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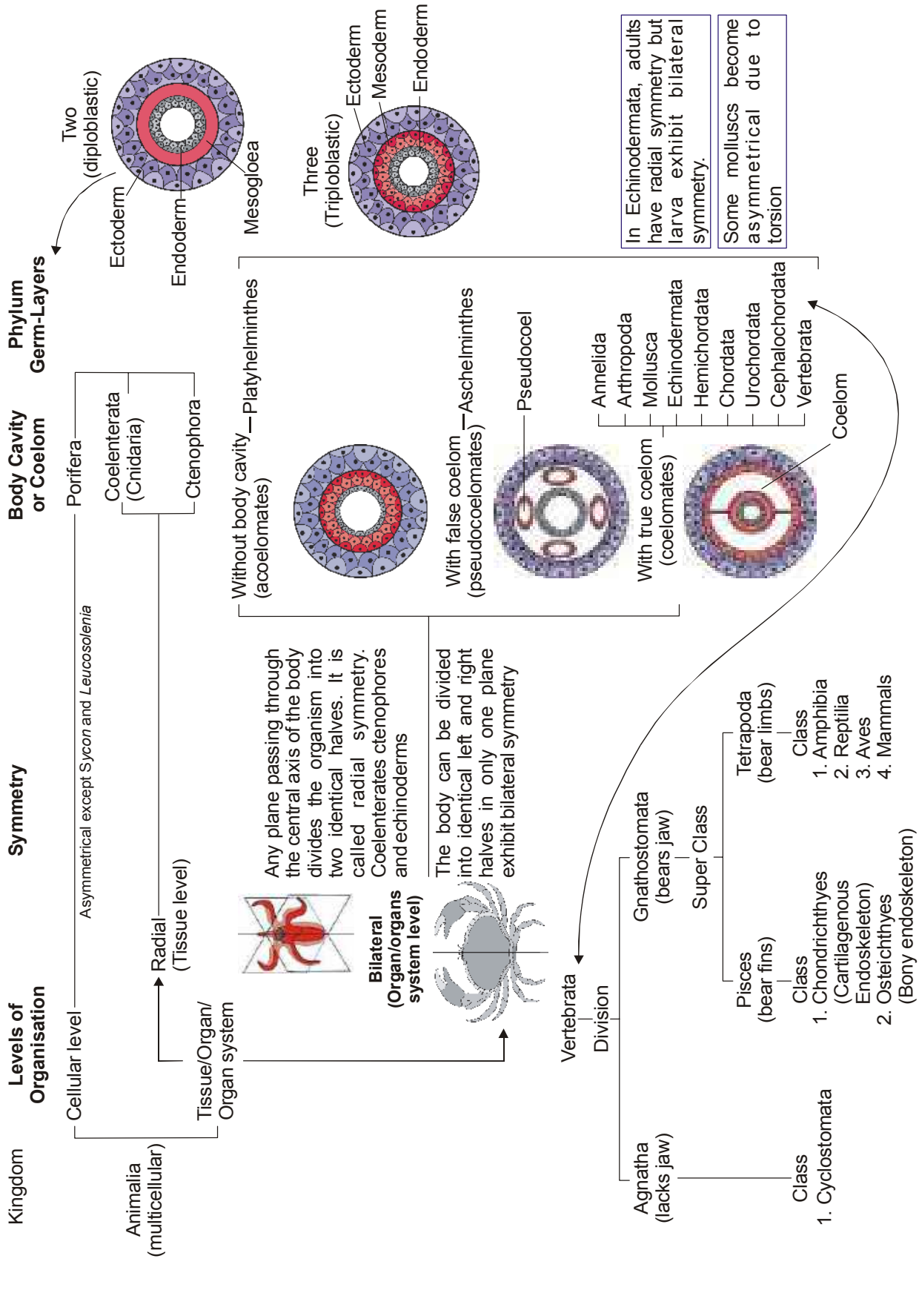
ZOOLOGY

E

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ANIMAL KINGDOM

BROAD CLASSIFICATION OF KINGDOM ANIMALIA BASED ON COMMON FUNDAMENTAL FEATURES



PHYLUM - PROTOZOA

(included in protista)

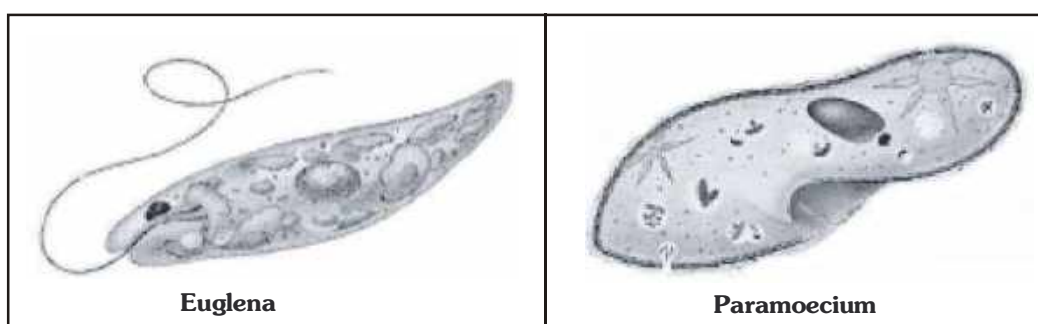
- World wide, Cosmopolitan mostly **Microscopic**, **Aquatic**, **terrestrial**, **free living** (*Amoeba*) or **parasitic** (*Plasmodium*). Solitary or colonial (*Proterosporgia*). Causes serious diseases or pathogenic.
- (1) Small microscopic, **Eukaryotic Unicellular**, Colourless, Spherical, Oval, Bell shaped, Spindle shaped slipper like having irregular Symmetry
- (2) Body level of organisation of Protozoans is **Protoplasmic level**.
- (3) Protoplasm is uninucleated or multinucleated, animals are **naked** or some have body bounded by delicate membrane or a firm **pellicle/Test/shell/Lorica (Loose outer covering)**.
- (4) In few groups of protozoa **Silica & CaCO₃ shell's** exoskeleton is found.
- (5) Few show **nuclear dimorphism**. e.g. *Paramoecium*.
- (6) Body performs all necessary biological activity so in them **subcellular - Physiological division of Labour** is found.
- (7) Locomotion structure
 - (1) Pseudopodia e.g. *Amoeba*, *Entamoeba*
 - (2) Whip like Flagella e.g. *Euglena*
 - (3) Hairy cilia e.g. *Paramoecium*
 - (4) Absent in sporozoans eg. Plasmodium (Malaria parasite)

All protozoans are heterotrophs and live as predators or parasites. They are believed to be primitive relatives of animals.

- (8) **Nutrition** of Protozoans are mainly **holozoic** (*Amoeba*), **Parasitic** (*Plasmodium*), **Saprophytic** and Digestion is **intracellular** take place in **food vacuole**.
- (9) **Respiration** and **Excretion** take place by exchange of gases through body surface. Nitrogenous waste is **Ammonia**.
- (10) Some excretion may occur through **contractile vacuole** (Present in fresh water protozoans). Some fresh water protozoans get rid of excess water through contractile vacuole known as **Osmoregulation**.
- (11) *Amoeba* has one and *Paramoecium* has two contractile vacuoles.
(Gullet in paramoecium help in ingestion)
- (12) **Reproduction** takes place by

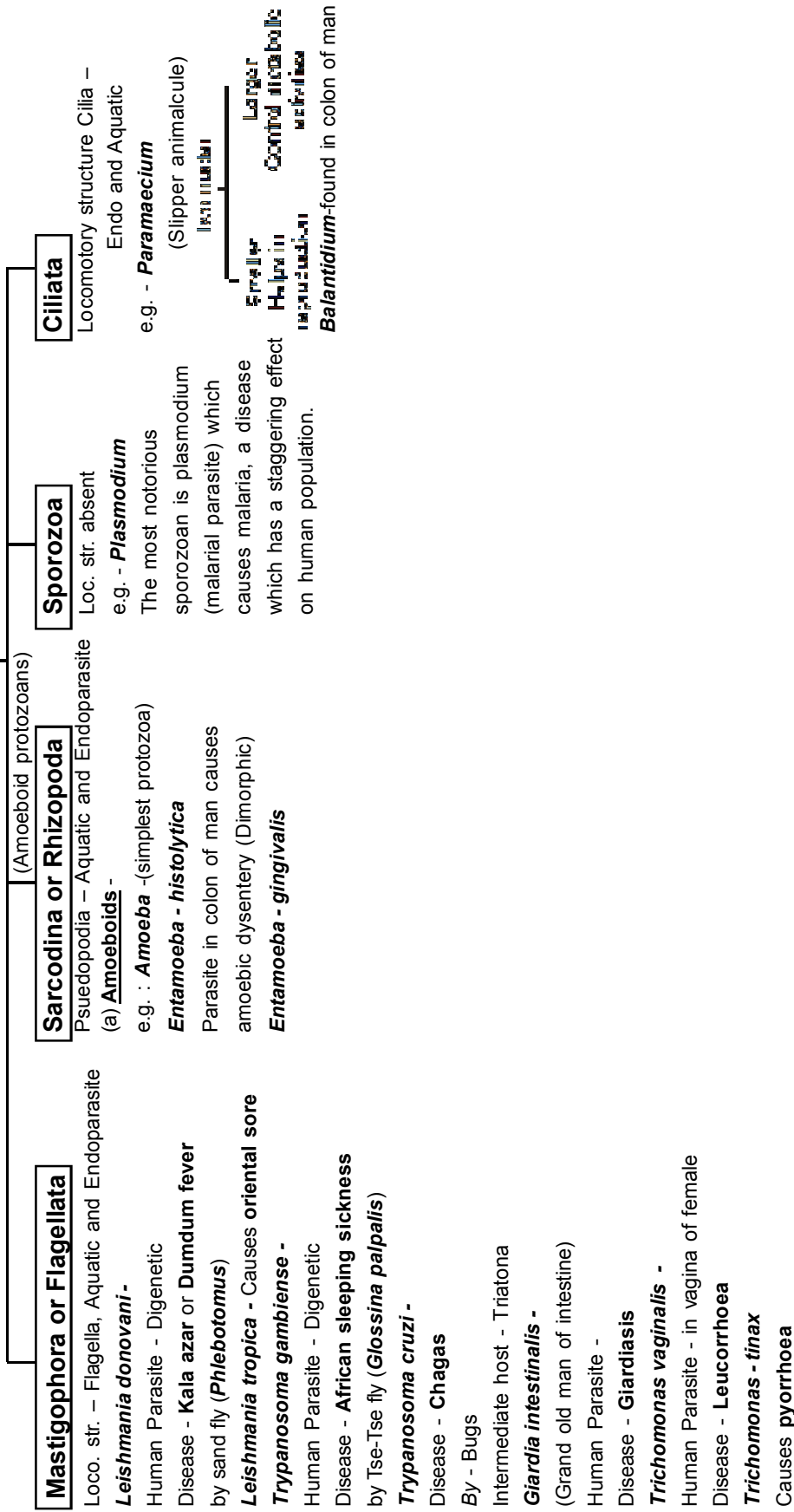
Asexual		Sexual	
(1)	Binary fission (a) Irregular – (<i>Amoeba</i>) (b) Transverse fission (<i>Paramecium</i>) (c) Longitudinal fission (<i>Trypanosoma</i> , <i>Euglena</i>)	(1)	Syngamy (<i>Plasmodium</i>)
(2)	Multiple fission (<i>Plasmodium</i>)	(2)	Conjugation (<i>Paramecium</i>)

Note : Now *Euglena* (myxotroph) is placed in Euglenoid and connecting link between Plant and Animal.



PROTOZOA

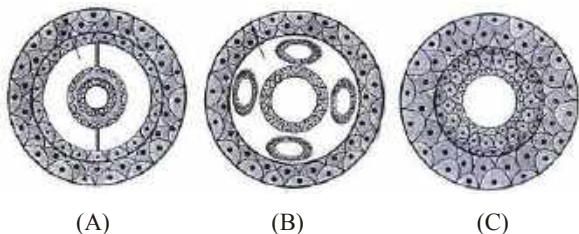
On the basis of locomotory organs & Nucleus apparatus



EXERCISE

INTRODUCTION

1. Identify the given diagram A, B and C for phylums:-



1	A	Platyhelminthes	B	Aschelminthes	C	Annelida
2	A	Platyhelminthes	B	Annelida	C	Aschelminthes
3	A	Annelida	B	Platyhelminthes	C	Aschelminthes
4	A	Annelida	B	Aschelminthes	C	Platyhelminthes

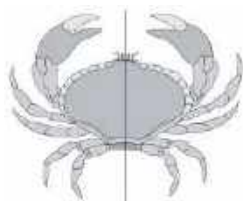
2. Consider the following four statements (a-d) and select the option which includes all the correct ones only :-

- (a) All members of animalia are multicellular.
- (b) In sponges the cells are arranged as loose cell aggregates
- (c) Platyhelminthes exhibit cellular level of organisation
- (d) All multicellular animals do not exhibit the same pattern of organisation of cells

Options :

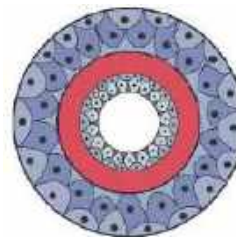
- (1) Statements (b), (c) and (d)
- (2) Statements (a), (b)
- (3) Statements (c), (d)
- (4) Statements (a), (b) and (d)

3. Identify the symmetry shown below as well as the related explanation and select the right option for the two together :-



	Symmetry	Explanation
1	Asymmetrical	Any plane that passes through the centre does not divide them equal halves
2	Radial	The body can be divided into identical left and right halves in only one plane
3	Bilateral	Any plane pass through the central axis of the body divides the organism into two identical halves
4	Bilateral	The body can be divided into identical left and right halves in only one plane

4. Given diagram below is the body organisation of animal, select the correct animal



- (1) Insect
- (2) Ascaris
- (3) Taenia
- (4) Physalia

5. The cross section of animal body is given below:



Which of the following group will possess the above cross section :-

- (1) Platyhelminthes
- (2) Ctenophora
- (3) Aschelminthes
- (4) Annelida

6. Animals are classified on the basis of :-

- (1) Arrangement of cells
- (2) Body symmetry
- (3) Nature of coelom
- (4) All of these

7. During the embryonic development, coelom formed from blastocoel is :-
 (1) Pseudocoel (2) Schizocoel
 (3) Enterocoel (4) Hemocoel
8. Which arrangement is in correct ascending order :-
 (1) Species < genus < order < family
 (2) Genus < species < family < order
 (3) Order < family < Genus < species
 (4) Species < genus < family < order

PROTOZOA

9. Protozoans are believed to be primitive relatives of animals because :-
 (1) They are heterotrophs and live as predator or parasites.
 (2) They are found in fresh water as well as in marine environments
 (3) Pellicle makes their body flexible
 (4) They can reproduce asexually and sexually
10. Find out the correct match from the following table

	Column-I	Column-II	Column-III
i	<i>Plasmodium</i>	Amoeboid protozoan	Malaria
ii	<i>Trypanosoma</i>	Flagellated protozoan	Sleeping sickness
iii	<i>Paramecium</i>	Ciliated protozoan	Gullet

- (1) i only (2) i and ii (3) iii only (4) ii and iii

11. Exoskeleton of silica is found in which protozoan :-
 (1) Amoeba (2) Foraminiferans
 (3) Radiolarians (4) Paramecium
12. Identify the correct match from the column-I, II and III :-

Column-I	Column-II	Column-III
A <i>Leishmania donovani</i>	a Chagas disease	i Termites
B <i>Trichonympha</i>	b Kala-azar	ii Silk worm
C <i>Nosema</i>	c Glucosidases	iii Bug
D <i>Trypanosoma Cruzi</i>	d Pebrine	iv Sand fly

- (1) B-a-i A-b-iv C-d-ii D-c-iii
 (2) A-b-iv B-c-i C-d-ii D-a-iii
 (3) A-b-iii B-c-ii C-d-i D-a-iv
 (4) B-b-iv A-c-i C-a-ii D-a-iii

13. *Entamoeba* differs from Amoeba in the absence of :-
 (1) Food vacuole (2) Pseudopodia
 (3) Contractile vacuole (4) Nucleus
14. Identify the given protozoan with type of sexual reproduction in it and select the right option for the two together :-



	Protozoan	Sexual reproduction
(1)	<i>Paramecium</i>	Transverse Binary fission
(2)	<i>Euglena</i>	Longitudinal Binary fission
(3)	<i>Euglena</i>	Conjugation
(4)	<i>Paramecium</i>	Conjugation

15. Which of the following character is found in all protozoans ?
 (1) Locomotory organ
 (2) Contractile vacuole
 (3) Holozoic nutrition
 (4) Eukaryotic organisation
16. Which of the following is characteristic feature of Rhizopods (Sarcodins) ?
 (1) Cilia (2) Food vacuole
 (3) Pseudopodia (4) Pellicle
17. Match the column-I with column-II and select the correct answer :-

Column-I

Column-II

- A. *Giardia intestinalis* i. Texas fever
 B. *Leishmania tropica* ii. Sterility
 C. *Babesia* iii. Diarrhoea
 D. *Monocystis* iv. Oriental sore

- (1) A-iii, B-ii, C-i, D-iv
 (2) A-ii, B-iv, C-i, D-iii
 (3) A-iii, B-iv, C-i, D-ii
 (4) A-i, B-iv, C-iii, D-ii

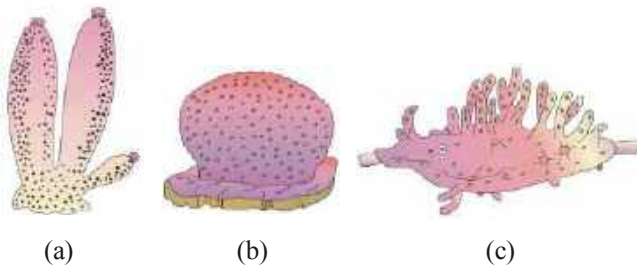
18. Which of the following is the main function of contractile vacuole ?
 (1) Digestion
 (2) Respiration
 (3) Reproduction
 (4) Osmoregulation
19. In which of the following class of protozoa, process of conjugation takes place ?
 (1) Sarcodina
 (2) Rhizopoda
 (3) Ciliata
 (4) Sporozoa
20. Which of the following is intermediate host of *Trypanosoma cruzi*?
 (1) *Phlebotomus*
 (2) *Glossina*
 (3) *Culex*
 (4) *Triatoma*
21. Micronucleus of *Paramoecium* is responsible for:
 (1) Metabolic activities
 (2) Reproductive activities
 (3) Respiratory activities
 (4) All of the above
22. In which of the following locomotion does not occur?
 (1) *Amoeba*
 (2) *Plasmodium*
 (3) *Paramoecium*
 (4) All of the above
23. In which of the following animal, body shape continuously change ?
 (1) *Paramoecium*
 (2) *Euglena*
 (3) *Plasmodium*
 (4) *Amoeba*
24. Which organism is considered as of slipper animacule?
 (1) *Amoeba* (2) *Euglena*
 (3) *Trypanosoma* (4) *Paramoecium*
25. Contractile vacuole of *Amoeba* is analogous to :-
 (1) Typhlosole of earthworm
 (2) Sweat gland of human
 (3) Uriniferous tubules of frog and man
 (4) Gastrovascular cavity of *Hydra*
26. In which of the animal dimorphic nucleus is found ?
 (1) *Amoeba proteus*
 (2) *Trypanosoma gambiens*
 (3) *Plasmodium vivax*
 (4) *Paramoecium caudatum*
27. Which of the following unicellular organism has a macronucleus for trophic function and one micronuclei for reproduction ?
 (1) *Trypanosoma*
 (2) *Paramoecium*
 (3) *Euglena*
 (4) *Amoeba*
28. Holophytic nutrition is found in
 (1) *Amoeba*
 (2) *Giardia*
 (3) 1 and 2
 (4) *Euglena*
29. Kala azar is transmitted by :
 (1) Tse Tse fly
 (2) Dragon fly
 (3) Sand fly
 (4) Fruit fly
30. Sleeping sickness is caused by
 (1) *Trypanosoma gambiense*
 (2) *Trypanosoma rangeli*
 (3) *Trypanosoma brucei*
 (4) *Trypanosoma cruzi*

PORIFERA

31. Cellular grade of organisation is found in :-
 (1) Sponges
 (2) Coelentrates
 (3) Platyhelminthes
 (4) Ctenophora
32. In sponges water enters through minute pores (A) in the body wall into a central cavity (B) from where it goes out through the (C) :-

1	A - Osculum	B - Spongocoel	C - Ostia
2	A - Ostia	B - Gastrovascular cavity	C - Osculum
3	A - Ostia	B - Spongocoel	C - Osculum
4	A - Ostia	B - Osculum	C - Gastrovascular cavity

33. Given below are the three figures of sponges. Which of the following sponges are found in fresh water:-

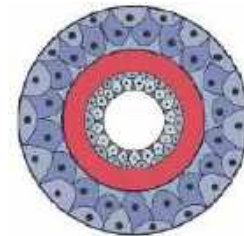


Select the correct option

- (1) Only a (2) Only c
(3) a and b (4) a and c
34. The members of phylum porifera are called sponges, having numerous distinguishable characters, but which of the following is considered as their peculiar character ?
(1) These are diploblastic animals
(2) Most members are marine and some are fresh water
(3) Choanocytes line the spongocoel
(4) Intracellular digestion
35. Which of the following characteristics is not associated with sponges ?
(1) Sponges have a water transport or canal system.
(2) Sponges reproduce asexually by fragmentation and sexually by formation of gametes.
(3) They are generally marine and mostly asymmetrical animals
(4) Sponges show tissue level of organisation
36. The skeleton of animals of phylum porifera consists of :-
(1) Spicules
(2) Spongin fibres
(3) Both 1 and 2
(4) Chitinous exoskeleton
37. *Spongilla* and *Euspongia* are members of phylum porifera, bear which of the following characters ?
(1) They have a water transport or canal system
(2) These are hermaphrodites with internal fertilisation
(3) Both 1 and 2
(4) These are exclusively marine
38. The canal system is characteristic feature of -
(1) sponges (2) helminthes
(3) echinoderms (4) coelenterates
39. *Sycon* belongs to a group of animals, which are best described as :-
(1) Unicellular or acellular
(2) Multicellular without any tissue organization
(3) Multicellular with a gastrovascular system
(4) Multicellular having tissue organization, but no body cavity
40. The middle layer in body wall of porifera is
(1) Mesoderm (2) Mesenchyme
(3) Mesoglea (4) Mesentery
41. After drying, a bath sponge contains
(1) hold fast (2) Tentacles
(3) spicules (4) spongin fibre
42. Osculum occurs in
(1) Star fish (2) Ray fish
(3) Hydra (4) Sponge

COELENTERATA, CTENOPHORA

43. The cross section of animal body is given below:-



Which of the following groups will satisfy the above cross section :-

- (1) Coelenterata (2) *Platyhelminthes*
(3) *Aschelminthes* (4) *Annelida*
44. Radial symmetry is found in :-
(a) Coelenterates
(b) Ctenophore
(c) Echinoderms
(1) Only a (2) Only b
(3) Only c (4) All a, b and c
45. Cnidarians and ctenophores resemble in their :-
(1) Levels of organisation
(2) Symmetry
(3) Diploblastic organisation
(4) All of the above

46. Consider the following statements :-
Obelia typically has
A. A radially symmetrical body
B. A gastrovascular body
C. Both a polyp and medusoid form
(1) A, B and C are correct
(2) B and C are correct
(3) A and B are correct
(4) A and C are correct
47. Consider the following characteristics of organisms:-
A. Diploblastic body
B. Possessing Medusoid form
C. Presence of both intracellular and extracellular digestion.
Which of the above are characteristics of *Hydra*.
(1) A and B (2) B and C
(3) A and C (4) A, B and C
48. Consider the following statements :-
Aurelia typically has
A. A radially symmetrical body
B. A gastrovascular body
C. Both a polyp and medusoid form
(1) A, B and C are correct
(2) B and C are correct
(3) A and B are correct
(4) A and C are correct
49. Which of the following pairs of animals belong to same phylum ?
(1) Sea anemone, Corals
(2) Sea fan, sea walnut
(3) Sea pen, scypha
(4) *Nereis*, *Ascaris*
50. How many in the given examples of animals are coelenterates ?
Physalia, *Obelia*, *Planaria*, *Pennatula*,
Gorgonia, *Pleurobrachia*, *Meandrina* and *Nereis*
(1) Three (2) Four
(3) Five (4) Six
51. Read the following (a-d) four statements for Ctenophora :-
(a) Diploblastic with tissue level of organisation
(b) The body bears eight external row of ciliated comb plates
(c) Digestion is both extracellular and intracellular
(d) Reproduction takes place only by sexual means
How many of the above statements are correct
(1) Four (2) Three
(3) Two (4) One
52. Which of the following is correct for medusa ?
(1) Sessile (2) Cylindrical
(3) Present in *Hydra* (4) Free-swimming
53. Which one of the following is a radially symmetrical, diploblastic animal with blind sac body plan ?
(1) *Asterias* (2) *Spongilla*
(3) *Earthworm* (4) *Hydra*
54. Which of the following belongs to Phylum Coelenterata ?
(1) Star fish (2) Sea fan
(3) Silver fish (4) Cuttle fish
55. Alternation of generation is found in :-
(1) Housefly (2) *Obelia*
(3) *Drosophila* (4) All of these
56. Which characteristic is true for ***Obelia*** ?
(1) Metagenesis (2) Morphogenesis
(3) Apolysis (4) Pedogeny
57. Which of the following animals have scattered cells with cell - tissue grade organisation ?
(1) Sponge (2) ***Hydra***
(3) Liver fluke (4) ***Ascaris***
58. In ***Hydra***, waste material of food digestion and nitrogenous waste material removed from :-
(1) Mouth and mouth
(2) Body wall and body wall
(3) Mouth and body wall
(4) Mouth and tentacles
59. Which of the following does not belongs to phylum coelenterata ?
(1) Sea pen (2) Sea anemone
(3) sea cucumber (4) sea fan

60. Nematocysts are found in
 (1) Porifera (2) Coelenterata
 (3) Nematodes (4) Annelida

PLATYHELMINTHES, ASCHELMINTHES, ANNELIDA

61. Psuedocoelom is found in :-
 (1) Ctenophore (2) Platyhelminthes
 (3) Aschelminthes (4) Both 2 and 3
62. Bilaterally symmetrical, triploblastic and acoelomate animals :-
 (1) Coelentrates (2) Ctenophore
 (3) Platyhelminthes (4) Aschelminthes
63. Which one of the following non-chordate is a protostomic, bilaterally symmetrical and schizocoelomate ?
 (1) *Nereis* (2) *Ctenoplana*
 (3) *Wuchereria* (4) *Taenia*
64. Creatures with single opening serving both as mouth and anus is found in :-
 (1) Coelenterates & Aschelminthes
 (2) Platyhelminthes & Ctenophora
 (3) Coelenterate & Porifera
 (4) All of the above
65. The biological name and their popular common name of animals are given below, select the correctly matched among following :-
 (1) *Ancylostoma* - Hook worm
 (2) *Obelia* - Jelly fish
 (3) *Physalia* - Spanish man of war
 (4) *Meandrina* - Sea fan
66. Which one of the following phyla is correctly matched with its general characteristics ?
 (1) Porifera - Cellular level of organisation and external fertilisation
 (2) Coelenterata - Diploblastic and Coelomates
 (3) Aschelminthes - Coelomates and Dioecious
 (4) Chordata - Coelomates and closed circulatory system
67. The digestive tract of Nematodes can be represented as :-
 (1) Incomplete type (2) Tube within a tube
 (3) Blind sac (4) Pseudocoel type

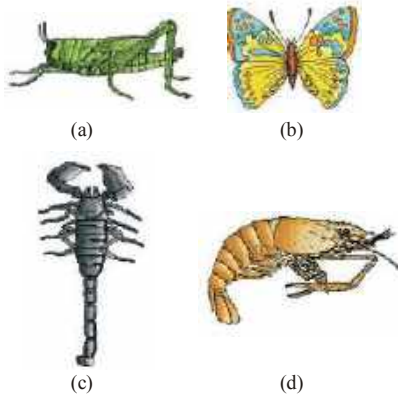
68. Select the group of organism given below those have triploblastic members only :-
 (1) *Ctenoplana*, *Taenia*, *Planaria*
 (2) *Euspongia*, *Physalia*, Sea anemone
 (3) *Wuchereria*, *Ascaris*, *Taenia*
 (4) *Frog*, *Ctenoplana*, *Hydra*
69. In which of the following, flat worm shows resemblance with round worm ?
 (1) Body plan
 (2) Level of organisation
 (3) Coelom
 (4) Symmetry
70. In the evolutionary history of the animal kingdom, which of the following features have evolved for the first time in phylum Annelida ?
 A. Metameric segmentation
 B. Organ level of organisation
 C. Closed circulatory system
 D. True coelom
 E. Bilateral symmetry
 Select the correct answer
 (1) B and E
 (2) A, B, C and D
 (3) A, C and D
 (4) Only A and B
71. In which of the following, round worms shows resemblance with annelida ?
 (1) Symmetry
 (2) Level of organisation
 (3) Excretory organ
 (4) 1 and 2 both
72. Select the set of organisms which have metameric segmentation :-
 (1) *Physalia*, Liver Fluke, Leech
 (2) *Gorgonia*, *Aedes*, Chiton
 (3) *Hydra*, *Aedes*, Sea-anemone
 (4) *Pheretima*, *Nereis*, *Hirudinaria*
73. How many animals in the list given below have pseudocoelom ?
Taenia, *Fasciola*, *Sycon*, *Ctenoplana*, *Ascaris*,
Wuchereria, *Ascidia*, *Branchiostoma*, *Ancylostoma*,
Aplysia.
 (1) Three (2) Four
 (3) Five (4) Six

74. Flame cells help in osmoregulation and excretion in:-
 (1) Ctenophore (2) Annelida
 (3) Aschelminthes (4) Platyhelminthes
75. Which animal possess lateral appendages parapodia, which help in swimming ?
 (1) *Nereis* (2) *Octopus*
 (3) *Prawn* (4) *Antedon*
76. What is common to Earthworm, *Nereis* and Leech?
 (1) Ventral nerve cord
 (2) Metamerism
 (3) Coelomate
 (4) All of the above
77. Which of the following pairs are correctly matched?
 (A) Flame cells - *Taenia*, *Fasciola*
 (B) Notochord - *Balanoglossus*
 (C) Metagenesis - *Physalia* and *Obelia*
 (D) Radula - *Pila*
 (1) A, B and C
 (2) Only A and C
 (3) A, C and D
 (4) Only A and D
78. What is true about *Ascaris*, *Neries*, *Wuchereria* and *Hirudinaria* ?
 (1) Acoelom
 (2) Pseudocoelom
 (3) Metamerism
 (4) Organ system level of organisation
79. Which one is not a platyhelminthes ?
 (1) Tape worm (2) Liver fluke
 (3) Hook worm (4) *Planaria*
80. Set of organism which are flatworms :-
 (1) Liverfluke, *Planaria*
 (2) *Planaria*, *Ascaris*
 (3) *Ascaris*, *Anclystoma*
 (4) Sandworm, *Planaria*
81. Which one of the following is a matching pair of a body feature and the animal possessing it?
 (1) Canal system - *Asterias*
 (2) Metagenesis - *Nereis*
 (3) Dorsal nerve cord - *Pheretima*
 (4) Muscular pharynx - *Ascaris*
82. Sexes are separate i.e. male and female are distinct. often female is longer than male in :-
 (1) Earthworm (2) Leech
 (3) *Ascaris* (4) Both 2 and 3
83. Hirudin is present in the saliva of :-
 (1) Leech (2) Earthworm
 (3) Scorpion (4) Cobra
84. Dioecious plantyhelminthe among the following is ?
 (1) *Schistosoma* (2) *Dugesia*
 (3) *Wuchereria* (4) *Hirudinaria*
85. Which of the following organisms is pseudocoelomate ?
 (1) Hookworm (2) Liver fluke
 (3) Jelly fish (4) Leech
86. Solenocytes occur in :-
 (1) Platyhelminthes (2) Arthropoda
 (3) Annelida (4) Aschelminthes
87. Practical purpose of taxonomy or classification :-
 (1) Facilitate the identification of unknown species.
 (2) Explain the origin of organisms.
 (3) To know the evolutionary history
 (4) Identification of medicinal plants
88. Similarity in ***Ascaris lumbricoides*** and ***Anopheles stephensi*** :
 (1) Sexual dimorphism
 (2) Metamerism
 (3) Anaerobic respiration
 (4) Endoparasitism
89. In contrast to Annelid the Platyhelminths show -
 (1) Absence of body cavity
 (2) Presence of pseudocoel
 (3) Radial symmetry
 (4) Bilateral symmetry
90. Which organism resides in Lymph nodes ?
 (1) ***Taenia*** (2) ***Wuchereria***
 (3) ***Plasmodium*** (4) ***Diplococcus***
91. Adult ***Wuchereria bancrofti*** attacks
 (1) Nervous system
 (2) Lymph vessels
 (3) Muscular system
 (4) Blood vessels

- 92.** Tape worms obtain their food from the host by
 (1) Sucking
 (2) Scraping
 (3) Absorption through integument
 (4) Autotrophic
- 93.** Tapeworm does not possess digestive system as it :-
 (1) does not require solid food
 (2) Obtains food through general surface
 (3) Does not require food
 (4) Lives in intestine
- 94.** Anus is absent in
 (1) *Fasciola* (2) *Pheretima*
 (3) *Periplaneta* (4) *Unio*

ARTHROPODA

- 95.** Select the group of organisms given below those have triploblastic members only :-
 (1) *Ctenoplane*, *Taenia*, *Planaria*
 (2) *Euspongia*, *Physalia*, *Sea anemone*
 (3) *Wuchereria*, *Culex*, *Apis*
 (4) *Aedes*, *Ctenoplane*, *Hydra*
- 96.** The four sketches (a,b,c and d) given below, represent four animals. Which of these is correctly identified in the options given, along with its correct type and phylum :-



		Animal	Type	Phylum
1	(d)	Scorpion	Living	Mollusca
2	(a)	<i>Locusta</i>	Gregarious pest	Arthropoda
3	(b)	Butter	Vector	Arthropoda
4	(c)	Prawn	Economical insect	Arthropoda

- 97.** Which one of the following statements about certain given animals is correct ?
 (1) Sea squid shows metamerism
 (2) Flat worms are pseudocoelomates
 (3) Insects are coelomates
 (4) Adult Star Fish is bilaterally symmetrical
- 98.** Which of the following is an example of an insect ?
 (1) Star fish (2) Cuttle fish
 (3) Silver fish (4) Devil fish
- 99.** Which of the following belongs to Phylum Arthropoda ?
 (1) Star fish (2) Gold fish
 (3) Silver fish (4) Cuttle fish
- 100.** Economically important insect among the following is ?
 (1) *Lepisma* (2) *Apis*
 (3) *Aphid* (4) *Aedes*
- 101.** Which of the following is *not* an insect ?
 (1) Ant (2) Mosquito
 (3) Spider (4) Locusts
- 102.** Given below are four matchings of an animal and its kind of respiratory organ :
 A. Silver fish – trachea
 B. Scorpion – book lung
 C. Prawn – gills
 D. Earthworm – lungs
 The correct matchings are :-
 (1) A and D (2) A, B and C
 (3) B and D (4) C and D
- 103.** Three pairs of legs are found in :-
 (1) Crab (2) Spider
 (3) Locust (4) Planaria
- 104.** Green glands found in some Arthropods they take part in
 (1) Excretion
 (2) Respiration
 (3) Digestion
 (4) Both 1 and 2
- 105.** Which disease is spread by female *Culex* ?
 (1) Malaria (2) Pneumonia
 (3) Typhoid (4) Filaria

- 106.** Which one of the following features is of insects?
 (1) Wings
 (2) Antennae
 (3) Compound eyes
 (4) 3 pairs of Legs

MOLLUSCA, ECHINODERMATA

- 107.** All animals of this phylum are exclusively marine:-
 (1) Mollusca (2) Ctenophora
 (3) Echinodermata (4) Both 2 and 3
- 108.** The members of which groups are exclusively marine:
 (a) Ctenophora (b) Echinodermata
 (c) Protochordata
 (1) Only a
 (2) Only b
 (3) Only a and b
 (4) All a,b and c
- 109.** Which of the following is incorrect for *Neopilina*?
 (1) Connecting link between Annelida and Arthropoda
 (2) Segmented mollusc
 (3) Larva - Trochophora
 (4) Marine
- 110.** Consider the following four statements (a-d) and select the option which includes all the correct ones only :-
 (a) The body of arthropoda is covered by chitinous exoskeleton
 (b) Molluscs are terrestrial or aquatic
 (c) Prawn contains a file-like rasping organs for feeding, called radula
 (d) The body of mollusc is divided into head, thorax and abdomen
 (1) Statements (b), (c) and (d)
 (2) Statements (a), (b)
 (3) Statements (c), (d)
 (4) Statements (a), (c) and (d)
- 111.** Find out the correct match from the following table:-

	Column-I	Column-II	Column-III
i	<i>Pinctada</i>	<i>Pearl oyster</i>	<i>Mollusca</i>
ii	<i>Chaetopleura</i>	<i>Chiton</i>	<i>Annelida</i>
iii	<i>Pila</i>	<i>Tusk shell</i>	<i>Mollusca</i>

- (1) Only i (2) i and ii
 (3) iii only (4) ii and iii

- 112.** Which one of the following invertebrates is a protostomic, bilaterally symmetrical and schizocoelomate?
 (1) *Dentalium* (2) *Ctenoplana*
 (3) *Wuchereria* (4) *Taenia*

- 113.** Which one of the statement is not true in case of Echinoderms?
 (1) Locomotion by water vascular system.
 (2) Presence of Blind sac body plan.
 (3) Mouth on lower side.
 (4) Presence of calcareous plate.
- 114.** The animals with bilateral symmetry in young stage and radial pentamerous symmetry in the adult stage, belong to the phylum –
 (1) Mollusca (2) Cnidaria
 (3) Echinodermata (4) Annelida

- 115.** Which is a characteristic feature of Echinodermata?
 (1) Vascular system
 (2) Bilateral symmetry
 (3) Radial canal
 (4) Water vascular system

- 116.** Trochophore larva occurs in
 (1) Annelida and Porifera
 (2) Coelenterata and Annelida
 (3) Mollusca and Coelenterata
 (4) Annelida and Mollusca

- 117.** An animal having unsegmented coelom superficial radial symmetry in adult but bilateral symmetry in larva is member of
 (1) Mollusca (2) Echinodermata
 (3) Arthropoda (4) Annelida

- 118.** Phylum Annelida resembles Mollusca in :-
 (1) Level of organisation
 (2) Metameric segmentation
 (3) Open type circulation
 (4) Calcareous shell

- 119.** In which phylum is Water Vascular System found?
 (1) Protozoa (2) Arthropoda
 (3) Porifera (4) Echinodermata

- 120.** Which one of the following invertebrates is a deuterostome and enterocoelous coelomate ?
 (1) *Pila* (2) *Ascaris*
 (3) *Aphrodite* (4) *Asterias*
- 121.** Echinoderms are Heartless, brainless and headless yet from evolutionary point of view, they have been placed on the top of the invertebrate phyla because of the presence in them of
 (1) power of reproduction
 (2) great power of regeneration
 (3) exclusively marine
 (4) enterocoel

UROCHORDATA, CEPHALOCHORDATA & PISCES

- 122.** Poison sting is found in :-
 (1) *Scoliodon* (2) *Exocoetus*
 (3) *Trygon* (4) *Catla*
- 123.** Which of the following is correct match of genetic name with it's common name ?
 (1) *Exocoetus* - flying frog
 (2) *Betta* - Fighting fish
 (3) *Toad* - Tree frog
 (4) *Pristis* - Electric fish
- 124.** Following statements are correct for which animal :-
 (a) Circular mouth
 (b) Body is devoid of scales and paired fins
 (c) Cranium and vertebral column are cartilaginous
 (1) *Petromyzon* (2) *Salpa*
 (3) Rohu (4) *Rana*
- 125.** *Branchiostoma* is a :-
 (1) Cephalochordate (2) Cyclostome
 (3) Hemichordate (4) Urochordate
- 126.** The cyclostomes are :-
 (1) Marine and non migratory
 (2) Fresh water form and non migratory
 (3) Marine and migrate to fresh water for spawning
 (4) Fresh water from and migrate to sea for spawning
- 127.** *Salpa* and *Doliolum* belong to :-
 (1) Cephalochordata (2) Hemichordata
 (3) Tunicata (4) Cyclostomata

- 128.** Mark the correct match of the animal and its common name :-
 (1) *Trygon* - dog fish
 (2) *Ascidia* - lancelet
 (3) *Pterophyllum* - flying fish
 (4) *Myxine* - hagfish
- 129.** Sharks do not have :-
 (1) Teeth (2) Claspers
 (3) Air bladder (4) Ventral mouth
- 130.** Shark, *Torpedo* (Electric ray) and *Trygon* (Sting ray) are fishes and belong to class:-
 (1) Cyclostomata (2) Chondrichthyes
 (3) Osteichthyes (4) Teleostomi
- 131.** Which of the following is not a characteristic of class chondrichthyes ?
 (1) Gill slits are separate and without operculum
 (2) They are predaceous
 (3) Air bladder is present
 (4) Notochord is persistent throughout the life
- 132.** Following are few examples of bony fishes. Find out the marine bony fishes :-
 (1) Flying fish (2) *Hippocampus*
 (3) Both (1) & (2) (4) *Lebeo*
- 133.** Which one(s) is/are not cartilaginous fish ?
 (1) *Carcharodon* (Great white shark), *Trygon* (Sting ray)
 (2) *Exocoetus* (Flying fish), *Catla* (Katla), *Clarias* (Magur)
 (3) *Scoliodon* (Dog fish)
 (4) *Pristis* (Saw fish)
- 134.** In chordates the notochord is :-
 (1) Mesodermal and dorsal to nerve cord
 (2) Endodermal and dorsal to nerve cord
 (3) Mesodermal and ventral to nerve cord
 (4) Endodermal and ventral to nerve cord

135.



