FEDERAL CHAPTERS

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CHAPTER 1
CELL STRUCTURE AND FUNCTION

* SINGLE STAINING

When only one stain, such as borax carmine (that stains nucleus) is used it is called single staining

* DOUBLE OR DIFFERENTIAL STAINING

When two stains, one that will stain nucleus e.g haematoxylin and other that will stain cytoplasm e.g eosin are used, the process is called double staining or differential staining.

→ Microdissection refers to the variety of techniques where a microscope is used to assist in dissection. It is done to remove tumour or granules from delicate tissue or cells like brain, heart and nerve cells.

→ Animal tissue cultures are used to see any abnormality in the cell e.g cancer, chromosomal disorder etc

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* Resolution power of naked eye = 0.1 mm
Resolving Power of Light Microscope = 250 nm
Resolving Power of Electron Microscope = 0.2 nm

→ Secondary cell wall is formed between the primary cell wall and plasma membrane only in sclerenchyma cells.

→ Lignin cements and anchors cellulose microfibrils together and it is mainly responsible for rigidity.

→ The fluidity of membrane is dependent on its lipid components, including phospholipids and cholestrol

→ The attachment of ribosomal subunits is controlled by presence of magnesium ion concentration of forming salt bonds between phosphate group of RNA and amino acid or both by magnesium ions and salt bonds.

→ The cell secretions mainly consist of proteins

→ In plant cell during cell division, Golgi complex also gives rise to vesicles which contain cell wall synthesizing materials. At cytokinesis, these Golgi vesicles are arranged on the cell equator, fuse together and form a structure called phragmoplast. Later on new cell wall is derived from this structure.

→ In plants and fungi, certain vacuoles carryout enzymatic hydrolysis, a function shared by lysosomes in animale cells.

→ Lysosomes contain about 40 different digestive enzymes.

→ The contents of lysosome are acidic.

→ Vacuoles are large vesicles originate from the endoplasmic reticulum and Golgi complex and plasma membrane.

→ Sieve tube cells in plants and RBCs in human are exceptional living cells that donot possess nucleus.

→ Nucleolus appears during interphase and disappears during cell division

MITOCHONDRIA

→ Mitochondria divide by fission.

→ The outer membrane is somewhat smooth like a sieve due to presence of porins. These are special proteins responsible for the transport of molecules across the membrane. Porins allow free passage of various molecules into the inter-membrane space.

→ The inner surface of cristae has grandular structures called F0-F1 particles. These particles are actually ATP Synthase enzymes.

→ Mitochondria contain small circular DNA

→ An interesting fact about them is that they are capable to survive outside the cell in artificial medium if carefully fractioned

→ Lysosomes regulate the number of mitochondria. Excess of mitochondria are digested by lysosomes

PLASTDS

→ Plastids are found in plant and algal cells.

→ Proplastids are young, immature and developing plastids.

→ Depending upon the structures in which they are found, the intracellular factors and on exposure to light, they may develop into leucoplast (colourless plastids) or chloroplast (green plastids)

→ Leucoplasts are found in parenchyma cells of root, stem and seeds. They act as storage organelles.

Amyloplast (store starch)
Elaioplast (store lipids)
proteinoplast (store protein)

THYLAKOIDS:

Thylakoids are of two types: Smaller Thylakoids and Larger Thylakoids.

Smaller Thylakoids are disc like sacs which are piled over one another like stack of coins. Each granum consist of 25-50 thylakoids and there are about 40-60 grana found in each chloroplast.

Larger thylakoids connect the grana with eachother and are also called intergrana. These membranes are colorless as they dont have pigments.

* MICROFILAMENTS:

→ also known as actin filaments
→ extremely thin contractile fibers
→ about 7 nm in diameter
→ Consist of four twisted chains.
→ Two chains of F-actin and two chains of tropomyosin with triplet troponin at intervals.
→ form myofibrils in muscles
→ involved in muscle contraction and relaxation
→ perform cyclosis

* MICROTUBULES

→ Small hollow cylinders
→ 25nm in diameter
→ 0.2 - 2.5 um in length
→ composed of tubulin protein
→ Each tubulin is a dimer.
→ In plant cells at the time of cell division freely dispersed microtubules organize themselves to form spindle fibres.
→ In animal cells, microtubules are involved in formation of centrioles, cilia, flagella and basal body

* INTERMEDIATE FILAMENTS

→ 8-10nm in diameter
→ basic subunit is vimentin
→ Vimentin subunits also form chains by linear arrangement
→ composed of three chains of vimentin which are twisted about eachother in such a way that no hollow space is left between them.
→ provide mechanical support to cell

* MOVEMENT OF CILIA:

The movement of cilia is due to sliding of double fibrils in two groups one after the other. Five out of nine double fibrils contract simultaneously. As a result cilium bends or shortens. This is called effective stroke.

Four out of nine double fibrils contract and cilia becomes straight. It is called recovery stroke

* MOVEMENT OF FLAGELLA:

A flagellum causes movement by the passage of rapid successive waves of bending from the attached to free end, as in flagellar movement of human sperms, which propel them forward within the fluid medium of the female reproductive tract

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CHAPTER 2

BIOLOGICAL MOLECULES

* In Protoplasm:

  Major Bioelements → 99%.

  Minor Bioelements → 1%.

  Trace elements → Less than 0.01%.

* All digestion reactions are examples of hydrolysis, which are controlled by enzymes such as carbohydrases, proteases, lipases, nucleases.

→ Water has high heat of vaporization i-e 574 calories per gram

→ Evaporation of only 2 mL out of one liter of water lowers the temperature of remaining 998 mL water by 1°C

→ Hydrophobic ~~redue~~ exclusion can be defined as reduction of the contact area between water and hydrophobic substances which are placed in water. e.g if you place few drops of ~~water~~ oil on surface of water, the oil drops will tend to join into a single drop.

Hydrophobic exclusion plays key roles in maintaining the integrity of lipid bilayer molecules.

→ Monosaccharides are usually found in open chain structure in crystalline form but when they are dissolved in water, most of them (pentoses and hexoses) are converted into ring chain structure.

→ Each pentose or hexose molecule in ring structure exists in either α or β form depending upon the position of -H and -OH group on C-1. If -OH group is found downward on C-1 then it is called α-sugar and if -OH group is present upward on C-1 then it is known as β sugar.

→ An example of enantiomer is D and L glucose. D sugars are right handed and L sugars are left handed molecules

→ Laboratory manufactured sugars are L sugars. On the other hand the naturally occuring sugars in bodies are D sugars. Proteins and cell receptors are designed to react only with D sugars.

→ All monosaccharides and two of three types of diasaccharides (maltose and lactose) have the open chemical structure needed to act as reducing agents. The third type of diasaccharides, sucrose and polysaccharides are non-reducing sugars.

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* Homopolysaccharides → Starch, Glycogen, Cellulose, chitin

* Heteropolysaccharides → Agar, Pectin, Peptidoglycan

→ Starch is digested in oral cavity and in small intestine by the enzyme amylase. Upon hydrolysis it yields maltose first and then maltose is further digested by maltase enzyme and yields glucoses. The presence of starch in a given sample can be confirmed by iodine test as it gives blue color with iodine solution. There are two types of starch i-e amylose (unbranched) and amylopectin (branched)

→ Glycogen composed of α- glucoses.

* IODINE TEST:

Starch → gives blue color

Glycogen → gives red color

Cellulose → no color

* Cellulose formed by condensation of hundreds of β-glucoses

* Chitin is second most abundant molecule on earth.

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* Chitin is the derivative of N-acetyl glucosamine monomers which is modified form of glucose

* FIBROUS PROTEINS: collagen, fibrinogen, actin, myosin, keratin

* GLOBULAR PROTEINS: Enzymes, Hormones, Antibodies, channel proteins

→ Ovalbumin is found in egg whites and casein is a milk-based protein. Both of them are involved in storage of amino acids.

