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## **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



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## 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

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## **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 stratified 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 stratified 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 its 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 secretory.

### **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
  - Testosterone
- 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 be 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 “Cart wheel cell”  
They produce antibodies



---

## **Mast Cell**

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

### **Heparin**

- Heparin is an anti coagulant.

### **Histamine**

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

### **Serotonin**

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

## **Lymphocytes**

- Lymphocytes are small cells.
- Lymphocytes are amoeboid cells.
- Lymphocytes act as scavengers
- Lymphocytes 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 cartilagenous 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 Hydroxypatite**
      - 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.
  - **Difecieny** 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* .

- **Canaliculi**

- **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 is 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 is 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 hypotonic 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 formed after the formation of reticulocytes.
- Vitamin B12 is essential for maturation of reticulocytes into RBC.
- Reticulocytes
  - are nucleated.
  - possess 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 micrometers
- 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 possess 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 from neutrophils is
  - 60-70 %

## Agranulocytes

- Agranulocytes lack granules.
- Agranulocytes do not 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 thrombocytes.
- 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.

## **Lymph**

### **Location of lymph**

Lymph is located at interstitial spaces

### **Opacity of lymph**

Lymph is transparent

### **Colour of lymph**

The colour of lymph may be

- Colourless
- Faint Yellow

---

## **Chemical nature of lymph on the basis of three classes**

Lymph is

- Slightly alkaline

## **Contents of lymph**

The contents of lymph are

- Matrix
- Cells
- Gases
- Substances
- Protein

**Matrix of the lymph** The matrix of the lymph is

- Plasma

**Cells of the lymph** The cells present in lymph are

- Lymphocytes

**Gases in lymph** The gases present in the lymph are

- Oxygen
- Carbon dioxide

**Substances present in lymph** The substances present in the lymph are

- Urea
- Glucose
- Vitamins
- Salts

---

### **Quantity of protein in lymph**

The quantity of protein in lymph is

- Very less

## **Lymphatic system**

### **Division of lymphatic system**

The division of lymphatic system are

- Lymphatic ducts
- Lymphatic vessels
- Lymph nodes
- Lymphatic capillaries

### **Formation of lymphatic vessels**

The formation of lymphatic vessels occurs by

- Union of lymphatic capillaries

### **System for production of lymph fluid**

The system producing the contents of lymph and lymph fluid is

- Lymphatic system

## **Lymph nodes**

**Shape of lymph nodes** The shape of lymph nodes is

- Oval shaped
- Bean shaped
- Kidney shaped

---

**Location of lymph nodes** The location of lymph nodes in lymphatic system is

- Lymphatic vessels

### **Function of lymph nodes**

The functions of lymph nodes are

- Lymph nodes filter.
- Lymph nodes produce lymphocytes.

**Cells produced by lymph nodes** The cells produced by the lymph nodes are

- Lymphocytes

### **Structure having valve in lymphatic system**

The structure having valve in lymphatic system are

- Lymphatic vessels

### **Need for valve in lymphatic vessels**

The need for valve in lymphatic vessels is

- Prevention of backward flow of lymph

## **Movement of lymph**

### **Structural factors in movement of lymph**

The structural factors in movement of lymph are

- Skeletal muscles

### **Process of movement of lymph in lymphatic system**

The process of movement of lymph in lymphatic system is

- Squeezing of surrounding muscles

---

## **Major lymphatic ducts**

The major lymphatic ducts are

- Right Lymphatic duct
- Thoracic duct

### **Location of right lymphatic duct**

The location of right lymphatic duct is

- Right sub clavian vein

### **Role of right lymphatic ducts**

The role of right lymphatic ducts is to

- Collect lymph from right portion of the body

### **Location of thoracic duct**

The location of left thoracic duct is

- Left sub clavian vein

### **Role of thoracic duct**

The role of thoracic duct is

- Collect lymph from left portion of the body

### **Direction of flow of lymph**

The direction of flow of lymph is

- Unidirectional



---

## **Final destination of flow of lymph**

The final destination of flow of lymph is

- Venous blood system

## **Functions of lymph**

The functions of lymph are

- Transportation
- Phagocytosis
- Blood volume

## **Transportation**

The materials transported by lymph are

- Gases
- Substances

**Gases** Lymph transports

- Respiratory gases

**Substances transported by lymph** The substance transported by lymph are

- Food materials
- Hormones

## **Phagocytotic nature of lymph**

The phagocytotic nature of lymph is

- Lymph destroys pathogens
- Lymph destroys foreign particles

---

**Structure for phagocytosis in lymph** The structure of phagocytosis in lymph are

- Lymph nodes

### **Balance of blood volume**

**Condition of transfer of blood from lymphatic system to blood vascular system** The condition of transfer of blood from lymphatic system to blood vascular system is

