Contents

Animal Tissues

Tissue

- Tissue is the group of cells.
- Tissues are
  - similar in origin
  - similar in structure
  - similar in function

Terms related to tissues

Histology

- The branch of science that deals with the study of tissues is histology.
- The term histology was coined by Mayer.
- Mayer was a German histologist.

Term tissue

- The term 'Tissue' was coined by Bichat.
- Bichat was an French Anatomist and Physiologist.

Father of modern histology

- The father of Modern Histology is Xavier Bichat

Father of histology

- The father of histology is Marcello Malpighi.
- Marcello Malpighi was an Italian Biologist.

Histogenesis

- Histogenesis is the study of development and differentiation of tissues

Types of animal tissues

- Animal tissues are classified on the basis of
  - structure
  - function
- The types of tissues on the basis of structure and function are
  - Epithelial tissue
  - Connective tissue
  - Muscular tissue
  - Nervous tissue

Epithelial Tissue

Structure of epithelial tissue

- Epithelial tissue is the covering tissue.

- The cells in epithelial tissues are compactly arranged.
- The cells of epithelial tissue form a sheet.
- Epithelial tissue covers
  - the body
  - external hollow surfaces of organs
  - internal hollow surfaces of organs

Development of epithelial tissue

- Epithelial tissues develop from all three layers.
- Epidermis of skin develops from
  - Ectoderm
- The Lining of coelom develops from
  - Mesoderm
- The Lining of alimentary canal develops from
  - Endoderm

Anatomy of epithelial tissues

- The cells of epithelial tissues are closely packed.
- The cells of epithelial tissue lack the intercellular spaces.
- The cells of epithelial tissue are connected together by a cementing substance.
- The cementing substance is made up of carbohydrate derivatives.
- The cementing substance of carbohydrate derivatives connecting the cells of epithelial tissue is called
  - desmosome
- The cells of epithelial tissue rest on the basement membrane.
- The basement membrane is also termed as basal lamina.
- The basal lamina has the following properties
  - The basal lamina is non cellular.
  - The basal lamina is formed by
    - collagenous substance
    - glycoproteinous substance

- Epithelial tissue is avascular tissue.
- Epithelial tissue receives the nourishments through diffusion.
- The nourishment is received from underlying connective tissues.

Basement membrane in epithelial tissues

- Basement membrane is structure exhibiting
  - Basement membrane is thin.
  - The basement membrane is non cellular.
  - Basement membrane is devoid of blood vessels.

Functions of Epithelial Tissue

- Protection
- Secretion
- Filtration
- Formation of gametes
  - The gametes are formed from germinal epithelium.

Types of Epithelial Tissues

- Epithelial tissue are divided into three types.
- The division is done on the basis of
  - shape of the tissues
  - structure of the tissues
  - function of the tissues
- The types of epithelial tissues on the basis of shape structure and function are
  - Simple epithelium
  - Compound epithelium
  - Specialized epithelium

Simple epithelial tissue

Anatomy of simple epithelial tissue

- Simple epithelial tissue is composed of a single layer of cells.
- The cells of simple epithelial tissue rest on the basement membrane.

Types of Simple Epithelial Tissue

- The types of simple epithelial tissues are
  - Simple Squamous epithelium
  - Simple Cuboidal epithelium
  - Simple Columnar epithelium
  - Pseudo-stratified epithelium

Simple Squamous epithelium

Structure of simple squamous epithelium

- The cells of simple squamous epithelium are
  - Large
  - Flat
  - Polygonal
- The cells of simple squamous epithelium rest on the basement membrane.
- The cells of simple squamous epithelium have large central nucleus.
- The intercellular spaces are absent in cells of simple squamous epithelium.
- The other term for simple squamous epithelium is pavement epithelium.
- The term for simple squamous epithelium is pavement epithelium because
  - The cells are flat.
  - The cells are hexagonal .
  - The cells lack the intercellular space.
  - The cells appear like the tightly fitted mosaic tiles on the floor.

Location of simple squamous epithelium

The simple squamous epithelium is found in

- The lining of the coelom
- The lining of alimentary canal
- The lining of nasal cavity
- The endothelium of blood vessel
- The endo cardium of heart
- The alveoli of lungs
- The nephrons
- The lining of buccal cavity
- The Tympanic cavity

Functions of simple squamous epithelium

- Protection
- Exchange of gases
- Absorption
- Filtration

Simple Cuboidal epithelium

Structure of simple cuboidal epithelium

- Simple cuboidal epithelium consists of cells that are of shape
  - cubical
- The cells of simple cuboidal epithelium rest on the basement membrane.
- The cells of simple cuboidal epithelium have no intercellular.
- There is the presence of a centrally located nucleus.
- The cuboidal cells may have cilia.
- The cilia in simple cuboidal epithelium may be located at their free surface.
- The functions of cilia in simple cuboidal epithelium are
  - Cilia of simple cuboidal epithelium conduct the mucus.
  - Cilia of simple cuboidal epithelium conduct other substances.

- The location of ciliated cuboidal epithelium is
  - ducts of nephrons.
- The cuboidal cells may be brush bordered.
- The brush bordered cuboidal cells may have microvilli.
- The functions of microvilli in cuboidal cells is for
  - The microvilli of simple cuboidal epithelium reabsorb.
- The location of simple cuboidal epithelium having microvilli is
  - Proximal Convoluted Tubules of nephrons

Location of simple cuboidal epithelium

The location of simple cuboidal epithelium are

- The thyroid gland
- The lining of gonads
- The sweat gland
- The salivary glands
- The pancreatic glands
- The female urethra
- The lining of convoluted tubules of nephrons
- The frontal surface of lens
- The back surface of pancreatic duct

Functions of simple cuboidal epithelium

- Secretion
- Excretion
- Absorption

Simple Columnar Epithelium

Structure of simple columnar epithelium

- The cells of columnar epithelium are tall

- The cells of columnar epithelium are pillar like.
- The cells of columnar epithelium are attached to the basement membrane.
- The intercellular space is absent in the cells of columnar epithelium.
- The nucleus are located at the basal regions in the cells of columnar epithelium.
- The free ends of columnar epithelium may have cilia.
- The free ends of columnar epithelium may be brush bordered.

