Research and Reviews: Journal of Agriculture and Allied Sciences e-ISSN: 2347-226X
p-ISSN: 2319-9857

Plant and Animal Tissues: Review

Vadlapudi Mojess*, G Mary Sandeepa

Department of Biotechnology, Vikrama Simhapuri University, Kakuturu, Nellore, Andhra State, India

Mini Review

Received: 27-Nov-2023, Manuscript No. JAAS-23-121179;
Editor assigned: 30-Nov-2023, PreQC No. JAAS-23-121179 (PQ);
Reviewed: 14-Dec-2023, QC No. JAAS-23-121179; **Revised:** 21-Dec-2023, Manuscript No. JAAS-23-121179 (R);
Published: 28-Dec-2023, DOI: 10.4172/2347-226X.12.3.007

***For Correspondence:**
Dr. Vadlapudi Mojess, Department of Biotechnology, Vikrama Simhapuri University, Kakuturu, Nellore, Andhra State, India
E-mail:
mojessvadlapudi17@gmail.com

Citation: Mojess V, Sandeepa GM. Plant and Animal Tissues: Review. J Agri Allied Sci. 2023;12:007.

ABSTRACT

Cell is the structural and functional unit of life, in every living organisms are made from a cells. Every cell containing cytoplasm, nucleus and plasma membrane. A collection of cells is referred to as a tissues, on this review we will discussing plant and animal tissues. Plant tissues are majorly divided into meristematic and everlasting tissue, permanent (everlasting tissue) tissue again categorised into simple and complex tissue. Simple tissue (composed of single cell type) sub classified into dermis, parenchyma, collenchyma, sclerenchyma. Complex tissue (tissue composed of more than one cell type) sub-categorised into xylem and phloem, xylem vessels containing tracheids, phloem containing sieve tubes and companion cells, sieve tubes and RBC does not containing nucleus, ultimate all cells containing nucleus except sieve tubes and RBC. Animal tissues are classified into epithelial, connective, muscular and nervous tissues. Epithelial tissues classified into simple epithelium and compound epithelium, simple epithelium again classified into squamous, cuboidal, columnar, ciliated epithelium. Connective tissues categorised into loose connective tissue, dense connective tissue, specialised connective tissue. loose connective tissue containing areolar and adipose tissues, specialised connective tissue containing bone, cartilage, blood, lymph. Muscular tissue sub-classified into striated (skeletal), unstriated (easy), cardiac tissues. In this review provide detail information about these plant and animal tissues.