- Decrement of volume of blood in blood vascular system

## **Lacteals**

### **Anatomy of lacteals**

Lymph Capillaries

### **Location of lacteals**

Intestinal villi

### **Function of lacteals**

Absorption

### **Substances absorbed by lacteals**

The components absorbed by lacteals are

- Fat soluble vitamins
- Fats

## **Disorders of lymph**

The disorder of lymph is called

- Oedema

---

### **Location of oedema in disorders of lymph**

The location of action of oedema in disorders of lymph is

- Around the cells

### **Result of oedema in disorders of lymph**

The result of oedema in disorders of lymph is

- Swelling

### **Term for oedema in disorders of lymph**

The other term for oedema in disorders of lymph is

- Ordropsy

## **Muscular tissue**

### **Term for study of muscles**

Myology

### **Strength of muscles**

Strong

### **Type of muscular tissues in terms of contraction**

Contractile tissues

### **Source of flesh in the body**

Muscles

---

### **Nature of origin of muscles**

- Mesodermal
- Ectodermal

### **Organs having muscles of mesodermal origin**

- Almost muscles of all organs

### **Organs having muscles of ectodermal origin**

- Mammary gland
- Sweat gland

### **Features of muscles**

- Excitability
- Contractility
- Extensibility
- Elasticity

### **Functions of Muscles**

- Shape
- Locomotion
- Facial Expression
- Mastication
- Heart Beat

### **Actions conducted by involuntary muscles**

- Respiration
- Peristalsis
- Propulsion of urine

---

## **Types of muscles**

- Voluntary
- Involuntary
- Cardiac

## **Voluntary muscles:**

### **Terms for voluntary muscles**

- Skeletal
- Striped
- Striated

### **Nature of voluntary muscles on the basis of control according to will**

- Controllable

### **Fatigueness of voluntary muscles**

- Get easily tired

### **Arrangement of muscles with skeleton in voluntary muscles**

- Attached with skeleton

### **Structure for attachment of muscles with skeleton in voluntary muscles**

- Tendon

### **Source of muscle fibre cells in voluntary muscles**

- Myoblast

---

### **Nature of voluntary muscles in terms of division**

- Cannot divide on their own

### **Location of voluntary muscles**

- Limb muscles
- Facial muscles
- Tongue
- Facial muscles
- Eye Muscles
- Abdominal Muscles

### **Functions of voluntary muscles**

- Movement
- Chewing
- Facial expression
- Posture

### **Structure of voluntary muscles**

#### **Branching of voluntary muscles**

Unbranched

#### **Shape of muscles in voluntary muscles**

Cylindrical

#### **Structure of end of voluntary muscles**

Blunt

---

**Binding structure of muscle fibre in voluntary muscles**

Sarcolemma

**Cytoplasm of muscle fibres of voluntary muscles**

Sarcoplasm

**Location of nucleus in muscle fibres of voluntary muscles**

Periphery

**Type of cells of muscle fibres of voluntary muscles in terms of number of nucleus**

Multinucleated

**Type of origin of cells of muscle fibres on the basis of arrangement of cells**

Syncytial

**Source of formation of cells of muscle fibres of voluntary muscles**

Myoblasts

**Nature of syncytial origin**

Fusion of multiple cells

**Contents of sarcoplasm in voluntary muscles**

- Syncytial nucleus
- Sarcoplasmic Reticulum
- Muscle glycogen
- Myoglobin

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**Term for cytoplasm in voluntary muscles**

- Sarcoplasm

**Term for endoplasmic reticulum in sarcoplasm in voluntary muscles**

- Sarcoplasmic reticulum

**Contents of sarcoplasmic reticulum in sarcoplasm in voluntary muscles**

- Calcium

**Function of myoglobin in voluntary muscles in voluntary muscles**

- Store oxygen

**Function of presence of oxygen in myoglobin in voluntary muscles**

- Production of ATP

**Colour of muscle fibre in voluntary muscles**

Deep red

**Cause of deep red coloration of muscle fibre in voluntary muscles**

Myoglobin pigment

**Contents of myofibril in voluntary muscles**

- Light bands
- Dark bands

**Contents of Bands of myofibril in voluntary muscles**

- Myofilaments



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### **Types of myofilaments in voluntary muscles**