Location of simple columnar epithelium

The location of simple columnar epithelium are

- The lining of the stomach
- The lining of the intestine
- The gastric glands
- The intestinal glands
- The gall bladder
- The ureter
- The uterine wall

The location of ciliated columnar epithelium are

- The respiratory tracts
- The bronchioles
- The oviducts

The location of brush bordered columnar epithelium are

- The intestinal mucosa.

Functions of simple columnar epithelium

- Secretion
- Absorption
- Protection

Pseudo stratified Epithelium

Structure of pseudo stratified epithelium

- Some of the cells of pseudo stratified epithelium are taller.
- The taller cells of pseudo stratified epithelium have cilia at their free ends
- Some of the cells of pseudo stratified epithelium are shorter.
- The shorter cells of pseudo stratified epithelium have no cilia.
- The cells of pseudo stratified epithelium rest on the basement membrane.
- The basement membrane on which the pseudo stratified epithelium rest is the same.
- The cells of pseudo stratified epithelium have no intercellular spaces.

Location of pseudo stratified epithelium

The location of pseudo stratified epithelium are

- The lining of trachea
- The large bronchi
- The ducts of some glands,
- The fallopian tubes

Functions of pseudo stratified epithelium

- The pseudo stratified epithelium propel of mucus in the lumen.
- The pseudo stratified epithelium propel the particles in the lumen.

Compound Epithelium

Structure of compound epithelium

- The cells in compound epithelium are arranged in multiple layers.
- The lowermost cells form the germinative layer.
- The other term for germinative layer is stratum germinativum.
- The germinative layer rest on the basement membrane
- The cells of compound epithelium divide and redivide.
    - The division of cells at the germinating layer forms the upper cells.

- The cells of compound epithelium are found in areas of
  - wear
  - tear

Types of Compound epithelium

- Stratified epithelium
- Stratified squamous epithelium
- Stratified cuboidal epithelium
- Stratified columnar epithelium
- Transitional epithelium

Stratified epithelium

Structure of stratified epithelium

- Stratified epithelium has several layers of cells.
- The lowermost cells cells of stratified epithelium rest on the basement membrane.

Stratified Squamous epithelium

Structure of stratified squamous epithelium

- The upper layer of cells in stratified epithelium are
  - flat
  - polygonal
  - squamous
- The lower layer of cells in stratified epithelium are
  - germinative
  - cuboidal or columnar
- The lower layer cells in stratified epithelium lie on the basement membrane.

Location of stratified squamous epithelium

- The skin
- The buccal cavity
- The tongue
- The vagina
- The uterus
- The urethra

Function of stratified squamous epithelium

- Stratified squamous epithelium protects areas exposed to friction
- Stratified squamous epithelium regenerates areas exposed to friction.

Types of Stratified Squamous Epithelium based on Keratin

- Keratinized squamous epithelium
- Non Keratinized squamous epithelium

Keratinized Stratified Epithelium

Structure of keratinized stratified epithelium

- The other term for keratinized stratified epithelium is
  - water proof epithelium
- Keratinized stratified epithelium has keratin.
- The keratin in keratinized startified epithelium is present on the outer surface.
  - Keratin is a sclero protein.
- The outer layer of cells in keratinized stratified epithelium become
  - flattened
  - horny
  - cornified
  - dead
- The transformation in the outer surface occurs by Keratinization.
- Keratinization is the process of formation of keratin

Location of keratinized stratified squamous epithelium

- The upper layer of skin
- The hair
- The nails
- The horns
- The hooves

Function of keratinized stratified squamous epithelium

- Keratinized squamous epithelium checks the loss of water.
- Keratinized squamous epithelium protects from bacterial invasion.

Non Keratinized Stratified Epithelium

Structure of non keratinized stratified epithelium

- Non keratinized strtified epithelium lacks Keratin.
- Non keratinized stratified epithelium is found in
  - soft part of the body
  - moist part of the body
- Non keratinized stratified epithelium has no power of checking the loss of water.

Location of non keratinized stratified epithelium

- The buccal cavity
- The pharynx
- The vagina
- The inner layer of rectum
- The anus

Function of non keratinized stratified epithelium

- Non keratinized stratified epithelium protects from wear and tear.
- Non keratinized stratified epithelium protects from from drying.

Stratified Cuboidal Epithelium

Structure of stratified cuboidal epithelium

The upper layer of cells in stratified cuboidal epithelium are cuboidal. The basal cells in stratified cuboidal epithelium are columnar.

Location of stratified cuboidal epithelium

- The mammary glands
- The ducts of sweat glands
- The urethra of female
- The conjunctiva

Function of stratified cuboidal epithelium

- The stratified cuboidal epithelium protects.

Stratified Columnar epithelium

Structure of stratified columnar epithelium

- Stratified columnar epithelium has columnar cells at the upper layer.
- Stratified columnar epithelium has cuboidal cells at the lower layer.

Location of stratified columnar epithelium

- The vasa deferentia
- The respiratory tracts

Function of stratified columnar epithelium

- Stratified columnar epithelium protects

Transitional Epithelium

Structure of transitional epithelium

- Transitional epithelium tissue is made up of 5 to 6 layers of cells.
- The cells of transitional epithelium have the ability of stretching.
- The basal cells of transitional epithelium are smaller.
- The middle cells of transitional epithelium are larger.
- The middle cells are
  - pear shaped
  - club shaped and
- The upper cells are
  - dome shaped
- The other term for transitional epithelium is water proof epithelium.

Location of transitional epithelium

- The urinary bladder
- The ureter
- The uterus

Function of transitional epithelium

- Transitional epithelium provides elasticity for the stretching of the organs.
- Transitional epithelium is water proof.

Specialized Epithelium

Composition of specialized epithelium

- Specialized epithelium is composed of cuboidal cells
- Specialized epithelium is composed of columnar cells
- The cells in specialized epithelium are modified to perform specialized functions.

Types of specialized epithelium

- Ciliated epithelium
- Sensory epithelium

- Germinal epithelium
- Glandular epithelium

Ciliated epithelium

Structure of ciliated epithelium

- Ciliated epithelium is composed of cuboidal or columnar cells
- Ciliated epithelium has cilia at it's free ends.