→ Fatty acids contain even number of carbons from 2 to 30.

→ About 30 different fatty acids are found.

→ Palmitic acid (16C) and stearic acid (18C) are most common fatty acids.

* Synthetic waxes are generally derived from petroleum or polyethylene e.g paraffin wax which is used to make candles

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* A phospholipid is formed when phosphatidic acid combines with one of the four organic compounds such as choline (a nitrogenous base), ethanolamine (an amino alcohol), inositol (an amino alcohol) and serine (an amino acid)

→ Most common type of phospholipid is phosphatidylcholine also called lecithin in which choline is attached to phosphate group of phosphatidic acid

→ Two isoprene units form a monoterpene e.g menthol.
Four form a diterpene e.g vitamin A, phytol
Six form a triterpene e.g ambrein
Natural rubber is a polyterpene

→ In steroid, three of the rings contain six carbon atoms, and the fourth contains five.

→ Bile salts which emulsify fats, and Vitamin D which helps to regulate calcium metabolism are also steroids.

→ The base in nucleic acid is a nitrogen containing ring structure

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PROSTAGLANDINS

→ Prostaglandins exist in virtually every mammalian tissue, acting as local hormones.

→ These are derived from arachidonic acid

→ Their functions vary widely depending on the tissue

→ Some reduce blood pressure, whereas others raise it

→ In the immune system, various prostaglandins help to induce fever and inflammation and and also intensify the sensation of pain

→ They also help to regulate aggregation of platelets for the formation of blood clots

→ The ability of aspirin to reduce fever and decrease pain depends on the inhibition of prostaglandin synthesis.

→ Nucleotides are also joined together by a condensation reaction like other biomolecules. Unlike proteins, carbohydrates, and lipids, however, the molecule that is released is not water but pryophosphate (two phosphate groups bound together)

→ Polynucleotides have free 5′ phosphate group at one end and a free 3′ hydroxyl group at the other end. By convention, these sequences are named as 5′ to 3′

→ Total purines and total pyridines are in 1:1 in any DNA

→ Each turn of duplex consist of 10 base pairs.

→ mRNA is about 3 to 4 % of total RNA of cell

→ Approximately, 80% of total RNA contents of a cell are rRNA

TRANSFER RNA (tRNA)

→ It is smallest of RNA molecules consisting of 75 to 90 nucleotides.

→ A tRNA is a single stranded molecule but it shows a duplex appearance at its some regions where complementary bases are bonded to one another.

→ Its 5′ end always terminates in Guanine base while its 3′ end is always terminated with base sequence of CCA. Amino acid is attached to tRNA at this end

→ tRNA has three loops.

1) The middle loop in all the tRNA is composed of 7 bases, the middle three of which form the anticodon; it is complementary to specific codon of mRNA

2) The D loop recognizes the activation enzyme

3) Theta (θ) loop recognizes the specific place on the ribosome for binding during protein synthesis.

→ There is atleast one tRNA molecule for each of the 20 amino acids found in proteins

→ Sixty tRNA have been identified. However, human cells contain about 45 different kinds of tRNA molecules, each transport a specific amino acid from cytoplasm to the surface of ribosome for protein synthesis

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CHAPTER 3
ENZYMES

→ With the exception of ribozymes, all the enzymes are globular proteins Ribozymes are the enzymes which consist of RNA and are found in ribosomes. e.g peptidyl transferase is a ribozyme which forms peptide bond during protein synthesis.

→ The substrate molecule is attached to the active site by non-covalent interactions like hydrogen bonding and hydrophobic interactions. Active site consist of 3-12 amino acids which may be scattered in the polypeptide but are brought together in a particular fashion due to secondary and tertiary folding of the protein molecule e.g the active site of aldolase consist of glycine, histidine, and alanine amino acids. An active site consist of two functional regions i-e binding site and catalytic site.

→ During the early nineteenth century, two French chemists grounded up barley seeds in water to make a crude mixture that would digest starch. They gave the name

diastase whatever it was that digested the starch

→ The final shape of active site is actually established after the attachment of cofactor.

→ On the other hand a prosthetic group is covalently bonded part of an enzyme which is permanently attached to enzyme and doesnot detach after the completion of reaction. An iron containing porphyrin ring attached to some enzymes like cytochromes is the example of prosthetic group.

→ The enzymes, which work according to this model (Lock and key), are called non-regulatory enzymes. However, this model is exercised by a very small number of enzymes e.g sucrase, maltase etc

→ When one enzyme can catalyze only one substrate and essentially no other is called absolute specificity e.g urease

→ The flexibility of active site ~~which~~ allows more than one type of related substances to be attached on active site and therefore, an enzyme can carry out more than one type of related reactions. e.g carbonic anhydrase which can add O_2 to haemoglobin as well as can control the formation of carbonic acid and bicarbonates in blood

Enzymes which follow the induced fit mechanism, are called regulatory allosteric enzymes for example hexokinase

→ The bonds which are most sensitive to temperature change are hydrogen bonds.

→ The temperature which causes denaturation of enzyme is called maximum temperature. The temperature where an inactive enzyme becomes active again is called minimum temperature

→ The enzyme papain from green papaya act both in acidic and alkaline media

→ An example of enzyme inhibitor is malonate. Succinate dehydrogenase that catalyze the formation of fumarate from succinate is competitively inhibited by melonate

→ Feedback inhibition is an example of reversible non-competitive enzyme inhibition.

→ Cyanides are potent poisons of living organisms bcz they can kill an organism by inhibiting cytochrome oxides essential for cellular respiration. They block the action of these enzymes by combining with iron which may be present in the prosthetic group. Ions of heavy metals such as mercury, silver or copper combine with thiol (-SH) groups in the enzyme breaking the disulphide bridges. These bridges are important in maintaining tertiary structure. When the bridges are broken, the enzyme becomes denatured and inactive

→ Hetero kinase (a transferase) transfers a phosphate group from ATP to glucose

→ Pepsin, Renin and trypsin are hydrolases

→ Histidine decarboxylase (a lyase) breaks the covalent bonds between carbon atoms in histidine forming CO_2 and histamine

→ Amino peptidases and carboxypeptidases both digest peptones into dipeptides

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→ Erypsin digest dipeptides into amino acids

→ Amylase digest starch into maltose

→ Cellulase digest cellulose into cellubiose, a disaccharide

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CHAPTER 4
BIOENERGETICS

→ Chlorophyll-a is a bluish green pigment. Chlorophyll-b is a yellowish green pigment

→ The only difference b·w chlorophyll-a and chlorophyll-b is that chlorophyll-a has methyl group on 2nd pyrrole ring whereas chlorophyll-b has aldehyde group

→ Carotenoids attract insects., birds and other animals for pollination and dispersal.

→ Lutein is widely distributed xanthophylls which is responsible for yellow color of foliage in autumn

→ Carotenoids show absorption at 430-500nm

→ The production of ATP during light reaction is called photophosphorylation and the mechanism is called chemiosmosis

→ NADP+ combines with electrons and hydrogen ions to form NADPH (reduced)

→ In cyclic light reaction there is no production of NADPH, no occurance of photolysis of water and therefore, no release of oxygen

→ In biological systems oxidation-reduction is a chemical reaction usually involves the removal of hydrogen atom from one molecule and the gain of hydrogen atom by another molecule.

→ Aerobic respiration produce 36 ATPs in eukaryotes and 38 ATPs in prokaryotes Anaerobic respiration yield only 2 ATPs.

→ Alcoholic fermentation is found in ~~yeast~~ yeast.

→ The direct synthesis of ATP from organic phosphorylated substrate is called substrate level phosphorylation

→ Krebs Cycle is also called Citric Acid Cycle or Tri Carboxylic acid (TCA) cycle bcz the first compound which is formed in the cycle is citrate (citric acid) that contains three carboxylic acid groups

→ Citrate and isocitrate are isomers of each other.