- Which of the following is a correct feature for animal?
 (1) It has four pairs of gills without operculum
 (2) It has claspers
 (3) Heart is three chambered
 (4) It has air bladder

- 136.** How many of the following are true fishes ?
Dog fish, Saw fish, Flying fish, Fighting fish, Angel fish, Hagfish
(1) 2 (2) 3 (3) 4 (4) 5

AMPHIBIA, REPTILIA

- 137.** Which one is correct match of Lizard ?
(1) *Calotes* - Tree lizard
(2) *Chameleon* - Garden lizard
(3) *Hemidactylus* - wall lizard
(4) All
- 138.** What is common in birds and human ?
(1) Both are dicondylic
(2) Both are homothermal
(3) Bipedal locomotion present
(4) 2 and 3 both
- 139.** Select the correct statement for Aves
(1) Feathers are present
(2) Forelimbs are modified as wings
(3) Both (1) and (2) correct
(4) They are cold blooded
- 140.** Axolotl larva is the name of larva of
(1) ***Amphioxus*** (2) Silkworm
(3) ***Ambystoma*** (4) Round worm
- 141.** Most favourable land adaptation in reptiles is
(1) Lungs (2) Scales
(3) Moist skin (4) Pentadactyl limbs
- 142.** Retention of larval characters even after sexual maturity is called
(1) Parthenogenesis (2) Ontogenesis
(3) Phyllogenesis (4) Neoteny
- 143.** ***Ichthyophis*** belongs to
(1) Amphibia (2) Mollusca
(3) Annelida (4) Reptilia
- 144.** The glands present in the skin of frog are
(1) Sweat and mammary glands
(2) Sweat and sebaceous glands
(3) Sweat and mucous glands
(4) Mucous and poisonous glands
- 145.** Corpus callosum is found in the brain of
(1) Elephant (2) Pigeon
(3) Crocodile (4) Frog

- 146.** The type of dentition in Crocodile is
(1) Acrodont (2) Heterodont
(3) Pleurodont (4) Thecodont
- 147.** Jacobson's organ is the olfactory organ in ?
(1) *Chelone* (2) *Neophron*
(3) *Hyla* (4) All of the above
- 148.** Which of the following has thecodont dentition ?
(1) Turtle (2) Tortoise
(3) Lizard (4) Alligator
- 149.** Which of the following snakes is non-poisonous :
(1) Cobra (2) Krait
(3) Viper (4) Python
- 150.** Which of the following is a poisonous snake ?
(1) *Eryx* (2) *Naja*
(3) Rate snake (4) *Python*

BIRDS, MAMMALS

- 151.** ***Archaeopteryx*** is :
(1) A living fossil
(2) A mammal
(3) A connecting link between annelida and arthropoda
(4) A connecting link between reptiles and birds
- 152.** Which of the following is an example of poisonous mammal :-
(1) *Vipera* (2) *Chelone*
(3) Male platypus (4) Whale
- 153.** Air sacs connected to lungs supplement respiration in :-
(1) Birds (2) Reptiles
(3) Amphibians (4) Mammals
- 154.** The most unique mammalian characteristic is :-
(1) Two pairs of limbs
(2) Mammary glands
(3) Internal fertilisation
(4) Four chambered heart
- 155.** Which of the following mammal is oviparous ?
(1) *Ornithorhynchus*
(2) *Delphinus*
(3) *Felis*
(4) *Canis*

- 156.** Which one of the following characters is not typical of the class Mammalia ?
 (1) Alveolar lungs
 (2) Ten pairs of cranial nerves
 (3) Seven cervical vertebrae
 (4) Thecodont dentition
- 157.** What is common between parrot, platypus and kangaroo ?
 (a) Ovoparity
 (b) Homoiothermy
 (c) Toothless jaws
 (d) Functional post-anal tail
 (1) a, b (2) b, d
 (3) b, c (4) a, b, c
- 158.** Which one of the following in birds, indicates their reptilian ancestry?
 (1) Scales on their hind limbs
 (2) Four-chambered heart
 (3) Eosinophils
 (4) Monocytes
- 159.** Which one of the following pairs of animals comprises 4 chambered heart?
 (1) Dog & Frog (2) Pigeon & Rabbit
 (3) Cat & Rohu (4) Pigeon & Snake
- 160.** Uricotelic mode of passing out nitrogenous wastes is found in :-
 (1) Reptiles and Birds
 (2) Birds and Annelids
 (3) Amphibians and Reptiles
 (4) Insects and Amphibians
- 161.** *Ornithorhynchus* is a
 (1) Duck (2) Dinosaur
 (3) Monotreme mammal (4) Fossil bird
- 162.** Which one is not exclusively marine ?
 (1) Seal (2) Walrus
 (3) Whale (4) Dolphin
- 163.** Mammals giving rise to immature young ones and nursing them in a pouch are
 (1) Monotremes (2) Marsupials
 (3) Primates (4) Carnivores
- 164.** Ear pinna is found in the
 (1) horse (2) pigeon
 (3) crocodile (4) frog
- 165.** The greatest evolutionary change that enabled the land vertebrates to be completely free from water, was the development of
 (1) four appendages
 (2) lungs
 (3) cleidoic eggs
 (4) four chambered heart
- 166.** Eggs of birds are
 (1) large, megalecithal, cleidoic
 (2) large, telolecithal, cleidoic
 (3) large, mesolecithal, cleidoic
 (4) small, megalecithal, cleidoic
- 167.** The character present in all birds, without exception, is :
 (a) Omnivory
 (b) Wings capable of flying
 (c) Beak without teeth
 (d) Eggs with calcareous shells
 (1) a, b (2) b, c (3) c, d (4) a, b, c
- 168.** Which of the following is an exclusive character of class Mammalia ?
 (1) Homoiothermy
 (2) Internal fertilization
 (3) Presense of a 4-chambered heart
 (4) Presence of a muscular diaphragm
- 169.** *Ornithorhynchus* and *Echidna* are examples of :-
 (1) Birds
 (2) Reptiles
 (3) Marsupial mammals
 (4) Prototherian mammals
- 170.** Oviparous mammals are :
 (1) Kangaroo
 (2) Duck bill platypus
 (3) Whale
 (4) Rabbit
- 171.** Which of the following is viviparous :
 (1) Running birds (2) Whales
 (3) Bats (4) Both (2) and (3)
- 172.** The eggs of eutherian mammals are
 (1) Mesolecithal type
 (2) Microlecithal type
 (3) Telolecithal type
 (4) Megalecithal type

173. Which one of the following lays eggs yet the female secretes milk ?

- (1) Bat (2) Kangaroo
(3) Platypus (4) Ostrich

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	4	4	4	1	4	1	4	1	4	3	2	3	4	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	3	4	3	4	2	2	4	4	3	4	2	4	3	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	3	2	3	4	3	3	1	2	2	4	4	1	4	4
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	3	1	3	1	4	4	2	2	1	2	3	3	2
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	3	1	2	1	4	2	3	4	3	4	4	1	4	1
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	4	3	4	3	1	4	3	1	1	1	1	1	1	1	2
Que.	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Ans.	2	3	2	1	3	2	3	3	3	2	3	2	3	1	4
Que.	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	4	4	1	2	1	1	2	3	4	4	2	1	4	4
Que.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
Ans.	4	3	2	1	1	3	3	4	3	2	3	3	2	3	4
Que.	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Ans.	4	3	4	3	3	2	4	1	4	1	4	1	4	4	2
Que.	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
Ans.	4	3	1	2	1	2	2	1	2	1	3	4	2	1	3
Que.	166	167	168	169	170	171	172	173							
Ans.	1	3	4	4	2	4	2	3							

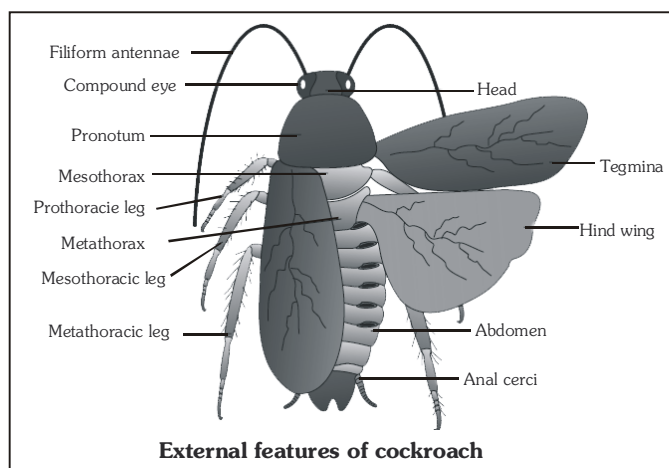
COCKROACH

1.0 COCKROACH

- Cannibalism - (if food is not available), omnivorous, nocturnal.
- Cockroach (*Periplaneta*) – at 25°C runs @ 130 cm/sec.
- It's chromosome no. is 34.

Classification :

- **Phylum : Arthropoda**
 - (a) Jointed appendages
- **Class : Insecta** :- largest class
 - (a) Body divided into head, thorax, abdomen
 - (b) Three pairs of legs (hexapoda)
- **Subclass : Pterygota**
 - (a) Two pairs of wings
- **Order : Orthoptera**
 - Wings dissimilar type.
- **Genus and species :**



- ***Periplaneta americana*** (named by Bermister) "Common cockroach" or "American cockroach, or Ship cockroach or Bombay canaris.
- ***Blatta* (Stylopaga) *orientalis***
- ***Blatta germanica*** - smallest cockroach
 - (a) Cursorial (fast runner) and less capacity of flight.
 - (b) Body divided into three parts called "**tegmeta**".

3 – Tegmeta } Head Thorax Abdomen
Embryo stage } 6 segment 3 segment 11 segment Total = 20

some segments fuse in adult stage.

Head 1 (6 segments fused)

Thorax 3 }
Abdomen 10 } Total 14 segment

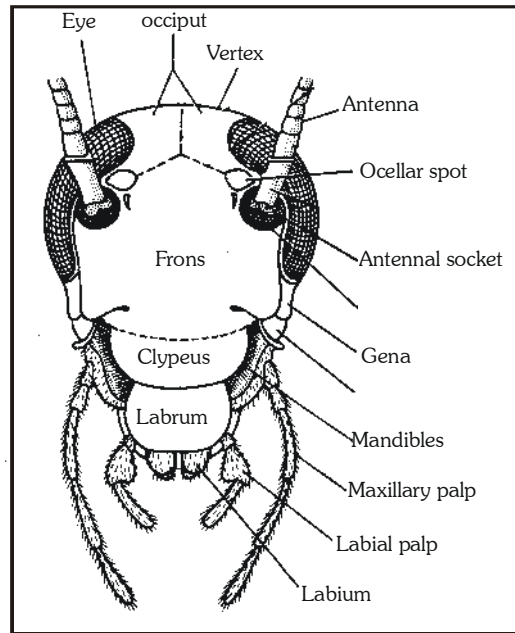
- (c) Exoskeleton of chitin plates occurs in each segment. Chitin plates are called "**sclerites**".
- (d) Sclerites are joined to each other by membrane called "**articular or arthroidal membrane**."
 - Sclerites of dorsal side - Tergum or tergite
 - Sclerites of ventral side - Sternum or sternite
 - Sclerites of lateral side - Pleurons or pleurites.

- **Head :**

- (a) "**Hypognathus Condition**":- Bends downwards at an angle of 90° from the long axis of body.
- (b) Top part of head is called "Vertex" and on this *vertex* a chitin plate present called "*Occiput*".
- (c) A small light coloured spot called **fenestra or ocellar spot**. Functions as a photoreceptor organ.

In Cockroach - it is inactive and is called "**vestigial simple eye**".

- (d) Lateral side of head apex bear a pair of **antennae**.
- (e) Main receptor of touch, temperature and vibrations in cockroach.
 - **Antennae** : Long filliform, unbranched.
 - Antennae consist of 3 parts – Scape (at base), Second segment - pedicel and remaining flagellum.
- (f) A big chitin plate situated below the vertex called *frons* or *forehead*.
- (g) Two long flattened chitin plates situated on lateral side called "*gena*" or "*cheek*"
- (h) A big chitin plate present in anterior part of frons called "*Clypeus*". A movable chitin plate joined with anterior part of clypeus known as "*labrum*" or "*Upper lip*".



1.1 Mouth Parts of Cockroach

"Biting and chewing type"

A cavity formed due to mouth parts called "**preoral cavity**" or "**cibarium**".

- (a) **Labrum or upper lip** :- It dorsally overhangs the mouth and hence referred to as "*upper lip*".
 - (b) **Mandibles** :-
 - 1-pair of mandibles. They have grinding and incising region.
 - (c) **First maxillae** :-
 - 1 pair of maxillae which picks up its food and puts it in preoral cavity for chewing.
 - Maxillary palps are also used as brush to clean antenna and wings.
 - (d) **Second maxillae or "labium" or lower lip**:- Have 2 podomere – Cardo and Stipes. Form floor of preoral cavity.
 - (e) **Hypopharynx or "lingua"** :-

It bears several sensory setae at its free end, and the opening of common salivary duct upon its basal part.
- "**Neck**", "**Soft Neck**" or "**Cervicum**"
 - It is extension of prothorax – highly flexible.

1.2 Thorax

In thorax three segments : Prothorax, Mesothorax and Metathorax

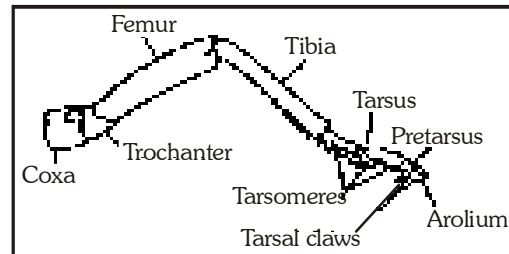
Thoracic appendages - (A) Legs, (B) Wings.

(A) Legs : One-pair of legs are present in each segment of thorax.

Legs are similar to pseudopodia of amoeba.

– Each leg is formed of five main **podomeres**.

- (a) "Coxa" - broadest segment
- (b) Trochanter - small segment
- (c) Femur - long segment
- (d) Tibia - longest segment



(e) Tarsus - made up of five subsegments called **tarsomeres**. Terminal tarsomere called **pretarsus** .

Pretarsus has two structures :-

- **Arolium or Pulvillus** : These are adhesive pads
- One pair claws : move on the smooth surface by the help of "arolium" and on rough surface with the help of claws. Both pad and claws found on pretarsus.
- Small pads present in between tarsus called "**Plantuli**". Cockroach climbs on the wall by the help of plantuli and arolium. Tactile setae are present on each segment of legs.

(B) Wings : There are 2 - pair wings

(a) Fore wings

↓

On mesothorax

↓

Long, narrow, opaque, dark leathery and strong

↓

Fore wings are so long so cover

full abdomen. In male projecting

beyond the tip of abdomen

- These are called **Elytra or Tegmina**.

A network of fine tubules called "**nervures**" is present in inner side of wings.

Also called **veins**, they strengthen the wings.

(b) Hind wing

↓

On Metathorax

↓

Small, broad, thin,
soft transparent, membranous

↓

These wings help in flight

1.3 Abdomen

(A) 10 segment

(B) 9 segment in male

(C) 7 segment in female

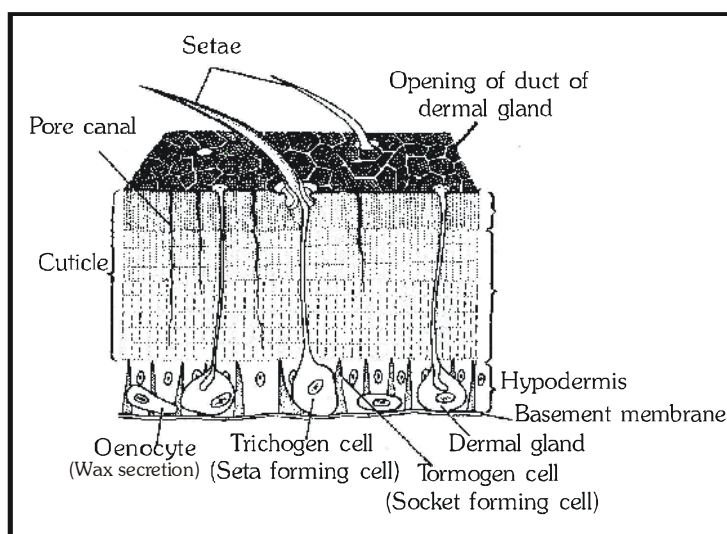
} obviously seen.

- **Stink gland** present in between 5th and 6th tergum. Smell repels the enemies.
- Each "**anal cercus**" - "15 segmented" : These are main sound receptor, found on 10th segment (both sexes).

- Projected one-pairs of spine like structure from 9th sternum of male called "**analstyles**". These are nonsegmented and help in copulation.
- 7th sternum of female - special type of boat shaped. Together with 8th-9th sterna, form **Brood/Genital Pouch/Gynatrium** (made up of gyanovalvular plate).
- All characters of sexual dimorphism in cockroach are present in abdomen.

1.4 Body Wall

- Body wall is made up of three layers -
 - (a) **Outermost - thick cuticle**. Cuticle is made up of alternate layer of protein and chitin.



- (b) **Hypodermis (Epidermis)**- Made up of columnar epithelium
- (c) "**Inner Most Layer**" or "**Basement Layer**" it is made up of *simple squamous epithelium*.

- "**BODY CAVITY**"

- (a) **Heamocoel**
- (b) Blood filled cavity
- (c) Blood of cockroach - "**haemolymph**"
- (d) Blood is colourless
- (e) Blood not related with respiration
- (f) **Trehalose** sugar in blood - disaccharide.

- "**HAEMOCOEL**"

- (a) Not true coelom
- (b) It is a **large blood sinus**
- (c) All arthropods - *True coelomate* but highly reduced and found only in the form of cavity of gonads.

Cavity of Gonads : True Coelom.

1.5 Digestive System : 3-part

(A) **Fore gut or stomodaeum** :- mouth to gizzard

Cuticle present in inner side of foregut. Mouth opens into small buccal cavity, which then opens into tubular pharynx. Pharynx - leads to a narrow tubular passage called esophagus.

In thorax oesophagus expands and called "**crop**". It stores food (also maximum occurs here).

Crop opens into thick walled gizzard.

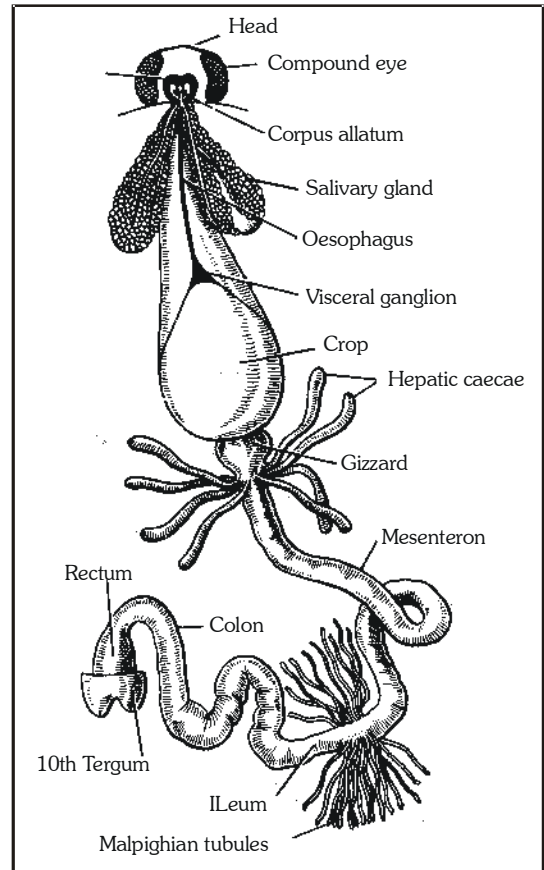
- (a) Wall of gizzard - circular muscle layer well developed.
- (b) Cavity of gizzard called - "**armarium**"
- (c) Six cuticular teeth occur in cavity.
- (d) Fine grinding of food occurs with the help of cuticular teeth.

(B) "**Mesenteron**" or "**Mid gut**"

- (a) Anterior Part is called **cardia**.
- (b) Gizzard opens in cardia by "**stomodial valve**".
- (c) Six to eight small and tubular, finger like blind processes called **hepatic caeca**, project freely into the heamocoel. These secrete "**digestive juice**"
- (d) Wall of mesenteron is muscular.

(C) "**Hind gut or Proctodaeum**"

- (a) Thin tubules attached at the junction of hind gut and mid gut called "**malpighian tubules**". These are excretory organs.
- (b) Hind gut has three parts :
 - (i) **Ileum** - It's wall is thin and internally folded. It's cuticle bears minute spines, which serve to break the peritrophic membrane.
 - (ii) **Colon** - Longest and broadest part
- (c) **Rectum** - Last part, oval shaped and internally folded wall. Its wall has 6 folds - called **rectal papillae**. These absorb water
- (d) **Anus** - at the end of 10th abdominal segment.
- (e) Fat body/urate cell/uricose gland help in excretion of male only, analogous to liver of vertebrate/chloragogen cell of earthworm. It also contain oenocytes, mycetocytes or prophocytes (store reserve food).



• **Salivary Gland** :

- (a) 1-pair - Saliva : Contains carbohydrate digesting enzymes. e.g., amylase, chitinase, cellulase.

• **Digestion** :-

- (a) Starts from preoral cavity
- (b) Saliva - Enzymes of saliva act upon the food till it reaches the crop. Digestion of carbohydrate takes place.
- (c) In crop - Hepatic caeca - Complete digestive juice reaches in crop through the gizzard.
- (d) Gizzard - Food thoroughly grinded into a paste by the thick and sharp edged cuticle of internal folds and grooves.
- (e) Grinded food enters into the midgut through stomodial valve.
- (f) **Wall of Cardia** :- A membrane secreted around the food called **peritrophic membrane**. It is made up of glycogen + protein. It serves to protect the wall of midgut from friction of food particles. This membrane is permeable to digestive enzymes and digested food. Bacteria present in midgut which are helpful in digestion of cellulase.
- (g) Distribution of digested food - by "heamocoelomic fluid"
 - Peritrophic membrane and undigested food enters into the ileum.
 - Spine - break the peritrophic membrane, so undigested substances are released in ileum,
 - Maximum absorption of H₂O occurred in rectum by rectal papilla.

1.6 Respiration

The respiratory system consists of a network of trachea, that open through 10 pairs of small holes called spiracles present on the lateral side of the body. Thin branching tubes (tracheal tubes subdivided into tracheoles) carry oxygen from the air to all the parts. The opening of the spiracles is regulated by the sphincters. Exchange of gases take place at the tracheoles by diffusion.

1.7 Blood Vascular System

- (a) "Open types" or "**lacunar types**" where blood is filled in blood sinuses.
- (b) Blood vessels are poorly developed.
- (c) Largest blood sinus - "haemocoel"

- (d) Blood of cockroach - "haemolymph".
 - Colourless - plasma
 - Blood corpuscles (haematocytes)

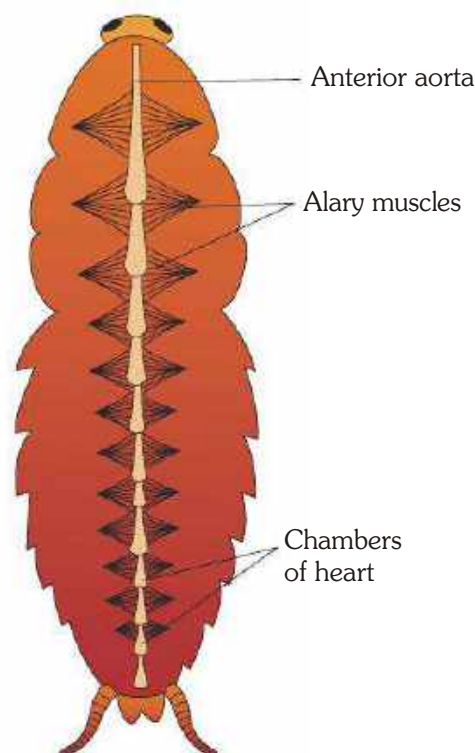
- (e) "Haematocytes" -
 - (1) Phagocytosis of bacteria
 - (2) Related with blood clotting.
- (f) Blood -
 - (i) Not related with respiration, because respiratory pigment is absent.
 - (ii) Diaphragms divide the haemocoel in three chambers i.e.
 - P.C.S. has heart in dorsal part (Peri cardiac sinus)
 - Middle sinus - P. Visceral sinus has alimentary canal and fat body.
 - Ventral chamber - Perineural sinus has nerve cord.

- **Haemocoel is divided into the 3-chamber**

- (i) Peri-cardial sinus (PCS) has heart in dorsal part
- (ii) Peri-visceral sinus (PVS) has alimentary canal and fat body
- (iii) Peri-neural sinus (PNS) has nerve cord

- **Heart of Cockroach (Neurogenic) :**

- (a) One tubular heart present
- (b) Divided into 13 chambers, lie along mid-dorsal line of thorax abdomen.
- (c) Chamber - inverted funnel like
- (d) Each chamber connected with P.C.S. by 1-pair of pores, called "**Ostia**". These pores act as valve. Due to presence of valve flow of blood in dorsal heart of cockroach → Posterior to Anterior (like dorsal vessel of earthworm)
- (e) First chamber of heart is in the form of long tubule called "**anterior aorta**".
- (f) 12-pairs of fan like muscles present in P.C.S. called **alary muscles**. These help in "blood circulation".
- (g) Tergosternal muscles also help in blood circulation.
- (h) Heart beat = 49 heart beat / min



1.8 Excretory System

Excretion is performed by Malpighian tubules. Each tubule is lined by glandular and ciliated cells. They absorb nitrogenous waste products and convert them into uric acid which is excreted out through the hindgut. Therefore, this insect is called uricotelic. In addition, the fat body, nephrocytes and urecose glands also help in excretion.

1.9 Nervous System

The nervous system of cockroach consists of a series of fused, segmentally arranged ganglia joined by paired longitudinal connectives on the ventral side. Three ganglia lie in the thorax, and six in the abdomen.

The nervous system of cockroach is spread throughout the body. The head holds a bit of a nervous system while the rest is situated along the ventral (belly-side) part of its body. So, now you understand that if the head of a cockroach is cut off, it will still live for as long as one week. In the head region, the brain is represented by supra-oesophageal ganglion which supplies nerves to antennae and compound eyes.

- **Compound Eyes :**

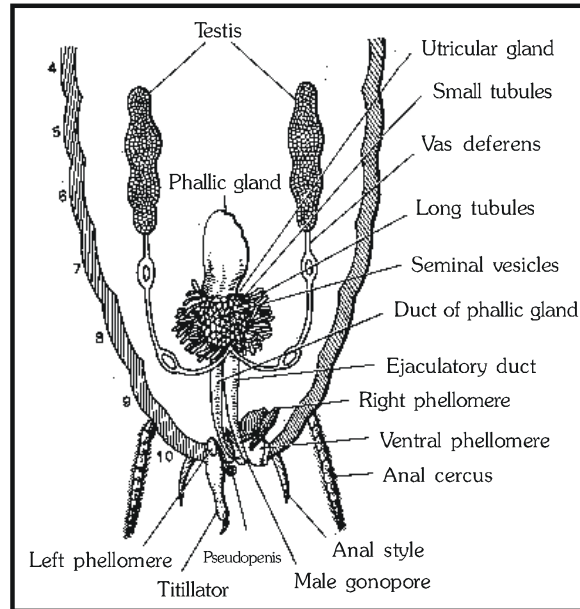
Compound eye made up of 2000 hexagonal units called *ommatidia*.

- **Mechanism** : two types of visions in insects are :
 - (A) **Apposition or mosaic vision :- during day**
 - (B) **Superposition image** :
 - (a) In the night, the pigment sheath of ommatidia
- **Endocrine System** : Inter cerebral gland/corpora cardiaca secretes brain hormones/neuro hormones which regulate metabolism of body. Prothoracic gland secretes moulting hormones (ecdysone). Corpora allata produce juvenile hormones (neotenene) which is antagonistic to ecdysone.

1.10 Reproductive System

Cockroach - "Unisexual"

- **Male reproduction system** :
 - (a) 1-pair of testis in "4-6" abdominal segment. Each testis formed of "3 or 4 lobes".
 - (b) Vasa deferentia - arises from each testis which opens into ejaculatory duct.
 - (c) Ejaculatory duct opens outside by male genital pore, situated ventral to anus.
 - (d) A gland associated with seminal vesicles called **mushroom gland or utricular gland** having two types of tubules.
 - (i) Small tubules on inner side - utriculi breviores.
 - (ii) Large tubules outside - utriculi majores
Tips of long tubules called "**Uricose gland**"
These absorb excretory material from haemocoel.
 - (e) A gland located on mushroom gland called **Phallic gland or Conglobate gland**. It opens outside by a long duct.
 - (f) Chitinous structures associated with phallic aperture and male genital pore called "**Phellomeres**" or **Gonapophysis**." (External genital organs).

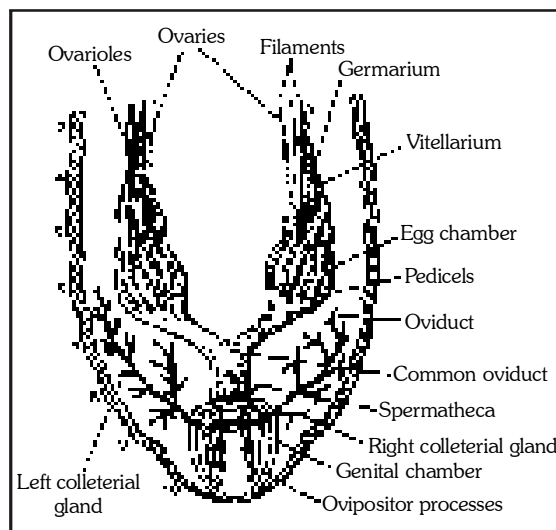


Phellomeres { (1) Left phellomere
(2) Right phellomere
(3) Ventral phellomere

- (a) Phallic aperture associated with left phallomeres.
 - (b) Male genital pore associated with ventral phellomeres.
- (A) **Left phellomere :-**
- (a) Made up of a flat chitinous plate
 - (b) Four types of lobes attached with it
 - Lower most lobe titillator, with a hooks on tips
 - "Pseudopenis" - long with bulbous apex
 - Asperate lobe and "acutolobe"
- (B) **Right phellomere** It is a chitinous structure, also hooked.
- (C) **Ventral - phellomere**
- Opening of ejaculatory duct lies at its base.
- (g) Spermatogenesis in testes
 - (h) Seminal vesicle :-Store the sperms
 - (i) All sperms glue together to form a ball called "**sperm ball**"
 - Long tubules secrete a membrane around sperm ball called **spermatophore**.
 - Small tubules :- secrete a nutritive fluid in spermatophore.

1.11 Female Reproductive System

- 1-pair of ovary situated in "2nd to 6th segment of abdomen".
- Each ovary is made up of 8-long tubules called "Ovarioles." One egg forms in each ovariole. It means 16 ova are matured at a time in cockroach. Both oviduct of ovaries fuse and form "vagina".
- Vagina - common oviduct opens into the genital chamber.
- Genital chamber - formation of genital chamber by the fusion of 3 abdominal sternite. (7th, 8th, 9th)
- 7th sternum - forms the floor of genital chamber.
- A pair of "spermatheca" associated with genital chamber.
- 1-pair of collateral glands associated with genital chamber. These are branched tubular glands. Left collateral gland more branched. These secrete hard egg case/ootheca around eggs.
- Three pairs of chitinous processes hanging from the roof of genital chamber into its cavity are the external genitalia of female cockroach. These are called ovipositor processes because these serve to arrange the ova in a newly formed ootheca.



1.12 Copulation

- "Breeding season :- from march to september.
The females secrete a highly odourous and volatile "sex attracting scent from their scent glands is called pheromones or ectohormones.
- Male cockroach opens the oothecae pore with the help of hooks.

1.13 Fertilization

- "Internal fertilization"
- After fertilization the left collateral gland secretes a soluble "milky protein" while the right one secrete dihydroxyphenol. Both secretions mix to form a brownish scleroprotein.
- Sclero protein forms a common egg case, called **ootheca**.

• **Development :-**

- 1 - female forms 15-40 ootheca in life time.
- Development of egg inside ootheca
- Ootheca are adaptation of terrestrial life to prevent the "water lose"
- Development time - "4 to 8" weeks
- Juvenile stage inside ootheca is called "**nymph**".
Nymph appears like adult except for wings and reproductive organs
- Nymph changes into an adult in - 1 year
- During metamorphosis - 7 to 12 times moulting [(average - 10) (according to NCERT-13)].

1.14 Metamorphosis

"Incomplete or paurometabolus"

- Egg - "megalecithal" and "centrolecithal"

EXERCISE

1. Zoological name of cockroach is :
 (1) *Glossina palpalis*
 (2) *Periplaneta americana*
 (3) *Musca nebulosa*
 (4) *Apis indica*
2. Diagnostic feature of insects is :
 (1) Segmented body
 (2) Chitin in body wall
 (3) Three pair of legs
 (4) One pair compound eyes
3. Which are the two common Indian cockroaches ?
 (1) *Periplaneta americana* and *Blatta indica*
 (2) *Periplaneta indica* and *Blatta orientalis*
 (3) *Periplaneta orientalis* and *Blatta americana*
 (4) *Periplaneta americana* and *Blatta orientalis*
4. Characteristic of group Insecta is :
 (1) Joined appendages
 (2) 3 pair of jointed legs
 (3) Chitinous exoskeleton
 (4) Compound eyes
5. Tergum is joined on the sides by :
 (1) Pleuron (2) Sternum
 (3) Alimentary canal (4) Muscles
6. Outer border of tergum bends downwards in cockroach and attaches with :
 (1) Muscles (2) Sternum
 (3) Pleura (4) Fat body cells
7. Mandibles of cockroach are :
 (1) Short with grinding teeth
 (2) Long and pointed
 (3) Short without teeth
 (4) Long and coiled
8. Head of cockroach according to its position is known as :
 (1) Hypopharynx
 (2) Hypocerebral
 (3) Hypognathus
 (4) Supragnathus
9. Tongue like structure in *Periplaneta* is :
 (1) Maxilla (2) Hypopharynx
 (3) Labium (4) Labrum
10. Which structure is known as lower lip of cockroach ?
 (1) Labrum (2) Labium
 (3) Mantum (4) Submentum
11. Wings of cockroach are mainly helpful in :
 (1) Egg laying
 (2) Preying
 (3) Finding the mate
 (4) Protecting against
12. *Periplaneta americana* differs from *Blatta orientalis* in :
 (1) Well developed wings
 (2) Wings absent
 (3) Only first pair wings developed
 (4) Second pair wing developed
13. Number of segments in cockroach leg :
 (1) 3 (2) 5 (3) 6 (4) 9
14. Undeveloped wings are found in :
 (1) Housefly (2) Cockroach
 (3) Mosquito (4) *Blatta*
15. Main character for the distinction between male and female cockroach :
 (1) Antennae (2) Mandibles
 (3) Anal cerci (4) Anal style
16. Anal styles are found in :
 (1) Housefly
 (2) Female cockroach
 (3) Male cockroach
 (4) Both male & female cockroach
17. Body segments are definite and well marked in :
 (1) *Hydra* (2) *Taenia*
 (3) Earth worm (4) Cockroach
18. Exoskeleton of cockroach is made up of :
 (1) Cartilage
 (2) Cuticle
 (3) Chitin
 (4) Amino acids
19. Cockroach and other insects have exoskeleton made up of :
 (1) Keratin (2) Spongin
 (3) Chitin (4) Cuticle

- 20.** The body cavity of cockroach is called :
 (1) Pseudocoel (2) Coelom
 (3) Hydrocoel (4) Haemocoel
- 21.** Which cells secretes wax located at the outer surface of body wall ?
 (1) Trophocytes (2) Oenocytes
 (3) Trichogen (4) Mycetocytes
- 22.** The fatbody of cockroach contains :
 (1) Oenocytes (2) mycetocytes
 (3) Trophocytes (4) All the above
- 23.** Hepatic caeca in cockroach are derived from :
 (1) Crop (2) Gizzard
 (3) Midgut (4) Proctodaeum
- 24.** Saliva of cockroach contains enzyme :
 (1) Lipase (2) Amylase
 (3) Pepsin (4) Trypsin
- 25.** Salivary glands of cockroach open on :
 (1) Maxilla (2) Hypopharynx
 (3) Labium (4) Labrum
- 26.** Mouth part of cockroach are suited for :
 (1) Piercing (2) Absorbing
 (3) Cutting & chewing (4) Drinking
- 27.** Cockroach is :
 (1) Omnivorous
 (2) Herbivorous
 (3) Carnivorous
 (4) Sanguivorous
- 28.** In cockroach food is crushed in which part :
 (1) Crop (2) Gizzard
 (3) Mesenteron (4) Oesophagus
- 29.** In which part of alimentary canal of cockroach is invagination of cuticle found ?
 (1) Anterior part
 (2) In midpart
 (3) In posterior part
 (4) Both in anterior and posterior part
- 30.** The inner layer of gizzard of cockroach is covered by:
 (1) By cuticle
 (2) By mucous membrane
 (3) By endoepithelium
 (4) By peritrophic membrane
- 31.** Maximum digestion takes place in which part of cockroach ?
 (1) In crop (2) In Gizzard
 (3) In mesenteron (4) In oesophagus
- 32.** Oxygen is carried to the tissues of cockroach by which organ :
 (1) Skin (2) Trachea
 (3) Plasma (4) Respiratory pigment
- 33.** Allary muscles in cockroach are associated or connected with :
 (1) Trachea (2) heart
 (3) legs (4) alimentary canal
- 34.** Number of pairs of spiracles in cockroach are :
 (1) 4 (2) 6 (3) 8 (4) 10
- 35.** In cockroach O_2 is carried to tissue by :
 (1) Haemoglobin and haemocyanin
 (2) Blood plasma
 (3) Tracheal tubes
 (4) Diffusion through integument
- 36.** Blood of cockroach does not contain haemoglobin because :
 (1) It respire through atmosphere
 (2) Respires through book lungs
 (3) It does not respire
 (4) It has some other means to carry oxygen direct into the tissues
- 37.** Give the name of blood vessel, which arises from first chamber of heart in cockroach :
 (1) Nephrocyte (2) Fenestrae
 (3) Ostia (4) Anterior aorta
- 38.** Number of chambers in the heart of cockroach :
 (1) 5 (2) 9 (3) 13 (4) 16
- 39.** Blood circulation in insects :
 (1) Flows in arteries and veins
 (2) With red blood corpuscles
 (3) Open type
 (4) Absent
- 40.** Heart of cockroach is :
 (1) Four chamberd
 (2) Vertral to gut
 (3) Longitudinal and beaded
 (4) Three chambered

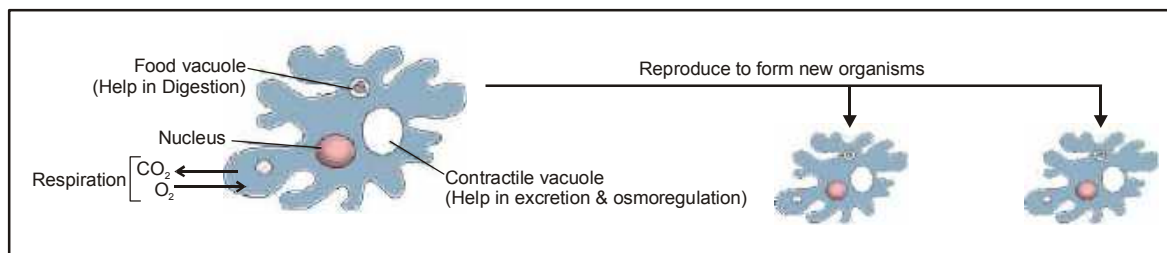
- 41.** The colour of haemolymph of cockroach is :
 (1) Yellow (2) Red
 (3) Green (4) Colourless
- 42.** Physiologically the heart of cockroach is :
 (1) Neurogenic (2) myogenic
 (3) Epigenic (4) Agenic
- 43.** Main excretory product of cockroach is :
 (1) Urea (2) Ammonia
 (3) Uric acid (4) Amino acid
- 44.** Function of Malpighian tubules of cockroach :
 (1) Digestion (2) Respiration
 (3) Excretion (4) Reproduction
- 45.** Excretory organs of cockroach are :
 (1) Trachea (2) Kidney
 (3) Nephridia (4) Malpighian tubules
- 46.** The nerve cord of cockroach is :
 (1) Double, ventral and solid
 (2) Double dorsal and hollow
 (3) Single, dorsal and solid
 (4) Single, ventral and hollow
- 47.** Ommatidia are found in :
 (1) Eyes of birds (2) Eye of frog
 (3) Eye of insects (4) Eye of rabbit
- 48.** Structural units found in the compound eye of cockroach are called :
 (1) Rhabdom (2) Cone cells
 (3) Ommatidia (4) Simple eye
- 49.** What type of vision is found in cockroach ?
 (1) Mosaic (2) Superposition
 (3) Binocular (4) None of them
- 50.** Ommatidia are units in the eyes of :
 (1) Amphibians (2) Mammals
 (3) Insects (4) Fishes

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	3	4	2	1	3	1	3	2	2	4	1	2	4	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	4	3	3	4	2	4	3	2	2	3	1	2	4	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	2	2	4	3	4	4	3	3	3	4	1	3	3	4
Que.	46	47	48	49	50										
Ans.	1	3	3	1	3										

ANIMAL TISSUE

In unicellular organisms, all functions like digestion, respiration and reproduction are performed by a single cell.