Location of ciliated epithelium

- The lining of trachea
- The bronchi
- The nephrons

Function of ciliated epithelium

- Ciliated epithelium conducts mucus in the lumen.
- Ciliated epithelium conducts other substances in the lumen.

Sensory epithelium

Structure of sensory epithelium

- The sensory epithelium has modified columnar cells.
- The sensory epithelium has sensory hairs at the free surface.
- The sensory epithelium has nerve endings at the lower end.

Location of sensory epithelium

- The tongue
- The nasal cavities
- The retina of eyes
- The cochlea of internal ear

Function of sensory epithelium

- Sensory epithelium perceives external stimuli.
- Sensory epithelium perceives internal stimuli.
- Sensory epithelium conducts the impulses.

Germinal epithelium

Structure of germinal epithelium

- Germinal epithelium are modified cubical epithelial cells.
- Germinal epithelium lines the gonads.
- Germinal epithelium has the power of gametogenesis.

Location of germinal epithelium

- The lining of seminiferous tubules
- The lining of ovary

Function of germinal epithelium

- Germinal epithelium perform gametogenesis.

Glandular epithelium

Structure of glandular epithelium

- Glandular epithelium tissue may have modified cubical or columnar cells.
- Glandular epithelium is secretary.

Types of glands

Number of cells

Unicellular gland

- Unicellular glands are one celled glands that secretes mucus

Examples of unicellular gland

- The Goblet cells

Multicellular gland

- Multicellular glands are formed of many cuboidal cells.

Examples of multicellular glands

- The sweat glands
- The gastric glands

Presence or absence of ducts

Exocrine gland

- Exocrine glands are ducted glands.
- Exocrine glands secrete enzymes.

Examples of exocrine glands

- The Salivary glands
- The Tear glands
- The lacrimal glands
- The gastric glands
- The intestinal glands

Endocrine gland

- Endocrine glands are ductless glands.
- Endocrine glands secrete hormones.

Examples of endocrine glands

- The thyroid gland
- The pituitary gland
- The adrenal gland

Heterocrine gland

- Heterocrine glands are both exocrine and endocrine in function.
- Heterocrine glands secrete both
  - hormones
  - enzymes

Examples of heterocrine glands

- The Pancreas
- The enzymes secreted by pancreas are
  - TAL
  - Somatostatin
  - PP
- The hormones secreted by pancreas are
  - Insulin
  - Glucagon,
- The enzymes secreted by testis are
  - Sperm lysin
- The hormones secreted by testis are
  - Testesterone
- The enzymes secreted by ovaries are

  - Fertilizin

- The hormones secreted by ovaries are
  - Oestrogen
  - Progesterone

Shape and complexity

- There are two types of glands on the basis of shape and complexity.
- The type of glands on the basis of shape and complexity are
  - Simple glands
  - Compound glands

Types of Simple Glands

- Simple glands have single unbranched duct.
- Simple glands may be tubular or alveolar.
- Simple glands may be coiled or uncoiled.
- Simple glands may branched or unbranched.

Examples of Simple tubular glands

- The Crypts of Lieberkuhn

Examples of Simple coiled tubular glands

- The Sweat glands

Examples of Simple branched tubular glands

- The gastric glands
- The Brunner's glands

Examples of Simple alveolar glands

- The mucus gland in frog
- The seminal vesicles

Examples of Simple branched alveolar glands

- The sebaceous glands
- The oil glands

Compound glands

Examples of Compound tubular glands

- The liver
- The testes
- The kidneys

Examples of Compound Alveolar glands

- The mammary glands
- The pancreatic glands

Examples of Compound tubulo-alveolar glands

- The salivary glands
- The Bartholin's gland
- The Cowper's gland

Mode of secretion

- Merocrine gland
- Apocrine gland
- Holocrine gland

Nature of Merocrine gland

- The secretions in merocrine gland are released from the cell surface.
- The secretions are released by diffusion.
- The secretions are released without losing any of its cytoplasm

Examples of merocrine gland

- The goblet cells
- The salivary glands
- The intestinal glands
- The sweat glands

Nature of Apocrine glands

- The secretions get collected in the apical part of the cells.
- The secretions are released by bursting along with some apical cytoplasm.

Examples of apocrine gland

- The mammary glands

Nature of Holocrine glands

The entire cell breaks down in order to release the secretions in holocrine glands.

Examples of holocrine glands

- The Sebaceous glands

Nature of secretion

Nature of Mucus glands

- Mucus glands secrete mucus
- Mucus is a

  - proteinous substance
  - slimy substances

Examples of mucus glands

- The goblet cells

Nature of Serous glands

- The serous glands secrete clear watery fluids.

Examples of serous glands

- The salivary glands
- The intestinal glands
- The sweat glands

Nature of mixed glands

- The mixed glands secrete
  - mucus substance
  - serous substance

Examples of mixed glands

- The gastric glands
- The pancreatic glands

Connective Tissue

- Connective tissue
  - connects other tissues
  - binds other tissues
  - holds other tissues
- Connective tissue originates from the mesodermal layer.

Characters of connective tissues

- There is the presence of intercellular space in connective tissue.
- The connective tissue has non-living fibres.
- There connective tissues have no basement membrane.
- The connective tissues may be + vascular + avascular

Matrix

- Matrix is a intercellular substance.
- Matrix is clear.
- Matrix is jelly like.
- The contents of matrix are
  - cells
  - fibres

Functions of connective tissues

- Connective tissue binds other tissues and organs.
- Connective tissues connects other tissues and organs.
- Connective tissues hold other tissues and organs.
- Connective tissues make supporting framework for the body
- Connective tissues store fat .
- Connective tissues acts as shock absorber.
- Connective tissues protects vital organs.
- Connective tissues pack organs
- Connective tissues transports substances across the body.
- Connective tissues fight with foreign toxins.

Types of connective tissues

- Connective tissues are divided on the basis of
  - type of matrix
- The types of connective tissues are
  - Connective Tissue Proper

- Loose Connective Tissue
- Dense Connective Tissue
- Hard Connective Tissue
- Fluid Connective Tissue

Connective Tissue Proper

- Connective tissue proper has a soft matrix.