→ Succinate undergoes dehydrogenation/ oxidation to form fumarate. The hydrogen and electrons which are released from succinate are taken up by FAD to form $FADH_2$.

→ A molecule of water gets added to fumarate to form malate.

→ F_o is embedded in the membrane and involves in the movement of protons from intermembrane space to mitochondrial matrix.
F_1 or elementary particle is a head like part which is projected from the surface of membrane towards matrix. It catalyze ATP synthesis by the combination of ADP and Pi. ATP synthesis become active in ATP formation when proton gradient having higher concentration of H^+ or protons on the F_o side as compared to F_1 side is established. The flow of protons through the F_o channel induces F_1 particles to function as ATP-Synthetase i-e the energy of the proton gradient is used in attaching a phosphate to ADP by high

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energy bond. This produces ATP. Oxidation of one molecule of $NADH_2$ produce 3 ATP molecules while a similar oxidation of $FADH_2$ forms 2 ATP molecules. The theory of ATP production by this mechanism is called chemiosmosis.

→ Addition of inorganic phosphate to any organic molecule is called phosphorylation but when phosphate is enzymatically transferred from an organic substrates molecule it is called substrate level phosphorylation

→ Out of total 36 ATP which are produced during aerobic respiration of human cells, 4 ATP are the result of substrate level phosphorylation and remaining 32 ATP are produced by chemiosmosis through electron transport chain

→ When the CO_2 levels inside the leaf drop to around 50 ppm, RuBisCO starts to combine oxygen with RuBP instead of CO_2. The net result of this is that instead of producing two 3C molecules of PGA, only one molecule of PGA and a toxic 2C molecule called phosphoglycolate are produced. The plant must get rid of phosphoglycolate.

→ C_4 pathway also known as Hatch-Slack cycle of C_4 pathway.

→ G3P known as PGAL

CHAPTER 5
ACELLULAR LIFE

→ Porcelain filter (pore size) → 100 - 1000nm

→ Viruses get destroyed by uv rays

→ Capsid is composed of identical repeating subunits called capsomeres (capsomers). The number of capsomers is particular to specific kind of virus.

Number of capsomers in:

Herpes Virus = 162

Adenovirus = 252

Polio virus = 32

→ Adenovirus cause common cold.

→ There are two forms of symmetry in virus capsid. When the capsomers are arranged in 20 triangles, it is called icosahedral (polyhedral or spherical)
When the capsomers are arranged in a hollow coil that appears rod shaped, it is called helical.

→ In bacteriophage capsid there are 12 vertices and 20 faces.
Two types of capsomers constitute the icosahedral capsid: pentagonal at the vertices and hexagonal at the faces.
There are always 12 pentons, but the

number of hexons varies among virus groups.

→ HIV capsid forms an unusual cone-shaped structure, with twelve of the pentameric rings and over a hundred hexamers.

→ More that 2,000 types of viral plant diseases are known

→ Rous sarcoma virus causes cancer in animals.

→ Papo virus causes warts
Poxivirus cause small pox
Picornovirus cause polio, Hepatitis A etc.
Paramyxovirus cause measles, mumps

* CLASSIFICATION OF VIRUS ON BASIS OF CAPSID:

1. Helical capsid e.g tobacco mosaic virus
2. Polyhedral capsid e.g Adenoviruses
3. Enveloped viruses e.g Influenza virus
4. Complex capsid e.g Bacteriophage

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CLASSIFICATION OF VIRUS ON BASIS OF GENOME

1. Double stranded DNA (dsDNA) → Small pox virus
2. Single stranded DNA (ssDNA) → mild rash virus
3. Double stranded RNA (dsRNA) → Diarrhea virus
4. Single stranded RNA (ssRNA); serves as mRNA → Rubella virus
5. ssRNA; template for mRNA synthesis → Influenza virus
6. ssRNA; template for DNA synthesis → HIV

→ Although we can often refer to the causative agent of cold as "the cold virus" there are actually more than 200 viruses that cause cold. Developing a vaccine against the infection is not practical.

→ Non-enveloped viruses can infact survive for long periods outside the host (up to several days) whereas enveloped viruses survive for shorter time periods. This is because many enveloped viruses rely on the proteins on the surface of the membrane to attach to the host cell, this envelope is generally sensitive to degradation to sunlight and normal cleaning procedures.

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→ The inner core of bacteriophage consist of a ssDNA genome.

→ The tail of bacteriophage surrounded by a contractile sheath, which contacts during infection of the bacterium.

→ Since the prophage contains genes, it can confer new properties to the bacteria. When a cell becomes lysogenized, occasionally extra genes carried by the phage get expressed in the cell. These genes can change the properties of the bacterial cell. This process is known as lysogenic conversion or phage conversion.

Clostridium botulinum, a causative agent of food poisoning, makes several different toxins, 2 of which are actually encoded by prophage genomes.

→ The assembly of phage components into mature infective phage particle is known as maturation. Within 20 to 25 minutes, approximately 200 phage particles are produced.

→ Conditions that favour the termination of the lysogenic state include: dessication, exposure to UV or ionizing radiation, exposure to mutagenic chemicals, etc.

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→ Antibacterial nanomedicines has been discovered in which bacteriophages can be formulated as targeted drug-delivery vehicles.

→ HIV infection can be divided into 3 stages: Asymptomatic carrier, AIDs Related Complex (ARS), Full Blown AIDs

→ Alpha interferon is effective against HBV

→ A combination of alpha interferon and ribavirin is the treatment choice for chronic hepatitis C.

→ Polio vaccine may be:

1) Killed Salk vaccine (Injectible Polio vaccine IPV)
2) Live, attenuated Sabin Vaccine (oral polio vaccine or OPV)

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CHAPTER 6
PROKARYOTES

→ The genes encoding ribosomal RNA are ancient and distributed over all lineages of life with little or no gene transfer. Therefore rRNA are commonly recommended as molecular clocks for reconstructing phylogenies, and divided prokaryotes into two evolutionary domains as part of the three-domain system, eubacteria, archea and eukaryotes.

→ The plasma membranes of archea contain unusual lipids that allow them to function at high temperatures. Lipids of archea contain glycerol linked to branched chain hydrocarbons in contrast to lipids of bacteria that contain glycerol linked to fatty acids.

→ Methanogenesis the ability to form methane is a type of metabolism that is performed only by some archea.

→ The most fundamental difference b.w archea and eubacteria is in their nucleic acid e.g rRNA

→ In addition to chlorophyll a, cyanobacteria also use phycobilins as accessory pigment phycocyanin, a blue pigment is their predominant phycobilins.

→ The smallest known bacteria belong to the group of Mycoplasmas, which infect animals. They are spherical bacteria and have approximate diameter of 0.1 to 0.2 μm.

→ One of the largest bacteria belong to Epulopiscium. It is visible to naked eye (600 μm long, 80 μm thick)

→ Helicobacter pylori exists as both a helix-shaped form and a spherical form. Such bacteria are called pleomorphic

COCCI BACTERIA

→ Sperical bacteria

→ generally appear in groups which can be distinguished on the basis of plane of cell division and number of cells

→ As a result of single (vertical) plane of cell division, bacteria appear in pairs, called diplococci or in chain of many cells called streptococci.

→ As a result of two plane of cell divisions (first vertical and then agan

verticle but at right angle to the first), bacteria appear in a square of four cells, called tetrad.

→ As a result of three plane of cell divisions (first vertical then again vertical but at right angle to the first and then horizontal), bacteria appear in a cubical arrangement of eight cells, called sarcinae.

→ If plane of cell division becomes irregular and many bacteria are produced which arrange like bunches of grapes, called staphylococci.

→ Some rod shaped bacteria (bacillus) have spherical ends like cocci. Such bacteria are called coccobacilli.

→ Thin and flexible spiral shaped bacteria are called spirochetes e.g Treponema pallidum. Relatively thick and rigid spiral shaped bacteria are called spirillum e.g Spirillum minus.