Keywords: Animal tissues; Plant tissues; Chondroblasts; Xylem and Phloem

INTRODUCTION

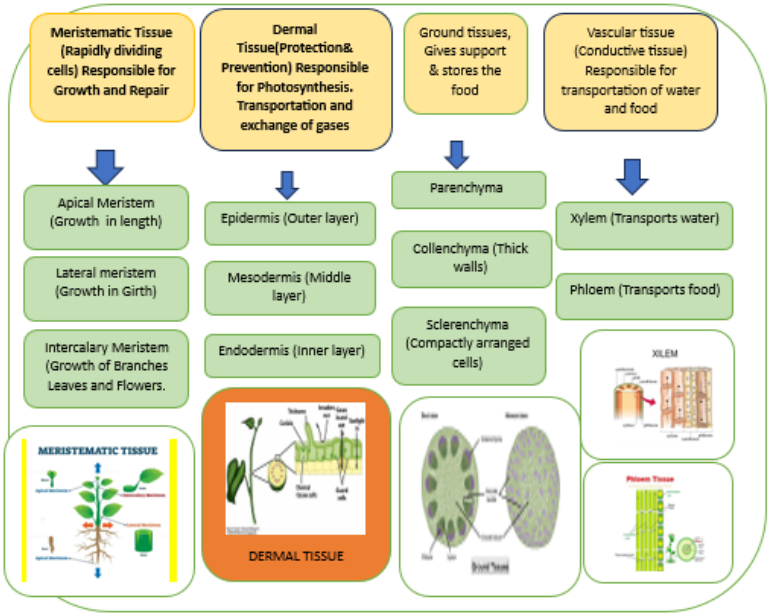
A group of biological cells that perform a similar way to function called as tissue. Cells of multi cellular organisms show division of labour, various metabolic activities are performed by different group of cells [1]. Each such group of cells forms a tissue. Plant tissues are of two main types- meristematic and permanent tissues. Meristematic tissue is the dividing tissue present at the growing regions of plants, they are meant for growth of an organ [2]. Permanent tissues are derived from meristematic tissue till they lose the ability to divide[3]. Animal tissues are epithelial, muscular, connective and nervous tissue. Depending on shape and function, epithelial tissue is classified as squamous, cuboidal, columnar and glandular, epithelium acts as a protective tissue in animals as it does in plants. Striated, smooth and cardiac muscles are three types of muscular tissues. They perform movement by contraction and relaxation[4]. The different types of connective tissues in our body include areolar tissue, adipose tissue, bone, cartilage, tendon, ligament and blood. Connective tissues have widely spaced cells (fibroblasts) embedded in a matrix having a variety of proteins, polysaccharides, minerals, salts and proteins fibers such as collagen and elastin. They bind or connect other tissues together, e.g., muscle to bone (tendon), bone to bone (ligament) or various body parts (blood). Nervous tissue is made up of neurons that receive and conduct impulses, impulse is the passage of electrical activity along the axon of a nerve cell. Epithelial tissues has free surface, which faces either a body fluid or the outside environment. Cells are compactly packed with little intercellular matrix. Simple epithelium is composed of a single layer of cells and functions as a lining for body cavities, ducts and tubes. The compound epithelium consists of two or more cell layers and has protective function as it does in our skin. Simple epithelium, on the basis of modification, divided into three types: Squamous, cuboidal, and columnar. Squamous epithelium is made of single thin layer of flattened cells with irregular boundaries, present in the wall of blood vessels and air sacs of lungs. Cuboidal epithelium are composed of a single layer of cube-like cells. Present in ducts of glands and tubular part of nephrons in kidneys, helps in secretion and absorption. Columnar epithelium are composed of a single layer of tall and slender cells, present in the lining of stomach and intestine, helps in absorption and secretion. Ciliated epithelium are modified cuboidal or columnar epithelium, cell bears cilia on their free surfaces, present in the inner surface of hollow organs like bronchioles and fallopian tubes. Epithelial tissue has a variety of functions depending on where its located in your body, including protection, secretion and absorption. Tissue that supports, protects, and gives structure to other tissues and organs in the body. Connective tissue also stores fat, helps move nutrients and other substances between tissues and organs, and helps to repair damaged tissue[5]. Skeletal muscles are under our conscious control, which is why they are also known as voluntary muscles, since the tissue looks striped when viewed under a microscope. Nervous tissues is found in the brain, spinal cord, and nerves. It is responsible for coordinating and controlling many body activities[6]. Its stimulates muscle contraction, creates an awareness of the environment, and plays a major role in emotions, memory, and reasoning. The cells of the meristematic tissue divides actively to form specialized structures such as buds of leaves and flowers, tips of roots and shoots, etc. These cells help to increase the length and girth of the plant. Primary dermal tissues, called epidermis, make up the outer layer of all plant organs (e.g., stems, roots, leaves, flowers). They help deter excess water loss and invasion by insects and microorganisms. Ground tissue carries out different functions based on the cell type and location in the plant, and includes parenchyma (photosynthesis in the leaves, and storage in the roots), collenchyma (shoot support in areas of active growth), and sclerenchyma (shoot support in areas where growth has created). Vascular tissue transports water, minerals, and sugars to different parts of the plant. Vascular tissue is made of two specialized conducting tissues: Xylem and phloem. Xylem tissue transports water and nutrients from the roots to different parts of the plant[7].

LITERATURE REVIEW

Plant tissues

The cells of meristematic tissue are similar in structure and have thin cellulose cell walls. The cells may be spherical, oval, polygonal or rectangular in shape. The cells of tissue are compactly arranged and do not have intercellular space. The cells have dense protoplasm with prominent nuclei. Vacuoles in these cells are either small or absent. On the basis of their position in the plant body, meristematic tissues are classified into three types- Apical, Lateral and Intercalary meristems. Apical meristem present at the tips of roots, shoots, branches and leaves. It brings about the elongation of the root and stem, it results in increase in the height of the plant, which is called primary growth. Lateral meristem present along the lateral side of the stems and roots, example: Cork cambium[8,9]. It causes the organs (stem or root) to increase in diameter and girth, this is called secondary growth. Intercalary meristem located at the base of leaves or internodes, Eg: stem of grasses and other monocots and below the nodes Eg: mint. It provides an increase of length of organ such as leaves and internodes. Meristematic tissue acts as a parent tissue from which other tissues develop, these tissue take part in growth by formation of new cells. The place of injury in plants is healed up by the formation of new cells by meristem[10,11] (Figure 1).

Figure 1. Plant tissues.

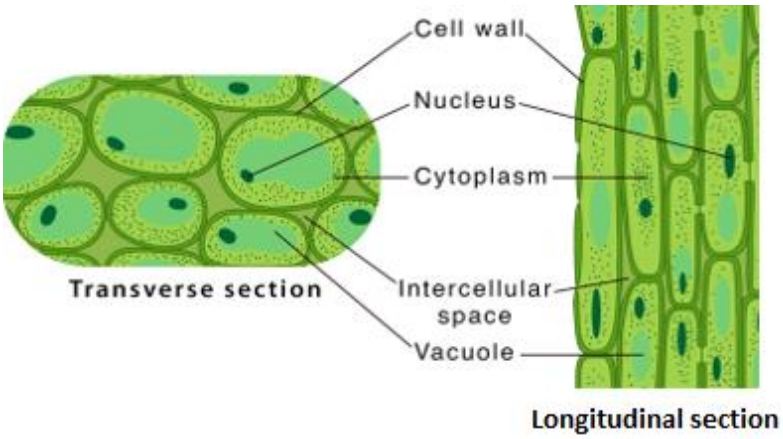


Permanent tissues

A permanent tissue is a group of cells, which is derived from the meristematic tissues, but these cells have lost the power of division temporarily or permanently. The development process by which cells which have been derived from meristematic tissue, take up a permanent shape, size and function is called differentiation. Permanent tissues are of three types: Parenchyma, collenchyma, and sclerenchyma. Parenchyma forms the bulk of plant body, it consists of thin walled living cells, the cells are isodiametric, i.e., equally expanded on all sides[12].