- Thick filament
- Thin filament

### **Contents of myofilaments in voluntary muscles**

Protein

### **Cause of name of striated muscles in voluntary muscles**

Light and Dark Bands

### **Terms for Dark bands in voluntary muscles**

- Anisotropic band
- A band

### **Contents of dark bands in voluntary muscles**

Thick filament

### **Protein present in dark bands of voluntary muscles**

Myosin

### **Line of bisection for dark bands of voluntary muscles**

Hensen's line

### **Term for hensen's line in voluntary muscles**

H line

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## **Terms for Light band in voluntary muscles**

- Isotropic band
- I band

## **Contents of light bands in voluntary muscles**

Thin filaments

## **Protein present in light bands of voluntary muscles**

Actin

## **Line of bisection in light bands in voluntary muscles**

Z line

## **Term for Z line in light band of voluntary muscles**

Krause's membrane

## **Function of Z line in voluntary muscles**

- Divide myofibril

## **Sacromere in voluntary muscles**

- Functional unit of skeletal muscles

## **Location of sacromere in voluntary muscles**

Myofibril

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**Range of location of sacromere in voluntary muscles**

- Between Z lines

**Length of sacromere in voluntary muscles**

2.5 micrometer

**Mechanism of contraction of voluntary muscles**

Slide actin over myosin

**Approximation of length of sacromere during muscle contraction in voluntary muscles**

Short

**Destination of Z lines in muscles contraction of voluntary muscles**

A band

**Ions mediating the contraction of voluntary muscles**

Calcium

**Proteins present at actin**

- Troponin
- Tropomyosin

**Location of proteins present at actin**

- Surface

**Function of troponin and tropomyosin**

- Block actin and myosin binding

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### **Function of calcium ions in muscle contraction of voluntary muscles**

- Bind Troponin

### **Consequence of binding of troponin in muscle contraction**

- Change configuration of tropomyosin

### **Activities in myosin in contraction of voluntary muscles**

- Breakdown of ATP
- Formation of Bridge
- Contraction of muscles

### **Breakdown of ATP**

#### **Reactants in release of energy in contraction of voluntary muscles**

ATP

#### **Products in release of energy in contraction of voluntary muscles**

- ADP
- Phosphate

#### **Location of breakdown of ATP in muscle contraction**

Myosin

### **Formation of bridge**

#### **Structure between myosin and actin in contraction of voluntary muscles**

- Cross bridge

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**Function of myosin in contraction of voluntary muscles**

- Pull actin

**Contraction of muscle**

- Shorten fibre

**Product in contraction of muscles in strenuous exercise**

Lactic acid

**Condition of formation of lactic acid in muscles**

- High energy demand

**Reactant in production of lactic acid in muscles**

- Pyruvic acid

**Nature of respiration of skeletal muscles at the condition of high energy demand**

Anaerobic

**Products in production of lactic acid in muscles**

- Lactic acid
- ATP

**Number of ATP molecules released in the reaction for production of lactic acid in muscles**

2

**Consequence of accumulation of lactic acid in muscles**

Fatigue

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### **Consequence of muscle fatigue in muscles**

- Decrease force of contraction of muscles

## **Outer covering of voluntary muscles**

### **Epimysium in voluntary muscles**

- Sheath of connective tissue

### **Function of epimysium in voluntary muscles**

- Cover muscle

### **Fasicula in voluntary muscles**

- Bundle of muscle fibres

### **Composition of fascicula in voluntary muscles**

- Myofibrils

### **Perimysium in voluntary muscles**

Sheath of connective tissue

### **Function of perimysium in voluntary muscles**

- Cover fascicula

### **Number of muscle fibres present in fascicula**

100 - 1000

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### **Endomysium in voluntary muscles**

Covering of muscle fibre

### **Function of endomysium in voluntary muscle**

Insulate muscle fibre

### **Location of sarcolemma in voluntary muscles**

Beneath endomysium

### **Function of sarcolemma in voluntary muscles**

Line sarcoplasm

## **Involuntary muscles**

### **Terms for involuntary muscles**

- Smooth
- Unstriated
- Unstriped

### **Nature of involuntary muscles in terms of control by will**

Uncontrollable

### **Involuntary muscles in terms of power of division**

- Can divide

### **Structures influencing activities of involuntary muscles**

- Hormones
- Nervous System

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## **Nervous system involved in the functioning of involuntary muscles**