→ The glycocalyx is an outer coating that covers the outside of bacterial cell wall. The glycocalyx exist in two fours i-e capsule and slime. The capsule is a condensed layer that is relatively tightly associated with the underlying cell wall and gives sticky or gummy nature to the cell, whereas, slime is a more loosely attached layer that gives slimy or slippery nature to the cell and can be removed from the cell more easily. Generally, the glycocalyx is made of polysaccharide. However, in some cases, protein can also be present.

→ There are two prominent functions of the glycocalyx. In the form of slime it prevents the phagocytosis of bacteria by the cells of immune system called macrophages. A bacterium with a glycocalyx becomes more pathogenic. The second function of a bacterial glycocalyx is to promote the adhesion of the bacteria to living and inert surfaces and the subsequent formation of adherent, glycocalyx-enclosed populations that are called biofilms.

Biofilm bacteria can become very hard to kill, partly due to the presence of the glycocalyx material.

→ Synonyms for peptidoglycan are murein and mucopeptide.

→ Some Gram-positive bacteria also have fibre of teicholc acid that protrudes outside the peptidoglycan, whereas Gram-negative bacteria do not have it.

→ Lying between the peptidoglycan layer of cell wall and the cell membrane in Gram-negative bacteria is the, periplasmic space which is the site of enzymes that degrade antibiotics. Pilus is present only in Gram negative bacteria. They allow bacterial cell to adhere to tissue and can help the bacterial cell resist attack from immune system cells in the human body

→ Bacterial flagella are composed of flagellin protein and lack microtubules. In this way they differ from eukaryotic flagella.

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→ Actinomycetes, which are a large group of spore-forming, Gram-positive bacteria that grow by forming long tubules called filaments. Under nutrient poor conditions these filaments differentiate into round thick walled resting structures termed exospores. In contrast to endospores, these structures are part of the reproductive process and are formed outer to the cell wall.

→ Azotobacter species and several others are known to form cysts, which are dormant cells with thickened cell walls. Encystment (cyst formation) occurs by changes in the cell wall; the cytoplasm contracts and the cell wall thicken. Cysts are resistant to desiccation and some chemicals, but cannot withstand high temperatures as endospores can.

→ Often a plasmid rather than the main bacterial DNA is transferred.

→ Saccharomyces cervisiae (yeast) has been used to produce Hepatitis B vaccine, alpha and gamma interferons.

→ In leaf spot disease, brown to white spots appear on leaves

→ In soft rot disease soft, wet, rotting appear on any part of the plant.
e.g Corynebacterium causes ear rot of wheat.

→ Pseudomonas solanacaerum causes wilt disease in potato

→ Rhizobium leguminosarum causes small galls called root nodule in legumes.

→ The plague or "Black Death" which killed 100 million people during the mid-fourteenth century, is caused by highly infectious bacteria, Yersinia pestis, spread by the fleas carried by infected rats.

→ The ability of members of the normal flora to limit the growth of pathogens is called colonization resistance.

→ The intestinal bacteria produce several B vitamins and vitamin K.

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CHAPTER 7
PROTISTS AND FUNGI

→ coenocytic mean multinucleate but not multicellular

→ syngamy (the union of gametes)

→ The organs of locomotion are (i) pseudopodia e.g Amoeba

(ii) cilia e.g Paramecium

(iii) Flagella e.g Trypanosoma

→ The parasitic protozoans donot have any specific means of locomotion e.g Plasmodium

→ Protozoans form resistant cyst to overcome unfavourable conditions

→ Naelgeria fowleri, called "brain eating" amoeba causes primary amoebic meningoencephalitis.

→ Amoeba proteus (free living)
Entamoeba histolytica (parasitic)

→ Sarcodina shell either made up of calcium carbonate (e.g Foraminifera) or made up of silica (e.g Actinopods)

* Ciliates:

Micronuclei → small diploid

Macronucleus → polyploid

* PIGMENTS IN:

1. Algae → chlorophyll a, carotenes
2. Euglenoids → chlorophyll a, b, carotenoids
3. Brown Algae → chlorophyll a, c, carotenes
4. Red Algae → chlorophyll a, carotenes
5. Green Algae → chlorophyll a, b, carotenes

→ Algae differ from the plants in this respect that sex organs in algae are unicellular, the zygote is not protected by the parent body and embryo is not formed.

→ Dinoflagellates are known to have occasional population explosions or blooms. These blooms frequently colour the water orange, red or brown and are ~~frequently colour~~ known as red tide. This is bcz of the release of carcinogenic compound, called red toxin.

Dinoflagellates have chlorophyll a and carotenes

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→ In green algae energy reserve products (starch) and cell wall composition (large quantity of cellulose) are identical to those of plants

→ Slime molds (myxomycota) are organisms that are fungus like in one phase of their life cycle and amoeba like in another phase of their life cycle. Slime molds are similar in some respect to fungi i-e body is filamentous, saprotroph, formation of zygote, and having nonmotile spores. Slime molds differ from fungi due to the presence of motility in the life cycle.

→ Majority of fungi like protists have centrioles in their cells and have cell wall made up of cellulose unlike fungi. Therefore, they have been excluded from kingdom fungi

→ The hyphae of oomycota are aseptate (coenocytic) i-e without cross cell wall (septa)

→ Zoospores are produced in sac like structure, the zoosporangium

→ Chlorella (a protist) has been used as an experimental organism in research in photosynthesis. → A relatively new food source is single cell protein (SCP)

→ The plasmodial slime mold Physarum polycephalum is a model organism that has been used to study many fundamental biological processes, such as growth and differentiation, cytoplasmic streaming, and the functions of cytoskeleton.

→ Fungi lack centrioles

→ The study of fungi is called mycology.

→ It has been suggested, that fungi evolved from red algae bcz both fungi and red algae lack flagella in all stages of their life cycle

→ Fungi can tolerate wide range of pH from 2-9

→ Fungal cells show a unique mitotic division, called nuclear mitosis in which spindle fibers are formed within the nuclear envelope for the distribution of chromosomes b·w daughter nuclei

→ Non-septate hyphae have no cross walls, are multinucleated or coenocytic e.g Rhizopus.
Septate fungi have cross wall e.g Penicillium. The septate hyphae either consist of monokaryotic or dikaryotic cells. The mycelium that consist of monokaryotic hyphae is called primary mycelium and that consist of dikaryotic hyphae is called secondary mycelium. The cross walls of septate hyphae are perforated so the cytoplasm can move from one compartment to other.

→ Yeast are the only unicellular fungi and therefore, called non hyphal fungi

→ Some fungi also form large fruiting bodies (basidiocarp and ascocarp), which are actually clusters of reproductive structures.

ASEXUAL REPRODUCTION IN FUNGI

Asexual Reproduction takes place by sporangiospores, conidiospore, budding and fragmentation.

Sporangiospores are produced in spherical sac like structures, the sporangia which are developed on the tips of special erectly growing hyphae, the sporangiophores e.g Rhizopus

Conidiospores are produced in the form of cluster of chains on the tips of special erectly growing hyphae, the conidiophores e.g Pencillium.

Budding is only shown in yeast in which first, nucleus is divided into two daughter nuclei by nuclear mitosis then an outgrowth is formed which takes one of the daughter nuclei and subsequently separated from the parent cell.

Fragmentation is the breakdown of mycelium into different fragments which again regenerate into new mycelium.

SEXUAL REPRODUCTION IN FUNGI

→ In three of the three main groups of fungi (Basidiomycota and Ascomycota) fusion of nuclei does not take place immediately after the fusion of cytoplasm; instead the genetically different nuclei of two individuals may coexist and divide in the same hyphae for most of the life of the fungus. Such a fungal hyphae having two genetically different nuclei is called dikaryotic hypha.

→ Zygomycota have no dikaryotic phase

* Fungi Diversity: more than 100,000 species (1 lac)

→ In zygomycota, each spore grow into a new plus or minus strain of mycelium

→ In unicellular yeasts, asexual reproduction takes place by budding and fission

→ Ascocarps can have different shapes. In cup fungi they are cup shaped, in molds they are flask shaped and in the morels they are stalked and crowned by bell shaped structure.