Loose Connective Tissue

Areolar Tissue

- Areolar tissue is a loose connective tissue.
- Areolar tissue has a matrix chracterizing
  - soft
  - transparent
  - jelly like

- The other term for areolar tissue is packing tissue.
- Areolar tissue has non living fibres .
- The fibres present in areolar tissue are loosely arranged.
- The fibres present in areolar tissue are arranged in random manners.
- **Areolae**
  - The space between the fibres is called areolae.

White Collagen fibres

- White collagen fibres are white fibres.
- White collagen fibres are arranged in bundles
- White collagen fibres are arranged in a wavy manner.
- White collagen fibres are unbranched.
- White collagen fibres are tough
- White collagen fibres are inelastic.
- The protein in the white collagen fibres is collagen protein.

Yellow elastic fibres

- Yellow elastic fibres are long.
- Yellow elastic fibres are branched.
- Yellow elastic fibres are present singly.
- Yellow elastic fibres are flexible.
- Yellow elastic fibres are elastic.
- The protein in the yellow elastic fibres is elastin protein.

Reticular fibres

- Reticular fibres are delicate fibres.
- Reticular fibres are short fibres.
- Reticular fibres are fine fibres.
- Reticular fibres are thread like fibres
- Reticular fibres form networks.
- Reticular fibres have reticulin protein.

Types of cells in areolar tissue

The cells in the areolar tissues are

- Fibroblasts
- Macrophages
- Plasma Cell
- Mast cell
- Lymphocytes

Fibroblasts

- Fibroblasts are fibre secreting cells
- Fibroblasts are large in size
- Fibroblasts have elongated protoplasmic processes
- Fibroblasts have oval nucleus.
- Fibroblasts secrete proteins.
- The proteins secreted by fibroblasts are

  - collagen
  - elastin
  - reticulin

Macrophages

- The other term for macrophages is histocytes.
- Histocytes are
  - large
  - irregular
  - amoeboid shape
- Macrophages have kidney shaped nucleus.
- Macrophages are phagocytic.

Plasma cell

Small round cells having large cart wheel nucleus , hence called as â€~Cart wheel cellâ€™ They produce antibodies

Mast Cell

Large oval cells which have granular cytoplasm Mast cell secretes Heparin, Histamine and Serotonnin

Heparin

- Heparin is an anti coagulant.

Histamine

- Histamine is a vasodilator.
- Vasodilator decreases blood pressure.
- Histamine is secreted in allergic conditions.

Serotonnin

- Serotonin is a vasoconstrictor.
- Vasoconstrictor increases blood pressure.

Lymphocytes

- Lymphocytes are small cells.
- Lymphocytes are amoeboid cells.
- Lymphocytes act as scavangers
- Lymphocytes by eat up the debris.
- Lymphocytes eat up the foreign bodies

Location of areolar tissues

- Beneath the dermis of skin
- Between and around muscles
- The blood vessels
- The nerve fibres
- The mesenteries in gastrointestinal tracts
- The Peritoneum

Functions of areolar tissues

- Areolar tissues are supportive.
- Areolar tissues are packing tissues.
- Areolar tissues heal wounds.
- Areolar tissues heal inflammations.
- Heparin prevents blood clotting.
- Areolar tissues bind and connect tissues.
- Areolar tissues destroy microbes.
- Areolar tissues engulf foreign bodies.

Adipose tissue

- Adipose tissue is a modified areolar tissue.

- Adipose tissue is also termed as a fat storing tissue.
- Adipose tissue consists of large number of fat storing cells.
- The fat storing cells of adipose tissue are called adipocytes.
- The other term for adipocytes is lipocytes.
- Adipocytes are modified fibrocytes.
- Adipocytes are
  - large
  - oval
  - spherical
  - fat

Types of adipocytes

- White adipocytes
- Brown adipocytes

White adipocytes

- White adipocytes contain single large fat droplet.
- White adipocytes contain
  - peripheral cytoplasm
  - peripheral nucleus

Brown adipocytes

- Brown adipocytes contain several small fat droplets.
- Brown adipocytes contain
  - peripheral nucleus
  - peripheral cytoplasm
- Brown adipocytes contain fat from from excess food.

Location of adipose tissues

- Beneath the skin as subcutaneous fat
- Around kidneys and eyeballs

- On the surface of heart
- Mesenteries
- Soles of feet
- Buttocks
- Hump of camel
- Blubber of whales

Functions of adipose tissues

- Adipose tissue is a reservoir of fat.
- Adipose tissue gives mechanical protection.
- Adipose tissue acts as shock absorber around
  - kidneys
  - heart
  - soles of the feet
  - buttocks
- Adipose tissue prevents heat loss.
- Adipose tissue acts as cushion
  - in eye socket

Facts on fats

- The fat is yellow in colour due to
  - lipochrome pigment
- The brown fat is brown in colour due to
  - iron rich mitochondria
  - containing cytochrome pigment
- The adipose tissue are not found in
  - lungs
  - eyelids
  - ear penis
  - and dorsum of hand
- Brown fat can yield 20 times more energy than white fats.

Dense Connective Tissue

- Dense connective tissue has compactly arranged fibres.

Types of dense connective tissues

- White fibrous tissue
- Yellow Elastic Tissue
- Reticular Tissue

White Fibrous Tissue

- White fibrous tissue is made up of the white collagen fibres.
- White collagen fibres are tough.
- White collagen fibres are inelastic.
- White fibrous tissue forms tendon.
- Tendon connects the muscles with bones.

Location of white fibrous tissues

- The Sclera of the eyeball
- The Cornea of eyeball
- The perichondrium of Cartilage
- The periosteum of bone
- Between the skull bones
- Duramater of the brain
- The spinal cord
- The pericardium of heart
- The kidney capsule
- The dermis of skin
- The lymph nodes

Functions of white fibrous tissues

- Tendon connects the muscles to bones
- White fibrous tissue provides mechanical protection.

- White fibrous tissue protects vital organs like
  - brain
  - spinal cord
  - heart
  - kidney

Yellow Elastic Tissue

- Yellow elastic tissue is made up of yellow elastic fibres
- Yellow elastic fibres are elastic.
- Yellow elastic tissue forms ligaments.