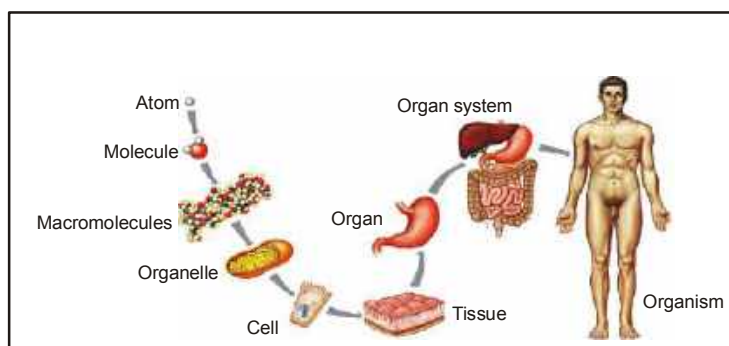


In the complex body of multicellular animals the same basic functions are carried out by different groups of cells in a well organised manner. The body of a simple organism like Hydra is made of different types of cells and the number of cells in each type can be in thousands.

The human body is composed of billions of cells to perform various functions.

Tissues : In multicellular animals, a group of similar cells alongwith intercellular substances perform a specific function. Such an organisation is called tissue. All complex animals consist of only four basic types of tissues. (i) Epithelial, (ii) Connective, (iii) Muscular and (iv) Neural.

Cells, tissues, organs and organ systems split up the work in a way that exhibits division of labour and contribute to the survival of the body as a whole.



Atom → Molecule → Macromolecule → Organelle → Cell → Tissue → Organ → Organ System → Organism

On the basis of functions and structure tissues are of four types -

S.N.	Types of tissue	Functions	Origin
1.	Epithelial	Covering, protection, diffusion, secretion, absorption	Ectoderm, endoderm, mesoderm
2.	Connective	Connect structures, provide support the body, transport substances in the body	Mesoderm
3.	Muscular	Contraction and relaxation which help in movement and locomotion	Mesoderm
4.	Nervous	To generate and conduct impulses in body	Ectoderm

EPITHELIAL TISSUE

PROPERTIES OF EPITHELIAL TISSUES

Word epithelium is composed of two words.

- Epi – Upon
- Thelia – growth

A tissue which grows upon another tissue is called Epithelium.

It always rest upon underlying connective tissue. Epithelium cells are closely packed with each other so there is very little inter cellular space.

Due to absence of/less intercellular spaces blood vessels, lymph vessels & capillaries are unable to pierce this tissue so blood circulation is absent in epithelium. Hence cells depend for their nutrients on underlying connective tissue.

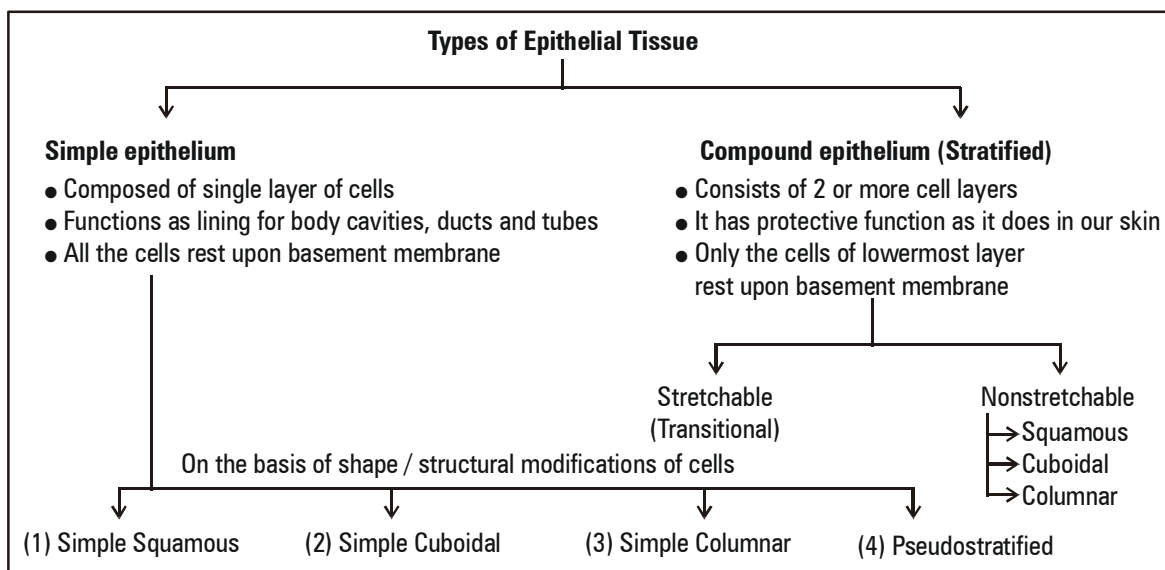
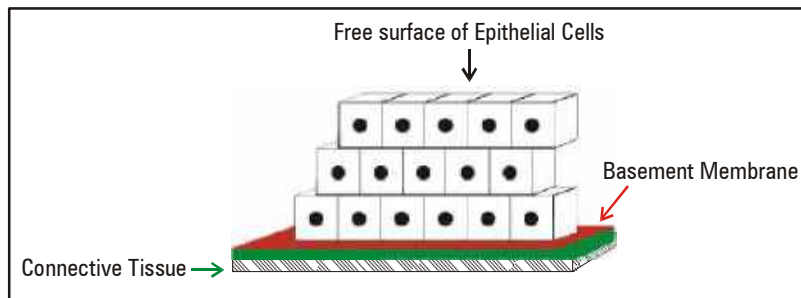
During embryonic development epithelium orginates first.

Power of regeneration is high in this tissue.

Between epithelium and connective tissue, a thin non living non-cellular basement membrane is present which is selectively permeable.

Basement membrane is secreted by both epithelium and connective tissue and made up of glycoproteins, mucopolysaccharides & protein fibres.

In nearly all animal tissues, specialised junctions provide both structural & functional links between its individual cells. This tissue has a free surface, which faces either a body fluid or the outside environment and thus provides a covering or a lining for some part of the body.



CELL JUNCTIONS

All cells in epithelium are held together with little intercellular material. In nearly all animal tissues, specialised junctions provide both structural and functional links between its individual cells. Three types of cell junctions are found in the epithelium and other tissues.

Interdigitation – Finger like processes of plasma membrane which enter into cytoplasm of adjacent cell. These structures are mainly found in transitional epithelium.

Desmosomes – This type of (Adhering junction) junction consists of disc - like protein plate with intermediate fibre known as tonofibrils. These structures provide mechanical support to stratified epithelium performing cementing to keep the neighbouring cells together.

Tight Junctions – At some places plasma membrane of adjacent cells become fused to form tight junction. They stop substances from leaking across a tissue. These structures are mostly found in columnar epithelium.

Gap Junctions – Facilitate the cells to communicate with each other by connecting cytoplasm of adjoining cells for rapid transfer of ions, small molecules and sometimes big molecules.

PLASMA MEMBRANE OF FREE END GET MODIFIED TO FORM 3 TYPES OF FUNCTIONAL STRUCTURES.

Microvilli

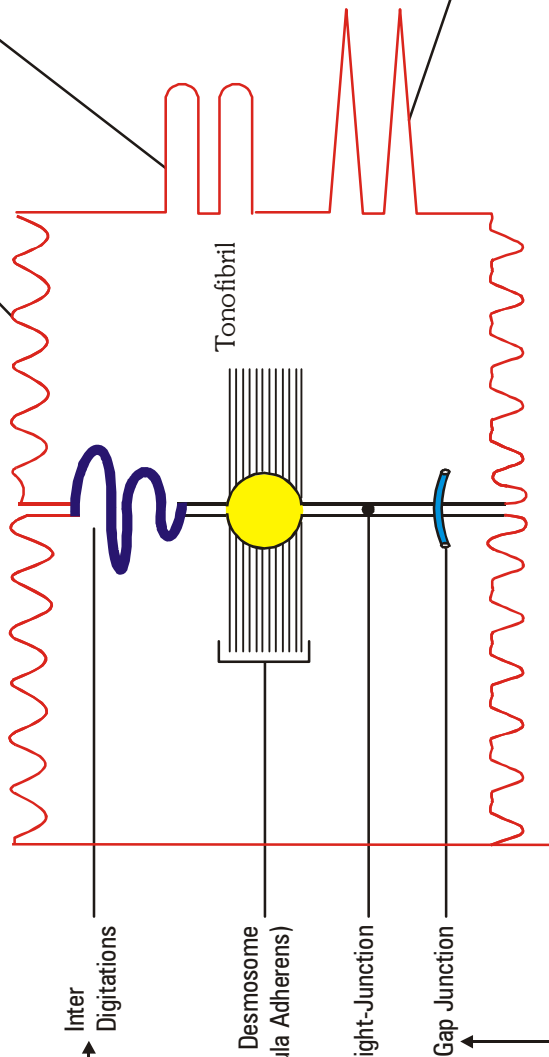
- These are minute protoplasmic process which are non motile, non contractile.
- They mainly help in absorption and secretion.
- They increase surface area more than 20 times.
- These are present in the wall of Intestine, Gall bladder, Proximal convoluted tubule etc.

Cilia or Kinocilia

- Motile and contractile protoplasmic process.
- Diameter of cilia is same from base to apex.
- Movement of cilia is in uniform direction and their function is to move particles or mucus in a specific direction over the epithelium.
- These are found in e.g. – Fallopian tube, Uterus.
 - Trachea.
 - Ependymal epithelium

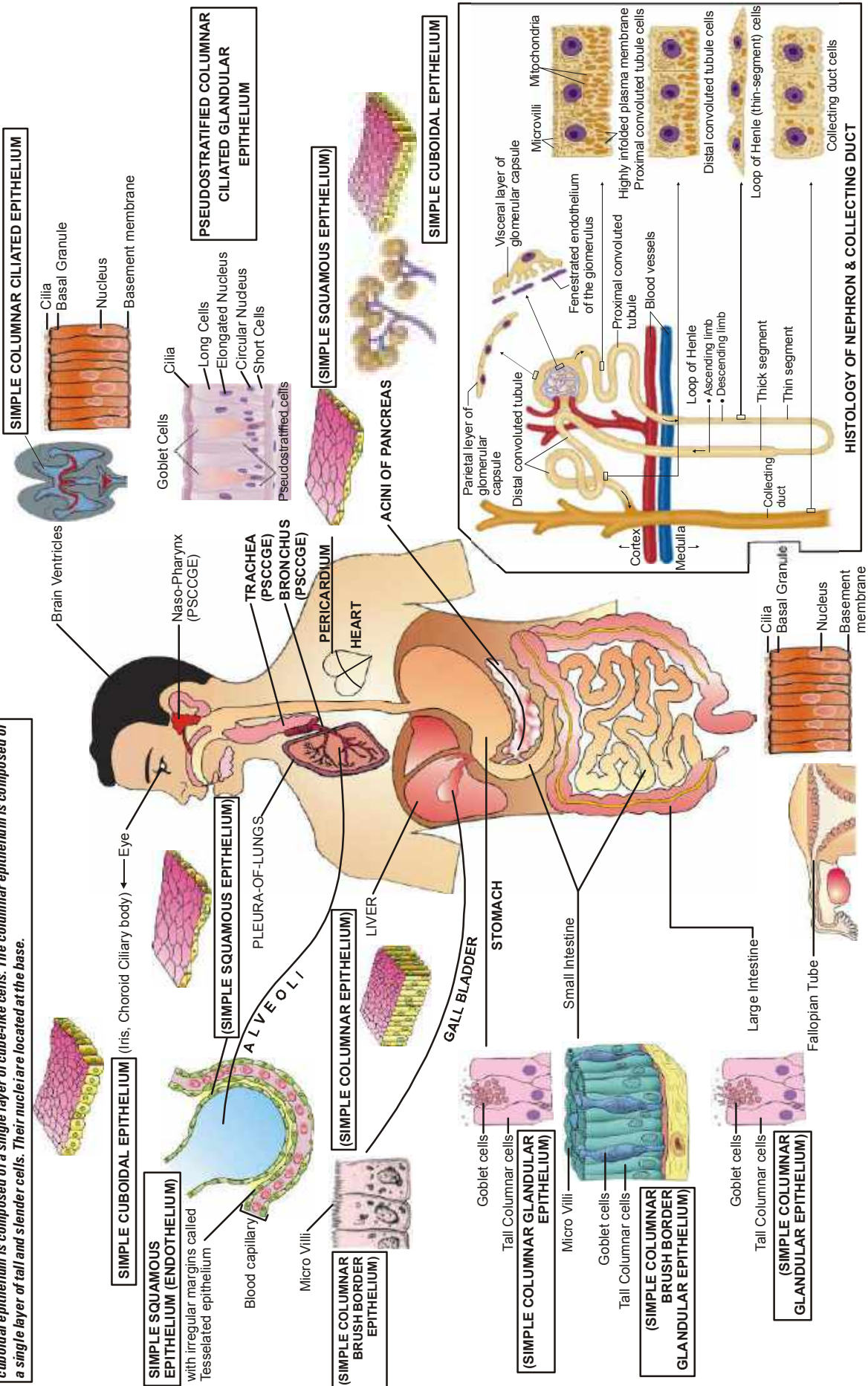
Stereocilia

- Non motile, non contractile cytoplasmic process.
- Base of stereocilia is broad and apical part is narrow so they are conical in shape.
- They increase surface area and found in e.g. – Epididymis
 - Vas deferens

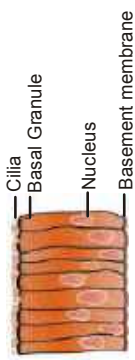


SIMPLE EPITHELIUM

Simple epithelium is composed of a single layer of cells and functions as a lining for body cavities, ducts, and tubes. The squamous epithelium is made of a single thin layer of flattened cells with irregular boundaries. The cuboidal epithelium is composed of a single layer of cube-like cells. The columnar epithelium is composed of a single layer of tall and slender cells. Their nuclei are located at the base.

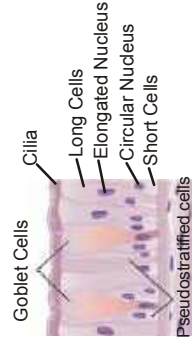


SIMPLE COLUMNAR CILIATED EPITHELIUM



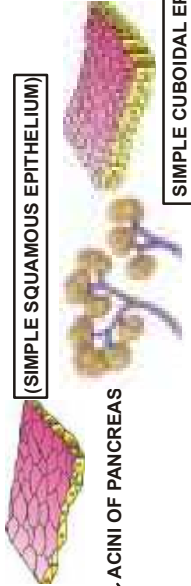
Cilia
Basal Granule
Nucleus
Basement membrane

PSEUDOSTRATIFIED COLUMNAR CILIATED GLANDULAR EPITHELIUM



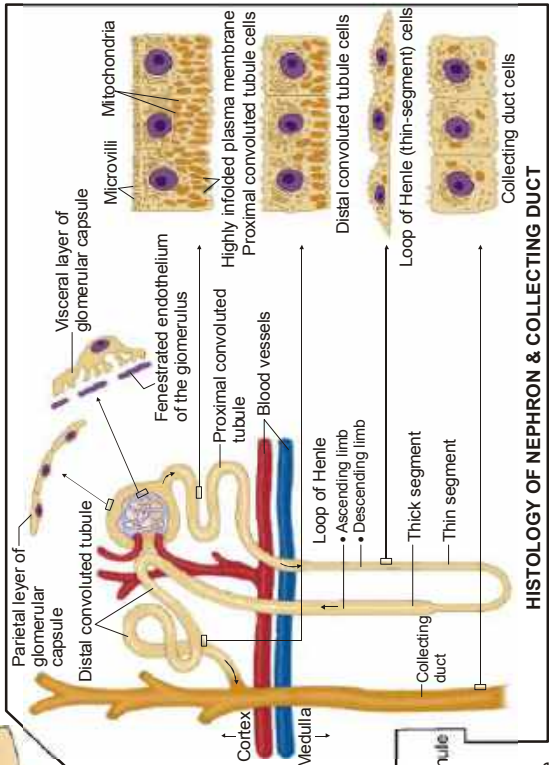
Goblet Cells
Cilia
Long Cells
Elongated Nucleus
Circular Nucleus
Short Cells
Pseudostratified cells

(SIMPLE SQUAMOUS EPITHELIUM)



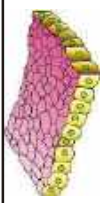
ACINI OF PANCREAS

SIMPLE CUBOIDAL EPITHELIUM



HISTOLOGY OF NEPHRON & COLLECTING DUCT

SIMPLE CUBOIDAL EPITHELIUM (Iris, Choroid Ciliary body)



SIMPLE SQUAMOUS EPITHELIUM (ENDOTHELIUM) with irregular margins called Tessellated epithelium



(SIMPLE SQUAMOUS EPITHELIUM)

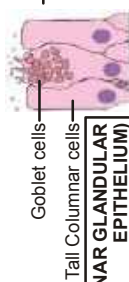


(SIMPLE COLUMNAR EPITHELIUM)

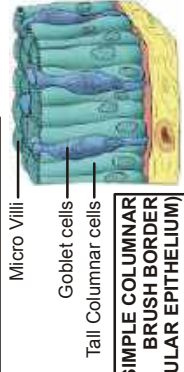
(SIMPLE COLUMNAR BRUSH BORDER EPITHELIUM)



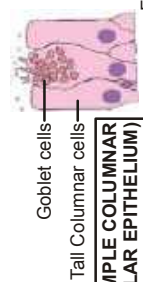
(SIMPLE COLUMNAR GLANDULAR EPITHELIUM)



(SIMPLE COLUMNAR BRUSH BORDER GLANDULAR EPITHELIUM)



(SIMPLE COLUMNAR GLANDULAR EPITHELIUM)

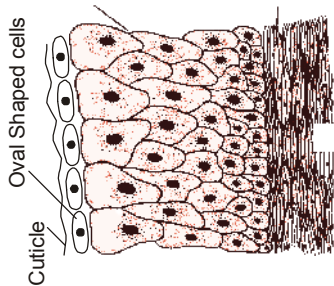


Cilia
Basal Granule
Nucleus
Basement membrane

COMPOUND EPITHELIUM

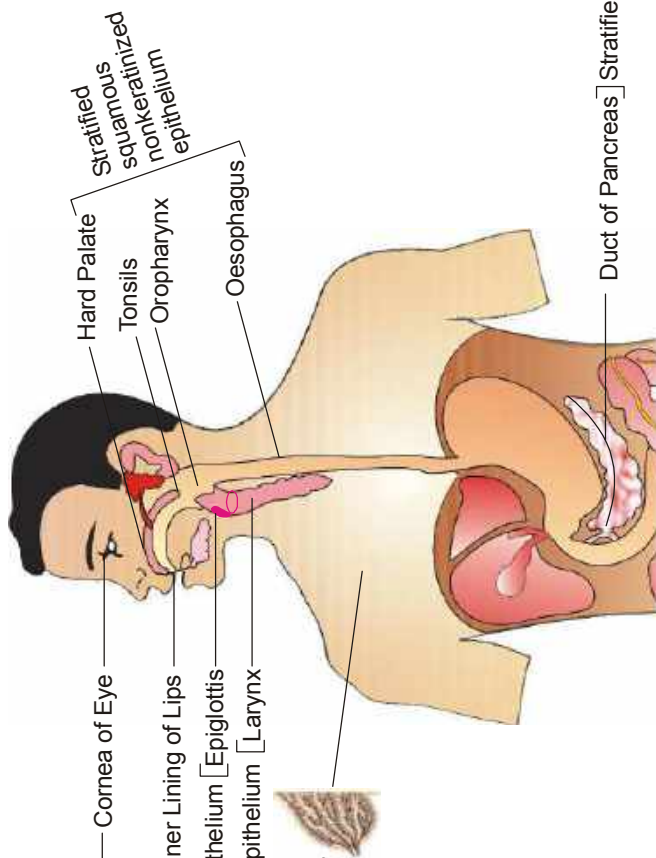
Compound epithelium is made of more than one layer (multi-layered) of cells and thus has a limited role in secretion and absorption. Their main function is to provide protection against chemical and mechanical stresses. They cover the dry surface of the skin, the moist surface of buccal cavity, pharynx, inner lining of ducts of salivary glands and of pancreatic ducts.

Transitional Epithelium



Top most-layer
Middle 2 to 4
Layers of pear
shaped cells
Inner most layer
of cells are
cube like

Squamous Nonkeratinised	Squamous Keratinised	Cuboidal	Columnar Ciliated	Columnar Non-Ciliated
<p>Living nucleated flat cells</p>	<p>Dead non nucleated flat cells Keratin</p>	<p>Cuboidal cells</p>		



Stratified squamous nonkeratinised epithelium

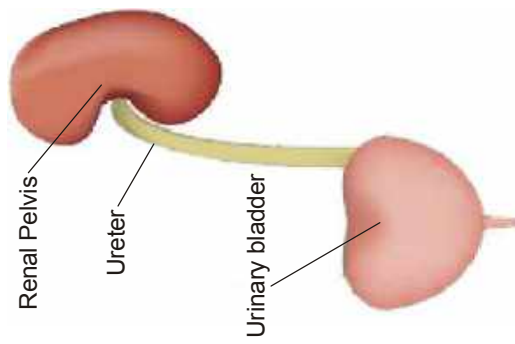
Stratified columnar nonciliated epithelium [Epiglottis]
Stratified columnar ciliated epithelium [Larynx]

Stratified cuboidal [Ducts of mammary glands]

Stratified squamous keratinised epithelium is found in epidermis of skin, Nails, Scales, Horns, Hooves, Feathers

Stratified cuboidal epithelium also found in lining of Vagina

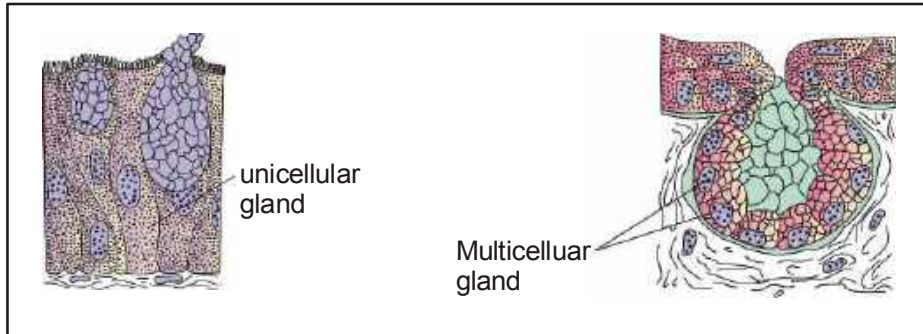
Transitional Epithelium



Stratified cuboidal epithelium

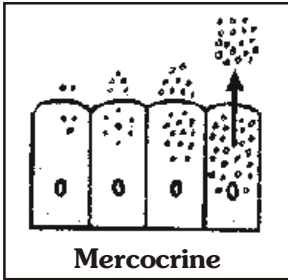
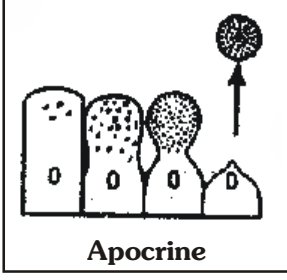
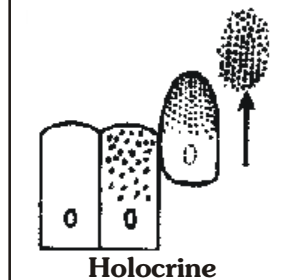
GLANDS

Some of the columnar or cuboidal cells get specialised for secretion and are called glandular epithelium. They are mainly of two types: unicellular, consisting of isolated glandular cells (goblet cells of the alimentary canal), and multicellular, consisting of cluster of cells (salivary gland).



On the basis of the mode of pouring of their secretions, glands are divided into two categories namely exocrine and endocrine glands. Exocrine glands secrete mucus, saliva, earwax, oil, milk, digestive enzymes and other cell products. These products are released through ducts or tubes. In contrast, endocrine glands do not have ducts. Their products called hormones are secreted directly into the fluid bathing the gland.

On the basis of nature of secretion :- 3 types of glands are there.

Gland	Acrine/Merocrine	Apocrine	Holocrine
Definition	In these glands secretory cells secrete substances by simple diffusion (Exocytosis). No part of cytoplasm is destroyed and secretes a watery fluid.	In this type of glands secretory products are collected in apical part of secretory cell and apical portion is also shed alongwith secretory matter	The production or secretion is shed with whole cell leading to its destruction, Secretory matter is more concentrated.
Diagram	 Merocrine	 Apocrine	 Holocrine
Examples	Maximum sweat glands of humans, Goblet cells, Salivary gland, Tear gland, Intestinal glands, Mucous gland.	Mammary glands. Sweat gland of arm pit, pubic region, skin around anus, lips, nipples etc.	Sebaceous, meibomian & Zeis gland

On the basis of number of cells

(a) Unicellular glands
Eg. Goblet cells, Paneth cells

(b) Multicellular glands
Eg. All glands except Goblet cells and Paneth cells

CELLS AND FIBRES OF CONNECTIVE TISSUE PROPER

(YELLOW-FIBRES)

ELASTIC FIBRES

- Composed of elastin proteins
- Branched but arranged singly
- Maximum elasticity is present
- Highly resistant to chemicals

MESENCHYME-CELL

- Small sized pleuripotent cells of connective tissue proper

MONOCLULAR-ADIPOCYTE

- Single large, central fat globule is present
- Cytoplasm and nucleus becomes peripheral
- Form white fat

MULTILOCLULAR-ADIPOCYTE

- Many, small, fat granules distributed in cytoplasm around nucleus
- Cytoplasm is more
- Form Brown fat

LYMPHOCYTES

- Centrally located large nucleus and cytoplasm is peripheral
- Key cells of immune system and involved in production of antibodies

PLASMA CELLS

- Small amoeboid cells
- In these cells rounded nucleus is present in which chromatin material is arranged like spokes (radial rows) in wheel so they are also called as cart wheel cells
- Also called clones of lymphocytes as these are formed by division of lymphocytes
- Produce and transport antibodies

FIBROBLAST

- Largest cells of connective tissue proper
- Maximum in number
- Irregular in shape due to long cytoplasmic processes
- Cytoplasm is rich in rough ER
- Primary function is to produce protein fibres
- Secrete matrix of connective tissue (Chief matrix producing cells)

COLLAGEN FIBRES (WHITE-FIBRES)

- Made up of collagen protein (most abundant protein in animal kingdom)
- Wavy, inelastic, tough fibres arranged in the form of bundles (fascia)
- On boiling they yield gelatin

MAST CELLS

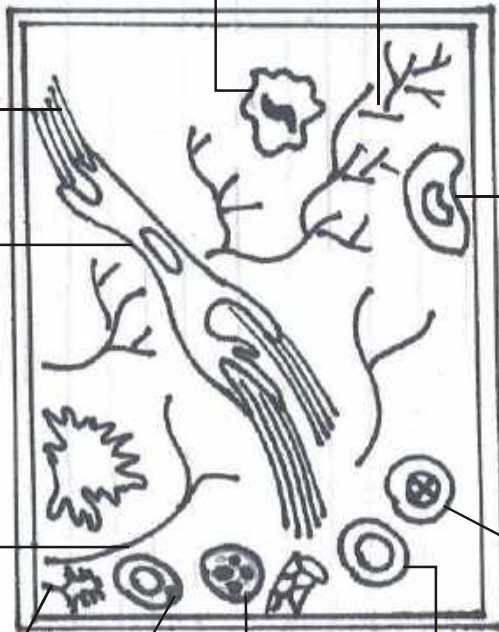
- Small and amoeboid cells with S-shaped nucleus
- Secrete-histamine, serotonin, heparin and matrix of connective tissue proper

RETICULAR FIBRES

- Also called arzyrophil fibres as they can be stained with silver salts
- Composed of reticulin protein
- Highly branched fibres which always form dense network
- Delicate fibres
- Elasticity is completely absent
- Mainly found in lymphoid organs such as spleen, lymph nodes etc.

MACROPHAGES

- 2nd largest in size
- 2nd maximum in number
- Amoeboid cells, kidney shaped nucleus
- Cytoplasm is agranular but appears to be granular due to more number of lysosomes
- Phagocytic in nature
- Destroy bacteria and viruses by phagocytosis
- Also called scavengers of connective tissue because they destroy dead or damaged cells to clean connective tissues
- Also called histiocytes



CONNECTIVE TISSUE

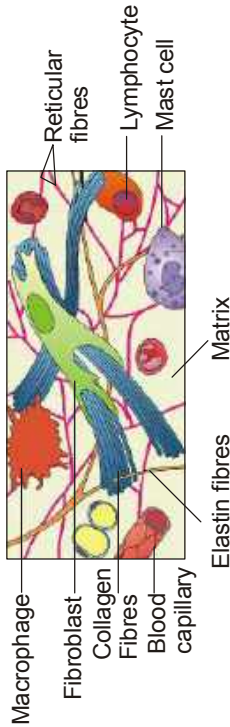
Connective Tissue :- Most abundant and widely distributed in the body of complex animals. They are named connective tissue because of their specialised function of linking and supporting other tissue/organs of the body.

TYPES OF CONNECTIVE TISSUES

LOOSE
(more matrix, less fibres)

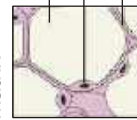
AREOLAR

- Also called loose or Spongy Connective tissue
- Most widely distributed tissue in the body
- Tissue with maximum intercellular spaces, these spaces are called Areolae
- It serves as a support frame work for epithelium



ADIPOSE

- Located mainly beneath the skin
- The cells of this tissue are specialised to store fats. The excess of nutrients which are not used immediately are converted into fats and are stored in this tissue.
- It is of two types (a) white fat (b) brown fat



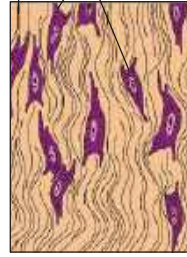
- White fat
 - One large fat globule is present
 - e.g Panniculus adiposus (hypodermis)
 - Yellow bone marrow
- Brown fat
 - Many small fat globules are present
 - e.g. Cold resistance device in new born baby

DENSE
(more fibres, less matrix)

(Fibres and Fibroblasts are compactly packed)

REGULAR

Bundles of collagen fibres and matrix are distributed in regular pattern



WHITE FIBROUS

- Collagen fibres are more
- Fibroblasts and mast cells are more

CORD

e.g. Tendon
(Connect bone with muscles)

YELLOW FIBROUS

- Elastic fibres are more
- Collagen fibres are less
- Reticular fibres are completely absent

CORD

e.g. Ligament
(Connect bone with bone)

SPECIALISED

Skeleton Connective Tissue

- Cartilage
- Bone

Blood

- Plasma
- Corpuscles
 - RBC
 - WBC
 - Platelets

SHEATH

e.g. This tissue is present in the skin, Pericardium, Periostrum, Perichondrium, Epimysium, Renal capsule, Duramater

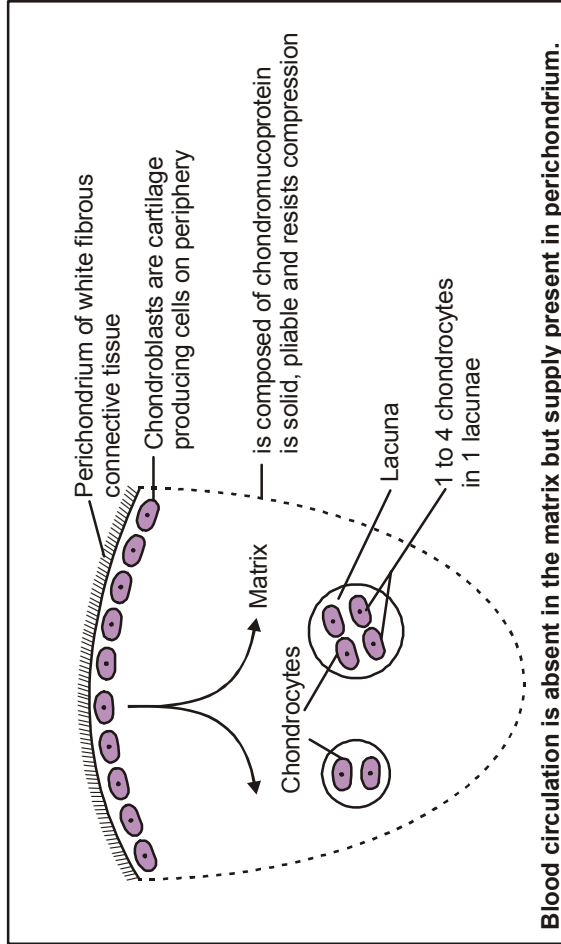
SHEATH

e.g. walls of alveoli, small bronchioles, blood vessels, lymph vessels, true vocal cords

SKELETAL CONNECTIVE TISSUE

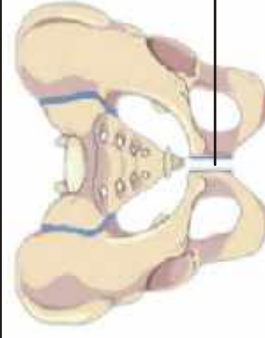
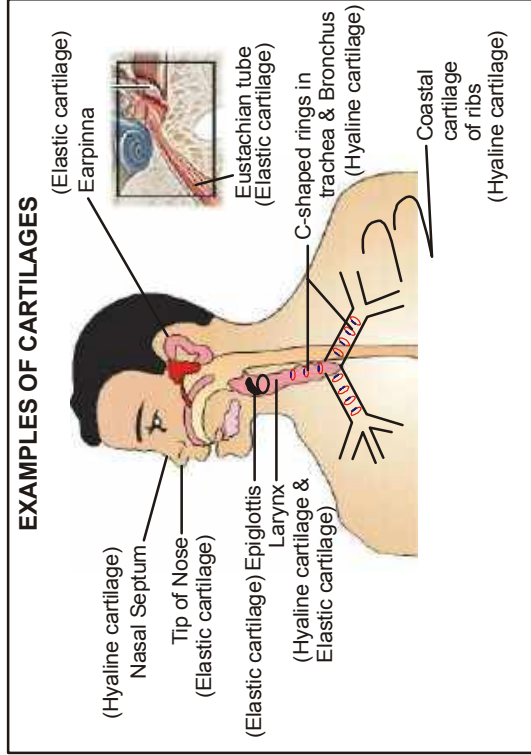
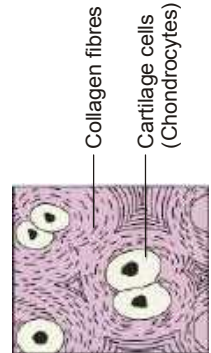
Matrix is dense and mineralised due to deposition of minerals it becomes hard. Also called supporting tissue, i.e. provide support to body. Skeletal connective tissue is of two types. (A) Cartilage (B) Bones

CARTILAGES



TYPES OF CARTILAGES

- (1) **HYALINE** - Fibres are absent, matrix is semitransparent
- (2) **FIBROUS** - (A) Elastic (B) White Fibrous - Strongest cartilage
- (3) **CALCIFIED** - Hardest cartilage.