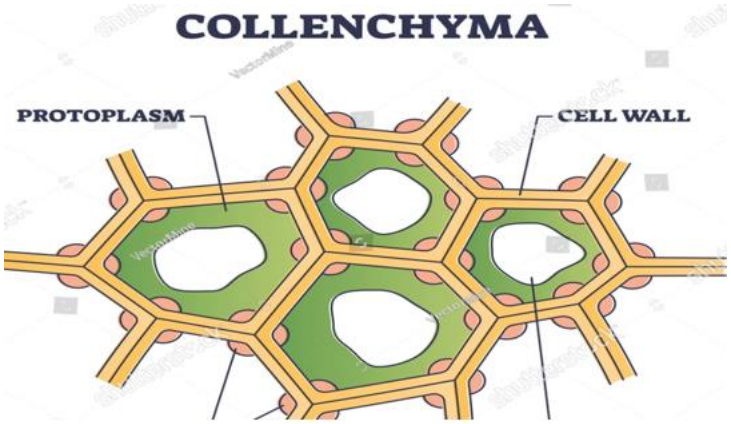
Parenchyma: Parenchyma is present in all the organs of the plants, i.e., roots, stems, leaves, flowers, fruits and seeds[13]. The main function of parenchymatous tissue is storage of food, e.g; starch in the parenchyma of cortex of potato tuber. Parenchyma forms the framework of all the plant organs and tissues like cortex, pitch etc. If chloroplast is present, the parenchyma tissue is called chlorenchyma and it performs photosynthesis[14] (Figure 2).

Figure 2. Parenchyma.



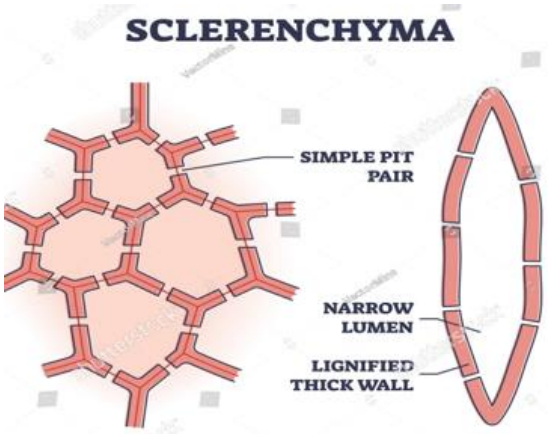
Collenchyma: Collenchyma is usually found in 3-4 layers beneath epidermis in stem, petioles and leaves of herbaceous dicot plants. The cells of this are living, elongated and irregularly thickened at the corner, in collenchyma, intercellular spaces are generally absent. It provides the mechanical support, protection, flexibility and elasticity to the plants organs. It allows easy bending in various parts of the plant (leaf, stem) without breaking, when cells of collenchyma contains some chloroplasts, they manufacture sugar and starch [15-17] (Figure 3).

Figure 3. Collenchyma.



Sclerenchyma: Sclerenchyma cells are dead cells and they are devoid of protoplasm, they are long and narrow as the walls are thickened due to lignin, such cell walls are called lignified. The cells of sclerenchyma are closely packed without intercellular spaces. Cells of sclerenchyma are of two types: Fibers and sclerides[18]. Fibers consists of very long, narrow, thick and lignified cells. Sclereids are irregular shaped, this tissue is present in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts. Husk of coconut is made up of sclerenchymatous tissue. Sclerenchyma is mainly mechanical and protective in function. It gives strength, rigidity, flexibility and elasticity to the plant body and, thus, enables it to withstand various strains [19] (Figure 4).

Figure 4. Schlerenchyma.

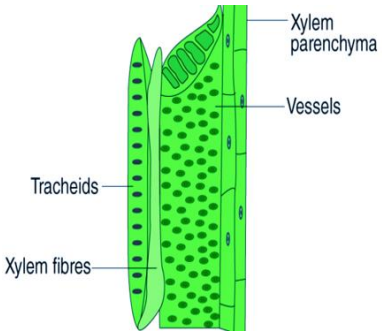


Complex permanent tissues

The complex tissue consists of more than one type of cell having a common origin, all these cells coordinate to perform a common function. Complex tissue are of two types: Xylem or wood and phloem or bast. Xylem and phloem are both conducting tissues and also known as vascular tissues; together both constitute vascular bundles.