Location of yellow elastic tissue

- The pinna
- The alveoli
- The arterial wall
- The epiglottis
- The dermis of skin

Functions of yellow elastic tissues

- Yellow elastic tissue stretches the body organs.
- Ligament connects bone to bone
- Ligament connects cartilage to cartilage

Structure of Reticular Tissue

- Reticular tissue is a modified areolar tissue.
- Reticular tissue is made up of reticular fibres.

Location of reticular tissues

- Around the muscle fibres

  - The term for reticular tissues around the muscle fibres is Sarcolemma.
- Around nerve fibres
  - The term for reticular fibres around the muscle fibres is Neurilemma.
- The lymph glands
- Tonsils
- Liver
- Kidney

Function of reticular tissues

- Reticular tissue act as delicate supporting network

Hard Connective Tissue

- Hard connective tissue has a hard matrix.
- The other term for hard connective tissue is skeletal tissue.
- The types of hard connective tissue are
  - cartilage
  - bones

Cartilage

- Cartilage is a hard connective tissue .

Terminologies related to cartilage

Chondrology

- Chondrology is the study of cartilages.

Chondrogenesis

- Chondrogenesis is the process of formation of cartilage.

Perichondrium

- The perichondrium is the outer covering of the cartilage.
- The perichondrium is made up of white fibrous tissue.

Chondrin

- Chondrin is a protein.
- Chondrin is present in the matrix of cartilage.

Chondroblast

- Chondroblast cells form the cartilage.

Chondrocyte

- Chondrocytes are inactive and mature cells.
- Chondrocytes form the cartilages.
- Chondrocytes are enclosed in the lacuna.

Lacuna

- Lacuna is a fluid filled cavity.
- The number of chondrocytes in the lacuna is :
  - 2-6

Characteristics of Cartilage

- Cartilage has cheese like matrix.
- The cells of the cartilage are scattered in the matrix.
- The cartilage has
  - collagen fibres in the matrix
  - the elastin fibres in the matrix.
- The cartilage is surrounded by a sheath of white fibrous tissue.
- The cartilage is avascular.

- The nutrients in the cartilage are obtained in the cells by diffusion.
- The blood vessels do not grow into cartilage
  - The chondrocytes in the cartilages produce a chemical anti-angiogenesis factor.
- The direction of growth in cartilage is uni directional.

Types of Cartilage

- The types of cartilages are divided on the proportion of fibres present in the matrix.
- The types of cartilages are divided on kinds of fibres present.
- The types of cartilages are:
  - Calcified cartilage
  - Hyaline cartilage
  - Elastin cartilage
  - White fibrous cartilage

Nature of Calcified Cartilage

- Calcified cartilage is formed by the calcification of hyaline cartilage.
- The calcified cartilage is
  - hard
  - inelastic
- The calcified cartilage is hard and inelastic because
  - The calcium in calcified cartilage deposits in the matrix.

Examples of calcified cartilage

- The head of humerus of frog
- The head of femur of frog

Nature of Hyaline Cartilage

- Hyaline cartilage is termed as transparent tissue.

  - The hyaline cartilage is termed as transparent tissue because it has glass like matrix.

- Hyaline cartilage has no fibres in it.
- Hyaline cartilage is the most common type of cartilage.

Location of Hyaline Cartilgae

- The vertebrate embryos
- The cartilageneous fishes
- The ends of long bones,
- The nasal bones
- The ribs
- The larynx
- The trachea
- The knee cap

Nature of Elastic Cartilage

- Elastic cartilage has elastic fibres.
- Elastic cartilage is elastic in nature.

Location of elastic cartilage

- Ear Pinna
- Epiglottis
- Eustachian tube

Nature of White Fibrous Cartilage

- White fibrous cartilage lacks perichondrium.
- White fibrous cartilage has collagen fibres.
- White fibrous cartilage is the most strongest cartilage.

Examples of white fibrous cartilage

- The pubic symphysis

- The intervertebral discs
- The acetabulum
- The glenoid cavity

Introduction to Bone

- **Bone** is a hard connective tissue.
- **Bone** has hard *matrix* .

Constitution of bone

- The **constituting** components of bone are
  - **Inorganic Salts**
    - *Calcium Magnesium* and *Phosphate*
    - **Calcium Hydrooxypatite**
      - This causes **hardness** of *bone* .
  - **Collagen Fibers** 33%
    - This **provides tensile strength** to the *bone* .
  - **Cells**
    - **Osteocytes**
    - **Osteoblasts**
    - **Osteoclasts**
  - **Protein**
    - Bone contains protein called **ossein** .

Features of bone

- **Bone** shows **bidirectional** growth.
- **Bone** grows **brittle** with increasing *age* .
  - This occurs due to *decrease* of *protein* in the matrix.

Bone Factors

Hormones

- **Parathormone**
  - This is secreted by *parathyroid* gland.
  - This **increases** blood *calcium* .
  - **Calcium** is drawn from *bone* to *plasma* .
- **Calcitonin**
  - This is secreted by *thyroid* gland.
  - This **decreases** blood **calcium** .
  - **Calcium** is drawn from **blood** to **bone** .

Vitamins

- **Vitamin D**
  - This vitamin is also known as **Calciferol** .
  - This vitamin is needed for **normal** growth and **development** of *bone* .
  - This vitamin has a role in **calcium phosphate** metabolism.
  - **Difiecieny** of this vitamin causes **rickets** .

Functions of bone

- The **functions** of *bone* are *illustrated* below
  - **Support**
  - **Framework**
  - **Movement of body**
  - **Protection**
  - **Calcium resorvior**

- **Blood Formation**
- **Fat storage**

Bone Terminologies

- **Osteology**
  - **Osteology** is the *study* of *bones* .
- **Ossification**
  - **Ossification** is also termed as **Osteogenesis** .
  - **Ossification** is the **process** of *formation* of *bone* .
- **Periosteum**
  - **Periosteum** is the outer **covering** of the bone.
  - **Histological Structure**
    - **Periosteum** is made up of **white fibrous tissue.**
  - **Contents Periosteum** contains
    - **Osteogenic** cells
    - **Osteoclast** cells
- **Lamellae**
  - **Lamellae** is the **matrix** of *bone* .
  - **Location** Between **Periosteum** and **Endosteum**
  - **Arrangement** *Concentric* rings
- **Ossein**
  - **Ossein** is *protein* .
  - **Location Matrix** of the *bone* .
- **Osteoblast cells**
  - **Type Osteoblast** cells are *active* .
  - **Location Osteoblasts** are **located** *below* **periosteum**

  - **Function Osteoblast** cells form **bones** .