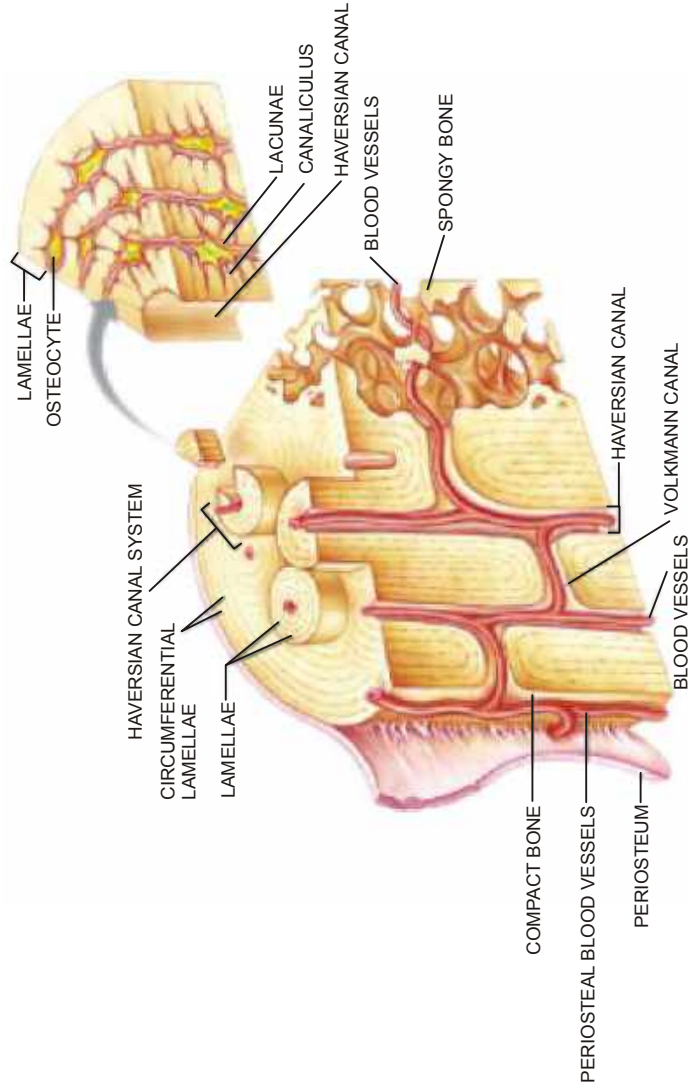
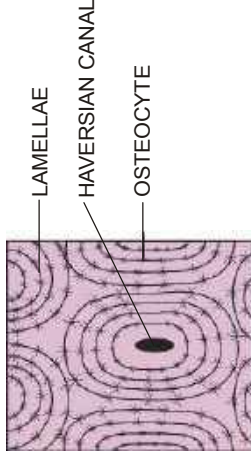


Ends of all long bones except femur and humerus are made of hyaline cartilage

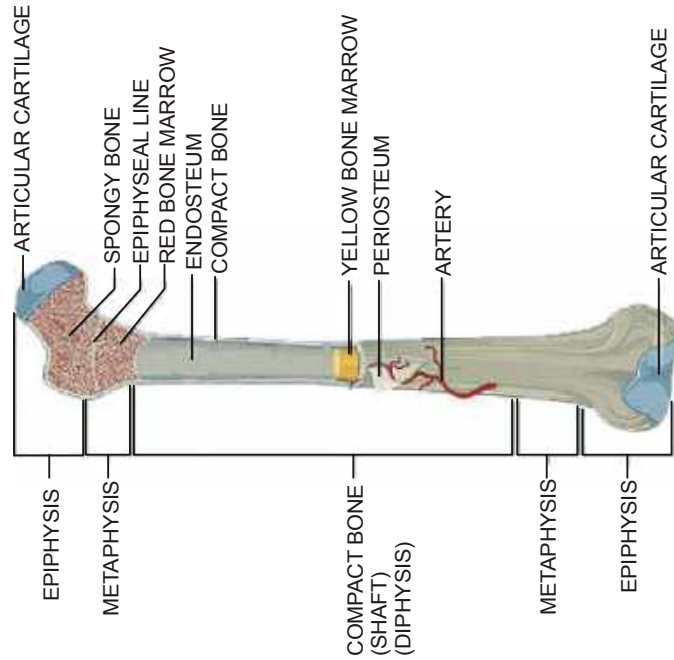
Ends of femur and humerus are made of calcified cartilage

SKELETAL CONNECTIVE TISSUE (BONE)

- Support and protect softer tissues and organs
- Process of formation of bone - OSSIFICATION
- Hardest tissue of our body.
- The bone marrow is some bones is the site of production of blood cells.
- Growth of bone is bidirectional.
- Matrix of bone is in the form of layers called lamellae.
- Protein present in bone is called ossein.
- Matrix is hard and nonpliable rich in Ca salts and collagen fibres.
- Mammalian long compact bone is characterised by the presence of Haversian canal system.



T.S. OF LONG BONE



L.S. OF LONG BONE

EXERCISE

EPITHELIAL TISSUE

1. Exoskeleton originated from (Eg feathers, nail, horn, hooves) :-
 - (1) Connective tissue proper
 - (2) Epithelium tissue
 - (3) Skeletal tissue
 - (4) Vascular tissue
2. Air sacs of lungs and Bowman's capsule are made up of :-
 - (1) Pavement Epithelium
 - (2) Columnar Epithelium
 - (3) Cuboidal Epithelium
 - (4) Pseudo stratified Epithelium
3. Ciliated epithelium found in :-
 - (1) Oviduct
 - (2) Trachea
 - (3) Uterus
 - (4) 1, 2 & 3 all
4. Brush border epithelium (Microvilli containing) found in:-
 - (1) PCT
 - (2) Loop of Henle
 - (3) Collecting duct
 - (4) Bowman's capsule
5. Epithelium of retina & thyroid is made up of which type of cells :-
 - (1) Squamous + Cuboidal
 - (2) Columnar + Cuboidal
 - (3) Columnar + squamous
 - (4) Only Cuboidal
6. Characteristic of simple epithelium is :-
 - (1) They are arranged in discriminate
 - (2) They make a definite layer
 - (3) Never divide
 - (4) Large intercellular spaces
7. Tesselated epithelium is present in:-
 - (1) Ependymal membrane
 - (2) Endothelium
 - (3) Schneidarian membrane
 - (4) Alveoli of lungs
8. Germinal epithelium is composed of :-
 - (1) Cubodial epithelium
 - (2) Columnar epithelium
 - (3) Squamous epithelium
 - (4) Glandular epithelium
9. Select the false statement with respect to epithelial tissue.
 - (1) It has a free surface
 - (2) It faces body fluids sometimes
 - (3) It faces the external environment sometimes
 - (4) It sometimes forms middle structure part of organs
10. Inner lining of blood vessel is composed of :-
 - (1) Pseudostratified epithelium
 - (2) Simple cubodial epithelium
 - (3) Simple squamous epithelium
 - (4) Ciliated columnar epithelium
11. Gall bladder lined by :-
 - (1) Simple columnar epithelium
 - (2) Stratified columnar epithelium
 - (3) Brush border columnar epithelium
 - (4) Brush border cubodial epithelium
12. Inner lining of stomach, rectum and colon is made of:-
 - (1) Simple squamous epithelium
 - (2) Simple cubodial epithelium
 - (3) Simple columnar epithelium
 - (4) Pseudostratified epithelium
13. The correct statement with respect to epithelial tissue is :-

A – cells are compactly packed
 B – cells have no intercellular matrix
 C – cells have little intercellular material
 D – it is single or multilayered

 - (1) A & D
 - (2) B & C
 - (3) A, C & D
 - (4) All of these
14. Wall of Bowman's capsule in nephron is made up of :-
 - (1) Cubodial epithelium
 - (2) Columnar epithelium
 - (3) Squamous epithelium
 - (4) Glandular epithelium
15. Which of the following is made up of cube like cells?
 - (1) Epithelium of fallopian tubes
 - (2) Epithelium of PCT
 - (3) Epithelium of stomach
 - (4) Epithelium of alveoli

- 16.** Mesothelium or Peritoneum is originated from:-
 (1) Ectoderm (2) Endoderm
 (3) Ectomesoderm (4) Mesoderm
- 17.** Brush border epithelium occurs in
 (1) Trachea (2) Stomach
 (3) Small intestine (4) Fallopiian tube.
- 18.** Adjacent epithelial cells are held together by means of
 (1) Liposomes
 (2) Glyoxisomes/glyoxysomes
 (3) Desmosomes
 (4) Microsomes.
- 19.** Simple epithelium is made of
 (1) Noncellular layer of hyaluronic acid
 (2) Actively dividing cells
 (3) Loosely arranged cells
 (4) Compactly packed single layer of cells.
- 20.** Characteristic of epithelial tissues is
 (1) Never produce glands
 (2) Cells can undergo rapid divisions
 (3) Abundant vasularisation
 (4) Large intercellular spaces.

CONNECTIVE TISSUE PROPER

- 21.** Matrix of connective tissue proper is secreted by-
 (1) Plasma cell (2) Fibroblast cell
 (3) Adipose cell (4) All the above
- 22.** Yellow fibers are present in :-
 (1) Arrange in bundles
 (2) Singly and branched
 (3) Singly and unbranched
 (4) Unbranched & arrange in bundles
- 23.** Most of the cells present in areolar connective tissue are :-
 (1) Mast cell (2) Plasma cell
 (3) Fibroblast (4) Macrophages
- 24.** Mast cells occur in
 (1) Connective tissue (2) Epithelial tissue
 (3) Skeletal tissue (4) Nervous tissue.
- 25.** Loose connective tissue is
 (1) Areolar (2) Bone
 (3) Blood (4) Cartilage.
- 26.** Ligament is
 (1) Modified white fibrous tissue
 (2) Inelastic white fibrous tissue
 (3) Modified elastic connective tissue
 (4) Modified epithelial tissues

- 27.** Collagen and elastin are formed by
 (1) Macrophages (2) Fibroblasts
 (3) Mast cells (4) Chondrocytes
- 28.** Ligament connects :
 (1) Bone to bone
 (2) Bone to muscle
 (3) Muscle to muscle
 (4) Both '2' and '3'
- 29.** Tendons and ligaments are specialized types of
 (1) Nervous tissue
 (2) Epithelial tissue
 (3) Muscular tissue
 (4) Fibrous connective tissue
- 30.** Ligament is mainly made up of
 (1) Reticulin (2) Elastin
 (3) Myosin (4) Collagen
- 31.** The main function of ligament is :
 (1) Joining of two bones
 (2) Joining of muscles
 (3) Joining of muscle to bone
 (4) Joining of muscle to nerves
- 32.** White adipose tissue contains :
 (1) Multilocular fat cells
 (2) Bilocular fat cells
 (3) Unilocular fat cells
 (4) alocular fat cells
- 33.** In human fibrous cartilage is found abundantly
 (1) Hyaline cartilage of joints
 (2) Nostrils
 (3) Intervertebral discs
 (4) External ear
- 34.** Red coloured fluid connective tissue which help in transport of gases is :-
 (1) Lymph (2) Blood
 (3) Haemoglobin (4) Tendon
- 35.** Areolar connective tissue joins -
 (1) Fat body with muscles
 (2) Integument with muscles
 (3) Bones with muscles
 (4) Bones with bones
- 36.** Mast cells secrete -
 (1) Hippurin
 (2) Myoglobin
 (3) Histamine
 (4) Hemoglobin

37. Given below is the diagrammatic sketch of a certain type of connective tissue. Identify the parts labelled A, B, C and D, and select the right option about them.



Options :

- | | Part-A | Part-B | Part-C | Part-D |
|---------------|------------|------------|-----------|--------|
| (1) Macro- | Collagen | Fibroblast | Mast cell | |
| phage | fibres | | | |
| (2) Mast cell | Collagen | Fibroblast | Macro- | |
| | fibres | | phage | |
| (3) Macro- | Fibroblast | Collagen | Mast cell | |
| phage | | fibres | | |
| (4) Mast cell | Macro- | Fibroblast | Collagen | |
| | phage | | fibres | |

BONE AND CARTILAGE

38. Haversian canal contain :-
 (1) Blood vessels & Nerves
 (2) Blood vessels only
 (3) Lymphatic only
 (4) Connective tissue only
39. Perichondrium is :-
 (1) Adipose tissue
 (2) White fibrous connective tissue
 (3) Yellow elastic tissue
 (4) Areolar connective tissue
40. Matrix of cartilage produced by :-
 (1) Chondrocytes (2) Chondro clasts
 (3) Osteocytes (4) Histiocytes
41. Which of following is lack of blood supply ?
 (1) Bone (2) Cartilage
 (3) Connective tissue (4) None
42. Which of the following are specialised connective tissue ?
 (1) Cartilage (2) Bone
 (3) Blood (4) All
43. Cartilage is present in :-
 (1) Between adjacent bones of vertebral column and limb
 (2) In middle of the long bone
 (3) Both
 (4) None
44. Which of the following have hard and non pliable ground substance ?
 (1) Cartilages (2) Bones
 (3) Both (4) Areolar tissues
45. Mammalian pinna is supported by
 (1) Hyaline cartilage
 (2) Calcified cartilage
 (3) Elastic cartilage
 (4) White fibrous connective tissue.
46. The kind of tissue that forms the supportive structure in our pinna (external ears) is also found in :-
 (1) Tip of the nose (2) Vertebrae
 (3) Nails (4) Ear ossicles
47. The supportive skeletal structures in the human external ears and in the nose tip are examples of :-
 (1) bone (2) cartilage
 (3) ligament (4) areolar tissue

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	4	1	4	2	2	1	4	3	3	3	3	3	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	3	3	4	2	2	2	3	1	1	3	2	1	4	2
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	3	3	2	2	3	3	1	2	1	2	4	1	2	3
Que.	46	47													
Ans.	1	2													

DIGESTION AND ABSORPTION

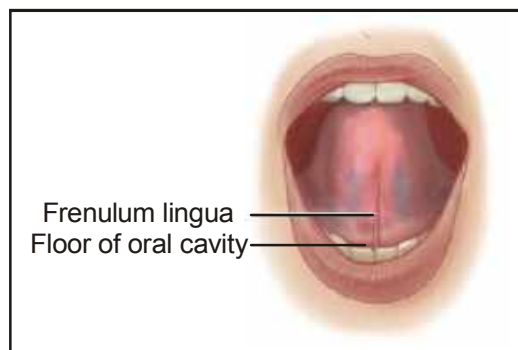
Food is one of the basic requirements of all living organisms. The major components of our food are carbohydrates, proteins and fats. Vitamins and minerals are also required in small quantities. Food provides energy and organic materials for growth and repair of tissues. The water we take in, plays an important role in metabolic processes and also prevents dehydration of the body. Biomacromolecules in food cannot be utilised by our body in their original form. They have to be broken down and converted into simple substances in the digestive system. This process of conversion of complex food substances to simple absorbable forms is called digestion and is carried out by our digestive system by mechanical and biochemical methods.

The human digestive system consists of the alimentary canal and the associated glands.

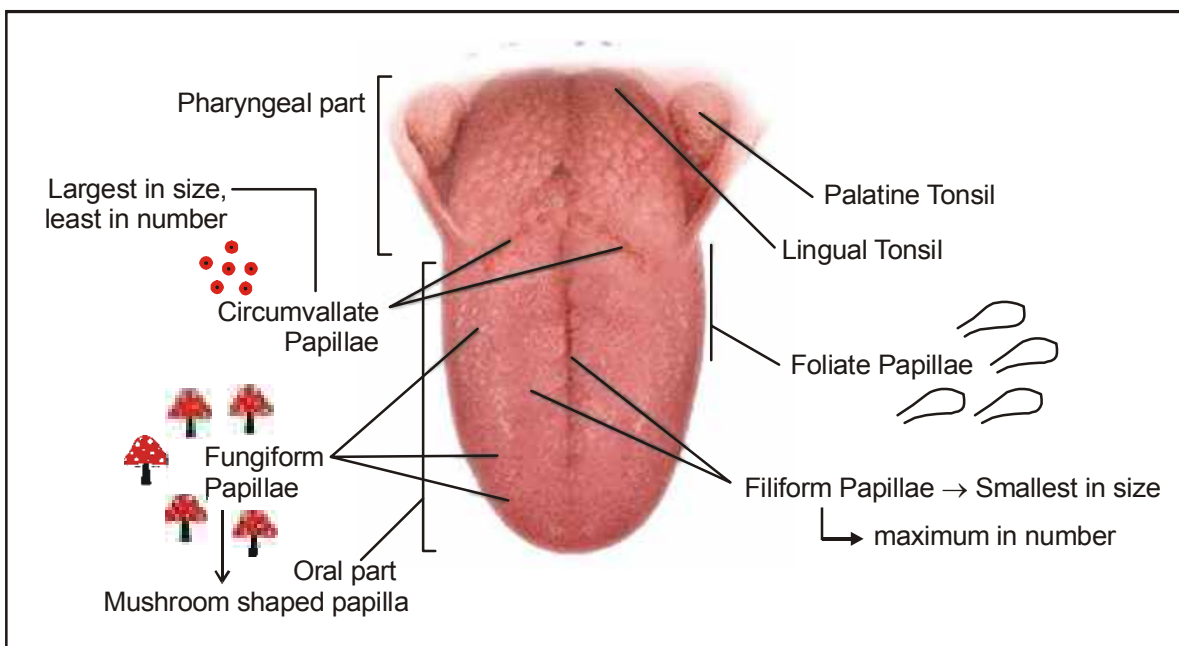
ALIMENTARY CANAL

The alimentary canal begins with an anterior opening – the mouth, and it opens out posteriorly through the anus. The mouth leads to the buccal cavity or oral cavity. The oral cavity has a number of teeth and a muscular tongue.

Tongue is highly muscular organ attach to the floor of oral cavity with the help of filamentous fold called frenulum lingua

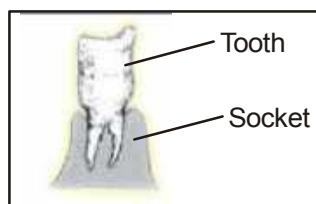


The upper surface of the tongue has small projections called papillae, some of which bear taste buds.

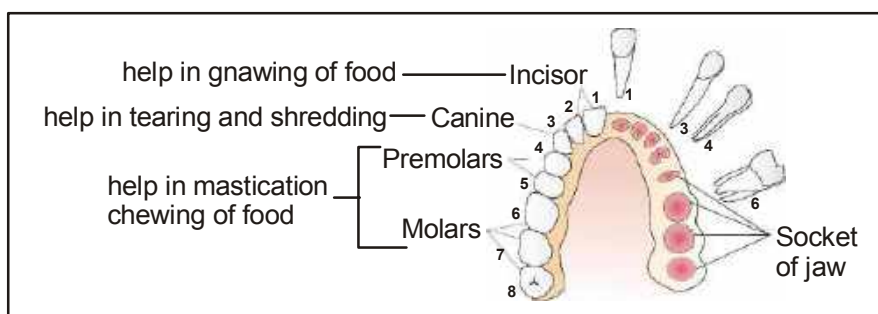


TEETH

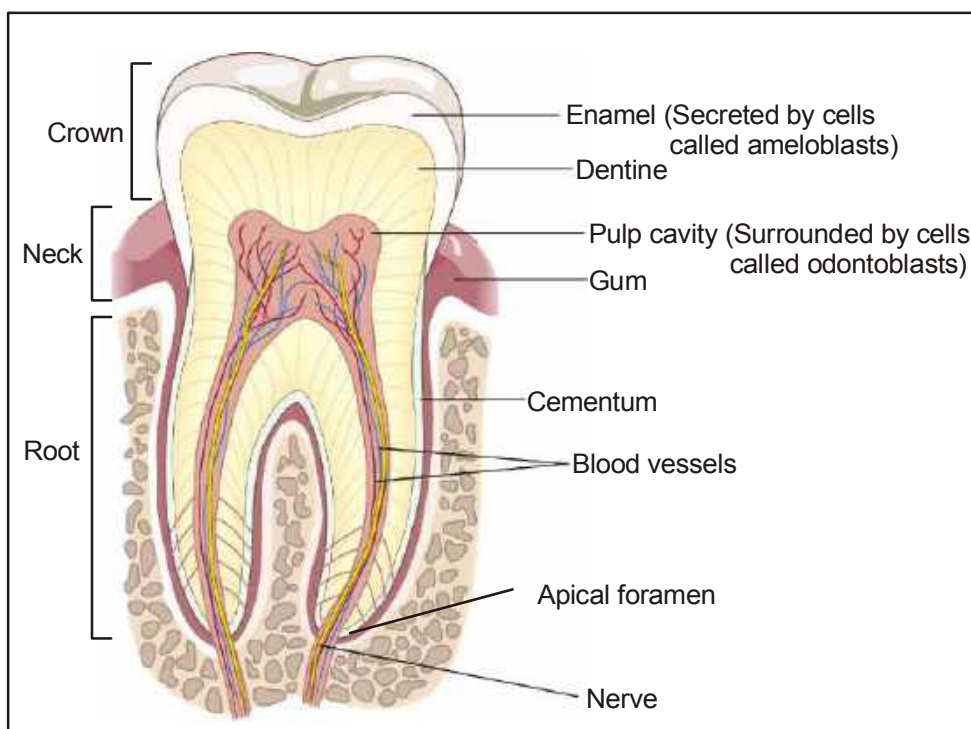
The oral cavity has a number of teeth and a muscular tongue. Each tooth is embedded in a socket of jaw bone. This type of attachment is called thecodont.



Majority of mammals including human being forms two sets of teeth during their life, a set of temporary milk or deciduous teeth replaced by a set of permanent or adult teeth. This type of dentition is called diphyodont. An adult human has 32 permanent teeth which are of four different types (Heterodont dentition), namely, incisors (I), canines (C), premolars (PM) and molars (M). Arrangement of teeth in each half of the upper and lower jaw in the order I, C, PM, M is represented by a dental formula which in human is $2123/2123$. (Diphyodont - 20 in number - 8 incisors, 4 canines, 6 molars) (monophyodont - 12 in number - 8 premolars, 4 last molars)



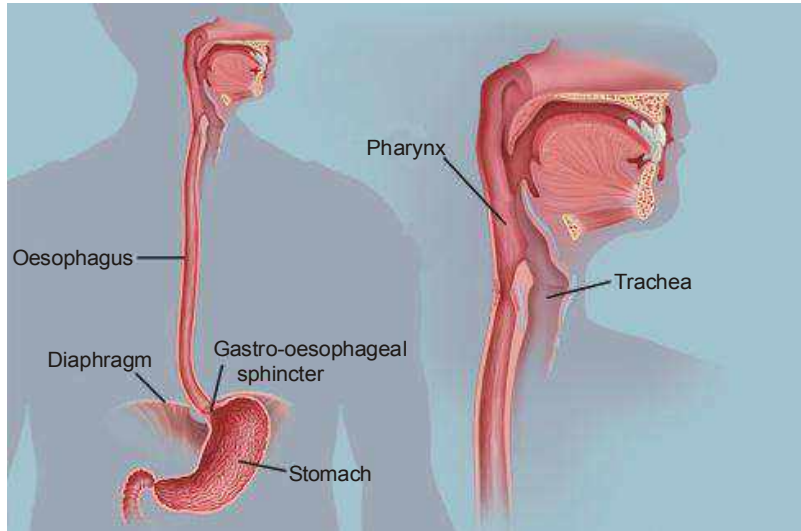
The hard chewing surface of the teeth, made up of enamel, helps in the mastication of food.



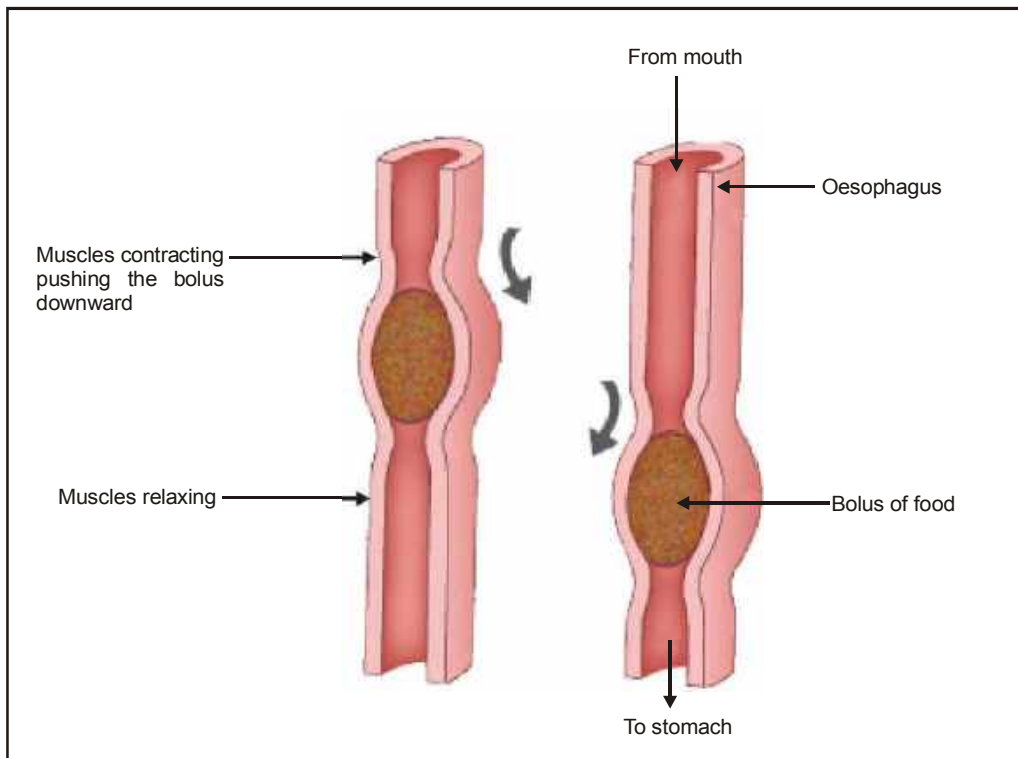
Enamel is the hardest substance of animal kingdom because it contains maximum amount of inorganic substances (96%). Dentine is the main part of tooth. Dentine contain 69% of inorganic substances.

OESOPHAGUS

The oral cavity leads into a short pharynx which serves as a common passage for food and air. The oesophagus and the trachea (wind pipe) open into the pharynx. The oesophagus is a thin, long tube which extends posteriorly passing through the neck, thorax and diaphragm and leads to a 'J' shaped bag like structure called stomach. A muscular sphincter (gastro-oesophageal) regulates the opening of oesophagus into the stomach.

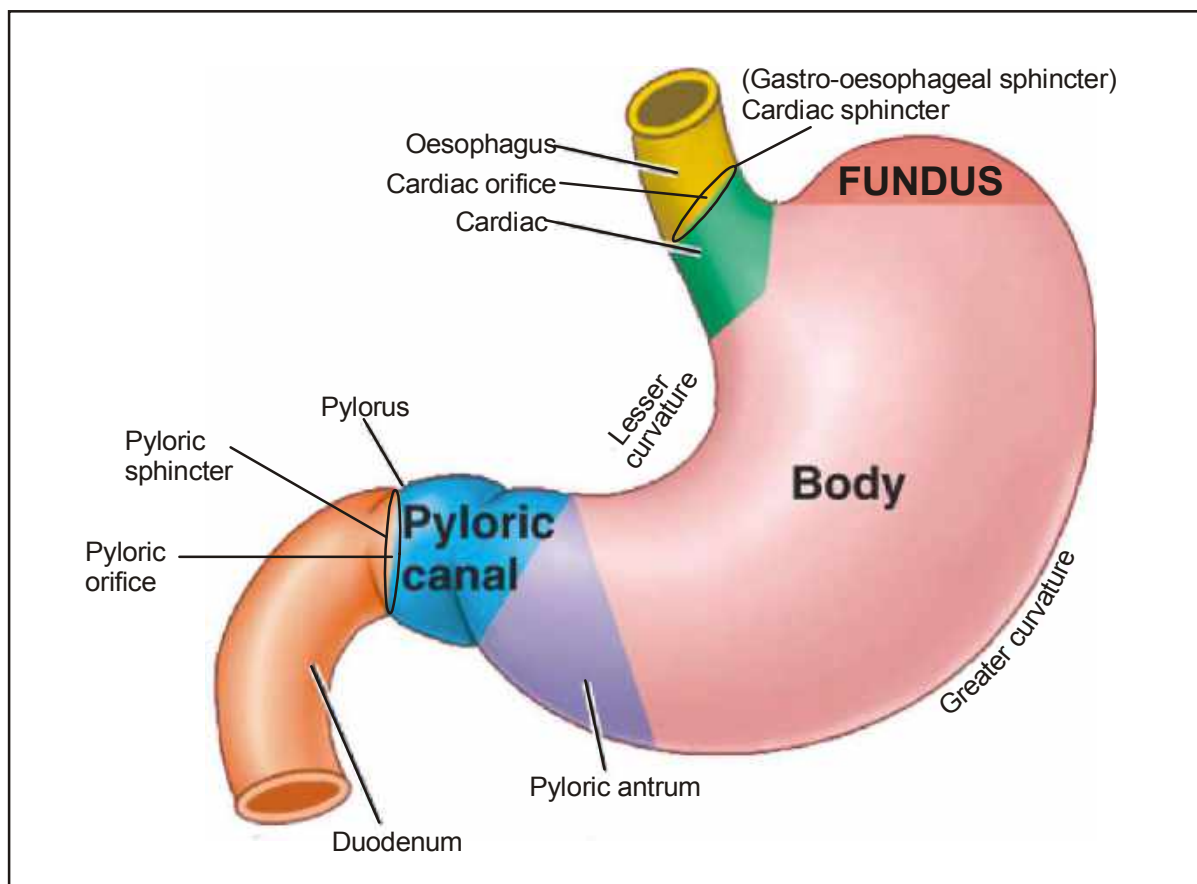


The bolus (mixture of food and saliva) passes down through the oesophagus by successive waves of muscular contractions called peristalsis. The gastro-oesophageal sphincter controls the passage of food into the stomach.



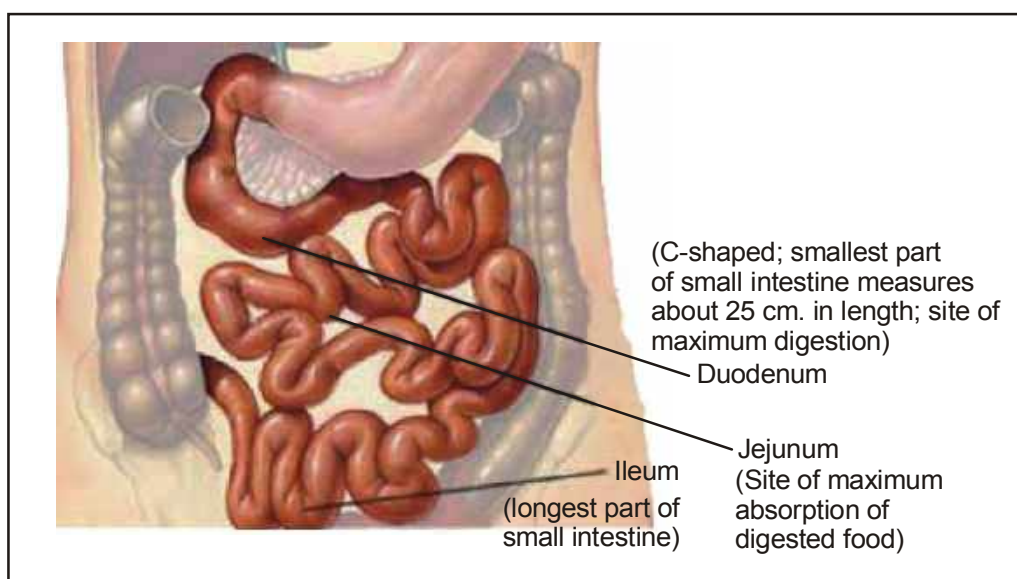
STOMACH

A muscular sphincter (gastro-oesophageal) regulates the opening of oesophagus into the stomach. The stomach, located in the upper left portion of the abdominal cavity, has four parts : cardiac, fundus, body and pylorus (cardiac portion in which the oesophagus opens, whereas the pyloric portion which opens into the first part of small intestine). The opening of the stomach into the duodenum is guarded by the pyloric sphincter.



SMALL INTESTINE

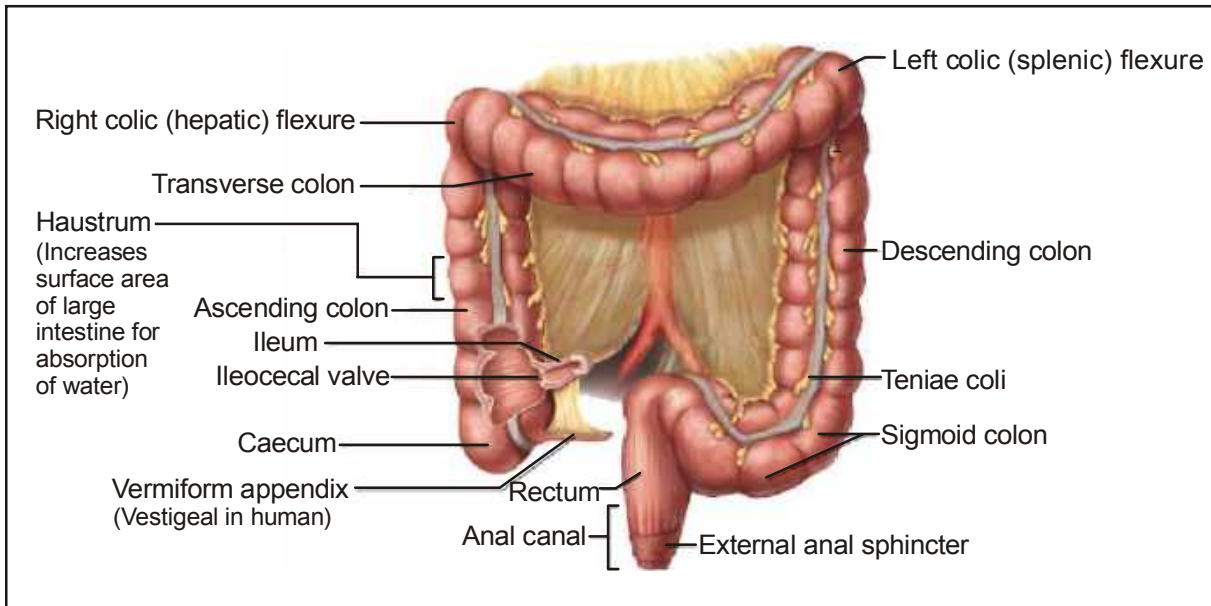
Small intestine is distinguishable into three regions, a 'C' shaped duodenum, a long coiled middle portion jejunum and a highly coiled ileum.



LARGE INTESTINE

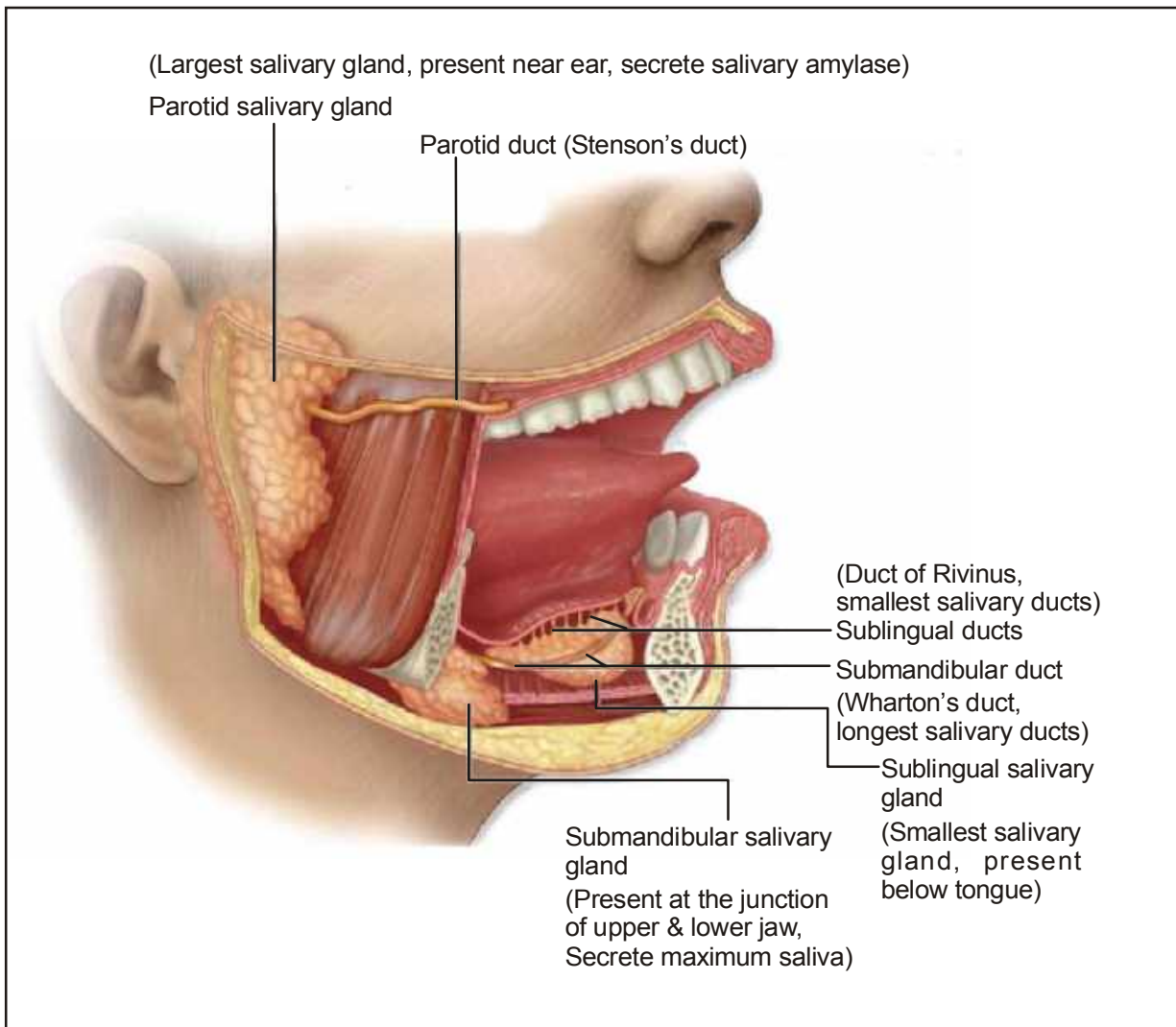
Ileum opens into the large intestine. It consists of caecum, colon and rectum. Caecum is a small blind sac which hosts some symbiotic micro-organisms. A narrow finger-like tubular projection, the vermiform appendix which is a vestigial organ, arises from the caecum. The caecum opens into the colon. The colon is divided into three parts – an ascending,

a transverse and a descending part. The descending part opens into the rectum which opens out through the anus.