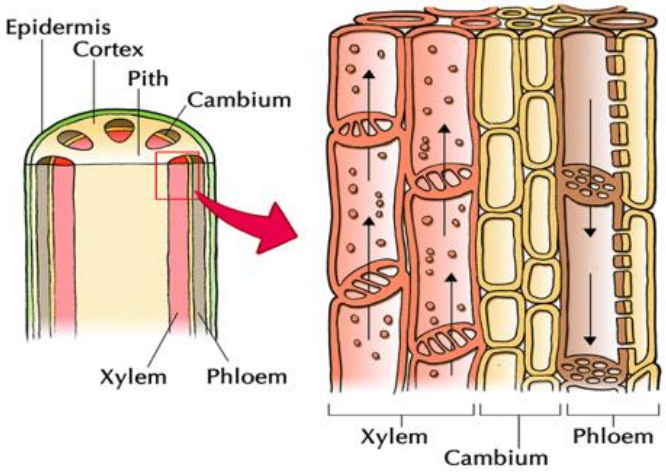
Xylem: Xylem is a vascular and mechanical tissue, xylem is composed of cells of four different types, tracheids, vessels of tracheae, xylem parenchyma and xylem sclerenchyma (or fibers). Except xylem parenchyma, all other elements are dead and bounded by thick lignified wall, tracheids and vessels are tubular structures[20]. The main function of xylem is to carry water and minerals salts upwards from the root to different parts of shoots, hence also called water conducting tissue. Since walls of tracheids, vessels and sclerenchyma of xylem are lignified, they give mechanical strength to the plant body. The parenchyma stores food and helps in the sideway conduction of water[21,22] (Figure 5).

Figure 5. Xylem.



Phloem: Phloem is a living conducting tissue, it also contains tubers just like xylem but does not perform mechanical function. Phloem is composed of following four elements or cells: Sieve tubes, companion cells, phloem parenchyma and phloem fibers[23]. Sieve tubes are slender, tube like structures with perforated walls. Companion cells are living parenchymatous cells lying on the sides of the sieve tubes. Sieve tubes and companion cells have close cytoplasmic connections with each other through fine pits. Phloem fibers are thick walled fibers with simple pits, phloem parenchyma are thin walled, living cell of parenchyma of phloem. Phloem transports (conducts) photosynthetically prepared food materials from the leaves to the storage organs and later from storage organs to the growing regions of the plant body[24](Figure 6).

Figure 6. Phloem.



Protective tissues: Protective tissues are a part of plant tissue system, protective tissues include epidermis and cork. Epidermis is the outermost protective layer of plant organs, epidermis are elongated and falttened, without intercellular space. They are living cells but their inner contents are similar to parenchyma cells[25]. In leaves, epidermis bears small pores called stomata, in some plants living in very dry habitats, the epidermis may be thicker since protection against water loss is critical. The function of epidermis is the protection of plant from injury and infection, cuticle of epidermis also helps to reduce water loss by evaporation to prevent dessication. Stomata present in the epidermis allow gaseous exchange to occur during photosynthesis and respiration, it also facilitates transpiration[26].

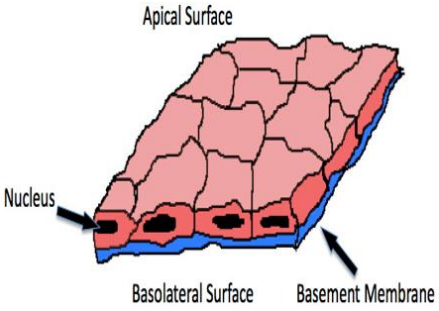
Cork (or Phloem): Cork cells are dead cells without having intercellular spaces, they appear at the periphery of roots and stems when they grow older and increase in girth. They also have a chemical called suberin in their walls that nakes them impervious to gases and water. The function of cork in plant body is to provide protection. It provides plants from external injury and infection, it also prevents dessication. Since cork does not catch fire easily, it is used for insulation, shock-absorber, and linoleum, it is also used for making sports good, such as shuttle-cock, table tennis paddles, cricket balls, etc [27-29].

Animal tissues

Epithelial tissues: All layers and organs in the body are lined by a group of tissues called Epithelial tissues which are commonly referred to as Epithelium, they cover the surface of all internal as well as external organs[30]. Epithelial tissue is highly permeable, thus it plays a significant role in the exchange of substances across the cells and helps in maintaining the osmoregulation. Depending on the number of layers of cells it is composed of, epithelium has been divided into simple epithelium and compound epithelium. The main function of epithelial tissue are protection, secretion, absorption, and sensation [31]. Simple 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 three types: Squamous epithelium, cuboidal epithelium, columnar epithelium[32].

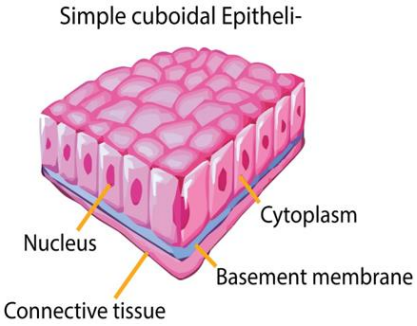
Squamous epithelium: It is a simple single-layered epithelium, structurally, squamous epithelium is made up of flat cells with irregular boundaries. It forms linings of blood vessels and alveoli[33] (Figure 7).