→ Examples of sac fungi : Yeast, Neurospora, Morels, Truffles, Penicillium.

→ Although club fungi occasionally do produce conidiospores asexually, they usually reproduce sexually.

→ Mushroom : Agaricus

→ Aspergilus sp is used to produce soya sauce and soya paste from soya bean

→ Yeast cells can take up foreign DNA and integrate into their genomes. Yeasts also have ~~plastids~~ plasmids that can be used as gene vectors and sometimes yeasts are better than bacteria at synthesizing and secreting eukaryotic protein. Yeast is currently used to produce a number of proteins. In some cases, the same product, e.g interferons used in cancer research can be made in either yeast or bacteria. In other cases such as hepatitis B vaccine, yeast alone is used

→ ~~Eff~~ Pink mold neurospora has been used for genetic research.

→ Some of the most poisonous mushrooms belong to the genus Amanita. Toxic species of this genus have been appropriately called such names as "destroying angel" (Amanita virosa) and "death cap" (Amanita phalloides). Eating a single mushroom of either species can be fatal. Jack-o-lantern is a poisonous mushroom. Ingestion of certain species of mushrooms causes intoxication and hallucinations.

→ Ergotism is caused by purple ergot rye. It causes nervous spasms, ~~convulut~~ convulsion, psychotic delusion and even gangrene.

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CHAPTER 8
DIVERSITY AMONG PLANTS

* Chara → a pond organism

→ Psilopsida are simplest known vascular plants known as whisk ferns known for their resemblance to whiskbrooms.

→ Lycopsida are only living plants to have microphylls.

FERNS

→ In ferns, when the frond is young and immature, it is coiled. This pattern of development is called circinate venation.

→ Sori are covered with a flap of tissue called false indusium.

→ In ferns, a mature sporangium is flattened, spherical or ellipsoidal. It consist of a stalk and upper swollen portion called capsule. Capsule is covered with single layered wall. Walls consist of two portions annulus and stomium. Annulus portion contains cells with thick cell walls.

Stomium consist of cell with thin cell walls. This is the site for bursting of sporangia

→ Fern spore wall contain exine and intine.

→ When spores get mature, the wall of sporangia burst. Sporangium becomes dry, so the cells of annulus region contract which exerts pressure on stomium cells. Stomium is weak region of wall of sporangia, so sporangia burst from this region. Bursting of sporangia cause the dispersal of spores.

→ During germination, exine of spore bursts and intine elongates into a tube like structure. The apical portion of tube gives rise to new generation of Adiantum the gametophyte generation.

→ The shape of gametophyte of Adiantum is heart like. It has a notch, where growing point resides.

→ Gametophyte of Adiantum is many cells thick from centre and only one cell thick at margins. Rhizoids are produced from underside of gametophyte for anchorage and absorption of water and nutrients. Gametophyte contains chloroplasts, so carry out photosynthesis. Gametophyte is independent

→ In carboniferous period fern like plants were present.

→ There are four groups of gymnosperms, conifers, Cycads, Ginkgo and Gnetophytes.

→ Ephidrene, a drug from Ephedra (Gymnosperm) is used for the relief of asthma and other respiratory ailments.

* ANGIOSPERMS

→ The anther when fully developed contains 2 to 4 elongated sacs called pollen sacs. The pollen sacs contain pollen grains.

→ Depending upon the species of the plant involved, an ovary may have one, two, several or even thousands of ovules. The ovule has an opening called micropyle.

→ Megaspore mother cell of the ovule undergoes meiosis to produce four haploid cells. Only one of these cells survive. The surviving cell is called megaspore which divides by mitosis three times to produce eight haploid nuclei. This structure is called embryo sac. Wall formation takes place and these nuclei are converted into cells. The cells of embryo

sac are : antipodal cells, polar nuclei, synergids and egg. The embryo sac having these cells are called female gametophyte.

→ Polar nuclei are two in number, placed in the centre. By the time egg has been fertilized, the two polar nuclei have combined to form a single fusion nucleus.

→ In some plants cotyledons digest and absorb endosperm as the ovule is maturing into seed.

→ Monocots : Lilies, orchids, grasses, wheat, rice

Dicots : Rose, pea, buttercup

→ Racemose Inflorescence : Brassica

Cymose Inflorescence : Dianthus (pink)

Compound Inflorescence : Amaltas (Cassia fistula)
↓
[Compound Racemose]

Compound Spike → Rice

→ Basipetal succession mean basal flowers are younger and the upper flowers are older.

→ Commercial cork is obtained from oak.

CHAPTER 9
DIVERSITY AMONG ANIMALS

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→ Radial symmetry is considered an adaptation for a sessile life.

→ If the body cavity develops between the mesoderm and endoderm it is called pseudocoelom (false cavity)

→ If the body cavity forms within the mesoderm and is completely lined by mesoderm the body cavity is a true coelom. It is filled with coelomic fluid.

→ The bath sponge has spongin fibre.

→ The embryo development in porifera include free swimming ciliated larval stages.

→ Sponges have evolved from the protists called choanoflagellates.

→ Corals are cnidarians. It is made of $CaCO_3$. The ectodermal cells of the corals take lime from the sea water and form their exoskeleton. These exoskeleton form coral reefs and even island.

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→ In a colony of obelia three types of zooids are present:

(1) Hydranth → a polyp stage

(2) Blastostyle → Asexually, reproduced zooid

(3) Medusae

→ In mollusca, coelom is divided into sinuses. Sexes may be separate e.g in Unio or united e.g in Helix aspersa

→ Toredo (Mollusc) a shipworm damages wooden parts in ships.

PHYLUM ANNELIDA

→ The coelomic fluid serves as hydrostatic skeleton also

→ Most of the annelids are hermaphrodite e.g earthworm, leech

→ Sexes are separate in some annelids e.g Nereis.

→ The mouth is surrounded by prostomium

→ Annelids are first group in the animal kingdom having definite closed blood vascular system which runs throughout the body.

→ Polychaetes (Annelid) form an important food item for many edible fish

PHYLUM ARTHROPODA

→ Coelom is not present as the main body cavity. It is reduced and is called haemocoel, bcz it is connected with the blood vascular system

→ Cyclops carry larvae of a nematode, the Guinea worm

→ Examples : Lobsters, crayfish, prawns, cyclops, fruit fly (drosophila), cockroach, grasshopper.

PHYLUM ECHINODERMATA

→ The mouth is on the oral side and anus is on the aboral side

→ Coelom consist of canals and spaces, and one of which forms water vascular system

→ The larvae such as bipinnaria and brachiolaria are complex and exhibit bilateral symmetry, autotomy and regeneration.

→ Nervous system includes a circumoral nerve ring and radial nerve cords. There is no brain.

→ Dried skeleton of echinoderms are used as fertilizer bcz of high percentage of calcium and nitrogen.

→ The stinging sea urchins are poisonous

→ Example : sea lily

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* Phylum Hemichordata or acorn worm have colourless blood without corpuscles.

* SUB PHYLUM UROCHORDATA

→ On the outside are two projections : the incurrent siphon which corresponds to the anterior end of the body and excurrent siphon that marks the dorsal side.

→ Larva has a mid-dorsal supporting rod, the notochord, in the tail, so the group has been named urochordata

→ Examples : Ascidia, Halosymthia etc

* Class Agnatha is divided into two classes: Myxini and Cephalospidomorphi
In class Agnatha buccal funnel and toothed tongue form a device for blood sucking in absence of jaws

* CLASS OSTEICTHYES

→ The caudal fin is homocercal

→ There are four pairs of aortic arches

→ Brain has ten pairs of cranial nerves.