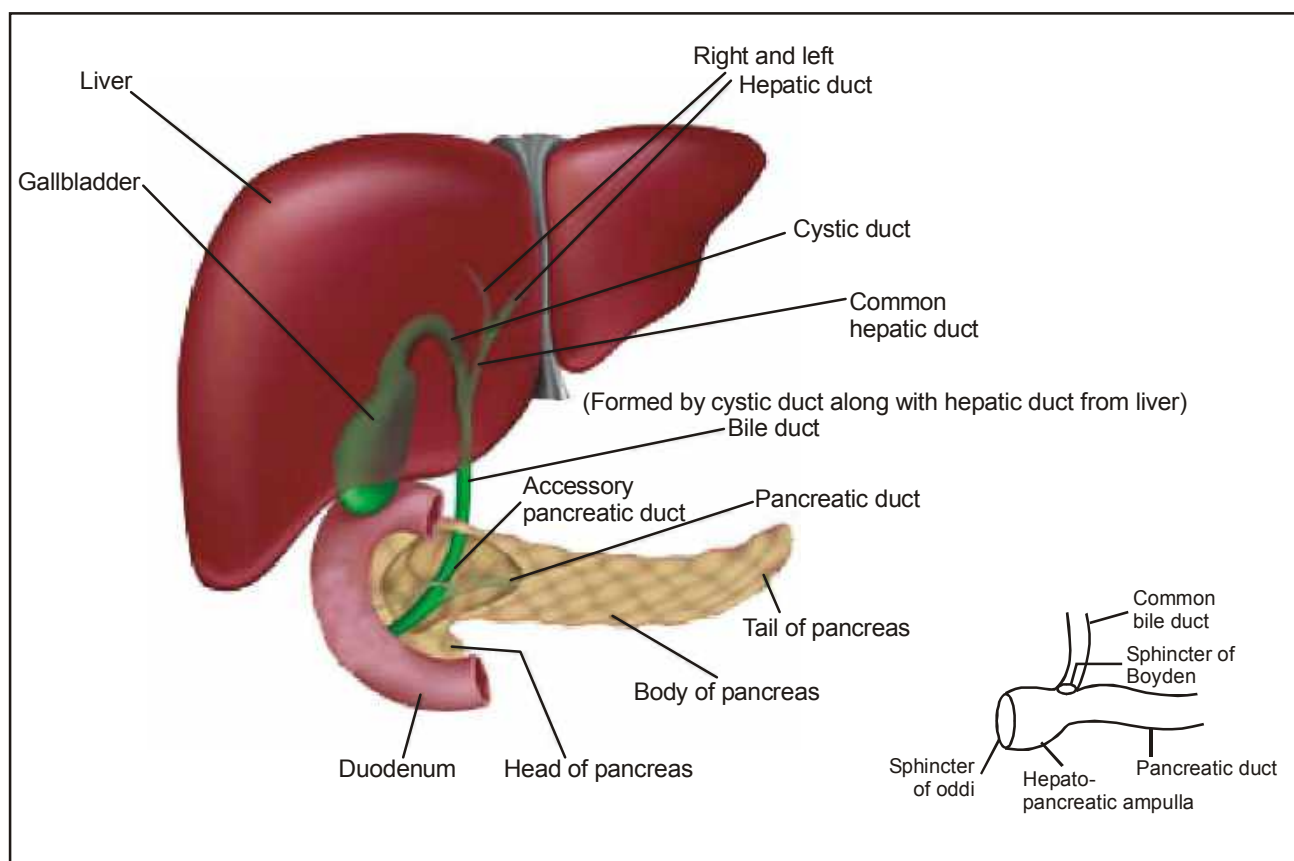
DIGESTIVE GLANDS

The digestive glands associated with the alimentary canal include the salivary glands, the liver and the pancreas. Saliva is mainly produced by three pairs of salivary glands, the parotids (cheek), the sub-maxillary/sub-mandibular (lower jaw) and the sublinguals (below the tongue). These glands situated just outside the buccal cavity secrete salivary juice into the buccal cavity.



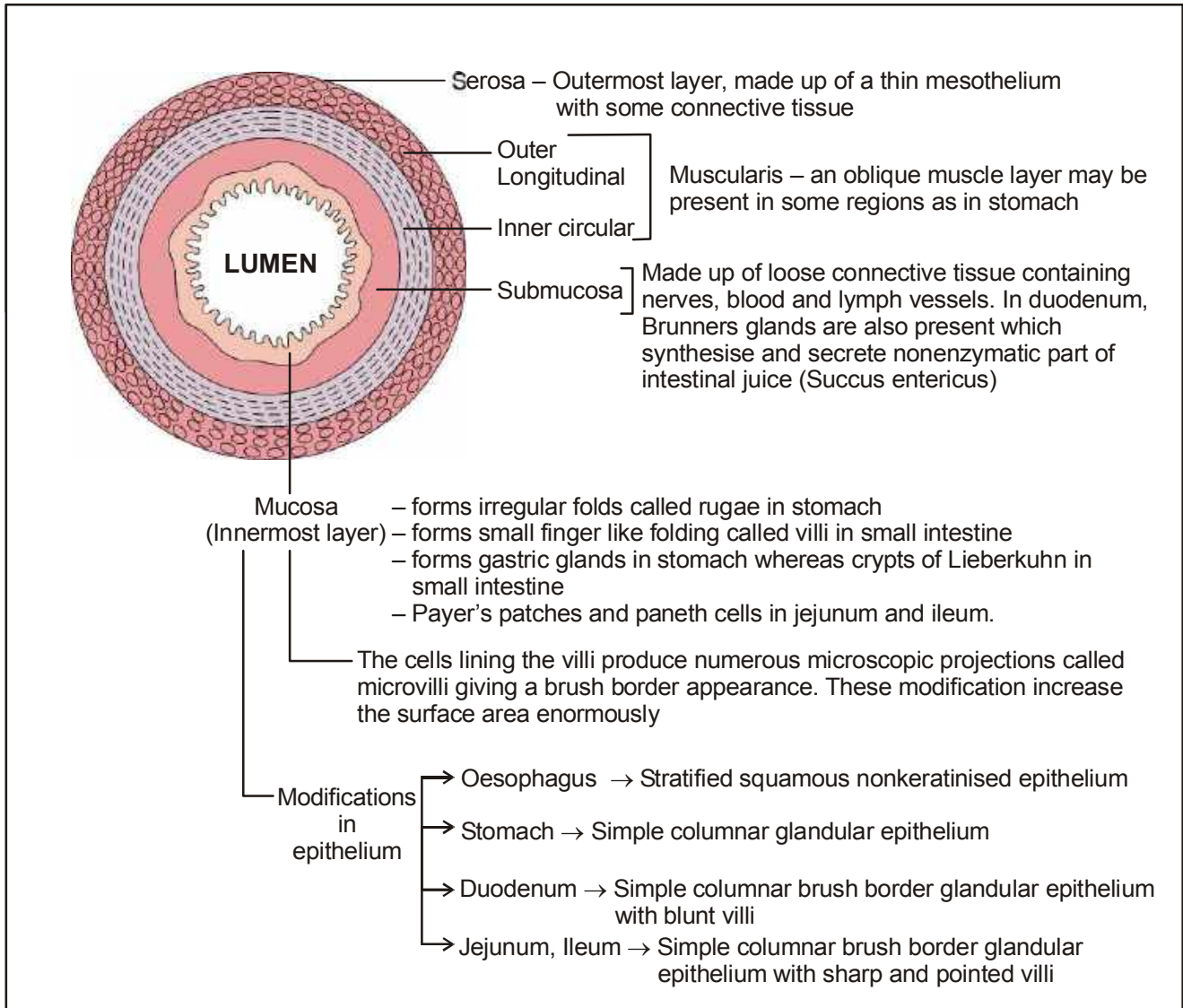
Liver is the largest gland of the body weighing about 1.2 to 1.5 kg in an adult human. It is situated in the abdominal cavity, just below the diaphragm and has two lobes. The bile secreted by the hepatic cells passes through the hepatic ducts and is stored and concentrated in a thin muscular sac called the gall bladder. The duct of gall bladder (cystic duct) along with the hepatic duct from the liver forms the common bile duct

The bile duct and the pancreatic duct open together into the duodenum as the common hepato-pancreatic duct which is guarded by a sphincter called the sphincter of Oddi. The pancreas is a compound (both exocrine and endocrine) elongated organ situated between the limbs of the 'C' shaped duodenum. The exocrine portion secretes an alkaline pancreatic juice containing enzymes and the endocrine portion secretes hormones, insulin and glucagon.



HISTOLOGY OF ALIMENTARY CANAL

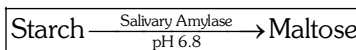
The wall of alimentary canal from oesophagus to rectum possesses four layers namely serosa, muscularis, sub-mucosa and mucosa. Serosa is the outermost layer and is made up of a thin mesothelium (epithelium of visceral organs) with some connective tissues. Muscularis is formed by smooth muscles usually arranged into an inner circular and an outer longitudinal layer. An oblique muscle layer may be present in some regions. The submucosal layer is formed of loose connective tissues containing nerves, blood and lymph vessels. In duodenum, glands are also present in sub-mucosa. The innermost layer lining the lumen of the alimentary canal is the mucosa. This layer forms irregular folds (rugae) in the stomach and small finger-like foldings called villi in the small intestine. The cells lining the villi produce numerous microscopic projections called microvilli giving a brush border appearance. These modifications increase the surface area enormously. Villi are supplied with a network of capillaries and a large lymph vessel called the lacteal. Mucosal epithelium has goblet cells which secrete mucus that help in lubrication. Mucosa also forms glands in the stomach (gastric glands) and crypts in between the bases of villi in the intestine (crypts of Lieberkuhn). All the four layers show modifications in different parts of the alimentary canal.



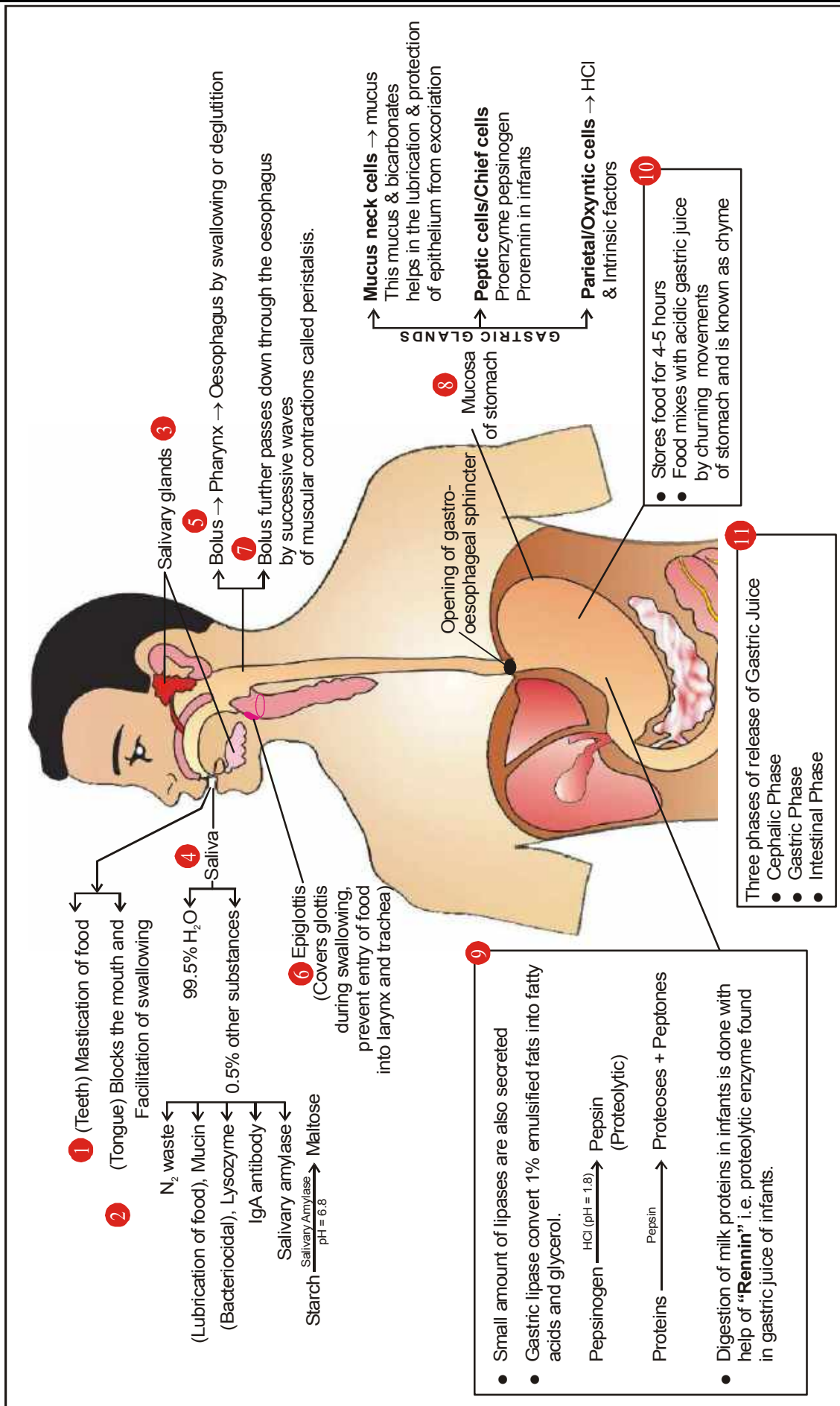
DIGESTION OF FOOD

The process of digestion is accomplished by mechanical and chemical processes.

The buccal cavity performs two major functions, mastication of food and facilitation of swallowing. The teeth and the tongue with the help of saliva masticate and mix up the food thoroughly. Mucus in saliva helps in lubricating and adhering the masticated food particles into a bolus. The bolus is then conveyed into the pharynx and then into the oesophagus by swallowing or deglutition. The bolus further passes down through the oesophagus by successive waves of muscular contractions called peristalsis. The gastro-oesophageal sphincter controls the passage of food into the stomach. The saliva secreted into the oral cavity contains electrolytes (Na⁺, K⁺, Cl⁻, HCO⁻) and enzymes, salivary amylase and lysozyme. The chemical process of digestion is initiated in the oral cavity by the hydrolytic action of the carbohydrate splitting enzyme, the salivary amylase. About 30 per cent of starch is hydrolysed here by this enzyme (optimum pH 6.8) into a disaccharide – maltose. Lysozyme present in saliva acts as an antibacterial agent that prevents infections.



The mucosa of stomach has gastric glands. Gastric glands have three major types of cells namely - (i) mucus neck cells which secrete mucus; (ii) peptic or chief cells which secrete the proenzyme pepsinogen; and (iii) parietal or oxyntic cells which secrete HCl and intrinsic factor (factor essential for absorption of vitamin B₁₂). Vitamin B₁₂ is also called cyanocobalamine. Deficiency of vitamin B₁₂ causes pernicious anaemia. The stomach stores the food for 4-5 hours. The food mixes thoroughly with the acidic gastric juice of the stomach by the churning movements of its muscular wall and is called the chyme. The proenzyme pepsinogen, on exposure to hydrochloric acid gets converted into the active enzyme pepsin, the proteolytic enzyme of the stomach. Pepsin converts proteins into proteoses and peptones (peptides).



The mucus and bicarbonates present in the gastric juice play an important role in lubrication and protection of the mucosal epithelium from excoriation by the highly concentrated hydrochloric acid. HCl provides the acidic pH (pH 1.8) optimal for pepsins. Rennin is a proteolytic enzyme found in gastric juice of infants which helps in the digestion of milk proteins. Small amounts of lipases are also secreted by gastric glands.

DIGESTION IN SMALL INTESTINE

BILE JUICE - pH 8.0 ; alkaline in nature

- Also called pseudodigestive juice
- Inhibit the action of HCl
- Activate pancreatic lipase
- Helps in emulsification of fats. Stimulate peristalsis
- Prevent food from decomposition

GIP - Gastric Inhibitory Peptide (Glucose dependent insulinotropic peptide)

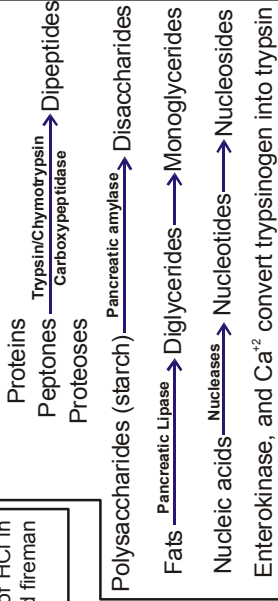
- Decrease the secretion of gastric juice in stomach

VIP - Vasoactive Intestinal Peptide

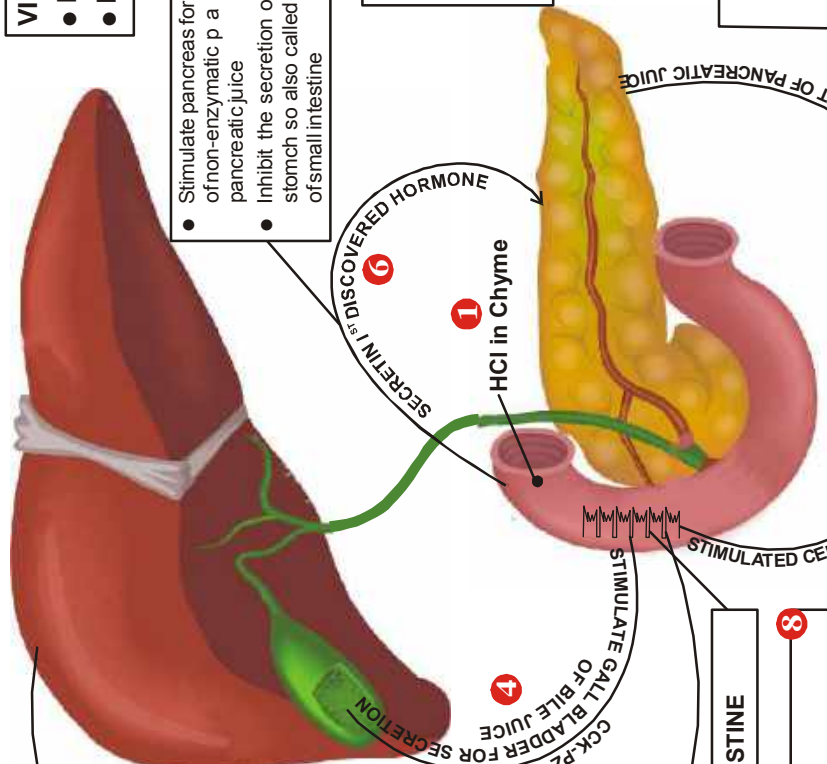
- Increase peristalsis in intestine
- Decrease peristalsis in stomach

- Stimulate pancreas for syn/sec of non-enzymatic part of pancreatic juice
- Inhibit the secretion of HCl in stomach so also called fireman of small intestine

DIGESTION IN DUODENUM
Biomacromolecules are digested in presence of bile juice and pancreatic juice



DIGESTION IN JEJUNUM AND ILEUM
Biomacromolecules are digested in presence of intestinal juice



2 ENTEROENDOCRINE CELLS OF INTESTINE

- **Villi** - Increase the activity of villi
- **Duocrinin** - Stimulate Brunner's glands for syn/sec of non-enzymatic part of intestinal juice
- Enterocrinin** - Stimulate Paneth cells or syn/sec of enzymatic part of intestinal juice

* SYN/SEC : Synthesis and Secretion

ABSORPTION OF DIGESTED FOOD

End products of digestion pass through the intestinal mucosa into blood or lymph.

Certain drugs coming in contact with the mucosa of mouth & lower side of the tongue are absorbed into the blood capillaries lining them.

Iron and calcium ions are absorbed

Principal organ for absorption of nutrients.

The digestion is completed here & the final products of digestion such as -

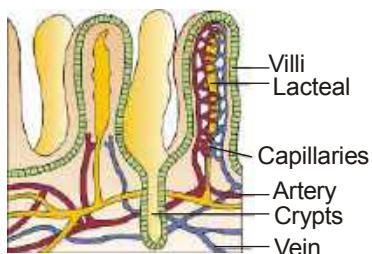
- Glucose
- Fructose
- Fatty acids
- Glycerol
- Amino acids

are absorbed through mucosa into blood vessels & lymph.

Absorption of H_2O , simple sugars and alcohol etc. takes place

Absorption of

- Water
- Some minerals and
- Drugs takes place



Fatty acids and glycerol being insoluble, cannot be absorbed into the blood. They are first incorporated into small droplets called micelles which move into the intestinal mucosa. They are re-formed into very small protein coated fat globules called the chylomicrons which are transported into the lymph vessels (lacteals) in the villi.

The absorbed substances finally reach the tissues which utilise them for their activities this process is called as Assimilation

DISORDERS OF DIGESTIVE SYSTEM

The inflammation of the intestinal tract is the most common ailment due to bacterial or viral infections. The infections are also caused by the parasites of the intestine like tape worm, round worm, thread worm, hook worm, pin worm, etc.

Jaundice : The liver is affected, skin and eyes turn yellow due to the deposit of bile pigments.

Vomiting : It is the ejection of stomach contents through the mouth. This reflex action is controlled by the vomit centre in the medulla. A feeling of nausea precedes vomiting.

Diarrhoea : The abnormal frequency of bowel movement and increased liquidity of the faecal discharge is known as diarrhoea. It reduces the absorption of food.

Constipation : In constipation, the faeces are retained within the rectum as the bowel movements occur irregularly.

Indigestion : In this condition, the food is not properly digested leading to a feeling of fullness. The causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating, and spicy food.

Protein-energy malnutrition (PEM) : It is caused due to dietary deficiencies of proteins and total food calories. PEM affects infants and children to produce Marasmus and Kwashiorkor.

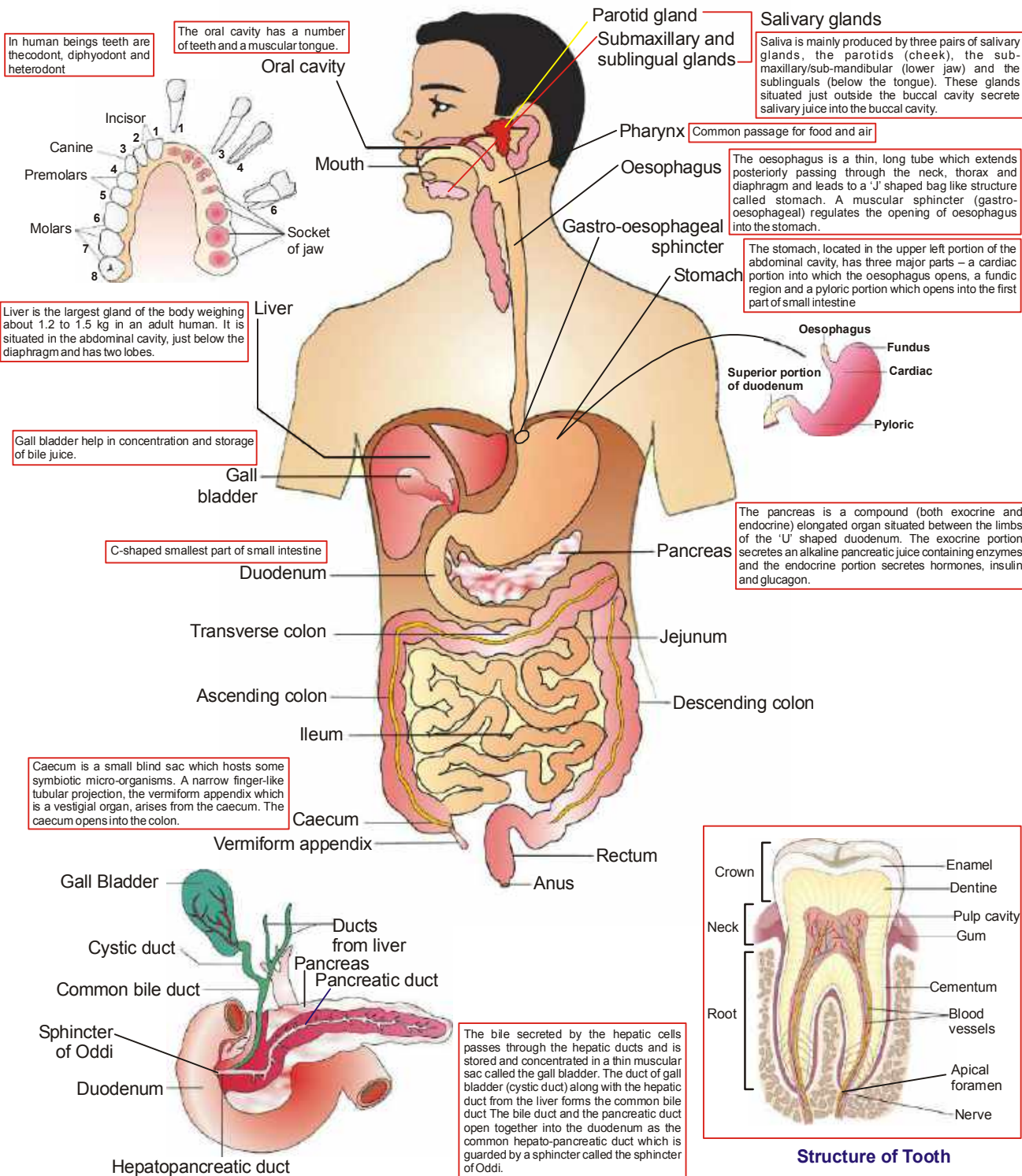
S.N.	KWASHIORKOR	MARASMUS
1.	It occurs due to protein deficiency unaccompanied by calorie deficiency	It occurs due to deficiency of proteins, carbohydrate & fats in the diet.
2.	It occurs in children of age 1-5 years (i.e. more than one year in age). It results from the replacement of mother's milk by a high calorie-low protein-diet.	It occurs in infants less than a year in age. If mother's milk is replaced too early by other foods which are poor in protein & calorie value. This often happens if the mother has second pregnancy or childbirth when the older infant is still too young.
3.	Symptoms : <ul style="list-style-type: none"> ● Wasting of muscles. ● Thinning of limbs. ● Failure of growth & brain development ● Oedema & swelling of body parts. 	Symptoms : <ul style="list-style-type: none"> ● Impaired growth & replacement of tissue proteins. ● Extreme emaciation of the body ● Thinning of limbs ● Skin dry, thin, wrinkled ● Declined growth rate & body weight. ● Impaired growth & development of brain & mental faculties.

Caloric value :

- The amount of heat liberated from complete combustion of 1 gm food in a bomb calorimeter (a closed metal chamber filled with O₂) is its gross calorific value or gross energy value (G.C.V.).
- The actual amount of energy liberated in the human body due to combustion of 1 gm of food is the physiologic value (P.V.) of food.

Food substance	G.C.V. (in K.cal/gm)	P.V. In K.cal/gm)
Carbohydrate	4.1	4.0
Protein	5.65	4.0
Fats	9.45	9.0

HUMAN DIGESTIVE SYSTEM



The Duct System of Liver, Gall-Bladder and Pancreas

EXERCISE

ANATOMY OF ALIMENTARY CANAL, DIGESTIVE GLANDS, HISTOLOGY OF ALIMENTARY CANAL

- How many teeth in man grows twice in life :
(1) 32 (2) 28 (3) 20 (4) 12
- In human teeth, which help in cutting
(1) Canine (2) Incisor
(3) Molar (4) Premolar
- Molars and Premolars are modified for :
(1) Crushing (2) Tearing
(3) Peristalsis (4) Cutting
- Pulp cavity of teeth is lined by :
(1) Odontoblast (2) Chondroblast
(3) Osteoblast (4) Amyloblast
- The longitudinal mucosal folds of inner wall of stomach are called :
(1) Papilla of vater (2) Rugae
(3) Villi (4) Fissure
- Glisson's capsule is associated with :
(1) liver (2) pancreas
(3) lungs (4) kidney
- In mammals the teeth are
(a) of different types
(b) embedded in the cuplike socket in the jaw bones
(c) only two sets, present throughout life
The condition are referred as :
(1) heterodont, thecodont, diphyodont
(2) thecodont, heterodont, diphyodont
(3) diphyodont, thecodont, heterodont
(4) heterodont, diphyodont, thecodont
- Find out the correct match :

Column I

Column II

- | | |
|-------------------------|--------------------------|
| A. Hepatic lobule | i. Sub mucosal glands |
| B. Brunner's glands | ii. Base of villi |
| C. Crypts of lieberkuhn | iii. Glisson's capsule |
| D. Sphincter of Oddi | iv. Gall bladder |
| E. Cystic duct | v. Hepatopancreatic duct |

- | | | | | | |
|-----|-----|----|-----|----|----|
| | A | B | C | D | E |
| (1) | iii | vi | ii | v | iv |
| (2) | v | ii | iii | vi | i |
| (3) | iii | i | ii | v | iv |
| (4) | iv | vi | v | ii | i |

- Gall bladder is found :
(1) below right lobe of liver
(2) below left lobe of liver
(3) in between the two lobes of liver
(4) third lobe of liver
- Bile can be prevented to release into the duodenum by :-
(1) pyloric valve
(2) sphincter of oddi
(3) cardiac sphincter
(4) sphincter of Boyden
- It is a correct dental formula for the child falling under age group 5-6 years :-
(1) $i = 2/2, c = 1/1, pm = 0/0, m = 2/2$
(2) $i = 2/2, c = 1/1, pm = 2/2, m = 3/3$
(3) $i = 1/1, c = 2/2, pm = 2/2, m = 3/3$
(4) $i = 2/2, c = 2/2, pm = 1/1, m = 3/3$

PHYSIOLOGY OF DIGESTION

- Enzyme present in saliva is :
(1) Maltase (2) Ptyalin
(3) Sacrase (4) Invertase
- Maximum digestion of food take place in -
(1) Stomach (2) Jejunum
(3) Colon (4) Duodenum
- Absence of which of these in bile will make fat digestion difficult-
(1) Cholesterol (2) Salts
(3) Pigment (4) Acids
- Pancreatic juice is released into-
(1) Duodenum (2) Ileum
(3) Stomach (4) Jejunum.
- The three secretions meeting the food in small intestine are-
(1) Bile juice, pancreatic juice and intestinal juice
(2) Pancreatic, intestinal and gastric juice
(3) Bile, pancreatic and gastric juice
(4) Bile, gastric juice and Saliva.
- Which one of the following hormone inhibits the secretion of gastric juice-
(1) Gastrin (2) Secretin
(3) CCK (4) Enterogastrin
- The enzyme that catalyse the changing of emulsified oil to fatty acids and glycerol is-
(1) Pepsin (2) Lipase
(3) Amylase (4) Sucrose

- 19.** Point out the odd one-
 (1) Rennin (2) Secretin
 (3) Calcitonin (4) Oxytocin
- 20.** Which one is not an enzyme of digestive system-
 (1) Enterokinase
 (2) Amylase
 (3) Trypsin
 (4) Enterogastrin
- 21.** Secretin stimulates the production of
 (1) Saliva (2) Gastrin
 (3) Bile (4) Pancreatic juice
- 22.** The cells in the wall of intestine are stimulated to produce secretin by-
 (1) Cholecystokinin (2) Bile juice
 (3) Acid in chyme (4) Gastrin
- 23.** Pancreatic lipase acts upon-
 (1) Glycogen (2) Triglycerides
 (3) Disaccharides (4) Polypeptides
- 24.** Amount of fat increases in the body due to excess intake of-
 (1) Vitamins (2) Minerals
 (3) Carbohydrates (4) None of these
- 25.** Bile is formed in-
 (1) Gall bladder (2) Liver
 (3) Spleen (4) Blood
- 26.** Enzyme trypsinogen is changed to trypsin by-
 (1) Gastrin (2) Enterogastrone
 (3) Enterokinase (4) Secretin
- 27.** Castle's intrinsic factor is connected with internal absorption of
 (1) Pyridoxine (2) Riboflavin
 (3) Thiamine (4) Cobalamine
- 28.** Ptyalin, a digestive enzyme produces-
 (1) Maltose (2) Smaller peptides
 (3) Peptones (4) Amino acids
- 29.** Rennin acts on-
 (1) Milk, changing casien into calcium paracaseinate at 7.2 - 8.2 PH
 (2) Proteins in stomach
 (3) Fat in intestine
 (4) Milk, changing casien into calcium paracaseinate at 1-3 PH
- 30.** Muscular contraction of Alimentary canal are-
 (1) Circulation (2) Deglutition
 (3) Chewing (4) Peristalsis
- 31.** Pepsinogen is converted to pepsin by:-
 (1) Low pH (2) Trypsinogen
 (3) Chymotrypsin (4) Enterokinase
- 32.** Mucus is secreted by the :-
 (1) Stomach (2) Duodenum
 (3) Large intestine (4) All of the above
- 33.** Lactose composed of :-
 (1) Glucose + galactose (2) Glucose + fructose
 (3) Glucose + glucose (4) Glucose + mannose
- 34.** Which of the following stimulates the secretion of gastric juice :-
 (1) Gastrin
 (2) Enterogasterone
 (3) Secretin
 (4) Hepatocrinin
- 35.** If for some reason the parietal cells of the gut epithelium become partially non-functional, what is likely to happen ?
 (1) The pH of stomach will fall abruptly
 (2) Steapsin will be more effective
 (3) Proteins will not be adequately hydrolysed by pepsin into proteoses and peptones
 (4) The pancreatic enzymes and specially the trypsin and lipase will not work efficiently
- 36.** In stomach after physical and chemical digestion food is called:-
 (1) Chyme (2) Chyle
 (3) Amino acid (4) Bolus
- 37.** A person who is eating rice. His food contains
 (1) Cellulose (2) Starch
 (3) Lactose (4) Protein
- 38.** In mammals milk is digested by action of-
 (1) Rennin (2) Amylase
 (3) Intestinal bacteria (4) Invertase
- 39.** Hydrolytic enzymes which does not act on low pH are called as :-
 (1) Protease (2) α -Amylase
 (3) Hydrolases (4) Peroxidase
- 40.** Which of the following is a dissacharide :
 (1) Glucose (2) Fructose
 (3) Sucrose (4) Galactose
- 41.** Glucose and galactose unite to form
 (1) Maltose (2) Sucrose
 (3) Isomaltose (4) Lactose

- 42.** Gastric enzyme pepsin reacts only in acidic medium with in a limited pH concentration. It varies:
 (1) 3.20 to 4.80
 (2) 4.00 to 4.50
 (3) 7.00 to 8.50
 (4) 1.50 to 2.60
- 43.** Stomach in vertebrates is the main site for digestion of :
 (1) Proteins (2) Carbohydrates
 (3) Fats (4) Nucleic acids
- 44.** The chief function of bile is to :
 (1) Digest fat by enzymatic action
 (2) Emulsify fats for digestion
 (3) Eliminate waste products
 (4) Regulate digestion of proteins
- 45.** The toxic substance are detoxicated in the human body by :
 (1) Lungs (2) Kidneys
 (3) Liver (4) Stomach
- 46.** Function of HCl in stomach is to :
 (1) Activate trypsinogen to trypsin
 (2) Facilitate absorption of food
 (3) Dissolve enzymes
 (4) Activate pepsinogen to pepsin
- 47.** The muscular contraction in the alimentary canal is known as :
 (1) Systole (2) Diastole
 (3) Peristalsis (4) Metachronal
- 48.** Succus entericus is also called :
 (1) Gastric juice (2) Intestinal juice
 (3) bile juice (4) Saliva
- 49.** Just as hydrochloric acid is for pepsinogen, so is the
 (1) haemoglobin to oxygen
 (2) enterokinase to trypsinogen
 (3) bile juice to fat
 (4) glucagon to glycogen
- 50.** What is the function of goblet cells :
 (1) Production of enzyme
 (2) Production of mucin
 (3) Production of hormone
 (4) Production of HCl
- 51.** Which of the following is different from others :
 (1) Gastrin (2) Ptyalin
 (3) Glucagon (4) Secretin
- 52.** Pancreatic juice is :
 (1) alkaline in nature
 (2) acidic in nature
 (3) neutral in nature
 (4) both acidic and alkaline in nature
- 53.** What is the common passage for bile and pancreatic juices
 (1) Ampulla of Vater (2) Ductus Choledochus
 (3) Duct of Wirsung (4) Duct of Santorini
- 54.** Cells of the pancreas is not digested by their own enzymes because :
 (1) enzymes are secreted in inactive form
 (2) cells are lined by mucous membrane
 (3) enzymes are released only when needed
 (4) none of the above
- 55.** Bile salts help in :-
 (1) digestion of fats
 (2) emulsification of fats
 (3) absorption of fats
 (4) both absorption and digestion of fats
- 56.** Bile secretion is proportional to the concentration of:
 (1) Protein (2) Fat
 (3) Carbohydrate (4) None of these
- 57.** pH of gastric juice is :
 (1) 2 (2) 4 (3) 6 (4) 8
- 58.** Which of the following hormone helps in secretion of HCl from stomach ?
 (1) renin (2) gastrin
 (3) secretin (4) somatomedin
- 59.** Carbohydrate digestion occurs first in which structure?
 (1) mouth (2) intestine
 (3) stomach (4) none of these
- 60.** Which of the following is called pseudo digestive juice ?
 (1) Saliva (2) Bile juice
 (3) Gastric juice (4) Intestinal juice
- 61.** Pepsinogen is secreted by :
 (1) chief-cells (2) oxyntic cells
 (3) mast cells (4) parietal cells
- 62.** Prorennin is secreted by :
 (1) zymogen cells (2) sertoli cells
 (3) islets of langerhans (4) hepatocytes

- 63.** Which one of the following is the correct matching of the site of action on the given substrate, the enzyme acting upon it and the end product :
- (1) Small intestine : proteins $\xrightarrow{\text{pepsin}}$ amino acids
 (2) Stomach : fats $\xrightarrow{\text{lipase}}$ micelles
 (3) Duodenum :
 triglycerides $\xrightarrow{\text{trypsin}}$ monoglycerides
 (4) Small intestine : starch $\xrightarrow{\alpha\text{-amylase}}$ disaccharide (maltose)
- 64.** Which one of the following enzymes carries out the initial step in the digestion of milk in humans ?
 (1) Pepsin (2) Rennin
 (3) Lipase (4) Trypsin
- 65.** Another substance of the category of glucose, sucrose and maltose is-
 (1) Myoglobin (2) Starch
 (3) Amino acids (4) Haemoglobin
- ABSORPTION - ASSIMILATION - EGESTION**
- 66.** Glycogen is stored in-
 (1) Blood (2) Liver
 (3) Lungs (4) Kidney
- 67.** Lacteals take part-
 (1) Digestion of milk
 (2) Absorption of fat
 (3) Digestion of lactic acid
 (4) None of the above
- 68.** Fatty acids and glycerol are first absorbed by-
 (1) Lymph vessels (2) Blood
 (3) Blood capillaries (4) Hepatic portal Vein
- 69.** Water absorption is mainly occur in :-
 (1) Colon (2) Intestine
 (3) Gastrum (4) Appendix
- 70.** Which of the following is absorbed in proximal intestine :-
 (1) Iron (2) sodium
 (3) Bile salts (4) Vitamin B₁₂
- 71.** Fully digested food reaches to liver by
 (1) Hepatic portal vein (2) Hepatic artery
 (3) Hepatic vein (4) All the above
- 72.** The organ in human body where glycogenolysis takes place?
 (1) muscles (2) liver
 (3) small intestine (4) kidney
- 73.** Protein are mainly required in the body for-
 (1) Growth (2) Repair
 (3) Both of these (4) None of these
- 74.** In mammals carbohydrate is stored in the form of-
 (1) Lactic acid in muscles
 (2) Glycogen in liver and muscles
 (3) Glucose in liver and muscles
 (4) Glycogen in liver and spleen
- DISORDERS**
- 75.** Jaundice is a disorder of :
 (1) Skin and eyes (2) Digestive system
 (3) Circulatory system (4) Excretory system
- 76.** Osteomalacia occurs due to the deficiency of :
 (1) Vitamin A (2) Vitamin B
 (3) Vitamin C (4) Vitmina D
- 77.** Protein deficiency leads to :
 (1) kwashiorkar (2) marasmus
 (3) cretinism (4) both (1) and (2)
- 78.** A patient is generally advised to specially, consume more meat, lentils, milk and eggs in diet only when the suffers from :
 (1) Kwashiorkar (2) Rickets
 (3) Anaemia (4) Scurvy

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	2	1	1	2	1	1	3	1	2	1	2	4	2	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	4	2	1	4	4	3	2	3	2	3	4	1	4	4
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	4	1	1	3	1	2	1	2	3	4	4	1	2	3
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	2	2	2	2	1	1	1	2	2	1	2	1	2
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	1	1	4	2	2	2	2	1	2	1	1	2	3	2	2
Que.	76	77	78												
Ans.	4	4	1												

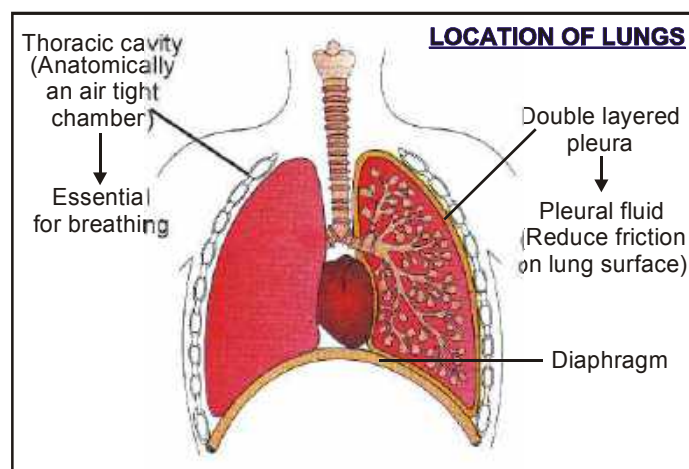
BREATHING AND EXCHANGE OF GASES

As you have read earlier, oxygen (O_2) is utilised by the organisms to indirectly break down nutrient molecules like glucose and to derive energy for performing various activities. Carbon dioxide (CO_2) which is harmful is also released during the above catabolic reactions. It is, therefore, evident that O_2 has to be continuously provided to the cells and CO_2 produced by the cells have to be released out. This process of exchange of O_2 from the atmosphere with CO_2 produced by the cells is called breathing, commonly known as respiration.