Figure 7. Squamous epithelium.



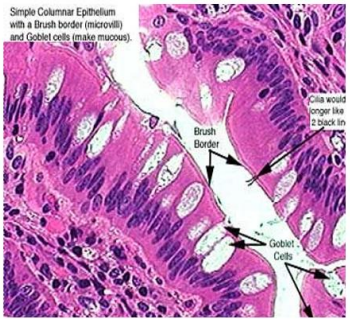
Cuboidal epithelium: It is made of cube-shaped cells. It forms the lining of kidney tubules and ducts of salivary glands[33](Figure 8).

Figure 8. Cuboidel epithelium.



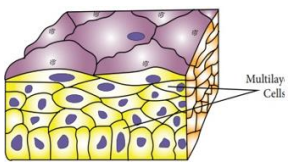
Columnar epithelium: It is composed of tall and slender, column-shaped cells. It forms the lining of stomach and intestine, in some organs, cuboidal and columnar epithelial have cilia present on the outer surface which is called ciliated epithelium. It helps in the directional movement of materials along the hollow organs like the respiratory tract. The cuboidal or columnar epithelia which are specialised in secretion are called glandular epithelium which includes the exocrine and endocrine glands[34] (Figure 9).

Figure 9. Columnar epithelium.



Compound epithelium: It is a multilayered (two or more layers of cells) tissue, helps in protection and has a limited role in secretion. Skin is a compound epithelium which functions as a barrier against, chemical and mechanical stresses[35] (Figure 10).

Figure 10. Compound epithelium.



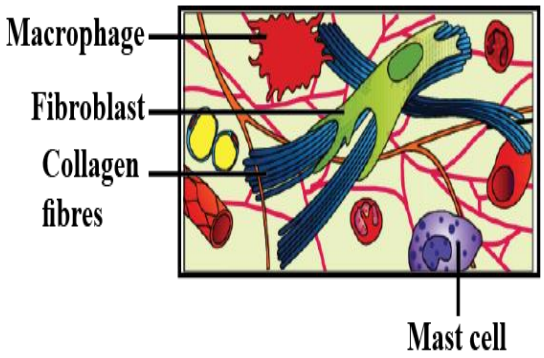
Connective tissue

The connective tissue is specialized to connect and anchor various body organs. It connects one bone with another and a bone with a muscle. The cells of connective tissue are loosely spaced and embedded in an intercellular matrix. The matrix may be jelly like, fluid, dense, or rigid. The nature of matrix decided the function of connective tissue. Connective tissue binds other tissues together in the organs, connective tissue also provides the structural framework and mechanical support to different tissues. It is also concerned with body defence, fat storage, repair etc. The main function of connective tissue are binding, supporting and packing together different organs of the body. It connects and supports the different tissues, organs, and parts of the body, among the animal tissues, connective tissues are the most abundant ones in the body. The connective tissue cells are freely arranged in a matrix and are widely distributed in the body[36].

Types of connective tissues

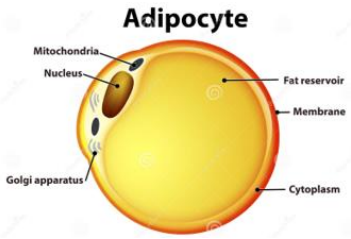
Areaolar connective tissue: Except for blood, all other cells secrete collagen (elastin) which offers elasticity and flexibility to the tissues. It is found underneath the skin; also around nerves and blood vessels, it is composed of fibroblasts, macrophages, and mast cells. It provides support and repair tissues[36] (Figure 11).

Figure 11. Connective tissue.



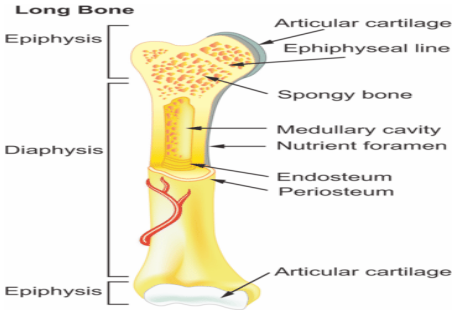
Adipose tissue: it consists of large number of oval and rounded adipose cells (adipocytes) filled with fat globules. The adipose tissue is abundant below the skin, between the internal organs (E.g: around the kidney) in yellow bone marrow. It serves as a fat reservoir. Adipose tissue acts as food reservoir by storing fat. It acts as an insulator and regulates body temperature. It is present in skin and organs, it is composed of fat globules and is characterized by fat storage. It provides insulation due to the fat present, areolar tissue and adipose tissue are two types of loose connective tissues where the cells and fibers loosely scattered in the semi-fluid matrix[37,38] (Figure 12).

Figure 12. Adipose tissue.