- **Osteocyte cells**
  - **Type Inactive**
  - **Age Mature**
  - **Location Lacuna**
  - **Function Osteocyte** cells form **bones** .
- **Osteoclast cells**
  - **Size Osteoclast cells** are **large** .
  - **Type of nucleus Multinucleated**
  - **Cell type Phagocytotic Location Osteoclast** cells are located in the *periosteum* .
    Function
    *
    * **Osteoclast** cells **reabsorb** *matrix* of the bone.
    * **Osteoclast** cells **remould** *bone* .
    * **Osteoclast** cells produce *enzymes* .
      - **Enzymes** of *osteoclast* cells *demineralize* the **matrix** .
- **Lacuna**
  - **Anatomical structure Lacuna** is a *cavity* .
  - **Contents**
    * **Lacuna** contains *Single* **osteocyte** cell
    * **Osteocyte** cells have **cytoplasmic processes** .
    * The **cytoplasmic** processes of **osteocytes** are *fingerlike* .
- **Canliculi**
  - **Anatomical Structure Canaliculi** is a *canal* .
  - **Function**
    * **Passes** *fingerlike* processes of *osteocyte cells* .
      - **Fingerlike** processes drive *nutrients*.

        - **Nutrients** are derived from *neighbouring cells /*

- **Endosteum**
    - **Location Endosteum** lines the *layer* of **marrow cavity** .
    - **Contents**
        - **Endosteum** is made up of *layer* of *osteoblast cells* .
- **Haversian canal**
    - **Location**
        - **Haversian** canal is present in *mammalian compact* **bone** .
    - **Anatomical Structure Haversian** canal is a **canal** .
    - **Shape**
        - Haversian canal is *longitudinal* .
        - Haversian canal is *cylindrical* .
    - **Contents**
        - **Blood Vessels**
        - **Lymph vessels**
        - **Nerves**
- **Compact Bone**
    - **Location**
        - **Compact Bone** is located at the **shaft** of *long* bones.
    - **Contents**
        - **Compact bone** has *yellow* bone marrow.
            - **Yellow** bone marrow produces **WBC's** .
            - **Yellow** bone marrow **stores** fat.
    - **Feature Compact** bone is
        - *Hard*
        - *Compact*
        - *Strongy*

- **Spongy Bone**
  - **Spongy Bone** is also *called* **Cancellous bone** .
  - **Shape**
    - **Spongy Bone** has the appearance of a **honey comb** .
  - **Location Spongy bones** is found at *end of*
    - *Long* bones
    - *Flat* bones
  - **Contents**
    - **Spongy bone** contains *red bone marrow.*
      - **Red bone marrow** produces
        1. **Red** blood *cells*
        2. **White** blood cells
  - **Feature Spongy bone** is
    - **Hard**
    - **Spongy**
- **Haversian System**
- **Haversian** system is also called **osteon** .
  - **Anatomical Structure**
    - **Center Haversian system** has **central** haversian canal.
    - **Peripheriry Haversian system** has *peripheral lamella* .
- **Volkman's canal**
  - **Anatomical structure Volkman's** canal is a **canal** .
  - **Arrangement in plane Volkman's** canal is a **horizontal** canal. **Function**
    - **Volkman's canal** connects two **haversian** canals.
- **Bone Marrow**
  - **Material nature**
    - **Bone** marrow is a substance which is

        - **Soft**
        - **Pulpy**
    - **Location**
        - **Bone marrow** is located at the **marrow cavity** .
    - **Types** The types of *bone* marrow are
        - **Red** bone marrow
        - **Yellow** bone marrow
- **Decalcification**
    - **Decalcification** is the *removal* of *hardness* of bone.
        - **Decalcification** is done by treating with HCl .
- **Decalcified bone**
    - **Decalcified** bone is a *bone* without hardness.

Structure of $T.S.$ of a decalcified bone

- The structure if $T.S.$ of a decalcified bone is
    - **Periosteum**
    - **Outer** layer of **osteoblast** cells
    - **Lamella**
    - **Marrow Cavity**

Structure of trabeculae

- The spongy bone is formed up of
    - The networks of trabeculae
- The trabeculae is
    - cluster of structures
- The trabeculae is surrounded by the marrow cavity.

Ossification

- Ossification is the process of formation of bone.

Types of ossification

The types of ossification are

- Endochondral ossification
- Intramembranous ossification

Nature of Endochondral ossification

- Endochondral ossification is the transformation of a cartilage into a bone.
- The cartilage transforming to a bone is called replacing bone.

Examples of Endochondral ossification

- The long bones
- The ribs
- The vertebra

Nature of Intramembranous ossification

- Intramembranous ossification is the ossification in the connective tissue.

Examples of Intramembranous ossification

- The facial bones
- The skull bones
- The clavicle

Ossification in tendon

- Sesamoid bone is formed by ossification in tendon.

Examples of ossification in tendon

- Patella

Fluid connective tissue

- Fluid connective tissue circulates within the vessels.
- The other term for fluid connective tissue is circulating tissue.

Contents of fluid connective tissue

- Fluid matrix
- Scattered cells
- No visible fibers
    - Fibres are only seen when blood clots.

Types of fluid connective tissue

- Blood
- Lymph

Blood

- The other term for blood is pseudo connective tissue
    - Blood lacks fibres
    - The matrix of the blood is formed by liver.
    - The cells of blood are formed by
        - Yolk sac
        - Liver
        - Spleen
        - Red bone marrow

Haemopoiesis

- The other term for haemopoiesis isi haematopoiesis.
- Haematopoiesis is the process of formation of blood cells.