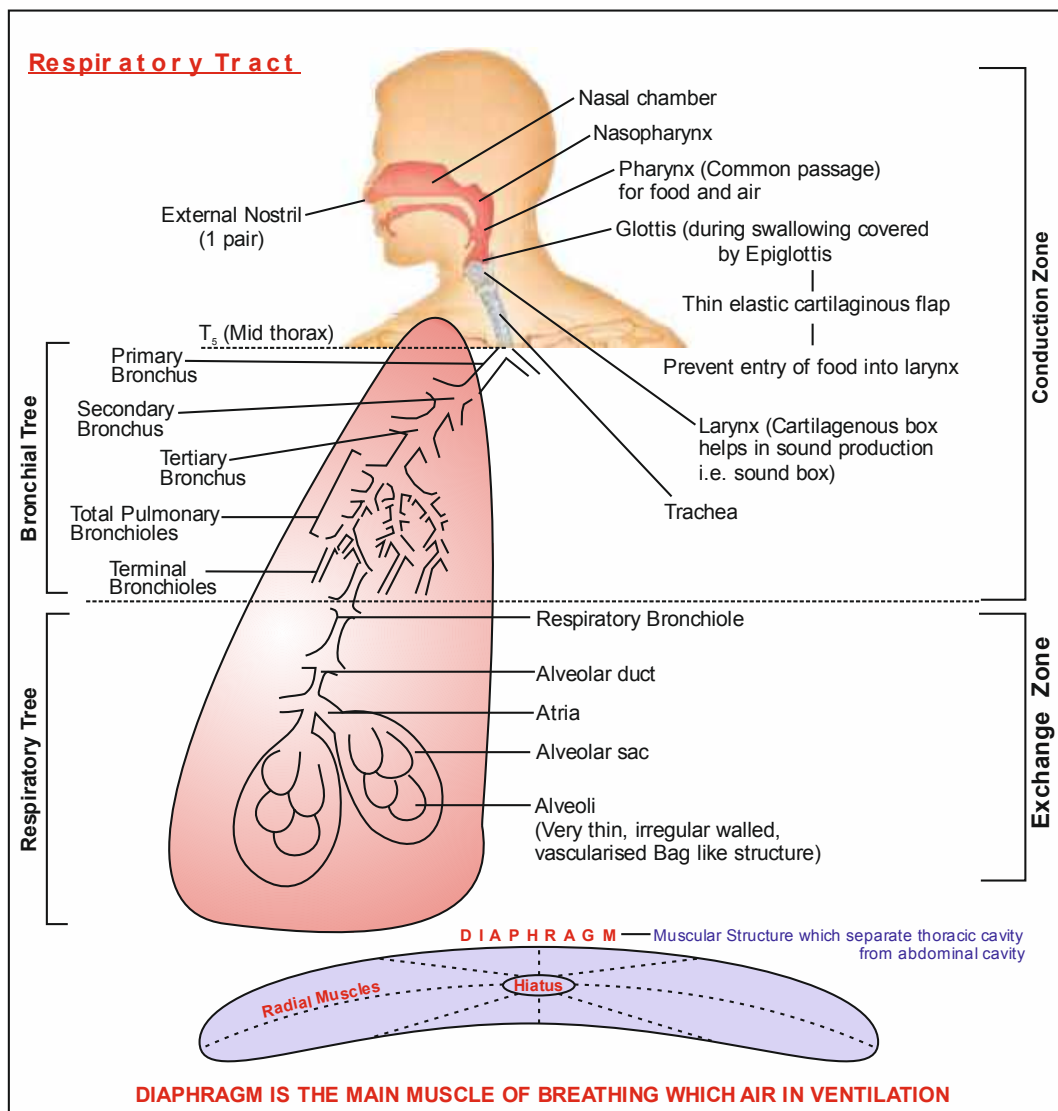
Respiration involves the following steps:

- (i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.
- (ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane.
- (iii) Transport of gases by the blood.
- (iv) Diffusion of O_2 and CO_2 between blood and tissues.
- (v) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2 (cellular respiration).

Respiratory organs	
Depend on	<ul style="list-style-type: none"> Habitat Level of organization
(1) Through general body surface = Sponges, (Simple diffusion)	coelenterates, flatworms
(2) Through Moist cuticle = Earthworm	
(3) Network of tracheal tubes = Insects	
(4) Gills = Aquatic arthropods, molluscs, fishes	
(5) Lungs (Vascularised bags) = Reptiles, Amphibians (also by Moist skin)	birds, mammals

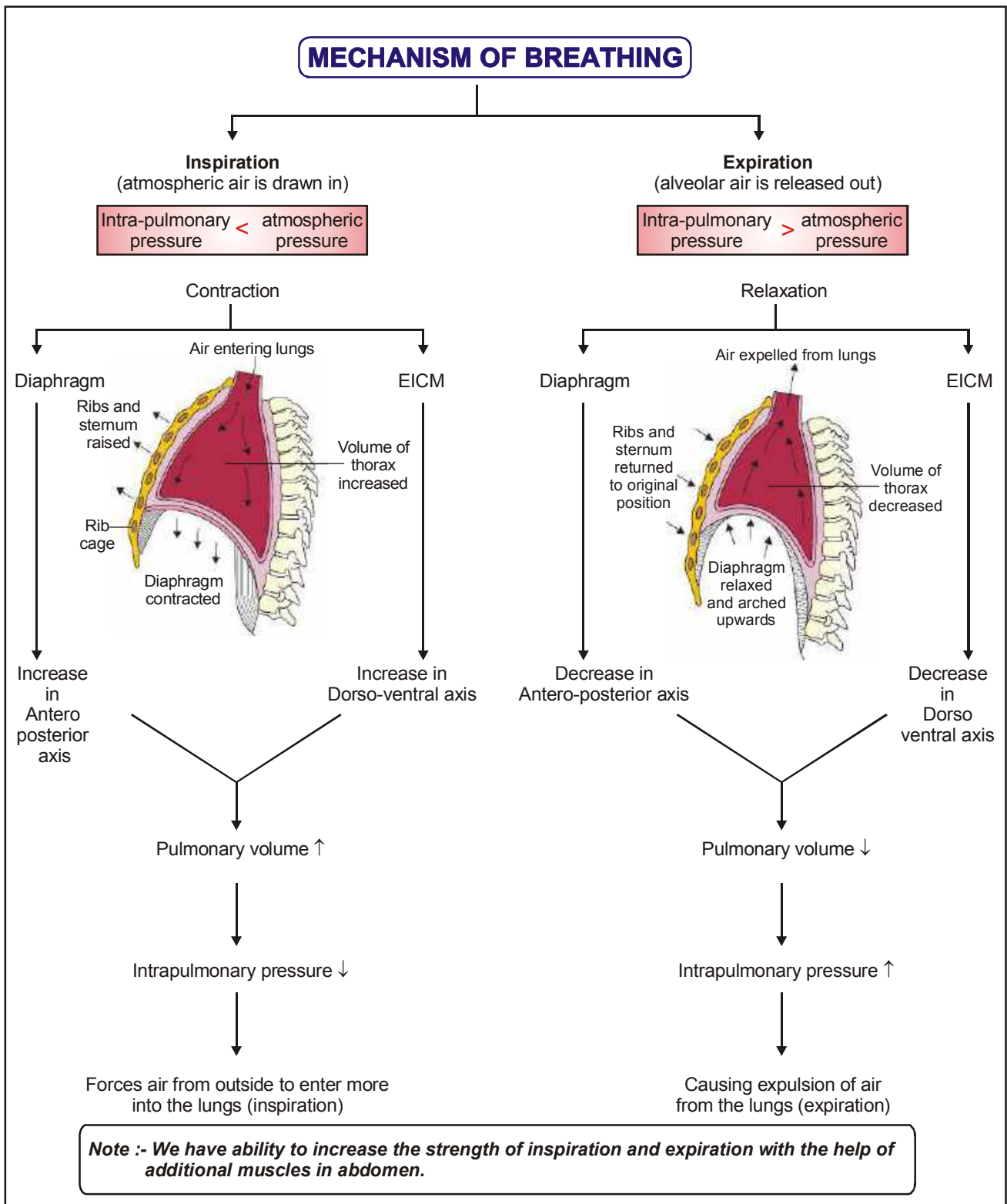


Outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface.



We have a pair of **external nostrils** opening out above the upper lips. It leads to a **nasal chamber** through the **nasal passage**. The nasal chamber opens into **nasopharynx**, which is a portion of **pharynx**, the **common passage for food and air**. Nasopharynx opens through glottis of the larynx region into the trachea. **Larynx** is a **cartilaginous box** which **helps in sound production** and hence **called the sound box**. During swallowing **glottis** can be covered by a thin elastic **cartilaginous flap** called **epiglottis** to **prevent the entry of food into the larynx**. **Trachea** is a straight tube extending up to the mid-thoracic cavity, **which divides at the level of 5th thoracic vertebra** into a right and left primary bronchi. Each **bronchi** undergoes repeated divisions to form the **secondary and tertiary bronchi and bronchioles** ending up in very **thin terminal bronchioles**. **The tracheae, primary, secondary and tertiary bronchi, and initial bronchioles are supported by incomplete cartilaginous rings**. Each **terminal bronchiole** gives rise to a number of very thin, irregular walled and vascularised bag-like structures called **alveoli**. The **branching network of bronchi, bronchioles and alveoli comprise the lungs**. We have two lungs which are covered by a **double layered pleura**, with **pleural fluid** between them. **It reduces friction on the lung surface**. **The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface**. **The part starting with the external nostrils up to the terminal bronchioles constitute the conducting part whereas the alveoli and their ducts form the respiratory or exchange part of the respiratory system**. **The conducting part transports the atmospheric air to the alveoli, clears it from foreign particles, humidifies and also brings the air to body temperature**. **Exchange part is the site of actual diffusion of O₂ and CO₂ between blood and atmospheric air**.

The lungs are situated in the thoracic chamber which is anatomically an air-tight chamber. The thoracic chamber is formed dorsally by the vertebral column, ventrally by the sternum, laterally by the ribs and on the lower side by the dome-shaped diaphragm. The anatomical setup of lungs in thorax is such that any change in the volume of the thoracic cavity will be reflected in the lung (pulmonary) cavity. Such an arrangement is essential for breathing, as we cannot directly alter the pulmonary volume.



Z:\NODE02\B080-BA\SPARK KOTA\BIOLOGY\ZOOLOGY\CLASS_XI-XII\ENG\05_BREATHING AND EXCHANGE OF GASES(RESPIRATORY).P65



In human beings breathing is negative pressure breathing where as in frog breathing is positive pressure breathing.

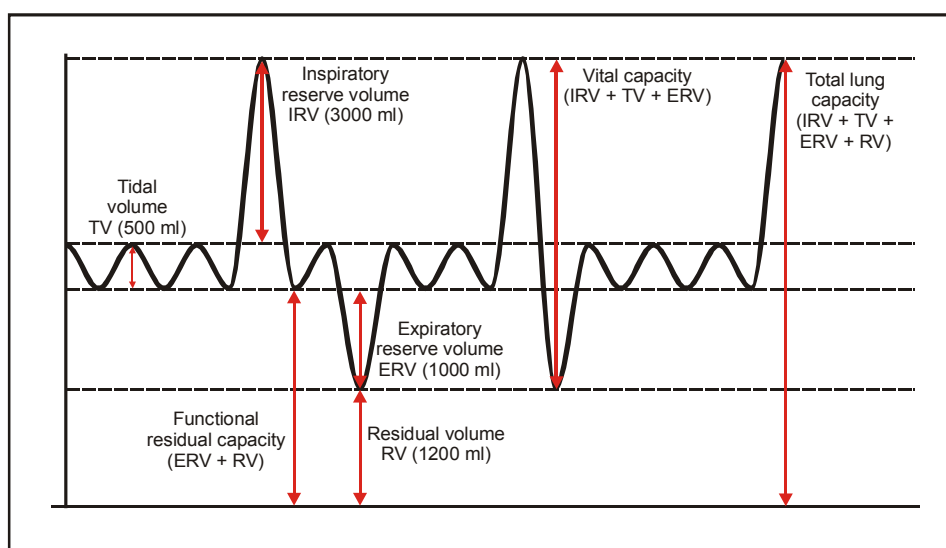
RESPIRATORY VOLUMES AND CAPACITIES

The volume of air involved in breathing movements can be estimated by using a spirometer which helps in clinical assessment of pulmonary functions.

- 1. Tidal Volume (TV):** Volume of air inspired or expired during a normal respiration. It is approx. 500 mL., i.e., a healthy man can inspire or expire approximately 6000 to 8000 mL of air per minute.
- 2. Inspiratory Reserve Volume (IRV):** Additional volume of air, a person can inspire by a forcible inspiration. This averages 2500 mL to 3000 mL.
- 3. Expiratory Reserve Volume (ERV):** Additional volume of air, a person can expire by a forcible expiration. This averages 1000 mL to 1100 mL.
- 4. Residual Volume (RV):** Volume of air remaining in the lungs even after a forcible expiration. This averages 1100 mL to 1200 mL.

By adding up a few respiratory volumes described above, one can derive various pulmonary capacities, which can be used in clinical diagnosis.

- 5. Inspiratory Capacity (IC):** Total volume of air a person can inspire after a normal expiration. This includes tidal volume and inspiratory reserve volume (TV+IRV).
- 6. Expiratory Capacity (EC):** Total volume of air a person can expire after a normal inspiration. This includes tidal volume and expiratory reserve volume (TV+ERV).
- 7. Functional Residual Capacity (FRC):** Volume of air that will remain in the lungs after a normal expiration. This includes ERV+RV.
- 8. Vital Capacity (VC):** The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.
- 9. Total Lung Capacity:** Total volume of air accommodated in the lungs at the end of a forced inspiration. This includes RV, ERV, TV and IRV or vital capacity + residual volume.



Vital capacity represents the maximum amount of air one can renew in the respiratory system in a single respiration. Thus, greater the vital capacity more is the energy available to the body.

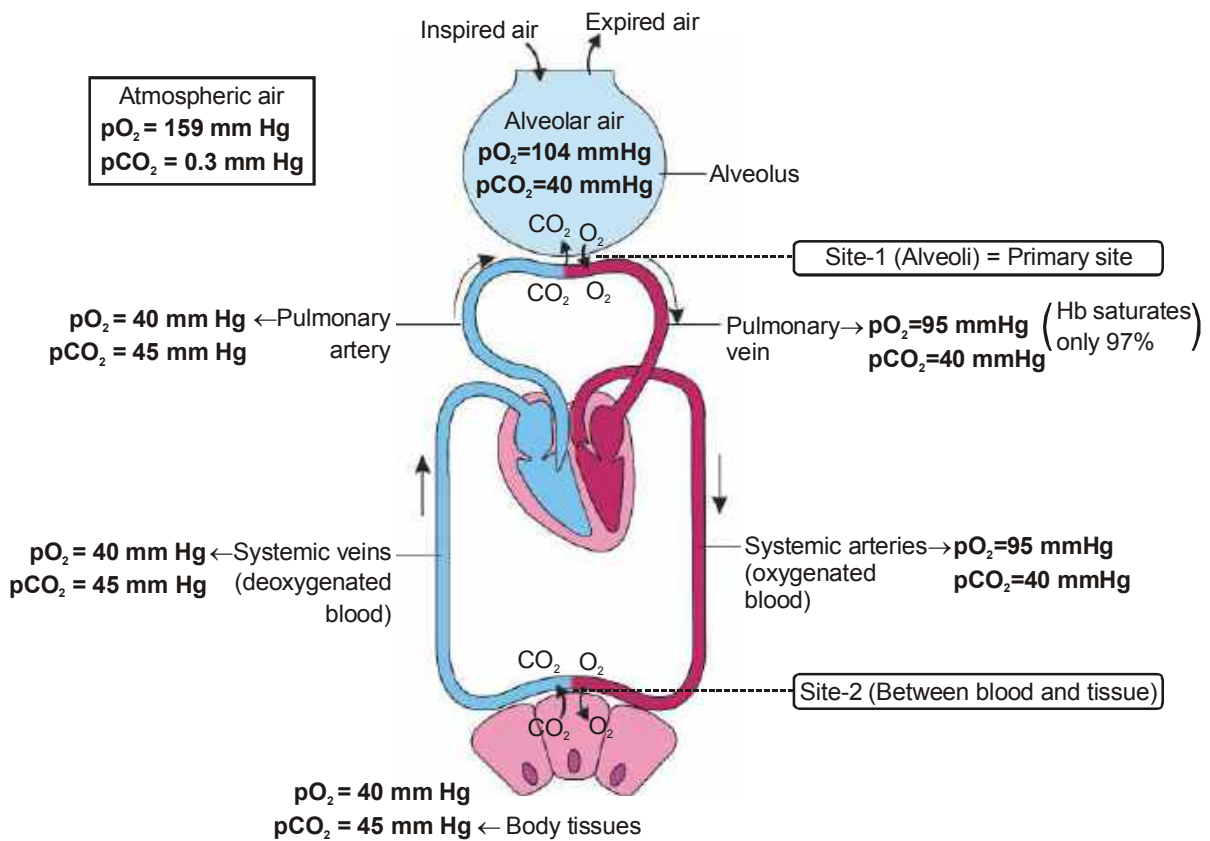
Que. What is Tidal volume? Find out the Tidal volume (approximate value) for a healthy human in an hour.

Que. State the volume of air remaining in the lungs after a normal breathing.

EXCHANGE OF GASES

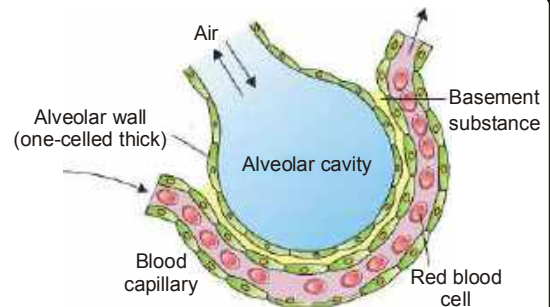
Exchange of Gases → Simple diffusion → based on → **Pressure/concentration gradient** → Partial pressure gradient
 → Solubility $\text{CO}_2 > \text{O}_2$ (20-25 times)
 → Thickness of diffusion membrane

Pressure contributed by an individual gas in a mixture of gases; represented by $P_{\text{O}_2}/P_{\text{CO}_2}$



Diffusion Membrane :- 3 layers
 (Thickness < 1mm)

- (1) Thin squamous epithelium of Alveoli
- (2) Endothelium of alveolar capillaries
- (3) Basement substance (in between them)

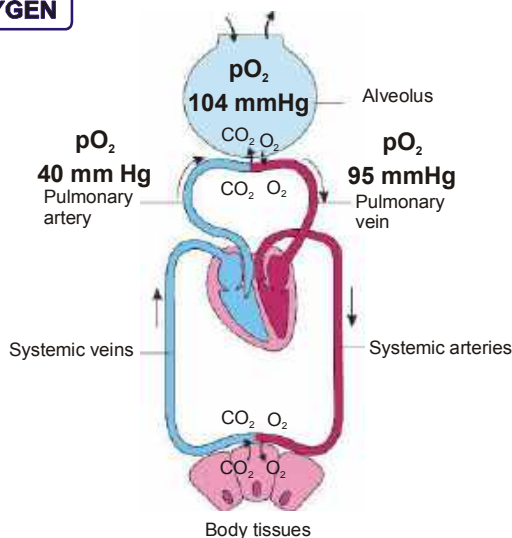
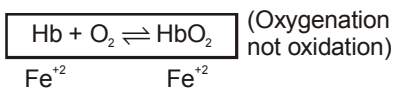
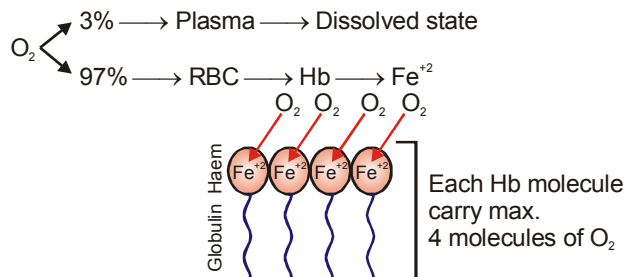


Diffusion capacity = Volume of gas diffuse through the diffusion membrane per unit difference in partial pressure in 1 min.

TRANSPORT OF GASES

TRANSPORT OF OXYGEN

At Alveoli Level :-

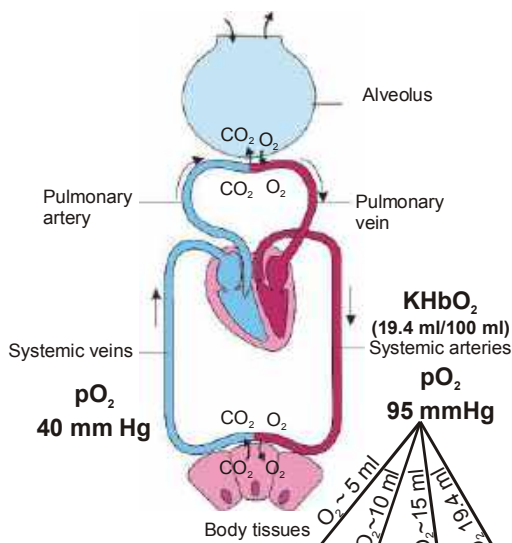
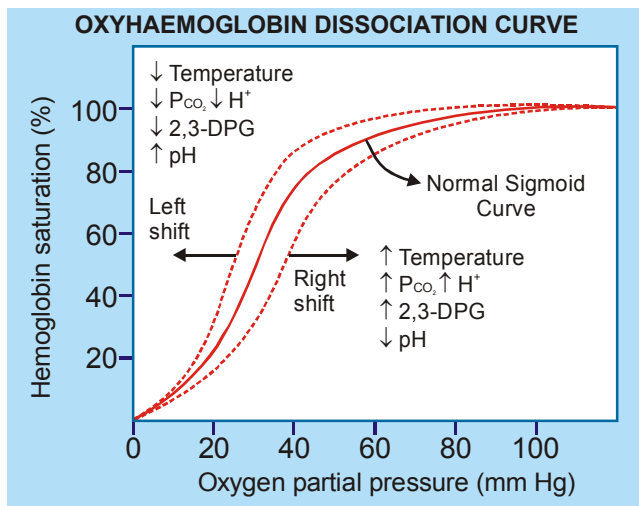


- $\uparrow pO_2, \downarrow pCO_2, \downarrow [H^+], \downarrow T, \downarrow 2-3 \text{ DPG}$ = Association, curve shift towards left, $\downarrow P_{50}$ value.
- $\downarrow pO_2, \uparrow pCO_2, \uparrow [H^+], \uparrow T, \uparrow 2-3 \text{ DPG}$ = Dissociation, curve shift towards right, $\uparrow P_{50}$ value.

Note :-

100 ml Blood carry = 19.4 ml of O_2
 (Calculation = 100 ml blood → 15 gm Hb → $15 \times 1.34 \text{ ml}$ → 20.1 ml O_2 ;
 $20.1 \times 97/100 = 19.4 \text{ ml}$)

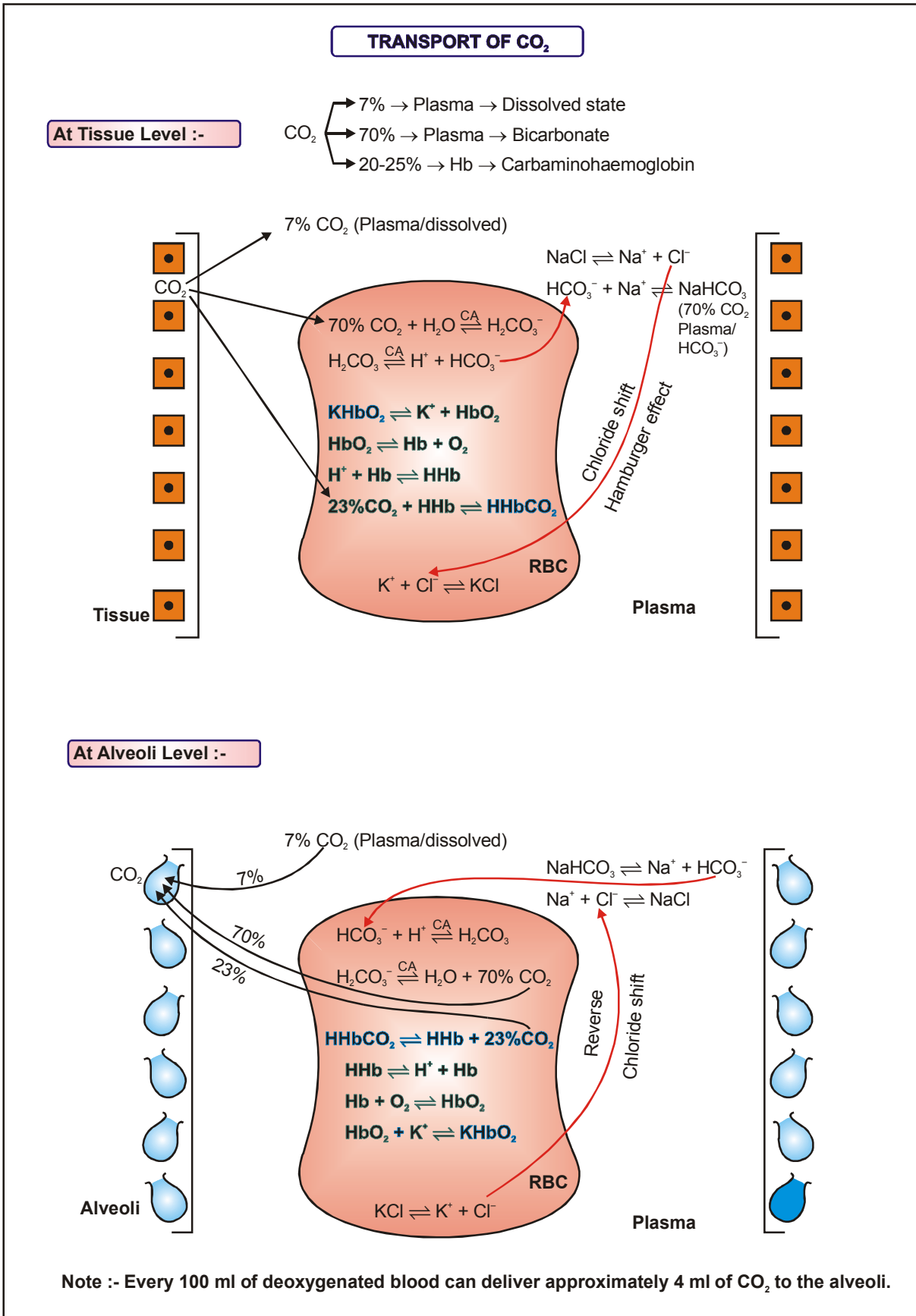
At Tissue Level :-



pO_2 (mm Hg)	40 (physiological condition)	30	20 (Heavy exercise)	0
% dissociation of HbO_2	25%	50%	75%	100%
% saturation of Hb with O_2	75%	50%	25%	0%

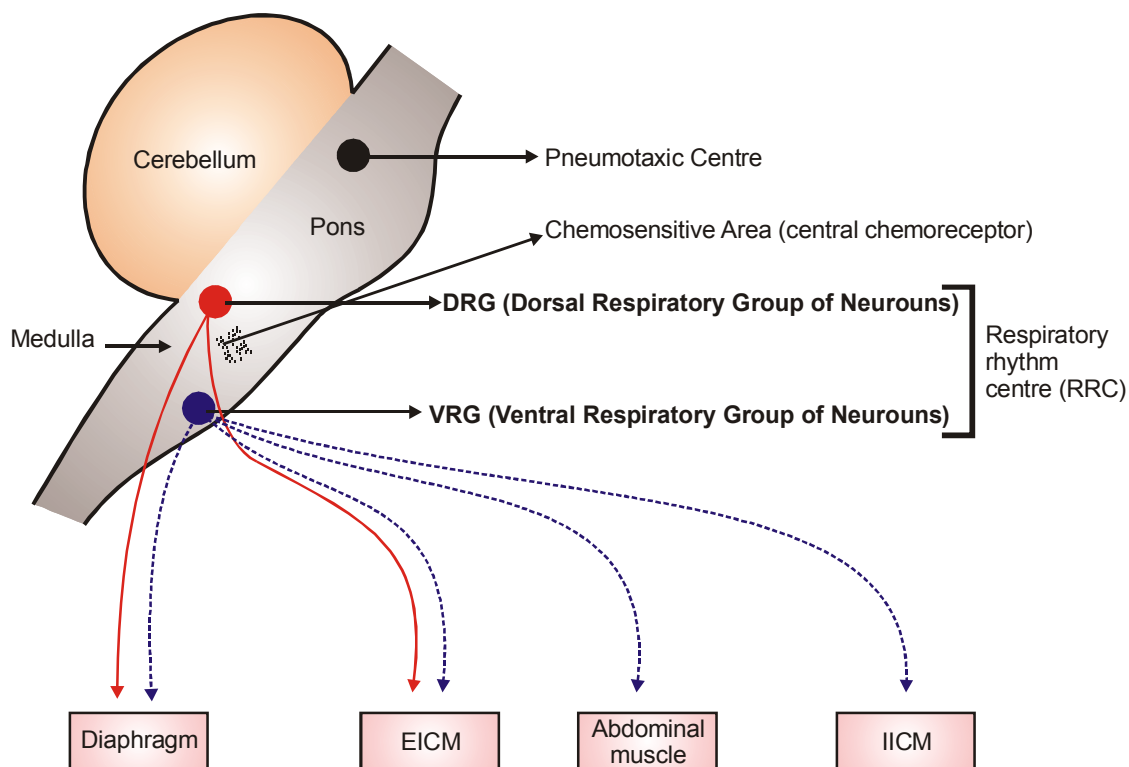
Note :- Every 100 ml of oxygenated blood can deliver around 5 ml of O_2 to the tissue under normal physiological condition.

This sigmoid shape of the dissociation curve is because of the binding of oxygen to haemoglobin. As the first oxygen molecule binds to haemoglobin, it increases the affinity for the second molecule of oxygen to bind. Subsequently, haemoglobin attracts more oxygen.



REGULATION OF RESPIRATION

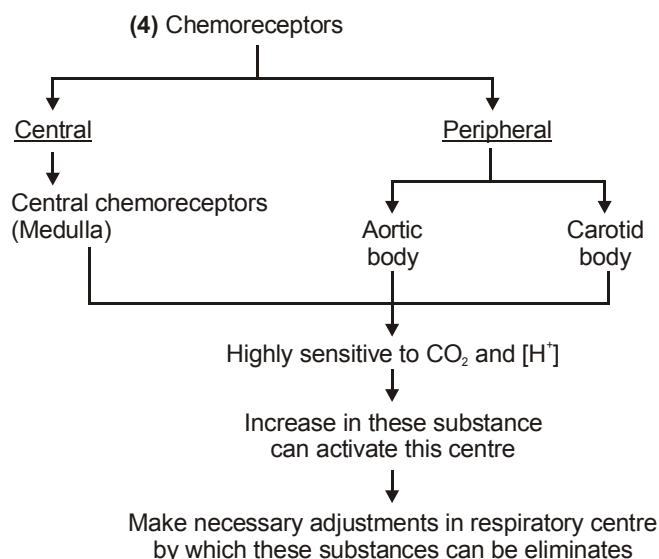
(Human have significant ability to maintain and moderate the respiratory rhythm with the help of neural system)



- (1) DRG → Normal Inspiration
 VRG → Forceful Inspiration
 → Forceful Expiration

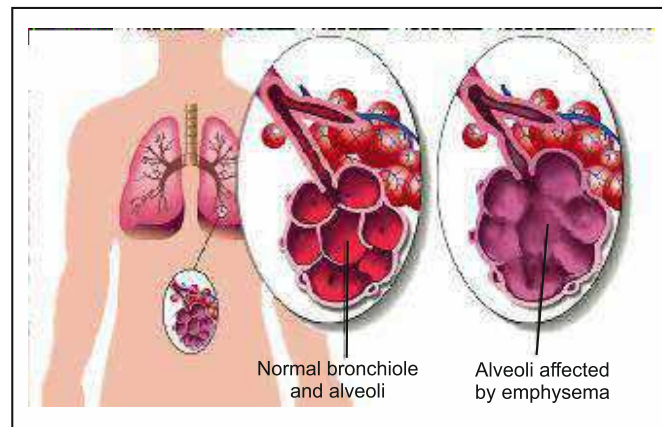
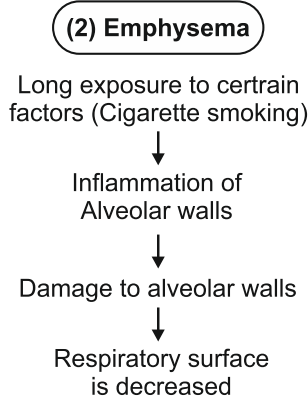
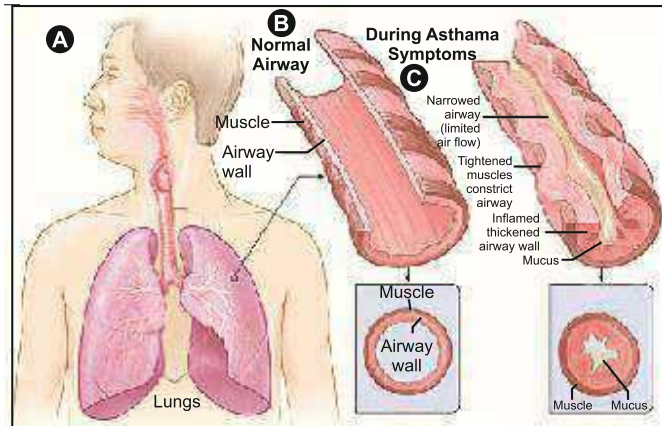
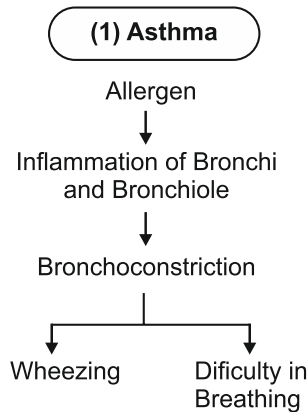
- (2) 4 cases :-
 (i) Normal Inspiration = DRG
 (ii) Normal Expiration = Passive process
 (iii) Forceful Inspiration = VRG
 (iv) Forceful Expiration = VRG

- (3) Pneumotaxic centre → RRC
 (Switch off point)
 ↓ duration of inspiration
 ↓
 ↑ Rate of respiration

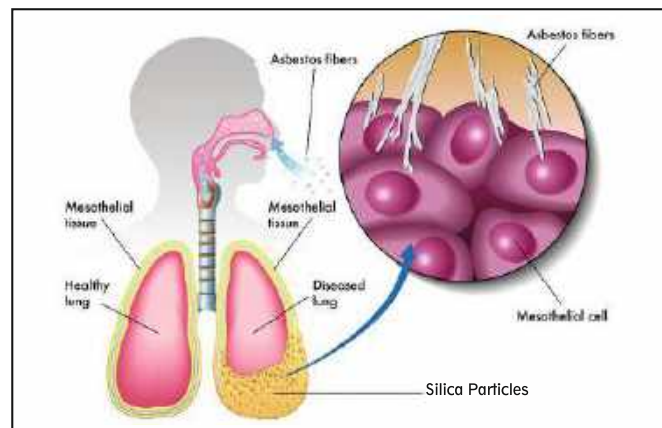
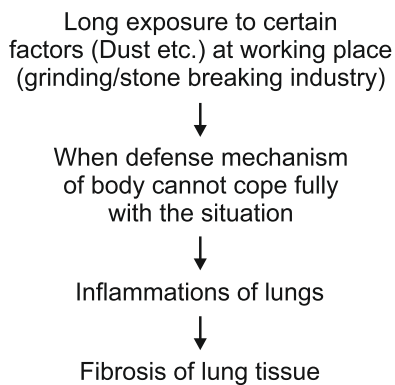


Note :- Role of oxygen in the regulation of respiratory rhythm is quite insignificant

DISORDERS OF RESPIRATORY SYSTEM



(3) Occupational respiratory disorders



EXERCISE

INTRODUCTION, RESPIRATORY ORGAN, EXCHANGE OF GASES

1. Exchange of bicarbonates and chloride ions between RBC and plasma is called:-
 - (1) Chloride shift.
 - (2) Bohr's effect.
 - (3) Haldane's effect.
 - (4) Intra cellular respiration.
2. If CO_2 concentration increases in blood then breathing rate will :-
 - (1) Increases
 - (2) Decrease
 - (3) Stop
 - (4) Remain unchanged
3. Food and air pathway are divided at :
 - (1) larynx
 - (2) pharynx
 - (3) oesophagus
 - (4) stomach
4. In which of the following animals, respiration occurs without respiratory organ ?
 - (1) Frog
 - (2) Fish
 - (3) Cockroach
 - (4) Earthworm
5. At the time of expiration, diaphragm becomes
 - (1) Oblique
 - (2) Normal
 - (3) Flattened
 - (4) Dome-shaped
6. When CO_2 concentration in blood increases, breathing becomes -
 - (1) There is no effect on breathing
 - (2) Slow and deep
 - (3) Faster
 - (4) Shallower and slow
7. The maximum bonding of haemoglobin is with :
 - (1) Carbonmonoxide
 - (2) Cabondioxide
 - (3) Oxygen
 - (4) Ammonia
8. Respiratory centre of brain is sensitive to :
 - (1) more O_2 concentration in blood
 - (2) more CO_2 concentration in blood
 - (3) accumulation of blood in brain
 - (4) all of these
9. Which of the following conditions is responsible for increase in ventilation rate of lungs ?
 - (1) decrease in O_2 content of inhaled air
 - (2) decrease in O_2 content of exhaled air
 - (3) increase in CO_2 content of inhaled air
 - (4) increase in CO_2 content of exhaled air
10. In lungs there is definite exchange of ions between RBC and plasma. Removal of CO_2 from blood involves :
 - (a) efflux of Cl^- ions from RBC
 - (b) influx of Cl^- ions into RBC
 - (c) influx of HCO_3^- ions into RBC
 - (d) efflux of HCO_3^- ions from RBC
 - (1) a, b
 - (2) a, c
 - (3) b, c
 - (4) c, d
11. After taking a long deep breath we donot respire for some seconds due to :
 - (1) More CO_2 in blood
 - (2) More O_2 in blood
 - (3) less CO_2 in blood
 - (4) less O_2 in blood
12. Which does not affect oxyhaemoglobin dissociation curve?
 - (1) high O_2 and high haemoglobin
 - (2) high O_2 and low CO_2
 - (3) high body temperature
 - (4) high pH
13. Respiration results in :
 - (1) release of O_2
 - (2) anabolism
 - (3) transfer of CO_2
 - (4) release of CO_2
14. Ascent of high mountains may cause altitude sickness in men. Prime cause of this is :
 - (1) excess of CO_2 in blood
 - (2) decreased efficiency of haemoglobin
 - (3) decreased partial pressure of O_2
 - (4) decreased proportion of O_2 in air
15. Which of the following statements are true/false ?
 - (a) The blood transports CO_2 comparatively easily because of its higher solubility.
 - (b) Approximately 8.9% of CO_2 is transported being dissolved in the plasma of blood.
 - (c) The carbondioxide produced by the tissues, diffuses passively into the blood stream and passes into red blood corpuscles and react with water to form H_2CO_3 .
 - (d) The oxyhaemoglobin (HbO_2) of the erythrocytes is basic.
 - (e) The chloride ions diffuse from plasma into the erythrocytes to maintain ionic balance.
 - (1) a, c, and e are true and 'b' and 'd' are false
 - (2) a, c and e are false and 'b' and 'd' are true
 - (3) a, b and d are true and 'c' and 'e' are false
 - (4) a, b and d are false and 'c' and 'e' are true