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CLASS AMPHIBIA

→ In some glands are poisonous, chromatophore pigment cells present in the skin
→ Amphibians are anamniotes (without amnion)
→ Example: Mud puppy (Necturus)

CLASS REPTILIA

→ Heart is incompletely four chambered, having two atria and partly divided ventricle.
→ Crocodiles ~~are~~ have completely four chambered heart.
→ hibernate in winter
→ Embryo is protected by three embryonic membranes known as amnion, allantois and chorion
→ Tortoise

CLASS AVES

→ There is only right aorta
→ The ureters open into the cloaca and the urinary bladder is absent.
→ Reptiles, birds and mammals are called amniotes

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CLASS MAMMALIA

→ Diaphragm is present only in mammals

→ Skull has two occipital condyles

→ Mammals have deciduous and permanent teeth.

→ Only left aortic arch is present

→ In some mammals hair have been modified into scales in pengolin, and spines in porcupine

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CHAPTER 10
FORM AND FUNCTION IN PLANTS

→ Deficiency of nitrogen or magnesium causes yellowing of leaves called chlorosis. The deficiency of phosphorus causes stunted root growth and deficiency of potassium causes leaf margins to become yellow or brown and pre-mature death of plant.

→ The nutrients may become deficient in the soil if a particular crop is grown again and again in the same soil. Therefore, crop rotation (cultivation of different crops alternatively in the same soil) or addition of fertilizers in the soil are possible remedies for this problem.

→ Hydroponic culture is one of the most useful methods to test whether a certain element is essential for plant or not. In this method, plants are cultured or grown on net, which is placed on surface of aerated water containing measured quantity of specific nutrients. The sample of water are analyzed time to time to determine which nutrient, the plant has absorbed

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* NECROSIS: It is the death of a part of plant body. It is due to deficiency of calcium, magnesium, copper and molybdenum

* CHLOROSIS: It is the yellowing of the green parts of a plant which show lack of chlorophyll due to mineral deficiency of nitrogen and magnesium

* STUNTED GROWTH: It is less than normal growth due to the deficiency of phosphorus, sulphur, potassium in plants.

* Mesophylls are special types of parenchymatous cells (thin walled living cells) which are present between the two epidermal layers of leaves. These cells are modified to carry out photosynthesis.

→ In dicots, there are two distinct layers of mesophyll, the palisade mesophyll and the spongy mesophyll.
The palisade mesophyll are elongated and compactly packed cells with no intercellular spaces between them. The epidermis beside palisade mesophyll is called upper epidermis.
On the other hand, spongy mesophyll are loosely packed cell with large intercellular spaces. The epidermis beside spongy mesophyll is called lower epidermis.

→ Such leaves, in which upper and lower epidermises can be differentiated bcz of the presence of two types of mesophyll cells, are called bifacial leaves.
In monocots, the leaves are monofacial as only spongy mesophyll cells are present between both epidermises.

→ In bifacial leaves, more stomata are distributed in lower epidermis as intercellular spaces are present along this epidermis. Whereas, isobilateral leaves have equal number of stomata in both epidermises.

→ At the time of dawn (sunrise) and dusk (sunset) the rate of photosynthesis becomes equal to the rate of respiration due to low intensity of light. In this situation, the CO_2 produced from respiration is sufficient to carry on photosynthesis and the oxygen released from photosynthesis is consumed in respiration. Therefore, the net gaseous exchange between plant and its environment is completely stopped. This is known as compensation point of photosynthesis

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→ Water potential of a medium is directly proportional to the concentration of water in that medium; therefore pure water has highest water potential. Water potential of pure water is designated a value of zero. Water potential of all the solutions or the cells must be less than zero i-e in negative range.

→ For water to move through the plant from the soil to the air, the conditions must exist as such:

Ψ_w of soil > Ψ_w of root > Ψ_w of stem > Ψ_w of leaf > Ψ_w of atmosphere

→ Solute potential is negative in a plant cell and zero in distilled water. In other words, the amount of available potential energy is reduced when solutes are added to an aqueous system. Thus Ψ_s decrease with increasing solute concentration.

→ Casparian strips: A band of suberin and lignin bordering four sides of root of endodermal cells.

→ Leaf is purely a source while fruit is particularly a sink on the other hand root and stem act as both source and sink

→ Xerophytes store a very high amount of water therefore called succulent plants.

→ In order to prevent crystallization in cell membrane, plants increase the proportion of unsaturated fatty acids (which have low freezing point), which help membrane to maintain structure at low temperature and crystal formation is inhibited. In order to prevent crystallization within cytoplasm, the plants native to cold regions such as oaks, maples, roses and other have adapted to bring changes in solute compositions of the cells which causes cytosol to super cool without ice formation, although ice crystals may form in the cell wall.

→ Most plants have adapted to survive in such high temperature stress situations by synthesizing large quantities of special proteins called heat shock proteins. Since these proteins are heat tolerant, so they embrace enzymes and other proteins thus help prevent denaturation.

→ The cork cambium or phellogen generally originates from outermost layer of primary cortex.

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→ The inner region of wood (some secondary xylem, primary xylem and central most tissue, the pith) is blocked by the deposition of wastes in later life and therefore gives a dark appearance. It is called heart wood.
The outer region of wood (consist of only secondary xylem) remain functional and therefore gives a light appearance. It is called sap wood.
The outer region of stem from vascular cambium to epidermis is called bark.
The portion of bark inner to the cork cambium is called inner bark (secondary phloem, primary phloem, pericycle, endodermis, primary cortex and secondary cortex)
The portion of bark outer to the cork cambium is called outer bark (cork and epidermis)

→ Auxins, gibberellins and cytokinins are called growth promoters bcz of their general role in promotion of growth while abscisic acid and ethene are called growth inhibitors.

→ Auxin was the first plant hormone identified.

→ More than 75 types of gibberellins have been isolated. Rather than giving each a specific name, the compounds are numbered e.g GA 1, GA 2 and so on.

→ Giberallic acid 3 (GA3) is the most widespread and most thoroughly studied.

→ Molecular structure of cytokinin is similar to adenine.

→ Naturally occuring zeatin, isolated first from corn (Zea mays) is the most active of the cytokinins.

→ Ethylene or ethene is a simple gaseous hydrocarbon produced from an amino acid and appears in most plant tissues in large amounts when they are stressed. It diffuses from its site of origin into the air and affects surrounding plants as well.

→ It has been discovered that the actual stimulus for flowering is the uninterrupted dark period rather than the light period. Therefore, it is really the length of dark period that is critical
Therefore, short-day plants are actually long night plants and long-day plants are short-night plants.

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→ Night interruption experiments on short day and long day plants have revealed that beside dark length the wavelength of light is also important in promotion or inhibition of flowering. e.g cocklebur a short day plant, will not flower if its long nights are interrupted but experiments revealed that red light (660 nm) was effective in preventing flowering and the far red light (730 nm) reversed the effect of red light. It was also demonstrated that if more than one type of light exposures were given to interrupt the night, the last light treatment always determines the response. The behaviour of long day plants was opposite in these experiments.

Researchers concluded that there must be some kind of photoreceptors in plants, due to which plants respond differently to these lights. This struggle finally leads to the discovery of these photoreceptor pigments in the form of phytochromes.

→ Phytochromes are blue-green pigment, which are involved in photoperiodism as photoreceptor.

→ Direct sunlight contains more red light than far-red light; therefore Pfr is present more in plants during the day. Far-red light are invisible heat radiations that are present in both day and night, but conversion of Pfr to Pr occurs mainly at night.

→ A short day plant requires a low ratio of Pfr to Pr. A night longer than critical length results in accumulation of Pr so the Pfr to Pr ratio becomes low. On the other hand a long day plant requires a high ratio of Pfr to Pr. A night shorter than critical length results in less formation of Pr so Pfr to Pr ratio becomes high

→ It has now been discovered that vernalin is actually giberellin

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CHAPTER 11
DIGESTION

→ GIT is approximately 9m (30 ft) long.