Chemical property of blood

- Blood is slightly alkaline.
- The pH value of blood is
  - 7.4
- The pH of blood is maintained by balancing the ratio of
  - sodium bicarbonate
  - carbonic acid

Amount of blood

- An adult human has
  - 5 to 5.5 litres of blood.
- Blood constitutes about
  - 8% of total body weight.

Functions of Blood

- Blood transports
  - nutrients
  - oxygen
  - carbon dioxide
  - hormones
  - unwanted waste products
- Blood protects.
- Blood conducts thermo regulation

Composition of blood:

Blood Plasma

- Blood plasma are
  - straw colored
  - fluid
- Blood cells are suspended in the plasma.

Amount of blood plasma

- Blood plasma occupies a blood volume of
  - 55

Contents of blood plasma

Water

- The amount of water present in blood plasma is
  - 90 – 92

Inorganic salts

- Sodium chloride
  - Sodium chloride is the primary salt of blood.
  - Amount of sodium chloride present is
    - 0.9
- Sodium bicarbonate
- Potassium
- Magnesium
- Phosphorus
- Iron
- Calcium
- Copper

- Chlorine
- Iodine

Organic waste materials

- Organic waste materials are also non protein nitrogenous substances
- The organic waste materials in blood are ;
  - uric acid
  - creatinine
  - hippuric acids

Plasma proteins

- The quantity of plasma proteins present in blood is
  - 7
- The types of plasma proteins in blood are
  - Albumin
  - Globulin
  - Fibrinogen

Albumins

- Albumins are the most abundant plasma proteins
- Albumins are responsible for
  - Collidal Osmotic Pressure
- Albumins are the only protein reserve of body
- Albumins are hydrophilic in nature

Globulins

- Globulins are of three types.
- The types of globulin are
  - alpha

        * Alpha globulin is synthesized in liver.
    - beta
        * Beta globulin is synthesized in liver.
    - gamma
        * Gamma globulins are formed by the plasma cells.

Antibodies

- Antibodies in plasma are immune-globulins.
- The antibodies are produced by
    - lymph nodes
    - spleen

Hormones and respiratory gases

Clotting factors

- Fibrinogen
    - Fibrinogen is formed in liver.
- Prothrombin
    - Prothrombin is formed in liver.

Functions of Plasma:

- Plasma transports
    - nutrients
    - respiratory gases
    - excretory wastes
    - hormones
- Immuno globulins in plasma provide immunity.
- Plasma conducts thermoregulation.
- Plasma maintains osmotic pressure.
    - Albumin maintains osmotic pressure holding waters

- Plasma maintains blood pH
  - Plasma proteins neutralize
    - strong acids
    - strong bases

Blood Corpuscles:

RBC

- The other term for RBC is Erythrocytes.

Structure of RBC

- RBCs are
  - circular
  - biconcave
  - non nucleated
    - The absence of nucleus increase the surface area.
    - The increased surface area is beneficial for oxygen transportation.
    - The increased surface area can accommodate maximum number of Haemoglobin.
- The diameter of RBC is
  - 7.5 micrometers

Contents of RBC

- RBC contains Haemoglobin pigment
  - The amount of space consumed by haemoglobin is
    - 33
  - The amount of haemoglobin molecules present per RBC molecules is
    - 280 millions
  - Iron is present in Haemoglobin
  - The amount of RBC in 100 ml of blood is
    - 15 gms of Hb.

Quantity of RBC

- The number of RBC per cubic mm of blood in female is
  - 4.5 to 5 millions per cubic mm blood
- The number of RBC per cubic mm of blood in male is
  - 5 to 5.5 millions per cubic mm blood

Rate of production of RBC

- The rate of production of RBC is
  - 2 millions per second

Lifespan

- The average lifespan of RBC is
  - 120 days

Erythropoiesis

- Erythropoietin is a hormone.
- Erythropoietin is secreted by liver in foetus.
- Erythropoietin is secreted by kidney in adults.
- Erythropoietin begins erythropoiesis.

Formation of RBC

- RBCs are formed in Red Bone marrow.
- The RBCs are formed from haemopoietic tissue.
- The RBCs are formed at early foetal life.
- The RBCs are formed in the yolk sac in foetal life.
- The RBCs are formed later in liver.
- The major site of haemopoietic activity from third to seventh months is
  - spleen

- The major site of haemopoiesis from birth to whole life is
  - red bone marrow

Destruction of RBC

- Haemolysis is the process of destruction of RBC.
- Haemolysis occurs in liver.
- RBC in broken into
  - plasma membrane
  - haemoglobin

Haemoglobin

Haemoglobin is broken into

- iron
  - Iron is retained by liver.
- protein + Incomplete metabolism of protein forms + bilirubin + bilivirdin + stercobilin + urochrome

```
+ Bilirubin and bilivirdin are bile pigments.
+ Strcobilin give color to feaces.
+ Urochrome gives color to urine.
```

Plasma membrane

- Plasma membrane of RBC is destroyed in
  - spleen.
- Spleen is the graveyard of RBC.

Disorders related to RBC

Anaemia

- Anaemia is the lack of abundant RBCs in blood .

Polycythemia

- Polycythemia is the presence of
  - abnormally large number of RBCs in blood
- Polycythemia increases the blood viscosity.
- Polycythemia increases the risk of intravascular clotting

Pernicious anaemia

- Pernicious anaemia is the development of immature RBC.
- Pernicious anaemia occurs due to the deficiency of
  - Vitamin B12

Facts about RBC

Rouleaux formation

- Rouleaux formation occurs when blood is mixed with anti coagulant.
- RBCs join together by their concave surfaces.
- The appearance is like the piles of coins.

Haemolysis

- Haemolysis is the bursting of RBC.
- Haemolysis occurs when blood is mixed with distilled water.
- Distilled water is also called as hypnotic solution.

Shrinking of RBC

- RBCs shrink when blood is kept in NaCl solution.
- NaCl solution is also called as hypertonic solution.
- The amount of NaCl for RBCs to shrink is
  - 8%

Formation of RBCs

- RBCs are followed after the formation of reticulocytes.
- Vitamin B12 is essential for maturation of reticulocytes into RBC.
- Reticulocytes
  - are nucleated.
  - posses cell organelles.
- RBC lacks mitochondria.
- RBC undergoes anaerobic respiration.
- Anaerobic respiration releases lactic acid.
- Release of Lactic acid is the cause of fatigue.