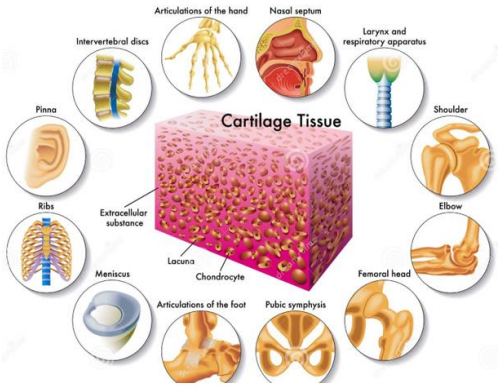
Bone: It is a hard connective tissue which forms the framework of the body, it has a rigid matrix rich in calcium and collagen fibers. Functions include protection, support, facilitates movements and serves as a site for blood cell production[39,40](Figure 13).

Figure 13. Bone.



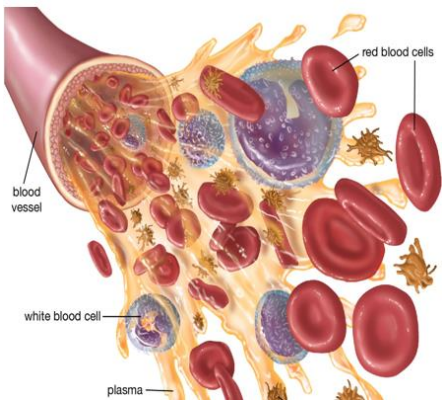
Cartilage: It is made of chondrocytes with dense, flexibility intercellular materials. In the majority of vertebrates, cartilages in embryos get replaced by bones on maturity. They are present at the tips of external ears, bronchi, vertebral column, etc[41,42] (Figure 14).

Figure 14. Cartilage.



Blood: It is the only fluid connective tissue composed of blood cells (RBC, WBC, and Platelets) and plasma. Transportation, defence, blood clotting and helps in homeostasis, blood, bone, and cartilage are specialised connective tissues[43,44] (Figure 15).

Figure 15. Blood.



Areolar (loose) connective tissue: it is a loose and cellular connective tissue, its matrix consists of two kinds of fibers: White collagen fibers and yellow elastic fibers. Areolar connective tissue is found between the skin and muscles, around blood vessels and nerves and in the bone marrow. If fills the space between different tissues and organs, hence called packing tissue [45]. It acts as supporting and packing tissue between organs lying in the body cavity. It provides rapid diffusion of oxygen and nutrients from blood vessels, it helps in repair of tissues after an injury. It helps in fighting foreign antigen and toxin [46].

Dense connective tissue: it is fibrous connective tissue. It is characterized by ordered and densely packed collection of fibers and cells [47]. It is the chief component of ligaments and tendons [48].

Ligament: These are elastic structures made up of yellow elastic fibrous tissues which connect bone to another [49]. Tendons, are cord like, strong inelastic structures that join skeletal muscles to bones, they are composed of white collagen fibrous tissue. It has great strength but its flexibility is limited [50,51].

Skeletal tissue: It forms the endoskeleton of the body of vertebrates. It includes cartilage and bone.

Muscular tissue, is responsible for movement in our body. Muscles contain special proteins called contractile proteins, which contract and relax to cause movement [52]. On the basis of their location, structure and function, there are following three types of muscles fibers: Straited muscles (straited, skeletal or voluntary muscles), Smooth muscles [53,54] (unstraited, visceral or involuntary muscles), Cardiac muscles (straited, involuntary muscles).

Nervous tissue: A tissue which is specialized to transmit messages in our body is nervous tissue. Brain, spinal cord and nerves are all composed of nervous tissue [55]. Nervous tissue contains highly specialised for the conduction of impulse over great distance at great speed. A neuron consists of a cell body (cyton or soma) with a nucleus and cytoplasm, from which long thin hair -like parts arise called dendrons. Dendrons further branched out to form dendrites [56,57]. From the distal part of cyton arises a very long process called axon [58]. The nervous tissue is responsible for the reception and transmission of information between different parts of the body [59]. The dendrites receive impulses and the axon takes impulses away from the cell body [60].

CONCLUSION

Cell is the basic structural and functional unit of life, every living organisms made of cells, without cell there is no living organisms, human life is also starting from single cell that is zygote, male gamate sperm cell, female gamate ovum fuse together in fallopian tubes in female reproductive system, fertilization process takes place then formation of zygote then zygote develops form embryo then develops into foetus finally mature baby will develops in mother womb. In plants also pollen grains reaches to stigma develops pollen tube through this tube pollen grains reaches to ovule one pollen grains fuses to egg cell, another pollen grains fuses to polar nuclei, then finally ovary develops into fruit, ovule develops into seed, this seed germinate and forms a new baby plant. A group of cells is called, without cells there is no tissues, without tissues we cannot performs our daily activities, higher organisms need tissues for performing daily activities, in this review we provided all plant and animal tissues and their functions, it is useful know about their plant and animal tissues names, location and functions.