→ The digestive tube consist of four major layers:

1. Internal mucosa
2. Submucosa
3. Muscularis
4. External serosa

These four layers are present in all areas of the digestive tract from the oesophagus to the anus.

→ The palate forms the roof of the oral cavity. It consists of a hard anterior part, the hard palate and a soft posterior part, the soft palate.

→ There are 32 teeth. Different teeth are adapted to handle food in different ways.

(i) The incisors (front teeth) are chisel shaped and their sharp edges are used to bite off relatively large pieces of food.

(i) The canine teeth are cone shaped and they are useful in grasping or tearing food

(iii) The premolars and molars have somewhat flattened surfaces and are specialized for grinding food particles.

→ There are three pairs of salivary glands:
(i) Parotid or Parotis
(ii) Submandibular
(iii) Sublingual
These glands secrete saliva having enzyme.

→ The watery part of saliva contains a digestive enzyme called salivary amylase, which breaks the covalent bonds b.w glucose molecules in starch and other polysaccharides to produce the diasaccharides, maltose and isomaltose. Only about 3-5% of the total carbohydrates are digested in the mouth.

→ Saliva prevents bacterial infection in the mouth as it contains lysozyme and immunoglobulin. Saliva has a pH between 6 and 7, a favourable range for the digestive action of amylase

→ Oesophagus is about 25 cm long

→ The largest part of the stomach is the body

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→ The muscularis of the stomach consist of three layers:

(i) An outer longitudenal layer

(ii) Middle circular layer

(iii) Inner oblique layer

→ The stomach is lined with simple columnar epithelium.

The mucosal surface forms numerous tube like gastric pits, which are the openings for the gastric glands.

→ The epithelial cells of the stomach can be divided into four main types. The first type is surface mucous cells, which produce mucous, is on the surface and lines the gastric pit.

The remaining three are in the gastric gland. They are:

1) Parietal (oxyntic) cells produce HCl and intrinsic factors

2) Chief (zymogenic) cells secrete pepsinogen

3) Endocrine cells secrete the hormone gastrin into the blood

→ The smooth muscles of the stomach produce contractions known as mixing waves.

→ Approximately 2-3 litres of gastric juice are produced each day.

→ Hormones that regulate stomach secretions include gastrin, secretin, gastric inhibitory polypeptide, and cholecytokinin.

→ Neuronal stimulation of the stomach mucosa results in the secretion of acetylcholine, which stimulates the secretory activity of both the parietal and chief cells and stimulates the secretion of gastrin from endocrine cells. Gastrin is released into the circulation and travels to the parietal cells, where it stimulates additional gastric juice secretion.

→ The greatest volume of gastric secretions is initiated by the presence of food in the stomach. The primary stimuli are distention (enlargement) of the stomach and the presence of amino acids and peptides in the stomach.

→ The entire small intestine is about 6m long

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→ Two important enzyme precursors are found in pancreatic juice. They are trypsinogen and chymotrypsinogen. Both are inactive forms.

The inactive chymotrypsinogen is converted to active form chymotrypsin by trypsin.

→ Jejunum is about 2.5 m long and ileum is about 3.5 m long.

→ The lining of the jejunum and ileum secrete several enzymes.

Amino peptidase : It splits polypeptides into dipeptides.

Erepsin : It splits peptides into amino acids

Lactase : It converts lactose to glucose and galactose

Maltase : It converts maltose to glucose

Sucrase : It converts sucrose to glucose and fructose

Pancreatic Lipase : It completes digestion of fats into fatty acids and glycerol

* CHYLE : By the action of enzymes, chyme is turned into a watery emulsion called chyle

→ Villi are 0.5 - 1.5 mm in length

→ The fats are mixed with cholestrol and proteins, forming small globules called chylomicrons, most of which are transported by exocytosis out of epithelial cells into lacteals. Lymph containing chylomicrons, eventually drains from the lymphatic system into large veins that return blood to the heart.

→ Lipoproteins are referred to as high or low-density lipoproteins. A lipoprotein with high lipid content has a very low density (LDL), whereas a lipoprotein with high density (HDL). Chylomicrons, which are made up of 99% lipid and only 1% protein, have an extremely low density.

→ The appendix contains a small amount of mucus associated lymphoid tissue which gives the appendix an undetermined role in immunity. However, the appendix is known to be important in foetal life as it contains endocrine cells that release biogenic amines and peptides hormones important for homeostasis during early growth and development. Appendicitis is an inflammation of the vermiform appendix and usually occurs bc2 of obstruction of the appendix. An appendectomy is removal of the appendix.

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→ Attached to the caecum is a small blind tube about 9cm long called the vermiform appendix. The walls of the appendix contain many lymph nodules.

→ The large intestine also helps in absorption of vitamins made by bacteria that normally live in the large intestine. These bacteria also produce large amounts of vitamins. The most important of these is Vitamin K and Biotin (a B vitamin)

→ The liver consist of two major lobes, left and right, and two minor lobes.

→ Bile consist of water, bile salts : sodium glycocholate and sodium taurocholate, bile pigment, bilirubin, cholestrols, lecithin (a phospholipid) mucus, cells and cell debris.

→ In the intestine, bacteria convert bilirubin into pigments that give the faeces its characteristic brown colour. Some of these pigments are absorbed from intestine, modified in the kidneys and excreted in the urine, contributing to the characteristic yellowish colour of the urine.

→ Some bacteria in the large intestine (colon) synthesize vitamin K, which is passively absorbed in the colon, and breakdown a small amount of cellulose to glucose. Gases called flatus (meaning, blowing) are produced by bacterial actions in the colon.

→ Fatty acids in the lumen of the duodenum stimulate endocrine cells to release the hormone cholecytokinin (CCK). CCK stimulates contractions in the smooth muscle of the gall bladder allowing bile release into the duodenum.

Acidic chyme in the lumen of the duodenum stimulates other endocrine cells to release the hormone secretin. Secretin produced by the duodenum is carried through the circulatory system to the liver and stimulates liver to release bicarbonate into the bile.

→ Denaturation of fatty acids and phosphorylation of fats take place in liver cells.

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→ Excess of amino acids undergo deamination producing pyruvic acid and ammonia. Ammonia produced by deamination of amino acids in hepatic cells is converted to urea (ornithine-arginine cycle)

Synthesis of vitamin A from carotene and synthesis of albumin from amino acids takes place in Liver.

Formation of blood proteins (like prothrombin, fibrinogen) are synthesized in liver cells. These are necessary for blood clotting.

Phagocytosis also occurs in Liver i-e dead RBCs are destroyed.

The bile pigments bilirubin (orange pigment) and biliverdin (green pigment) are formed from the breakdown of haemoglobin.

Liver produces heparin, an enzyme that prevents clotting of blood inside the blood vessels. RBCs are formed during foetal life. Detoxification occurs in Liver.

→ Gall bladder: 8 cm long and 4 cm wide. The gall bladder is connected to the common bile duct by the cystic duct.

→ The major proteolic enzymes are trypsin, chymotrypsin, and carboxy peptidase. They are secreted in their inactive forms as trypsinogen, chymotrypsin, and procarboxypeptidase and are activated by the removal of certain peptides from the larger precursor proteins. If these were produced in their active forms, they would digest the tissues producing them

→ Helicobacter pylori is the most important factor in peptic ulcer disease, accounting for 90% of duodenal ulcer and 70% of the gastric ulcer.

Peptic ulcers tend to run in families i-e it is a hereditary disease.

CHAPTER 12
CIRCULATION

→ The study of the diseases of cardiovascular system is called angiology

→ The ~~part~~ pericardium consist of two parts:

1) The outer part consist of inelastic white fibrous tissue

2) The inner part is made up of two membranes. The inner membrane is attached to the heart and the outer one is attached to the fibrous tissue. Pericardial fluid is secreted between them and reduces the friction between the heart wall and surrounding tissues when the heart is beating.