Facts about RBC

- The maximum number of RBC count per unit volume of blood is in
  - aves
- The largest RBCs are present in
  - Amphibians
  - The size of RBC in amphibians is
    - 80 micro meters
- The smallest RBCs are present in
  - Musk deer
- Animals having nucleated RBCs are
  - Camel
  - Llamas

White Blood Cells

- The other term for white blood cells is leucocytes.
- WBCs are the largest blood corpuscles.
- The diameter of WBCs is
  - 8 to 15 micrometers

- WBCs are nucleated.
- WBCs are amoeboid.
- WBCs may posses shape of
  - round
  - irregular
- WBCs are non pigmented.
- WBCs have the power of amoeboid movement

Amount of WBC

- The amount of RBC per cubic mm of blood is
  - 8,000 - 10,000 per cubic mm of blood

Average lifespan

- The average lifespan of WBCs is
  - 10 to 13 days

Terms related to white blood cells

Diapedesis

Diapedesis is the movement of WBC across the blood vessels.

Formation of WBC

- WBCs are formed in
  - bone marrows
  - lymph glands

Types of WBC

- There are two types of WBC.
- The WBC are characterized on
  - presence of granules
  - type of nucleus
- The types of WBC are
  - Agranulocytes
  - Granulocytes

Granulocytes

- Granulocytes have cytoplasmic granules
- Granulocytes have multilobed nucleus. .
- The types of granulocytes are
  - neutrophils
  - eosinophils
  - basophils
- Granulocytes respond to the dyes in laboratory.

Eosinophils

- The dye taken by eosinophils is
  - red acidic dye
  - The other term for red acidic dye is eosin.
  - Eosinophils take red acidic dye due to
    - detoxification

Basophils

- The dye taken by basophils is
  - alkaline methylene blue
  - Basophils take alkaline methylene blue due to

        * heparin
        * histamine
        * serotonin

Neutrophils

- The dye taken by neutrophils are
    - purple
        * red acidic eosin
        * alkaline methylene blue
- Neutrophils are phagocytic
- Neutrophils are the most abundant WBC.
- The amount of WBC formed form neutrophils is
    - 60-70 %

Agranulocytes

- Agranulocytes lack granules.
- Agranulocytes donot have
    - multi lobulated nucleus.
- The types of agranulocytes are
    - lymphocyte
    - monocyte

Monocytes

- Monocytes are the largest WBC.
- The size of monocytes is
    - 20 micrometers
- Monocytes are phagocytotic.

Lymphocytes

- Lymphocytes are the smallest WBCs.
- The size of lymphocytes is
  - 7 micrometers
- Lymphocytes are phagocytic.

Disorders of WBC

Leukemia

- Leukemia is also called blood cancer.
- Leukemia occurs due to
  - excessive formation of WBC

Leucopenia

- Leucopenia is the condition of
  - abnormally low number of WBC

Platelets

- The other term for platelets is thrombrocytes.
- The role of platelets is
  - to clot blood

Amount of platelets

- The number of platelets per cubic mm of blood is
  - 2 to 4 lakhs per cubic mm.

Dimensions of platelets

- The diameter of platelets is
  - 2 - 3 micrometers
- Platelets are the smallest blood corpuscles

Lifespan of platelets

- The lifespan of platelets is
  - about a week.

Formation of Thrombocytes

- The process of formation of thrombocytes is
  - Thrombopoiesis

Disorders of thrombocytes

Thrombocytosis

- The increase in the number of platelets is Thrombocytosis .
- Thrombocytosis causes intravascular clots.

Thrombocytopenia

- The decrease in the number of platelets is Thrombocytopenia.
- Thrombocytopenia causes internal bleeding.

Contents of thrombocytes

- Thrombocytes contain
  - clotting factors
- The clotting factors of thrombocytes promote blood clotting.

- The clotting factors are
  - Thromboplastin
    - The other term for thromboplastin is thrombokinase.
  - Prothrombin
  - Fibrinogen
  - Calcium ions

Blood coagulation

- Blood coagulation is the mechanism of prevention of blood loss.
- Blood coagulation occurs when
  - a blood vessel is ruptured
- Blood clotting stops haemorrhage.

Time for blood coagulation

- The time required for blood clot is from
  - 2 minutes
  - 8 minutes

Blood clotting

The process of clotting of blood is

- release of enzymes
- formation of thrombin
- formation of fibrin
- clotting of blood

Release of enzymes

- The damaged platelets releases enzymes.
- The enzymes released by damaged platelets are
  - Thromboplastin
  - Thrombokinase.

Formation of thrombin

- Prothombrin is converted into thrombin.
- The conversion of prothrombin into thrombin takes place in the presence of
  - thrombokinase
  - calcium ions

Formation of fibrin

- Fibrinogen is converted into fibrin.
  - Fibrin is a fibrous material
  - Fibrin is converted as an insoluble networks.
- The conversion is done by
  - thrombin

Blood clot

- Fibrin traps the blood cells.
- Fibrin forms a red solid mass of blood cells.
- The red solid mass of blood cells is called blood clot.
- The blood clot acts like a seal in
  - the ruptured blood vessel

Terms related to blood clotting

Serum

- Serum is the blood plasma minus clot.
- Serum is a pale yellow fluid.

Thrombosis

Thrombosis is the clotting of blood in an unbroken blood vessel.

Thrombus

Thrombus is the clot lodged in a vessel.

Minerals

- The mineral necessary for coagulation of blood is
  - Calcium
- The vitamin necessary for synthesis of clotting factors is
  - Vitamin K

Heparin

- Coagulation of blood in vessels is prevented during the normal circulation by
  - heparin
- Heparin inhibits conversion of
  - prothrombin into thrombin
- This is done by activating
  - antithrombin in blood

Storage of Blood

- Blood clotting is prevented in by adding
  - oxalate
  - citrate
- Oxalate or citrate react with
  - calcium
- The reaction of oxalate or citrate with calcium forms
  - insoluble compound
- The free calcium ions for clotting of blood are absent.

Temperature for storing blood

- Blood is stored at
  - 4 degrees Celsius.