REFERENCES

1. Alekseenko S, et al. Comparative analysis of the outcome of external and endoscopic frontal sinus surgery in children. Acta Otolaryngol. 2020;140:687-692.
2. Gilbey P, et al. The quality of the surgical field during functional endoscopic sinus surgery-the effect of the mode of ventilation: A randomized, prospective, double-blind study. Laryngoscope. 2009;119:2449-2453.
3. Meltzer EO, et al. Rhinosinusitis: Developing guidance for clinical trials. J Allergy Clin Immunol. 2006;119:S17-S61.
4. Stankiewicz JA, et al. Nasal endoscopy and the definition and diagnosis of chronic rhinosinusitis. Otolaryngol - Head Neck Surg. 2002;623-627.
5. Srivastava M, et al. Comparative evaluation of chronic rhinosinusitis patients by conventional radiography, computed tomography and Diagnostic Nasal Endoscopy (DNE). Indian J Otolaryngol Head Neck Surg. 2016;68:173-178.

6. Rahman T, et al. Outcome of endoscopic sinus surgery in the treatment of chronic rhinosinusitis. Mymensingh Med J. 2016;25;261-270.
7. Raffat S, et al. Comparison of endoscopic sinus surgery and continued medical treatment therapy for refractory chronic rhinosinusitis. Pakistan J Med Heal Sci. 2021;15:2285.
8. Galletti B, et al. Endoscopic sinus surgery with and without computer assisted navigation: A retrospective study. Auris Nasus Larynx. 2019;46:520-525.
9. Verillaud B, et al. Endoscopic endonasal skull base surgery. Eur Ann Otorhinolaryngol Head Neck Dis. 2012;129:190-196.
10. Levy J, et al. Endoscopic orbital decompression for graves ophthalmopathy. Isr Med Assoc J. 2004;6:673-676.
11. Jain K, et al. A comparison between surgical techniques and results of endoscopic dacryocystorhinostomy versus external dacryocystorhinostomy. J Evol Med Dent Sci. 2018;7.
12. Senior BA, et al. Long-term results of functional endoscopic sinus surgery. Laryngoscope. 1998;108; 151-157.
13. Ho XT, et al. To evaluate the results of functional endoscopic sinus surgery to patients suffering from chronic sinusitis with sphenoid sinusitis. J Med Pharm. 2017;6:114.
14. Mascarenhas JG, et al. Long-term outcomes of endoscopic sinus surgery for chronic rhinosinusitis with and without nasal polyps. Braz J Otorhinolaryngol. 2013;79:306-311.
15. Alanin MC, et al. Effect of functional endoscopic sinus surgery on outcomes in chronic rhinosinusitis. Curr Allergy Asthma Rep. 2020;20:27.
16. Damm M, et al. Impact of functional endoscopic sinus surgery on symptoms and quality of life in chronic rhinosinusitis. Laryngoscope. 2002;112:310-315.
17. Yong-Mei B, et al. Meta-analysis of the effect of the clinical pathway applied to patients with endoscopic sinus surgery in China. ORL. 2019;81:159-170.
18. Wennberg JE. Time to tackle unwarranted variations in practice. BMJ. 2011;342:d1513.
19. Wennberg JE, et al. Geography and the debate over medicare reform tl-suppl web exclusives. Health Aff. 2002
20. Hastan D, et al. Chronic rhinosinusitis in Europe - An underestimated disease. A GA2 LEN study. Allergy. 2011;66:1216-1223.
21. Ference EH, et al. Commentary on gender differences in prevalence, treatment, and quality of life of patients with chronic rhinosinusitis. Allergy Rhinol. 2015;6:e82-e88.
22. Bachert C, et al. Pathophysiology of chronic rhinosinusitis, pharmaceutical therapy options. Laryngo- rhino-otologie. 2015.
23. Heikkinen T, et al. The common cold. Lancet. 2003.
24. Hwang J, et al. A case of painful post-traumatic trigeminal neuropathy after endoscopic sinus surgery. Korean J Otorhinolaryngol Neck Surg. 2021;64:268-272.
25. Morse JC, et al. Chronic rhinosinusitis in elderly patients is associated with an exaggerated neutrophilic proinflammatory response to pathogenic bacteria. J Allergy Clin Immunol. 2019;143:990-1002.
26. Yancey KL, et al. Advanced age adversely affects chronic rhinosinusitis surgical outcomes. Int Forum Allergy Rhinol. 2019;9:1125-1134.
27. Hopkins C, et al. Psychometric validity of the 22-item sinonasal outcome test. Clin Otolaryngol. 2009;34:447-454.
28. Ghadersohi S, et al. Development and preliminary validation of a new patient-reported outcome measure for Chronic Rhinosinusitis (CRS-PRO). J Allergy Clin Immunol Pract. 2020;8:2341-2350.
29. Khan AH, et al. Development of Sinonasal Outcome Test (SNOT-22) domains in chronic rhinosinusitis with nasal polyps. Laryngoscope. 2022

