they add to the effectiveness of the mitotic spindle arrangement. In humans, dysfunctioning of centrosomes can stimulate cancer as a result of an increase in the levels of instability in chromosomes or due to the metastatic capability of cancer cells. However, the study on this lacks evidence