- 16.** Statements :
- (a) Carbonic anhydrase is present in the erythrocytes
 (b) In erythrocytes the carbondioxide combine with water and is transported
- (1) Statement 'a' is correct and is responsible for statement 'b'
 (2) Statement 'a' is not correct but statement 'b' is correct
 (3) Both 'a' and 'b' are wrong
 (4) Statement 'a' is correct but not involved in statement 'b'
- 17.** Membrane separating air in pulmonary alveoli from blood capillaries :
- (1) alveolar epithelium
 (2) cardiac epithelium
 (3) endothelium of blood capillaries
 (4) both '1' and '3'
- 18.** External respiration refers to exchange of gases between
- (1) Inspired air and blood
 (2) Blood and tissue fluid
 (3) Expired air and blood
 (4) Environmental air and lungs
- 19.** For proper transport of O_2 and CO_2 blood should be
- (1) Slightly acidic (2) Strongly acidic
 (3) Strongly alkaline (4) Slightly alkaline
- 20.** What would happen when blood is acidic
- (1) Binding of oxygen with haemoglobin increases
 (2) Red blood corpuscles are formed in higher number
 (3) Binding of oxygen with haemoglobin decreases
 (4) There is no change in oxygen binding nor number of RBC
- 21.** Which one of the following statement is correct?
- (1) Chest expands because air enters into the lungs
 (2) Air enters into the lungs because chest expands
 (3) The muscles of the diaphragm contracts because air enters into the lungs
 (4) All of the above statements are correct
- 22.** The combination of oxygen with haemoglobin is called
- (1) Oxidation (2) Oxygenation
 (3) Reduction (4) None of the above
- 23.** The covering of lungs in human is
- (1) Peritoneum (2) Pericardium
 (3) Pleural membrane (4) Glission capsule
- 24.** Respiratory system is derived from
- (1) Ectoderm (2) Endoderm
 (3) Both 1 & 2 (4) Endo mesoderm

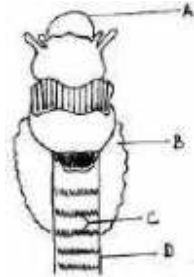
- 25.** Among mammals, the efficiency of ventilation of lungs as compared to reptiles and birds is better developed by the presence of
- (1) Ribs & costal muscles (2) Only ribs
 (3) Only costal muscles (4) Diaphragm
- 26.** In human respiration takes place in
- (1) Cells lining the lungs cavity
 (2) Cells found in blood
 (3) All living cells of the body
 (4) Only RBC
- 27.** The process of respiration is concerned with
- (1) In take of O_2 (2) Liberation of O_2
 (3) Liberation of CO_2 (4) Liberation of energy
- 28.** Lungs man are
- (1) Sucken lungs (2) Pressure lungs
 (3) Aquatic lungs (4) None
- 29.** Respiratory rate in new born baby is
- (1) Equal to adult (2) Less then adult
 (3) More than adult (4) None
- 30.** Carbonic anhydrase is abundantly found in
- (1) W.B.C. (2) RBC
 (3) Blood plasma (4) All

MECHANISM AND REGULATION OF RESPIRATION, PULMONARY CAPACITIES, OXYGEN AND CARBONDIOXIDE TRANSPORT, RESPIRATORY DISORDERS

- 31.** Which is correct
- (1) Respiratory centres are not affected by CO_2
 (2) In humans vital capacity is just double the expiratory volume
 (3) A human lung has 10^3 alveoli
 (4) During inspiration the lungs act as suction pump
- 32.** Characteristic feature of haemoglobin is
- (1) Reversible union with Oxygen
 (2) It is Blue colour
 (3) Presence of Cu
 (4) Presence of globulin portein
- 33.** Vocal cords occur in
- (1) Pharynx (2) Larynx
 (3) Glottis (4) Bronchial tube
- 34.** In which part of lungs gaseous exchange takes place in human :-
- (1) Trachea & alveolar duct
 (2) Trachea & bronchi
 (3) Alveolar duct & alveoli
 (4) Alveoli & Trachea
- 35.** Hb is a
- (1) reproductive pigment (2) respiratory pigment
 (3) carbohydrate (4) fat

- 36.** Hamburger phenomenon is also known as
 (1) bicarbonate shift (2) chloride shift
 (3) potassium shift (4) all of these
- 37.** After a deep inspiration and maximum expiration, the capacity of lungs is known as –
 (1) Vital capacity (2) Tidal volume
 (3) IRV (4) ERV
- 38.** O₂ dissociation curve is :
 (1) sigmoid curve (2) parabolic
 (3) hyperbolic (4) straight line
- 39.** Chloride shift occurs in response to :
 (1) H⁺ (2) K⁺
 (3) HCO₃⁻ (4) Na⁺
- 40.** During normal respiration without any effort the volume of air inspired or expired is called –
 (1) Tidal volume (2) Reserve volume
 (3) Residual volume (4) None of these
- 41.** Vital capacity of lungs is
 (1) TV + IRV + ERV
 (2) TV + IRV + RV
 (3) TV + ERV
 (4) IRV + ERV
- 42.** Which of the following statements is not true ?
 (1) The partial pressure of O₂ in deoxygenated blood is 40 mm Hg.
 (2) The partial pressure of O₂ in oxygenated blood is 95 mm Hg
 (3) The partial pressure of O₂ in alveolar air is 104 mm Hg
 (4) The partial pressure of CO₂ in alveolar air is 40 mm Hg
 (5) The partial pressure of CO₂ in deoxygenated blood is 95 mm Hg.
- 43.** The type of tissue lining the nasal passage and bronchioles is –
 (1) columnar ciliated epithelium
 (2) cuboidal epithelium
 (3) neurosensory epithelium
 (4) germinal epithelium
- 44.** Match the items in column I with column II and choose the correct option
- | | column I | | column II | | | | |
|--------------------------------|----------|-------|-----------|---------------------|------|--|--|
| (A) Tidal volume | | | (i) | 2500 to 3000 mL | | | |
| (B) Inspiratory reserve volume | | | (ii) | 1000 mL of air | | | |
| (C) Expiratory reserve volume | | | (iii) | 500 mL of air | | | |
| (D) Residual volume | | | (iv) | 3400 to 4800 mL air | | | |
| (E) Vital capacity | | | (v) | 1200 mL of air | | | |
| | A | B | C | D | E | | |
| (1) | (iii) | (iv) | (ii) | (i) | (v) | | |
| (2) | (iii) | (i) | (ii) | (v) | (iv) | | |
| (3) | (iii) | (i) | (iv) | (v) | (iv) | | |
| (4) | (iv) | (iii) | (ii) | (i) | (v) | | |
- 45.** Hamburger's phenomenon explains
 (1) formation of HCO₃⁻
 (2) chloride shift
 (3) oxygen saturation of Hb
 (4) breathing mechanism
- 46.** The cavities of lungs alveoli are lined by –
 (1) cuboidal epithelium
 (2) columnar epithelium
 (3) stratified cuboidal epithelium
 (4) squamous epithelium
- 47.** In alveolar air, the partial pressure of CO₂ is
 (1) 40 mm of Hg (2) 42 mm of Hg
 (3) 44 mm of Hg (4) 46 mm of Hg
- 48.** Emphysema is disease characterized by :
 (1) haemorrhage of pulmonary capillaries
 (2) increase in number of air sacs
 (3) infection of mycobacterium trabeculae
 (4) inflation of alveolar sacs
- 49.** What happen to the O₂ dissociation curve of Hb if pH is decreased ?
 (1) shift to left (2) shift to right
 (3) remain unchanged (4) will oscillate erratically
- 50.** Residual volume is :
 (1) lesser than tidal volume
 (2) greater than inspiratory volume
 (3) greater than vital capacity
 (4) greater than tidal volume
- 51.** Simplest respiratory organ is :
 (1) gills (2) contractile vacuole
 (3) skin (4) lungs

52. Covering over lungs is called :
 (1) periosteum (2) pericardium
 (3) peritoneum (4) pleura
53. About 97% of O₂ is transported by RBC. The remaining 3% is
 (1) dissolved in plasma and transported
 (2) remains in lungs
 (3) attached to cell membranes
 (4) inside the mitochondria
 (5) in peroxisomes
54. The diagram represents the human larynx. Choose the correct combination of labelling from options given



A	B	C	D
(1) larynx	parathyroid	tracheal cartilage	trachea
(2) nasolarynx	thyroid	tracheal cartilage	trachea
(3) trachea	thyroid	bronchiole	tracheal cartilage
(4) epiglottis	thyroid	tracheal cartilage	trachea
(5) epiglottis	parathyroid	Trachea	Tracheal cartilage

55. Whether a child died after normal birth or died before birth can be confirmed by measuring –
 (1) tidal volume of air
 (2) residual volume of air
 (3) the weight of the child
 (4) the dead space air
56. The major amount of CO₂ in both invertebrate and vertebrate is transported as –
 (1) carbonic acid
 (2) carbamino haemoglobin
 (3) dissolved gas
 (4) none of these
57. CO is more toxic than CO₂ because it :
 (1) Damages lungs
 (2) form acid with water
 (3) Affects the nervous system
 (4) reduces the oxygen carrying capacity of haemoglobin

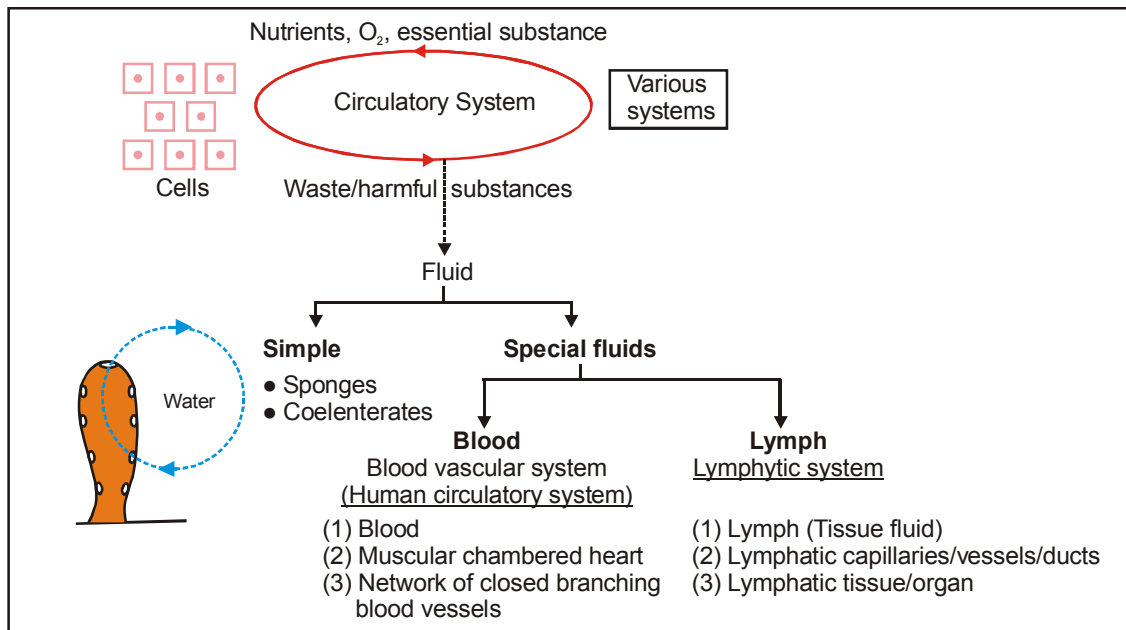
58. Tidal volume for a healthy human in an hour :
 (1) 500 ml
 (2) 3600 ml to 4800 ml
 (3) 360000 ml to 480000 ml
 (4) 10000 ml
59. When CO₂ concentration in blood increases, breathing becomes :
 (1) slow and deep
 (2) faster and deeper
 (3) shallower and slow
 (4) there is no effect on breathing
60. Which of the following factors raise the P₅₀ value and shifts the HbO₂ dissociation curve to right :
 a. Rise in P_{CO₂}
 b. Fall in temperature
 c. Rise in H⁺ (=fall in pH)
 d. Fall in diphosphoglyceric acid
 Answer codes :
 (1) a and b are correct (2) b and d are correct
 (3) a and c are correct (4) a, b and c are correct
61. Lungs have large number of narrow tubes :
 (1) Alveoli (2) Bronchi
 (3) Bronchioles (4) Tracheae
62. Book lungs are respiratory organs in –
 (1) Scorpion (2) Prawn
 (3) Snail (4) Cockroach
63. Hypoxia is the condition in which less oxygen become available to the tissues. This may be due to
 (1) less oxygen in the atmosphere
 (2) more CO₂ in the air
 (3) less RBC's in blood
 (4) all of the above
64. The total number of alveoli present in both the lungs of man is
 (1) 30 millions (2) 800 millions
 (3) 300 millions (4) 30 lakhs
65. The amount of volume of air that can be inspired expired normally is called
 (1) Tidal volume (2) Vital capacity
 (3) Residual volume (4) Normal volume
66. Book lungs are respiratory organs of
 (1) Mollusca (2) Mammals
 (3) Arachnida (4) Earthworm

67. Read the following statements and select the correct one
 (1) The H^+ released from carbonic acid combines with haemoglobin to form haemoglobinic acid
 (2) Oxyhaemoglobin of erythrocytes is alkaline
 (3) In lungs, the oxygen from the alveolus reaches the blood through active transports
 (4) In a healthy person, the haemoglobin content's more than 25 gms/100 ml
 (5) More than 70% of CO_2 is transferred from tissues to lungs in the form of carbamino compounds
68. How many molecules of oxygen are carried by one molecule of haemoglobin.
 (1) 6 (2) 8 (3) 2 (4) 4
69. Lack of pulmonary surfactant produces
 (1) Asthma
 (2) Emphysema
 (3) Cystic fibrosis
 (4) Respiratory distress syndrome
70. Respiration is regulated by -
 (1) Medulla oblongata and cerebellum
 (2) Pons and medulla oblongata
 (3) Spinal cord and medulla oblongata
 (4) Spinal cord and pons
71. Pulmonary vessels, bronchus and nerves enter or, leave the lungs at ?
 (1) The apex
 (2) The capsule
 (3) The cardiac notch
 (4) The Hilus
72. Chloride shift is essential for the transportation of:
 (1) CO_2 (2) O_2
 (3) CO_2 and O_2 (4) N_2
73. Carbonicanhydrase enzyme is found in ?
 (1) Plasma (2) R.B.C
 (3) W.B.C (4) Platelets

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	1	2	4	4	3	1	2	3	2	3	1	4	3	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	4	4	4	3	2	2	3	4	4	3	4	1	3	2
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	1	2	3	2	2	1	1	3	1	1	5	1	2	2
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	1	4	2	4	3	4	1	4	2	4	4	3	2	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73		
Ans.	3	1	4	3	1	3	1	4	4	2	4	1	2		

BODY FLUIDS AND CIRCULATION



BLOOD

Special connective tissue (Fibre free fluid matrix)

Plasma

- Matrix
- Straw coloured
- 55% of blood

90-92% water

Other

Proteins (6-8%)

Minerals (small amount)
 (Na⁺, Ca⁺⁺, Mg⁺⁺, HCO₃⁻, Cl⁻)

Nutrients (Glucose, Amino acids, Lipids)

→ Fibrinogen :-

- Needed for clotting/coagulation of blood (other clotting factor are also present in plasma in inactive form)
- Serum = Plasma – Clotting factor

→ Globulin :-

Primarily involved in defence mechanism (Antibodies)

→ Albumin :-

Help in osmotic balance (BCOP)

Formed Elements

- 45% of Blood

Erythrocytes/RBC :-

- Most Abundant
- Formed in red bone marrow
- Biconcave in shape
- Have red coloured, iron containing gases transporting pigment hemoglobin (12-16 gm Hb/100 ml blood)
- Average life span = 120 days (Destroyed in spleen/graveyard)
- Count (Adults) :- 5 – 5.5 million/mm³
- Devoid of nucleus

Platelets (Thrombocytes) → Cell fragments

- Produced from megakaryocytes (special cells in bone marrow)
- Count = 1.5-3.5 Lakh platelets/mm³
- Involved in coagulation/clotting of blood
- Reduction in their number → Clotting disorders (Excessive loss of blood)

Leucocytes/WBC :-

- Relatively less in number
- Nucleated
- Life span = short lived
- 2 main categories
- Colourless due to lack of Hb
- Count (Adult) = 6000-8000/mm³

Granulated

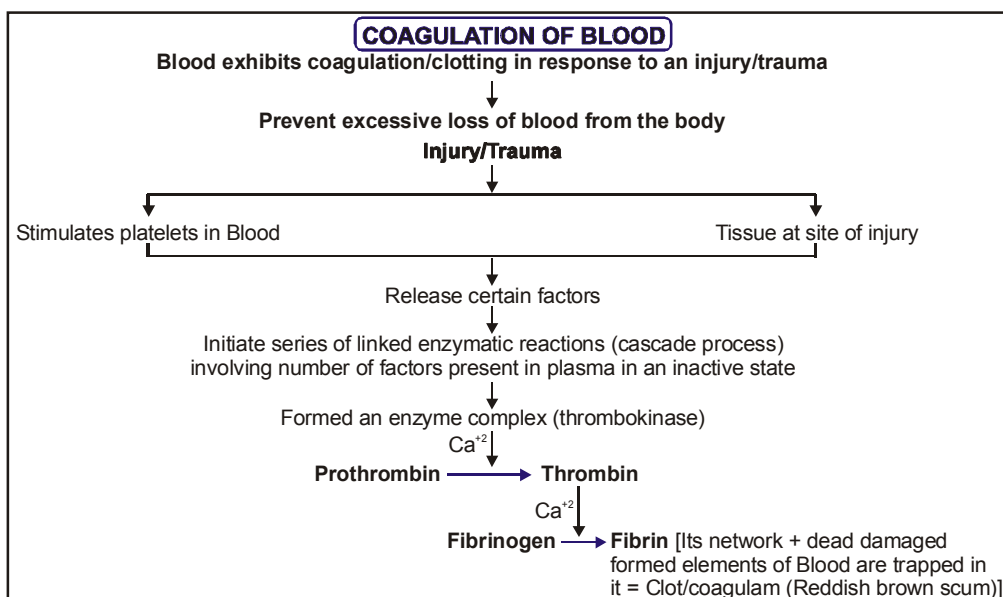
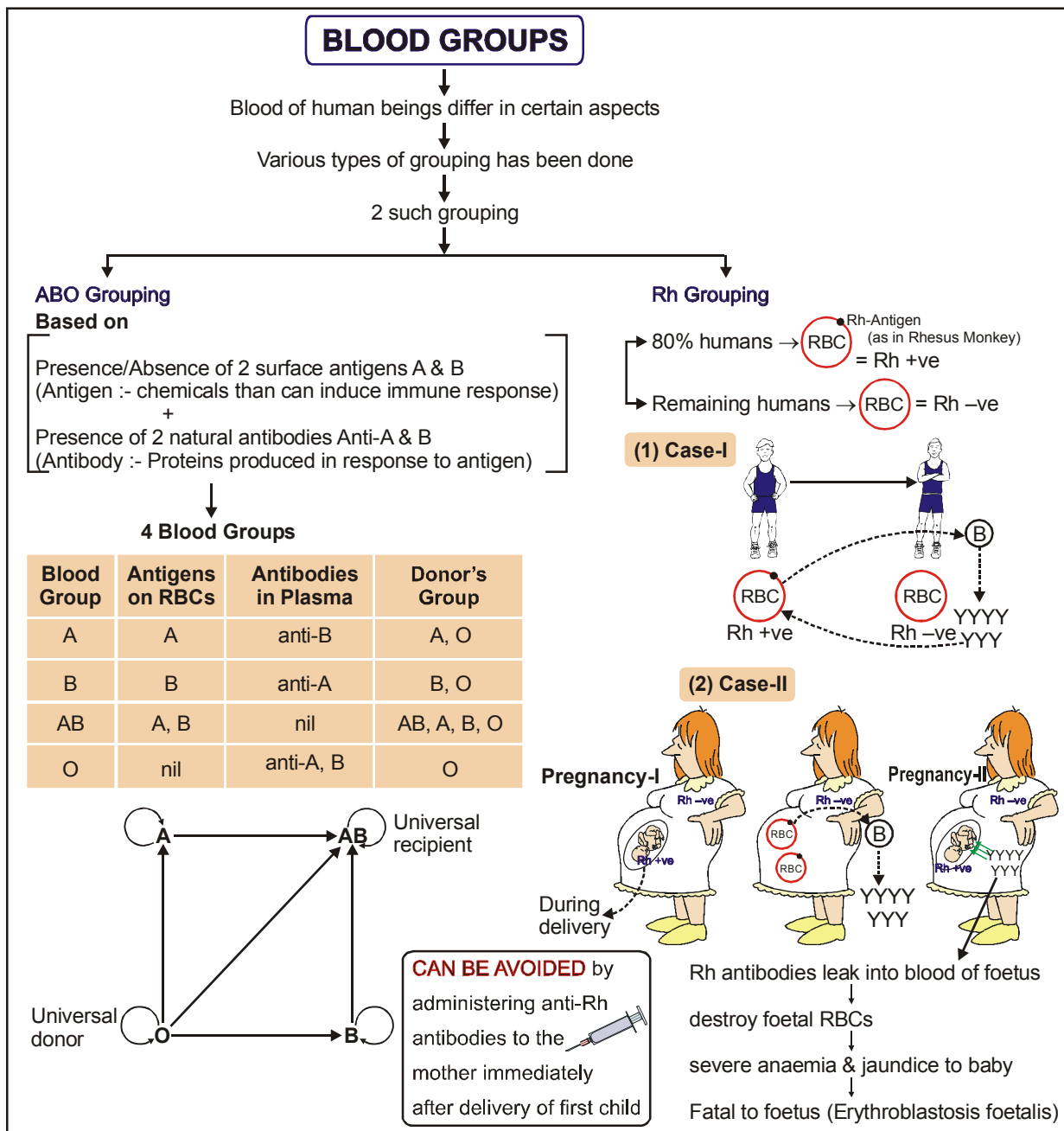
- Eosinophil = 2-3% = Resist infection, allergic reactions
- Basophil = 0.5-1% = Histamin, Serotonin, Heparin
- Neutrophil = 60-65% = Phagocytic

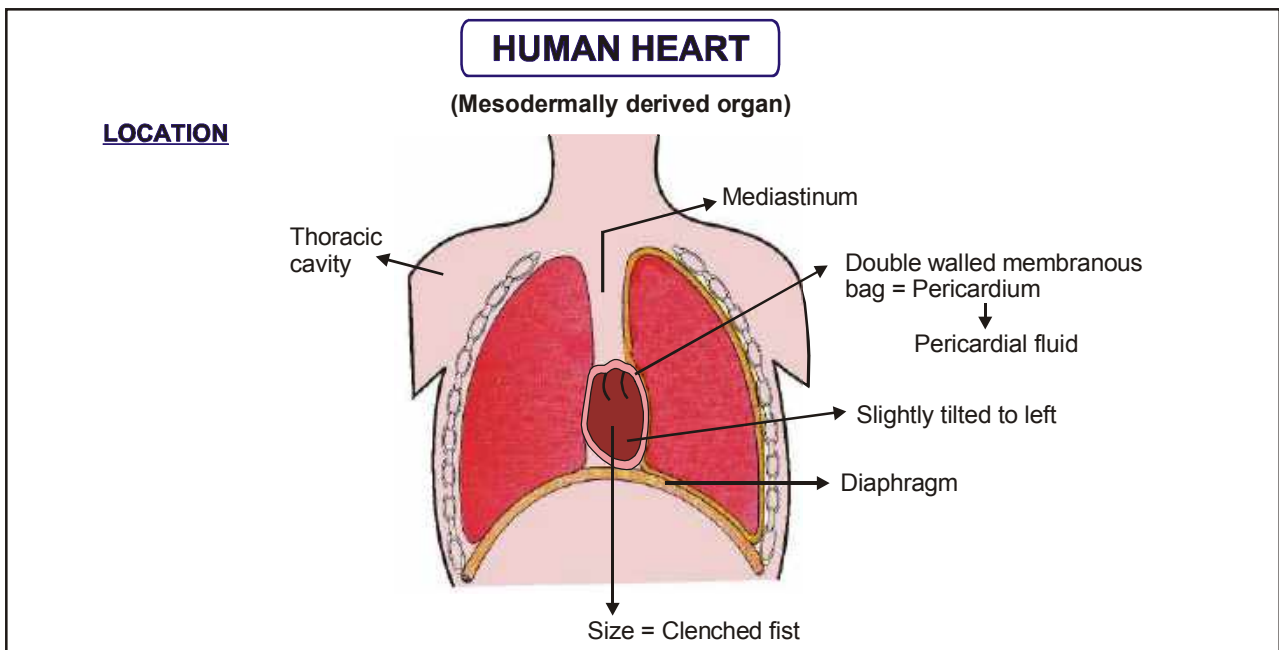
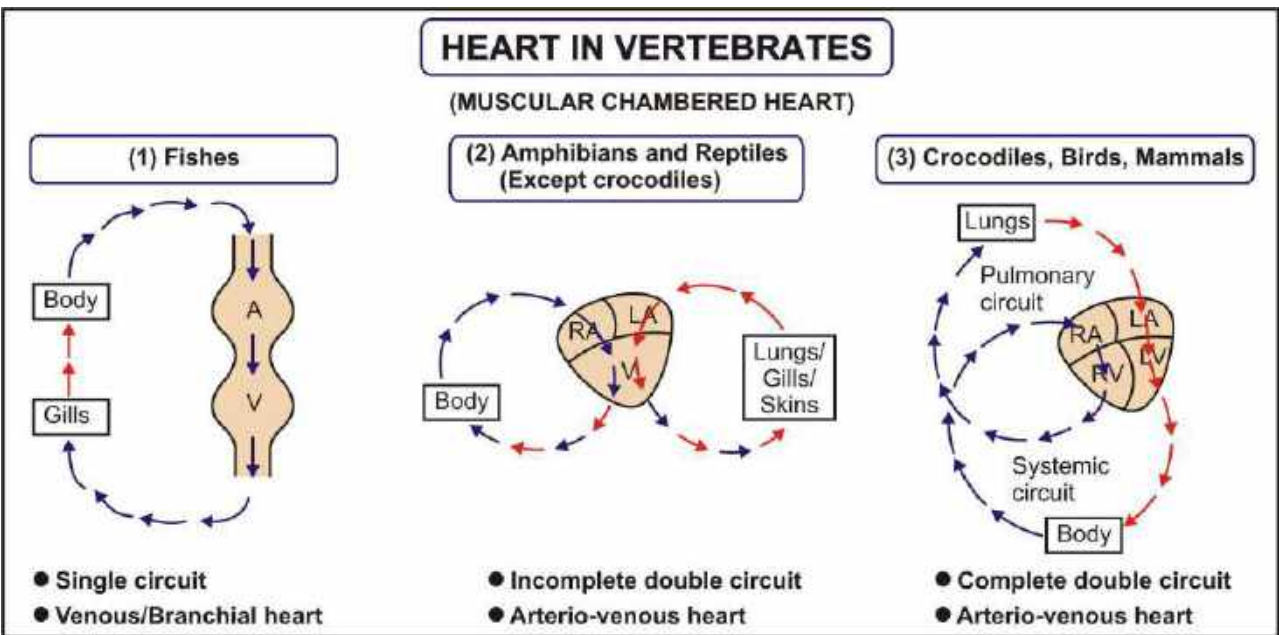
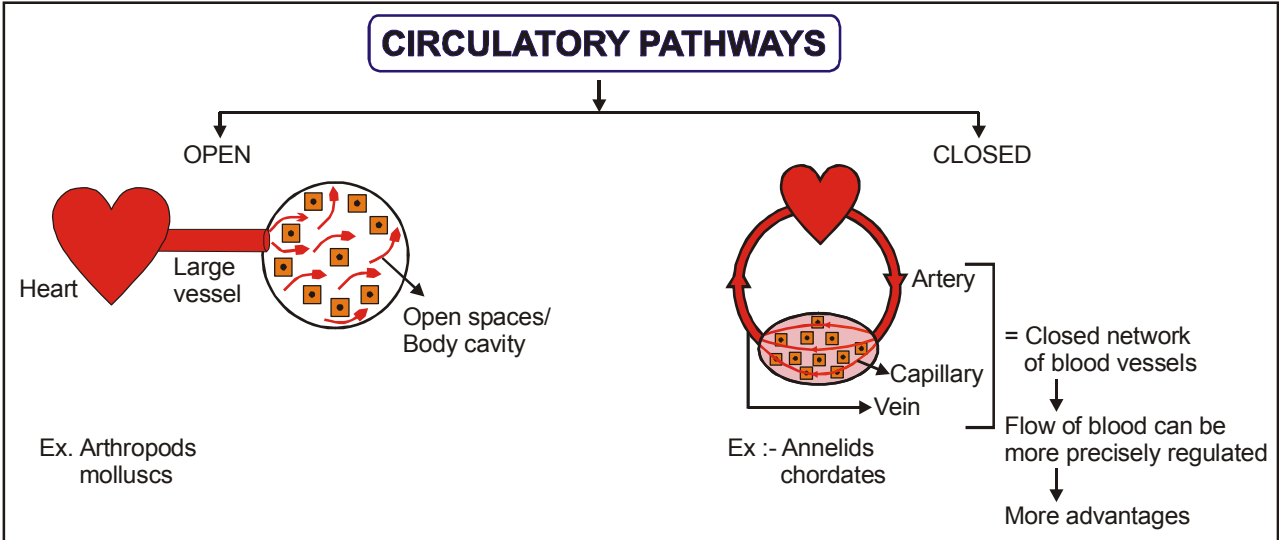


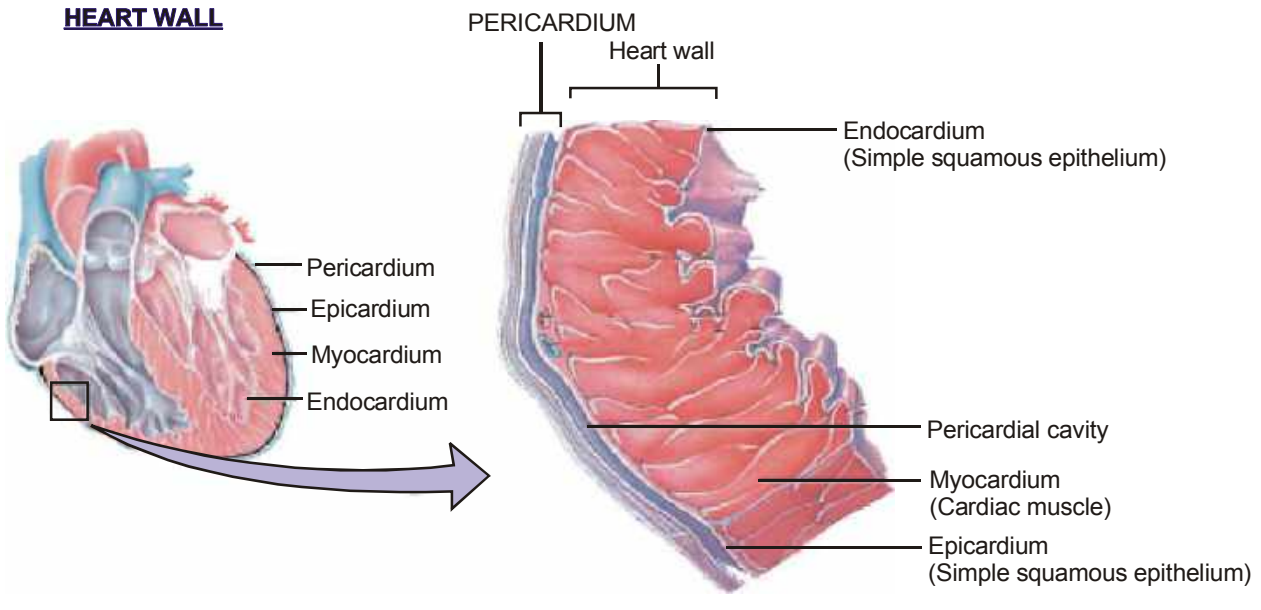
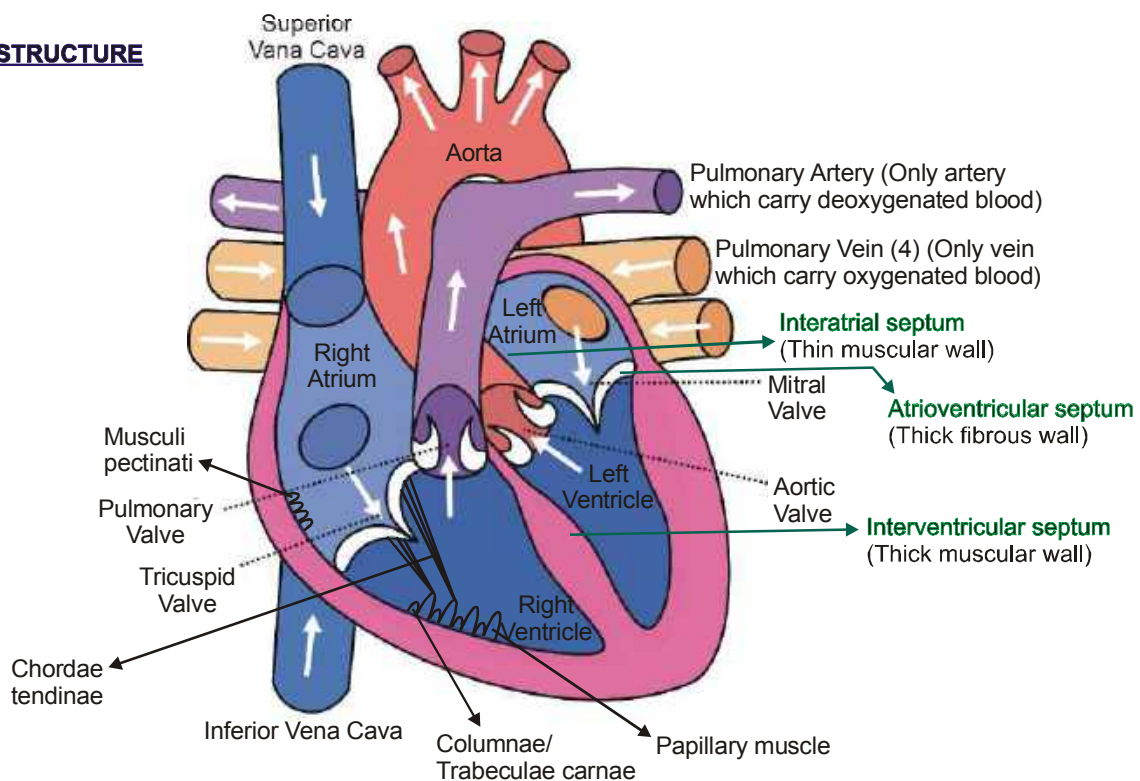
Agranulated

- Monocyte (6-8%) = Phagocytic
 - Lymphocytes (20-25%)
- ↳ T = Responsible for immune response
 ↳ B



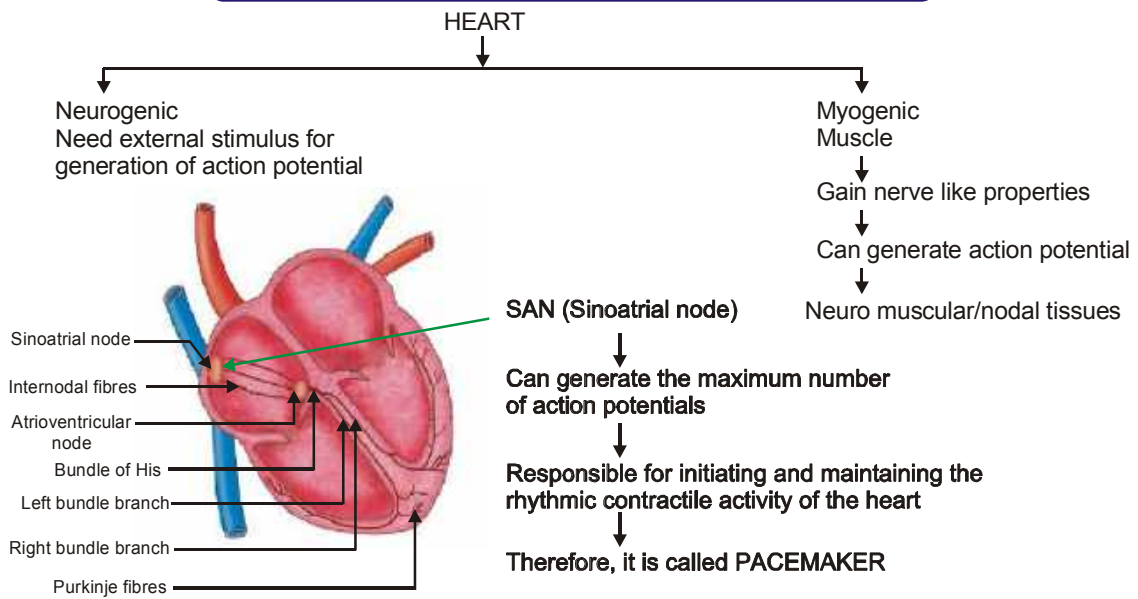




HEART WALL**STRUCTURE**

- Total number of valves in adult human heart = 4
- Valves prevent the backflow of blood i.e. from ventricles to atria and from arteries to ventricles.
- Chordae tendinae prevent the reverse opening of AV valves during ventricular systole.

CONDUCTION PATHWAY (NODAL TISSUE)



- **Heart beat** = Rhythmic contraction and relaxation of heart
- **Heart beat per minute** = Heart rate (70-75 beats/min) (avg. 72 beats/min)
- **Tachycardia** = Temp. ↑, loss of blood, exercise
- **Bradycardia** = Temp. ↓, Athlete

REGULATION OF CARDIAC ACTIVITY

[A special neural centre in the medulla oblongata can moderate the cardiac function through autonomic nervous system (ANS)]

NEURAL

CARDIAC CENTRE (MEDULLA)



HORMONAL

Adrenal medullary hormones can also increase the cardiac output.