→ The inelastic nature of the pericardium as whole prevents the heart from being overstretched or overfilled with blood

→ Heart wall is composed of three layers of tissue:

1. Epicardium (outermost)
2. Myocardium
3. Endocardium (innermost)

→ The heart valves are formed by a fold of the endocardium, making a double layer of endocardium with connective tissue in between.

→ The right atrium receives the superior vena cava, the inferior vena cava, and the coronary sinus (the coronary sinus is an additional opening into the right atrium that receives venous blood from the myocardium of the heart itself)

→ The left atrium receives the four pulmonary veins.

→ Each ventricle contains cone-shaped muscular pillars called papillary muscles. These muscles are attached by thin, strong connective tissue strings called chordae tendineae to the cusps of the AV valves. The papillary muscles contract when the ventricles contract and prevent the valves from opening into the atria by pulling on the chordae tendinae attached to the valve cusps.

→ The heart muscle rests 0.1 to 0.3 second between the beats

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→ The SA node has been developed from the sinus venosus and has become a part of the atrium, so it is called sinoatrial node.

→ AV node is connected to a strand of specialized muscles (in the ventricular septum) known as atrioventricular bundle or bundle of His. This bundle passes through a small opening in the fibrous skeleton to reach the interventricular septum, where it divides to form right and left bundle branches, which extend beneath the endocardium on either side of the interventricular septum to the apices of the right and left ventricles respectively.

The inferior, terminal branches of the bundle branches are called Purkinje fibres, which are large-diameter cardiac muscle fibres. They have fewer myofibrils than most cardiac muscle cells and donot contract forcefully. Intercalated discs are well developed b.w the Purkinje fibres and contain numerous gap junctions. As a result of these structural modifications, action potentials travel along the Purkinje fibres much more rapidly than through other cardiac muscle tissue.

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→ A cardiac arrythmia is a disturbance in electrical rythm of heart. It may be:

(i) bradycardia : heart beat less than 40 beats per minute

(ii) tachycardia : heart beat more than 100 beats per minute

Arrythmia are controlled by surgical insertion of artificial pacemaker.

→ The wave deflections designated as P, QRS and T are produced as specific events of the cardiac cycle.

* P Wave : → depolarization of atrial fibres of SA node
→ ventricles are in diastole

* P-R Interval :
→ period of time from the start of the P wave to the beginning of QRS complex.
→ This interval indicates the amount of time required for the SA depolarization to reach the ventricles.

* QRS Complex :
→ indicates depolarization of ventricles
→ ventricles are in systole
→ blood is being ejected from heart

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* S-T Segment: represents the period between the completion of ventricular depolarization and initiation of repolarization.

* T Wave: produced by ventricular repolarization.

→ The P Wave represents excitation and occurs just prior to contraction of the atria.
The second wave, or the QRS complex, occurs just prior to contraction of the ventricles.
The third, or T wave occurs just before the ventricles relax.

→ Artery consist of three layers:
1. Tunica externa / Tunica adventitia
2. Tunica media
3. Tunica interna / Tunica intima

* Diameter:
Aorta = 23 mm
Arterioles = 0.2 mm
Capillaries = 7-9 μm
Venules = 40-50 μm

* Capillaries are approximately 1mm long

→ Several substances called kinins can cause powerful vasodilation are formed in the blood and tissue fluids of some organs e.g histamine.

→ Hepatic portal vein, the largest vein of the hepatic portal system, is formed by the union of all the veins coming from digestive system.

→ The portal system that begins with capillaries in the viscera and ends with capillaries in the liver is the hepatic portal system

→ Within the liver the blood flows through a series of dilated capillaries which empty into hepatic veins. The hepatic veins join the inferior vena cava.

→ Before birth, the two major arteries - the aorta and the pulmonary artery - are connected by a blood vessel called the ductus arteriosus. This vessel is an essential part of foetal blood circulation. Before a baby is born, the foetus's blood doesnot need to go to the lungs to get oxygenated. The ductus arteriosus is a hole that allows the blood to skip the circulation to the lungs. Within minutes, or

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up to a few days after birth, the vessel is supposed to close as part of the normal changes occuring in the baby's circulation. If the ductus arteriosus is still open (or patent) the blood may skip this necessary step of circulation. The open hole is called the patent ductus arteriosus. This opening allows oxygen-rich blood from the aorta to mix with oxygen-poor blood from the pulmonary artery. This can put strain on the heart and increase blood pressure in the lung arteries.

→ When a person survives a heart attack, scar tissue (a type of connective tissue) grows into the areas where the heart muscles have died. The scar tissue cannot contract as cardiac muscle. As a result the damaged heart is permanently weekened.

→ About one sixth of the body consist of spaces b·w the cells, which collectively are called the interstitium.

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→ The anterior part of nasal cavities that contain hairs is called vestibule.

→ The macrophages also secrete many different proteins when they perform phagocytosis of the microbes. Some of these proteins trigger the maturation of monocytes into macrophages, thereby increasing their numbers. Another protein interleukin-I signals the brain to raise the body temperature, producing fever. Some other proteins also stimulate the specific immune response.

→ Natural-killer (NK) cells are a type of T-lymphocytes. They are also called cytotoxic T-cells. In general, natural killer cells do not directly attack invading microbes. Instead, NK cells strike at the cancerous cells or body cells that have been invaded by viruses.

→ NK cells also attack cancer cells at an early stage of tumor.

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→ Interferons belong to the large class of proteins known as cytokines, molecules used for communication between cells during infection. They are released by host cells in response to the presence of several pathogens especially viruses. Interferons are named for their ability to "interfere" with viral replication. In this way, interferons limit cell-to-cell spread of viruses in the body. Interferons also activate immune cells, such as natural killer cells and macrophages that in turn destroy virally infected cells.

→ Certain WBCs in response to the infection, also release hormones collectively called endogenous pyrogens that further increase the temperature set point of hypothalamus bcz higher body temperature than normal increases the activity of phagocytic WBCs that attack upon bacteria. The endogenous pyrogens also cause other cells to reduce the concentration of iron in the blood bcz many bacteria require more iron to reproduce at temperature of 38°C or 39°C than at 37°C, so fever and reduced iron in the blood combine to slow down their rate of reproduction. Fever also increase the production of interferons that travel to other cells and increase their resistance to viral attack.

The higher body temperature may directly inactivate the virus particles, particularly enveloped viruses, which are more heat-sensitive than non-enveloped viruses. Replication of some viruses is reduced at higher temperatures, therefore fever may inhibit replication.

→ Interleukin-1 causes fever by first inducing the formation of one of the prostaglandins. When drugs block prostaglandin formation, the fever is either completely abrogated or at least reduced. In fact, this may be the explanation for the manner in which aspirin reduces the degree of fever because aspirin impedes the formation of prostaglandins from arachidonic acid. It also would explain why aspirin ~~impedes the formation of prostaglandins~~ doesnot lower the body temperature in a normal person because a normal person doesnot have interleukin-1. Drugs such as aspirin that reduce the level of fever are called antipyretics.

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→ When macrophages perform phagocytosis of invaded microorganisms, after digesting them they not only display microbial antigens on their surfaces but also begin to secrete about 100 different compounds including various enzymes, interferons and a protein called interleukin-1. The interleukin-1 secreted by macrophages activates the T cells and in turn begin to secrete interleukin-2, which then activates the B cells. Interleukin-1 also promotes a general response to injury, causing fever and activating other mechanisms that defend the body against invasion.

→ Interleukin-1 also stimulates the helper T cells to secrete another protein, the interleukin-2 that not only compel the helper T cells to divide but also causes the proliferation of certain cytotoxic T cells and B cells.

→ Two main categories of T cells have been identified :

(i) CD8 Cells have surface markers designated CD8, include cytotoxic T cells and suppressor T cells

(ii) Helper T cells or CD4 cells have a surface marker designated as CD4

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→ Helper T cells secrete interleukin 2 which stimulates cell division of T cells and B cells. In other words, these cells recruit even more cells to help fight the pathogen.