30. Deconde AS, et al. Development of a clinically relevant endoscopic grading system for chronic rhinosinusitis using canonical correlation analysis. Int Forum Allergy Rhinol. 2016;6:478-485.
31. Shumon A, et al. Nasal polypectomy and endoscopic sinus surgery for the management of ethmoidal polyp. Bangladesh J Otorhinolaryngol. 2012;18:161-165.
32. Chauhan N, et al. A comparative study of microdebrider assisted v/s conventional endoscopic sinus surgery for nasal polyposis. Int J Pharm Res. 2020;65:193-196.
33. Lageju N, et al. Endoscopic sinus surgery for sinonasal polyposis: Microdebrider or conventional instruments. J Nepal Med Assoc. 2017;56:447-450.
34. Nair S, et al. Impact of endoscopic sinus surgery on symptom manifestation of chronic rhinosinusitis. Med J Armed Forces India. 2010;66:41-45.
35. Rajguru R. Nasal polyposis: Current trends. Indian J Otolaryngol Head Neck Surg. 2014;66:16-21.
36. Amodu EJ, et al. Chronic rhinosinusitis: Correlation of symptoms with computed tomography scan findings. Pan Afr Med J. 2014.
37. Casserly P, et al. Nasal endoscopy and paranasal sinus Computerised Tomography (CT) findings in an Irish cystic fibrosis adult patient group. Eur Arch Oto-Rhino-Laryngology. 2015;272:3353-3359.
38. Chakravarti A, et al. Outcome of endoscopic sinus surgery in patients with symptomatic chronic rhinosinusitis with minimal changes on computerised tomography. Indian J Otolaryngol Head Neck Surg. 2011;63:359-363.
39. Mulvey CL, et al. Predictive ability of bedside nasal endoscopy to diagnose invasive fungal sinusitis in a pediatric population. Int J Pediatr Otorhinolaryngol. 2018;
40. Zinreich SJ, et al. Fungal sinusitis: Diagnosis with CT and MR imaging. Radiology. 1988;169:439-444.
41. Kennedy DW. Prognostic factors, outcomes and staging in ethmoid sinus surgery. Laryngoscope. 1992.102:1-18.
42. World Health Organization (WHO). Cancer. 2020.
43. Rinoldi C, et al. Nanotechnology-assisted rna delivery: from nucleic acid therapeutics to COVID-19 vaccines. Small Methods. 2021:5;2100402.
44. Zhu Y, et al. RNA-based therapeutics: an overview and prospectus. Cell Death Dis. 2022:13;644.
45. Ahmadzada T, et al. Fundamentals of siRNA and miRNA therapeutics and a review of targeted nanoparticle delivery systems in breast cancer. Biophysical Rev. 2018:10;69-86.
46. Carthew RW, et al. Origins and mechanisms of miRNAs and siRNAs. Cell. 2009:136;642-655.
47. Lam JKW, et al. siRNA versus miRNA as therapeutics for gene silencing. Mol Ther Nucleic Acids. 2015:4;e252.
48. Bader AG, et al. The promise of microRNA replacement therapy. Cancer Res. 2010:70;7027-70230. 10.1158/0008-5472.CAN-10-2010.
49. Oveili E, et al. The potential use of mesenchymal stem cells-derived exosomes as microRNAs delivery systems in different diseases. Cell Commun Signal. 2023:21;20.
50. Segal M, et al. Challenges identifying efficacious miRNA therapeutics for cancer. Expert Opin Drug Discov. 2020:15;987-992.
51. Manikkath J, et al. Nanoparticulate strategies for the delivery of miRNA mimics and inhibitors in anticancer therapy and its potential utility in oral submucous fibrosis. Nanomedicine. 2022:17;181-195.
52. Lee SWL, et al. (2019). MicroRNA delivery through nanoparticles. J Controlled Release. 2019:313;80-95.
53. Shojaei S, et al. (2021). Delivery of miR-381-3p mimic by mesenchymal stem cell-derived exosomes inhibits triple negative breast cancer aggressiveness; an *in vitro* study. Stem Cell Rev Rep. 2021:17;1027-1038.
54. Hu B, et al. Therapeutic siRNA: state of the art. Signal Transduct Target Ther. 2020:5;101.

55. Dana H, et al. Molecular mechanisms and biological functions of siRNA. Int J Biomed Sci. 2017:13;101.

56. Gomes-da-Silva LC, et al. Challenging the future of siRNA therapeutics against cancer: the crucial role of nanotechnology. Cell Mol Life Sci. 2014:71;1417-1438.

57. Abashkin V, et al. Silver nanoparticles modified by carbosilane dendrons and PEG as delivery vectors of small interfering RNA. Int J Mol Sci. 2023:24;840.

58. Qin S, et al. mRNA-based therapeutics: powerful and versatile tools to combat diseases. Signal Transduct Target Ther. 2022:7;166.

59. Pardi N, et al. mRNA vaccines—a new era in vaccinology. Nat Rev Drug Discov. 2018:17;261-279.

60. Dolgin E. The tangled history of mRNA vaccines. Nature. 2021:597;318-324.