Autonomic nervous system

## **Location of involuntary muscles**

- Wall of hollow organs
- Alimentary canal
- Blood vessels
- Respiratory passage
- Urinary bladder
- Ureter
- Genital tract

## **Structure of involuntary muscles**

### **Approximation of length of involuntary muscles**

Elongated

### **Shape of involuntary muscles**

Spindle

### **Contents of involuntary muscles**

Myofibrils

### **Arrangement of myofibrils in involuntary muscles**

Longitudinal

### **Type of cells of involuntary muscles in terms of number of nucleus**

Uninucleated



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**Structure absent in involuntary muscle but present in voluntary**

Sarcolemma

**Function of plasma membrane in involuntary muscles**

Cover involuntary muscles

**Cause of name of unstriated muscles in involuntary muscles**

Absence of dark and light bands

**Contents of involuntary muscles**

- Thick filaments
- Thin filaments

**Proteins present at the involuntary muscles**

- Actin
- Myosin

**Pattern of arrangement of actin and myosin proteins in irregular muscles**

Irregular

**Cause of name as unstriated muscles of smooth muscles**

Irregular pattern of arrangement

**Muscle unit absent in involuntary muscles**

Myofibrils

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**Function of gap junctions in involuntary muscles**

Connect smooth muscles

**Connection of involuntary muscles with the skeleton**

No connection

**Approximation of time of contraction of involuntary muscles**

Prolonged

**Approximation of rate of time of contraction of involuntary muscles**

Slow

**Fatigueness expressed in contraction of involuntary muscles**

Not fatigued

**Cause of muscle contraction in involuntary muscles**

Slide actin and myosin filament  
(a sliding filament mechanism) over each other.

**Source of energy for the contraction of involuntary muscles**

ATP

**Calcium binding protein present in involuntary muscles**

Calmodulin

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### **Function of calmodulin in involuntary muscles**

Bind with calcium during contraction

## **Cardiac muscles**

### **Location of cardiac muscles**

Heart Wall

### **Structure of cells of cardiac muscles**

#### **Approximation of length of cells of cardiac muscles**

Long

#### **Shape of cells of cardiac muscles**

Cylindrical

#### **Branching of cells of cardiac muscles**

Branched

#### **Type of cells of cardiac muscles in terms of quantity of nucleus**

Uninucleated

#### **Structure of connection of cells of cardiac muscles**

Bridge

#### **Shape of connection of bridge of cells of cardiac muscles**

Oblique

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### **Thickness of filaments of cardiac muscles**

- Thick filaments
- Thin filaments

### **Type of protein in cardiac muscles**

Troponin

### **Covering of cardiac muscles**

Sarcolemma

### **Location of intercalated discs in cardiac muscles**

Cardiac muscles fibres

### **Function of intercalated discs in cardiac muscles**

- Connect muscle fibres
- Interlock fibres

### **Consequence of action of intercalated discs in cardiac muscles**

Strength

### **Location of nucleus at the cells of cardiac muscles**

Centre

### **Contents of intercalated discs in cardiac muscles**

- Gap junctions
- Desmosomes

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### **Function of gap junctions in cardiac muscles**

Connect cytoplasm of muscle columns

### **Consequence of connection of cytoplasm with adjacent columns in cardiac muscles**

Transfer cations

for the transmission of cations for muscle contractions

### **Event of transmission of cations with adjacent columns in cardiac muscles**

Muscle Contraction

### **Function of desmosomes in cardiac muscles**

Connect cells

### **Function of oblique bridge in cardiac muscles**

Connect muscle fibres

### **Nature of cardiac muscles in terms of interaction with nervous system**

Myogenic

### **Myogenic**

- Contractions generated within the muscles are not initiated by the nervous system

### **Shape of cardiac muscles**

Cylindrical

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**Structure of end of cardiac muscles**

Blunt

**Proteins present at cardiac muscles**

- Actin
- Myosin

**Type of cardiac muscles in terms of movement by will**

Involuntary

**Nerves supplying the heart**

- Vagus Nerve
- Autonomic nervous system

**Approximation of amount of mitochondria in cardiac muscles**

Abundant

**Tiring of cardiac muscles**

Dont get fatigued