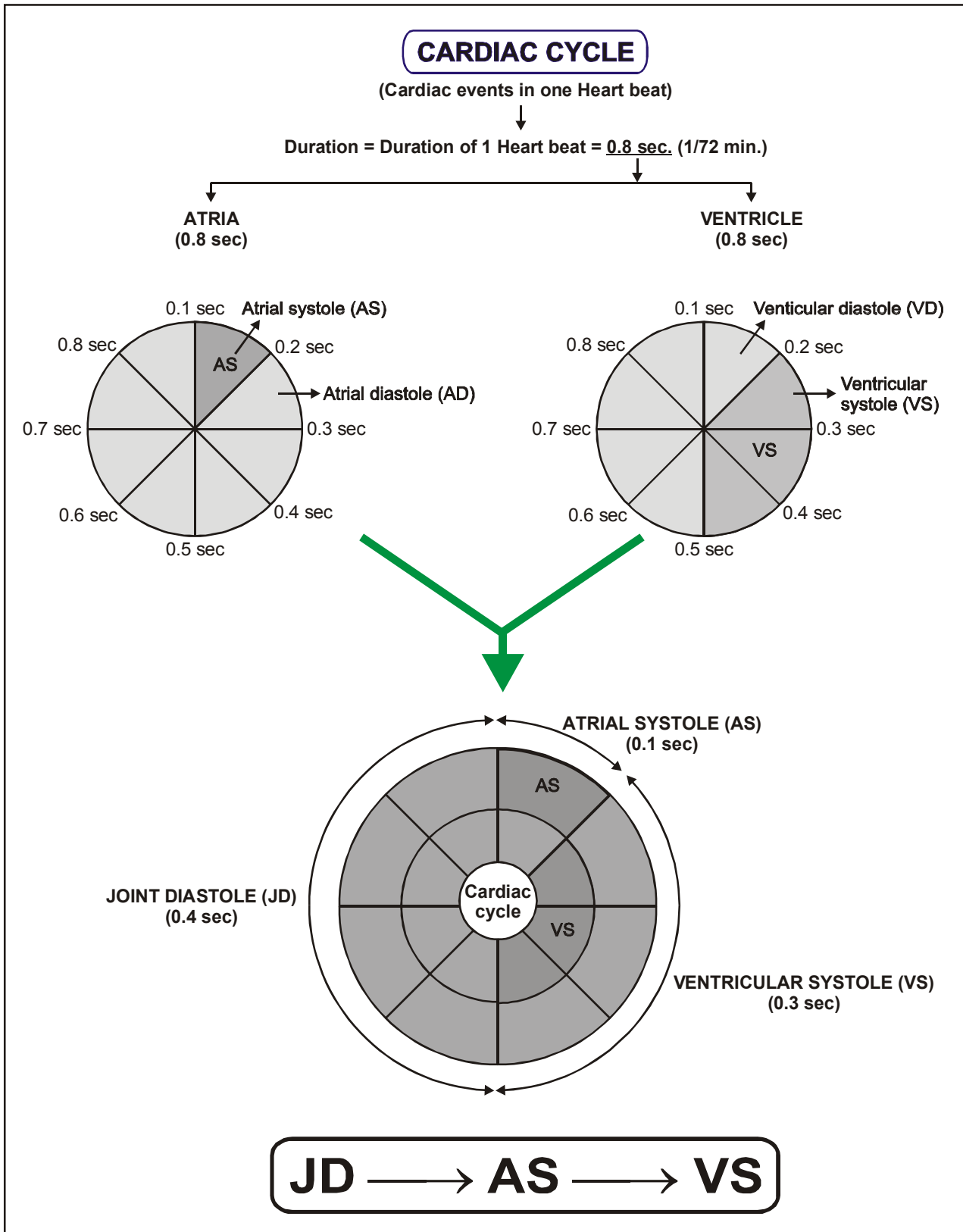


SYMPATHETIC NERVE FIBRES

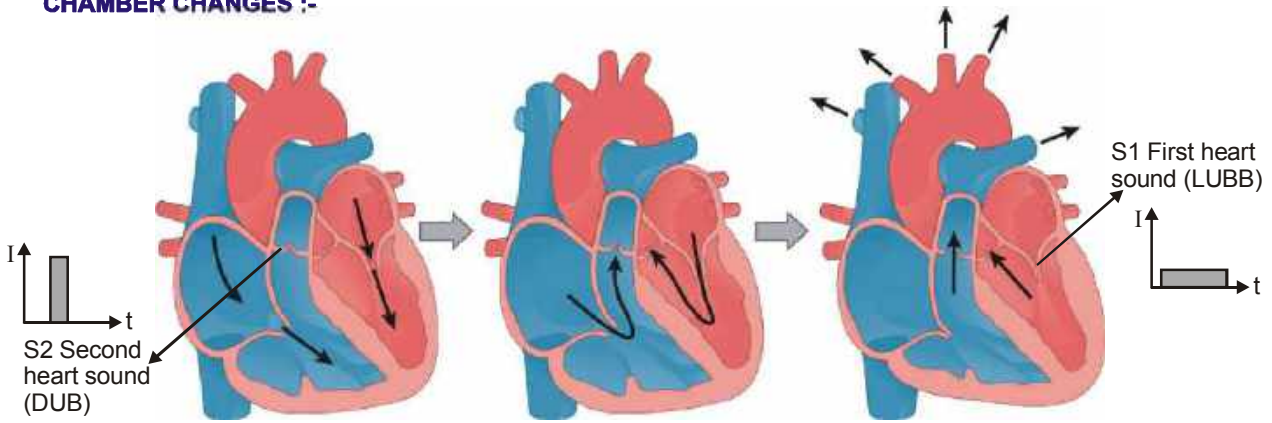
- ↑ Heart rate
- ↑ Ventricular contraction strength
- ↑ Cardiac output

PARASYMPATHETIC NERVE FIBRES (VAGUS NERVE)

- ↓ Heart rate
- ↓ Ventricular contraction strength
- ↓ Cardiac output



CHAMBER CHANGES :-



Joint Diastole (JD)

- All four chambers are in relaxed state
- Tricuspid and Bicuspid valves are open
- Semilunar valves are closed

Atrial Systole (AS)

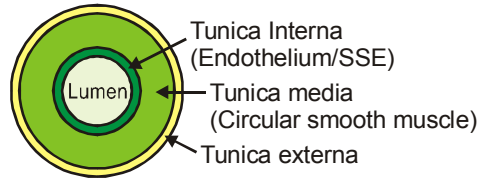
- SAN now generates an action potential
- Atrial contraction (AS) increases the flow of blood into the ventricles by about 30 per cent.

Ventricular Systole (VS)

- Action potential is conducted to the ventricular side
- Ventricular systole increases the ventricular pressure causing the closure of tricuspid and bicuspid valves
- As the ventricular pressure increases further, the semilunar valves are forced open

- The ventricles now relax
- Ventricular pressure falls causing the closure of semilunar valves
- Ventricular pressure declines further, the tricuspid and bicuspid valves are pushed open by the pressure exerted by atrial blood
- Ventricles and atria are now again in a relaxed (joint diastole) state as earlier.

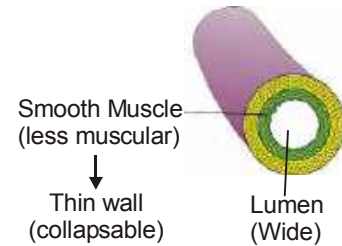
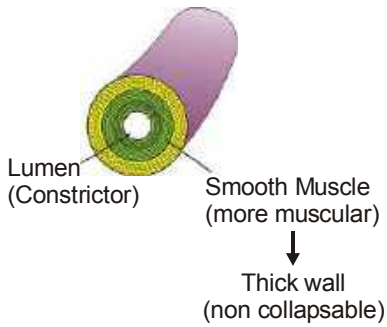
BLOOD VESSELS



Artery

Capillary

Vein

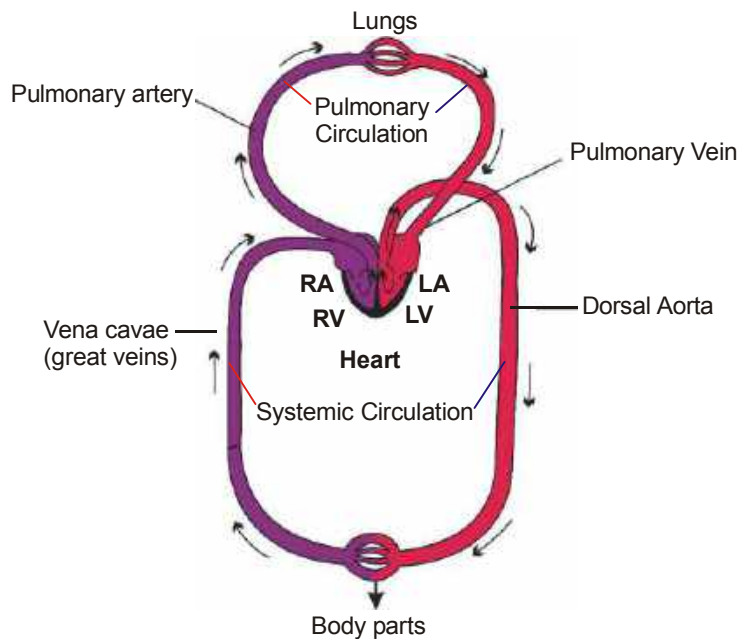


- Blood flows : Away from heart (with high pressure and speed)
- Elastic wall
- Valves absent

- Join arteries and veins
- Single layered
- 'Exchange vessel'

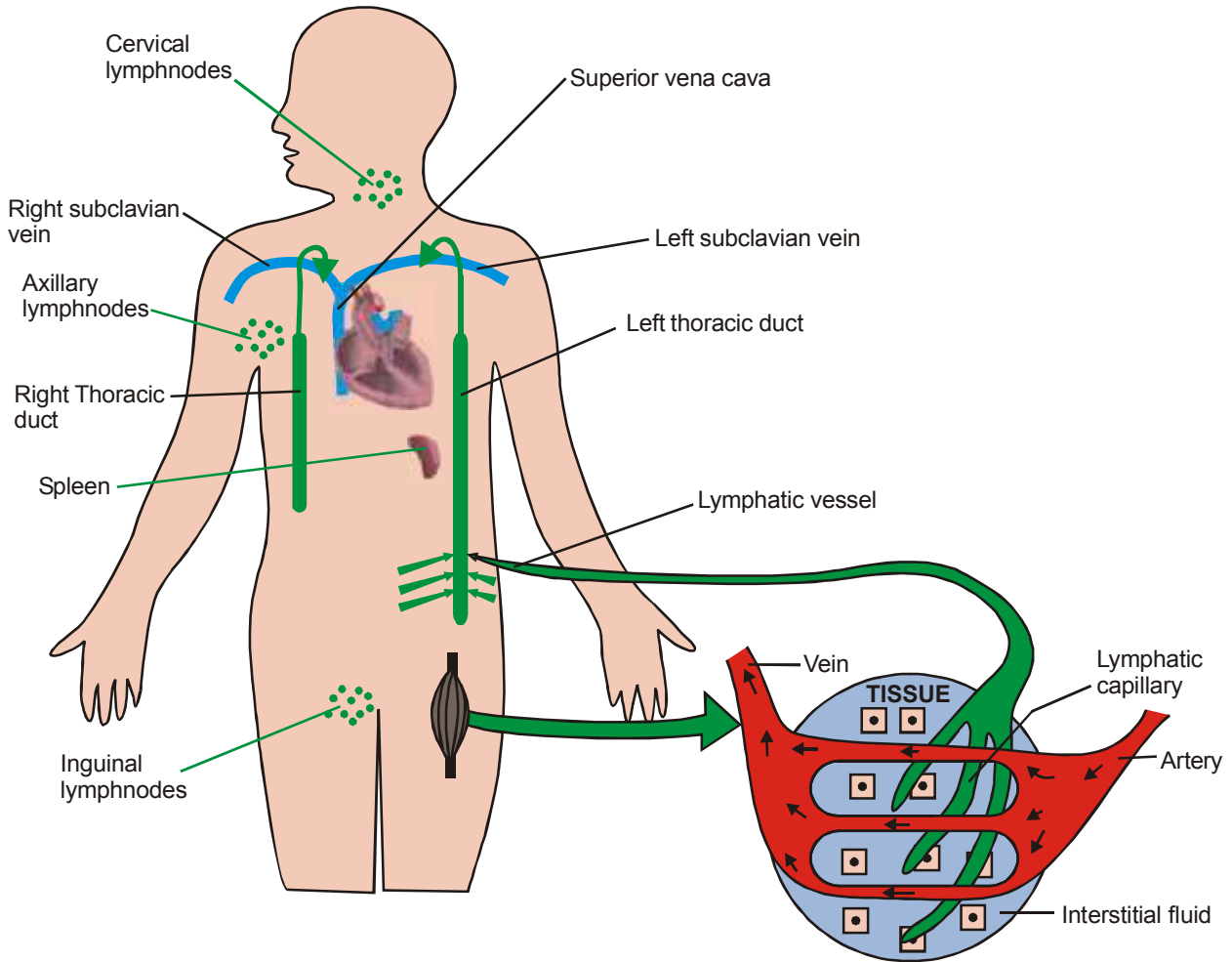
- Blood flows : Towards heart (with low pressure and speed)
- Non-elastic wall
- Valves present

DOUBLE CIRCULATION



THE LYMPHATIC SYSTEM

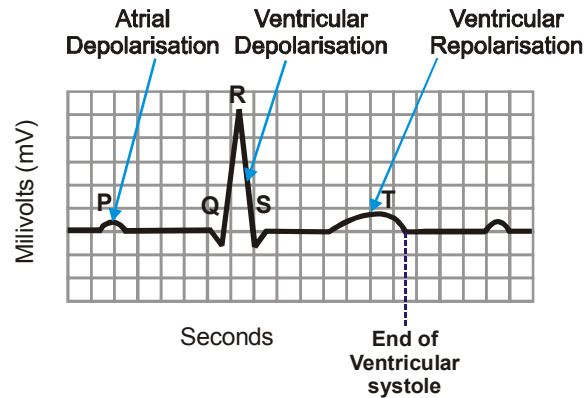
(Lymph/Tissue fluid, Lymph vessel, Lymph Nodes)



BLOOD	LYMPH
<ul style="list-style-type: none"> ● RBC] Present ● Platelets] Present ● Neutrophil ↑ ● Clotting time (less) 	<ul style="list-style-type: none"> ● RBC] Absent ● Platelets] Absent ● Lymphocytes ↑ ● Clotting time (more)
<ul style="list-style-type: none"> ● O₂/Nutrients ↑ ● Soluble protein ↑ ● WBC ↑ 	<ul style="list-style-type: none"> ● CO₂ ↑ ● Insoluble protein ↑ ● WBC ↓

ELECTROCARDIOGRAPH (ECG)

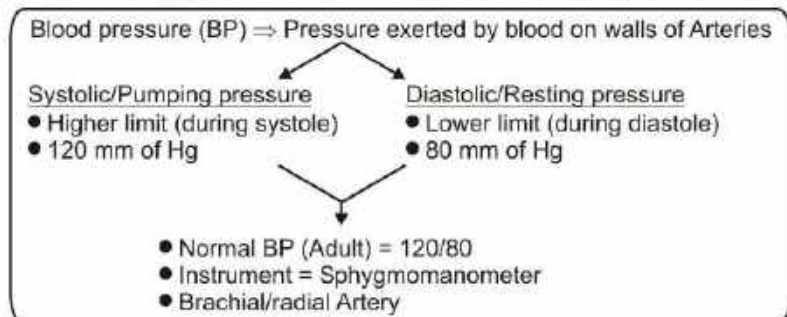
(Graphical re-presentation of electrical activity of heart)



- Heart rate can be determined by counting the number of QRS complexes that occur in a given time period.

DISORDERS OF CIRCULATORY SYSTEM

- High blood pressure (Hypertension) :-** Blood pressure that is higher than normal i.e. (140/90)



- Coronary artery diseases (CAD) :-** Atherosclerosis of coronary artery

Atherosclerosis	Arteriosclerosis
<p>Cholesterol, calcium, fat, fibrous tissues deposit in lumen</p>	<p>Ca²⁺ deposition in walls ↓ Hardening of artery</p>
<p>↓</p> <p>Narrowing of artery</p>	

- Angina pectoris :-** Acute chest pain → When not enough oxygen is reaching the heart muscle. (More common among the middle aged and elderly)
- Myocardial infarction/Heart attack :-** Sudden death of heart muscle → Due to inadequate blood supply.
- Cardiac arrest :-** Heart stop beating
- Heart failure :-** Heart not pumping blood effectively → To meet the needs of the body

EXERCISE

BLOOD

1. Which of following act as middleman :-
 (1) WBC (2) Lymph
 (3) Plasma (4) Blood
2. Process by which blood cells are formed in bone marrow :-
 (1) Haemopoiesis (2) Haemolysis
 (3) Thrombopoiesis (4) Erythroblastosis
3. Largest leucocytes :-
 (1) Neutrophil (2) Basophil
 (3) Monocyte (4) Lymphocyte
4. Content of haemoglobin / 100 ml of Blood :-
 (1) 15 gm (2) 20 gm
 (3) 10 gm (4) 5 gm
5. Identify the given diagram :-

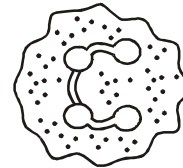


- (1) Basophils (2) Acidophils
 (3) Monocytes (4) Lymphocytes
6. Serum is :-
 (1) Blood - Blood cells (2) Plasma - Fibrinogen
 (3) Blood - Plasma (4) Blood - RBC
7. Blood bank of body is :-
 (1) Liver (2) Spleen
 (3) Heart (4) Bone marrow
8. Worn out RBC are destroyed by :-
 (1) Kupffer's cells (2) Bone cells
 (3) Mast cells (4) None
9. Which of the following is the correct function of diagram given below :-



- (1) Protect body against allergy
- (2) Secrete heparin and histamin
- (3) Destroy bacteria and virus
- (4) Directly kill microbe

10. Identify the DLC of the diagram given below :-



- (1) 60% to 65% (2) 2% to 3%
 (3) 6% to 8% (4) 20% to 25%
11. Which statement is true for WBC :-
 (1) Non nucleated
 (2) In deficiency cancer is caused
 (3) Manufactured in thymus
 (4) Can squeeze through blood capillaries
12. Which WBC has maximum lobes of nucleus :-
 (1) Neutrophil (2) Acidophil
 (3) Basophil (4) Lymphocyte
13. Blood cells are produced by bone marrow in :-
 (1) All bones (2) Some bones
 (3) Most of the bones (4) None
14. Which WBC has maximum life span :-
 (1) Basophil (2) Monocyte
 (3) Acidophil (4) Neutrophil
15. 100 ml. pure blood carries :-
 (1) 1.34 ml. O₂ (2) 20 ml. O₂
 (3) 15 ml. O₂ (4) 4 ml. O₂
16. T-lymphocyte are differentiate in :-
 (1) Bone marrow (2) Liver
 (3) Thymus gland (4) Kidney
17. Ion which present maximum in blood plasma :-
 (1) K⁺ (2) Ca⁺⁺
 (3) Mg⁺⁺ (4) Na⁺
18. A person having Blood group 'A' receive should blood from which group-
 (1) A, AB, O (2) A, O
 (3) O (4) B, AB
19. Which is not a plasma protein :-
 (1) Heparin (2) Albumin
 (3) Prothrombin (4) Fibrinogen

- 20.** Megakaryocyte cell is :-
 (1) RBC producer
 (2) Thrombocyte producer
 (3) WBC producer
 (4) Protein producer
- 21.** Person having 'B' blood group have antibody :-
 (1) Anti A (2) Anti B (3) Both (4) None
- 22.** In which pair erythroblastosis foetalis occur :-
 (1) Rh⁺ male & Rh⁻ female
 (2) Rh⁻ male & Rh⁻ female
 (3) Rh⁺ male & Rh⁺ female
 (4) Rh⁻ male & Rh⁺ female
- 23.** AB blood group can be donated to :-
 (1) A (2) B (3) AB (4) O
- 24.** Blood clotting requires
 (1) Na⁺ and K⁺
 (2) Na⁺ and prothrombin
 (3) Na⁺ and thromboplastin
 (4) Ca²⁺ and thromboplastin.
- 25.** Platelets are a source of
 (1) Fibrinogen (2) Calcium
 (3) Thromboplastin (4) Haemoglobin
- 26.** Maximum number of white blood corpuscles is that of
 (1) Basophils (2) Neutrophils
 (3) Monocytes (4) Eosinophils.
- 27.** Life span of human white blood corpuscles is
 (1) 24 hours (2) Less than 10 days
 (3) 120 days (4) 100 hours.
- 28.** Which of the following is not a granulocyte ?
 (1) Lymphocyte (2) Basophil
 (3) Neutrophil (4) Eosinophil.
- 29.** Which of the following are involved in body defence
 (1) Neutrophils (2) Lymphocytes
 (3) Macrophages (4) All the above.
- 30.** Prothrombin, albumin and fibrinogen are synthesised by
 (1) Pancreas (2) Bone marrow
 (3) Spleen (4) Liver.
- 31.** Immature RBCs of mammals have
 (1) No nucleus
 (2) Single beaded nucleus
 (3) Many nuclei
 (4) Single nucleus.
- 32.** Megakaryocytes
 (1) Produce leucocytes
 (2) Forms blood platelets
 (3) Are bone cells
 (4) Are carriers of oxygen
- 33.** During blood clotting, fibrin is produced by
 (1) Thrombokinase (2) Prothrombin
 (3) Liver (4) Proteolysis
- 34.** Number of erythrocytes per mm³ of human blood is
 (1) 4 million (2) 5 million
 (3) 8 million (4) 0.5 million
- 35.** Number of WBCs per mm³ of human blood is
 (1) 8000 (2) 100000
 (3) 5000 (4) 16000
- 36.** Globulin is
 (1) Plasma protein
 (2) Antigen
 (3) Serum
 (4) Found in lymphatic tissue.

HISTOLOGY OF HUMAN HEART, ANATOMY OF HUMAN HEART, HEARTS OF VERTEBRATES, CIRCULATORY PATHWAYS

- 37.** The valves of the heart are attached to papillary muscles by :-
 (1) Columnae carinae (2) Chordae tendinae
 (3) Tendinae (4) Pectinati muscles
- 38.** Heart of fish has :-
 (1) Oxygenated blood (2) Deoxygenated blood
 (3) Both (4) None
- 39.** Membrane surrounding the heart is :-
 (1) Peritoneum
 (2) Visceral membrane
 (3) Pericardium
 (4) None
- 40.** Which has the thickest walls :-
 (1) Right auricle (2) Left auricle
 (3) Right ventricles (4) Left ventricle
- 41.** Three chambered heart found in :-
 (1) Fish (2) Frog
 (3) Rabbit (4) Man
- 42.** The mitral valve is supported by :-
 (1) Bundle of HIS (2) Ductus arteriosus
 (3) Foramen ovale (4) Chorda tendinae

CONDUCTING SYSTEM OF HEART, HEART BEAT, REGULATION OF CARDIAC ACTIVITY

- 43.** The largest and the thickest heart chamber is
 (1) Left ventricle (2) Left atrium
 (3) Right atrium (4) Right ventricle
- 44.** Valves present between right atrium and right ventricle is
 (1) Mitral valve (2) Tricuspid valve
 (3) Bicuspid valve (4) Semilunar valve
- 45.** Closed circulatory system occurs in
 (1) Cockroach (2) Fish
 (3) Mosquito (4) Housefly
- 46.** Pericardial fluid is secreted by
 (1) Myocardium (2) Parietal peritoneum
 (3) Visceral peritoneum (4) Pericardium
- 47.** Systemic heart refers to :-
 (1) The heart that contracts under stimulation from nervous system
 (2) Left auricle and left ventricle in higher vertebrates
 (3) Entire heart in lower vertebrates
 (4) The two ventricles together in humans
- 48.** Number of set of papillary muscles found in human heart :-
 (1) Two (2) Three
 (3) Four (4) Five
- 49.** Which animal has most mixing of oxygenated and deoxygenated blood in the ventricles ?
 (1) Scoliodon (2) Rabbit
 (3) Frog (4) Human
- 50.** Open circulatory system is present in
 (a) Arthropoda (b) Annelida
 (c) Chordates (d) Mollusca
 (1) c only (2) c and b
 (3) a and b (4) a and d
- 51.** Papillary muscles are located
 (1) Heart ventricle of rabbit
 (2) Dermis of mammalian skin
 (3) Orbit of vertebrates eyes
 (4) Pylorus of vertebrate stomach
- 52.** Purkinje fibers are found in
 (1) Brain (2) Kidney
 (3) Skin (4) Heart
- 53.** If due to some injury the chordae tendinae of the tricuspid valve of the human heart is partially non-functional, what will be the immediate effect ?
 (1) The flow of blood into the pulmonary artery will be reduced
 (2) The flow of blood into the aorta will be slowed down
 (3) The 'pacemaker' will stop working
 (4) The blood will tend to flow back into the left atrium

- 54.** Which one generates heart beat?
 (1) Purkinje fibres
 (2) Cardiac branch of vagus nerve
 (3) SA node
 (4) AV node
- 55.** Heart beat is initiated by
 (1) AV node (2) SA node
 (3) Bundle of His (4) Purkinje fibres
- 56.** Ventricular contraction in command of
 (1) S.A. Node (2) A.V. Node
 (3) Purkinje fibers (4) Papillary muscles
- 57.** Impulse of heart beat originates from -
 (1) S. A. Node (2) A. V. Node
 (3) Vagus Nerve (4) Cardiac Nerve
- 58.** Bundle of His is a network of :-
 (1) Muscle fibres distributed throughout the heart walls
 (2) Muscle fibres found only in the ventricle wall
 (3) Nerve fibres distributed in ventricles
 (4) Nerve fibres found throughout the heart
- 59.** SA node is located in the wall of :-
 (1) Right ventricle
 (2) Left ventricle
 (3) Right atrium
 (4) Left atrium
- 60.** If parasympathetic nerve of the human is cut then heart beat :-
 (1) Unaffected (2) Decreases
 (3) Increases (4) Stop
- 61.** When does the blood enter in atria. Choose the correct answer :-
 (a) during generation of impulse from SAN
 (b) atrial relaxation
 (c) as the tricuspid and bicuspid valves are open
 (d) joint diastole
 (1) a, b (2) a, b, c (3) b, c, d (4) all
- 62.** Choose the correct pathway of the transmission of impulses in the heart beat :
 (1) AV node → S A node → Bundle of His → Purkinje fibres
 (2) SA node → AV node → Bundle of His → Purkinje fibres
 (3) SA node → Bundle of His → AV node → Purkinje fibres
 (4) AV node → Bundle of His → SA node → Purkinje fibres

63. Pacemaker and pacesetter in human heart are _____ and _____ respectively :-
 (1) SA node, Bundle of his
 (2) AV node, Bundle of his
 (3) SA node, AV node
 (4) SA node, Purkinje fibres

CARDIAC CYCLE, DOUBLE CIRCULATION, PORTAL SYSTEM

64. Stroke volume and cardiac output are _____ and _____ respectively :-
 (1) 50 ml, 5 L (2) 5 L, 50 ml
 (3) 70 ml, 5 L (4) 120 ml, 5L
65. 1st Heart sound is heard as :-
 (1) 'Lub' at end of systole
 (2) 'Dub' at end of systole
 (3) 'Lub' at beginning of Ventricular systole
 (4) 'Dub' at beginning of Ventricular systole
66. The sound of lubb is produced during closure of
 (1) Bicuspid valve (2) Tricuspid valve
 (3) Semilunar valves (4) Both (1) and (2)
67. Identify the correct statement regarding the heart sounds :-
 (A) In a healthy individual, there are two normal heart sounds called *lubb* and *dubb*
 (B) *Lubb* is the first heart sound. It is associated with the closure of the semilunar and bicuspid valves at the beginning of atrial systole.
 (C) The second heart sound *dubb* is associated with the closure of the semilunar valves at the beginning of joint diastole.
 (1) A and B (2) A and C
 (3) B and C (4) All
68. Cardiac output is the :-
 (1) Amount of blood pumped by both ventricles in one minute
 (2) Amount of blood pumped by each ventricle in one minute
 (3) Amount of blood pumped by each ventricle in one second
 (4) Amount of blood pumped by each ventricle in one stroke
69. Time period of cardiac cycle in human heart is 0.8 sec. In which of the following condition this time period is decreases :-
 (a) Exercise (b) Infants
 (c) Old age (d) Athletes
 (e) Relax condition
 (1) a, b, c (2) a, b
 (3) b, c, e (4) d, e

70. During atrial systole flow of blood into ventricles increases about :-
 (1) 70% (2) 5% (3) 30% (4) 50%
71. Which among the following is correct during each cardiac cycle ?
 (1) The volume of blood pumped out by the right and left ventricles is same.
 (2) The volume of blood pumped out by the right and left ventricles is different
 (3) The volume of blood received by each atrium is different
 (4) The volume of blood received by the aorta and pulmonary artery is different
72. Blood enters into the heart because muscles of :
 (1) Atria relax
 (2) Ventricle contract
 (3) Ventricle relax
 (4) Atria contract
73. Cardiac output is determined by
 (1) Heart rate
 (2) Stroke volume
 (3) Blood flow
 (4) Both 1 and 2
74. The duration of cardiac cycle is
 (1) 0.8 sec. (2) 0.8 μ sec.
 (3) 0.08 sec. (4) 0.008 sec.

BLOOD VESSELS

75. The correct sequence of layers found in the walls of arteries from inside outward is :
 (1) Tunica adventitia, tunica interna & tunica media
 (2) Tunica interna, tunica externa & tunica media
 (3) Tunica interna, tunica media & tunica externa
 (4) Tunica media, tunica externa & tunica interna
76. Pulmonary artery differs from pulmonary vein in having
 (1) Thick wall (2) Thin wall
 (3) Valves (4) Both (2) and (3)
77. Blood vessel which brings oxygenated blood to left auricle is
 (1) precaval vein
 (2) Post caval vein
 (3) Pulmonary vein
 (4) Pulmonary artery

- 78.** An artery is a vessel that carries blood :
 (1) Away from the heart
 (2) Towards the heart
 (3) Which is deoxygenated without any exception
 (4) none of these
- 79.** What is true about vein
 (1) All veins carry deoxygenated blood
 (2) All veins carry oxygenated blood
 (3) They carry blood from organs towards heart
 (4) They carry blood from heart towards organs
- 80.** The exchange of materials between blood and interstitial fluid is by
 (1) Arterioles (2) Arteries
 (3) Capillaries (4) Veins
- 81.** Artery supply O₂ blood to liver is –
 (1) Hepatic artery (2) Hepatic portal vein
 (3) Hepatic vein (4) Renal artery
- 82.** Which of the following is poorly developed in vein?
 (1) Tunica interna (2) Tunica externa
 (3) Tunica media (4) None of the above
- 83.** Which organ is called as grave yard of RBCs ?
 (1) Pancreas (2) Kidneys
 (3) Liver (4) Spleen

BLOOD PRESSURE, DISEASES, ECG

- 84.** The value of diastolic blood pressure is
 (1) 120 mm Hg (2) 80 mm Hg
 (3) 120/80 mm Hg (4) 40 mm Hg
- 85.** Blood pressure is measured by
 (1) Sphygmomanometer (2) Phonocardiogram
 (3) Electrocardiogram (4) Stethoscope

- 86.** Normal pulse pressure is
 (1) 80 mm Hg (2) 120 mm Hg
 (3) 40 mm Hg (4) 320 mm Hg
- 87.** Coronary heart disease is due to :
 (1) Streptococci bacteria
 (2) Inflammation of pericardium
 (3) Weakening of the heart valves
 (4) Insufficient blood supply to the heart muscles
- 88.** Which one indicates the hypertension ?
 (1) 90/60 mmHg
 (2) 120/85 mmHg
 (3) 110/70 mmHg
 (4) 140/100 mmHg
- 89.** The deposition of lipids on the wall lining the lumen of large and medium sized arteries is referred to as
 (1) Deep vein thrombosis
 (2) Stokes – Adams syndrome
 (3) Osteoarthritis
 (4) Atherosclerosis
- 90.** To obtain a standard ECG a patient is connected to the machine with three electrodes
 (1) one to each ankle and to the left wrist
 (2) one to each wrist and to the left ankle
 (3) one to each wrist and to the left chest region
 (4) one to each ankle and to the left chest region
- 91.** The QRS complex of a standard ECG represents the
 (1) excitation of the atria
 (2) depolarization of the ventricles
 (3) repolarisation of the ventricles
 (4) None of the above

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	3	1	2	2	2	1	2	1	4	1	2	2	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	4	2	1	2	1	1	3	4	3	2	2	1	4	4
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	2	2	2	1	1	2	2	3	4	2	4	1	2	2
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	4	3	4	1	4	1	3	2	1	1	2	3	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	2	3	3	3	4	2	2	2	3	1	1	4	1	3
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	1	3	1	3	3	1	3	4	2	1	3	4	4	4	2
Que.	91														
Ans.	2														

EXCRETORY PRODUCTS AND THEIR ELIMINATION

Animals accumulate ammonia, urea, uric acid, carbon dioxide, water and ions like Na^+ , K^+ , Cl^- , phosphate, sulphate, etc., either by metabolic activities or by other means like excess ingestion. These substances have to be removed totally or partially.

Removal of nitrogenous waste or the substances which are in excess in body from the body and is called excretion.

Ammonia, urea and uric acid are the major forms of nitrogenous wastes excreted by the animals.

Ammonia is the most toxic form and requires large amount of water for its elimination, whereas uric acid, being the least toxic, can be removed with a minimum loss of water.

The process of excreting ammonia is Ammonotelism. Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic in nature. Ammonia, as it is readily soluble, is generally excreted by diffusion across body surfaces or through gill surfaces (in fish) as ammonium ions. Kidneys do not play any significant role in its removal.

Terrestrial adaptation necessitated the production of lesser toxic nitrogenous wastes like urea and uric acid for conservation of water. Mammals, many terrestrial amphibians and marine fishes mainly excrete urea and are called ureotelic animals. Ammonia produced by metabolism is converted into urea in the liver of these animals and released into the blood which is filtered and excreted out by the kidneys. Some amount of urea may be retained in the kidney matrix of some of these animals to maintain a desired osmolarity.

Reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water and are called uricotelic animals.

- Excretory matter in spider is Guanine**

Homeostasis : Maintenance of steady state (Walter Cannon).

Homeostatic mechanism are important for normal life as they maintain condition within a range in which, the animals metabolic processes can occur. The process which is concerned with removal of nitrogenous waste materials (e.g., urea, uric acid, CO_2 , Ammonia, salts, excess water etc.) is termed excretion.

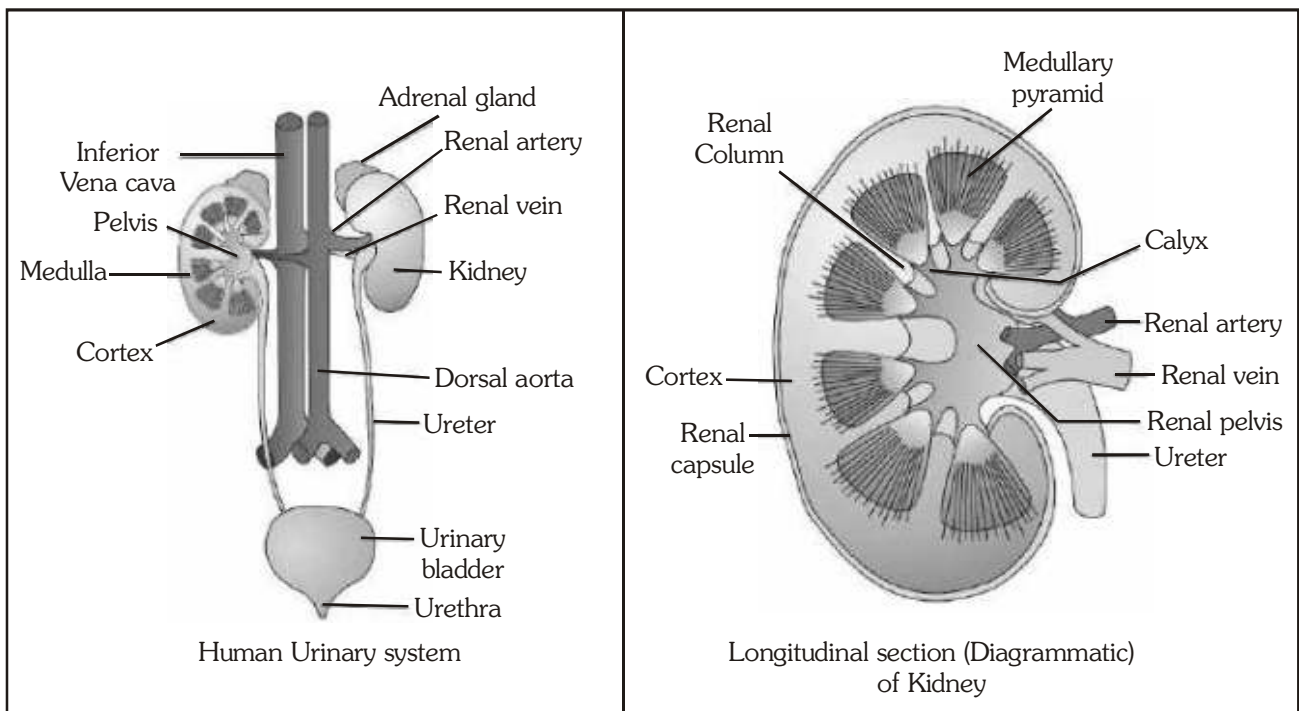
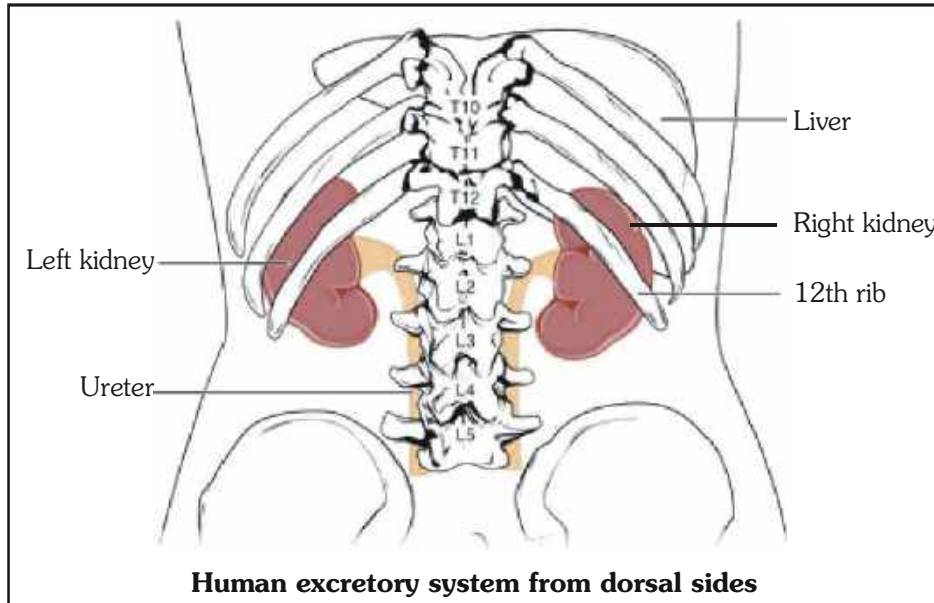
Excretory organs in animals :

A survey of animal kingdom presents a variety of excretory structures. In most of the invertebrates, these structures are simple tubular forms whereas vertebrates have complex tubular organs called kidneys. Some of these structures are mentioned here. Protonephridia or flame cells are the excretory structures in Platyhelminthes (Flatworms, e.g., Planaria), rotifers, some annelids and the cephalochordate – Amphioxus. Protonephridia are primarily concerned with ionic and fluid volume regulation, i.e., osmoregulation. Nephridia are the tubular excretory structures of earthworms and other annelids. **Nephridia** help to remove nitrogenous wastes and maintain a fluid and ionic balance. **Malpighian tubules** are the excretory structures of most of the insects including cockroaches. Malpighian tubules help in the removal of nitrogenous wastes and osmoregulation. **Antennal glands** or **green glands** perform the excretory function in crustaceans like prawns. **Coxal Glands** are excretory organs in spiders (Arachnida)

Animals	Flatworms e.g. Planaria	Earthworm	Insects e.g., Cockroach	Crustaceans e.g., Prawn	All chordates
Excretory organs	Protonephridia (Flame cells)	Nephridia	Malpighian tubules	Green glands	Kidneys

Position and dimension of kidneys in human body.

Kidneys are reddish brown, bean shaped structures situated between the levels of last thoracic and third lumbar vertebra close to the dorsal inner wall of the abdominal cavity. Each kidney of an adult human measures 10-12 cm in length, 5-7 cm in width, 2-3 cm in thickness with an average weight of 120-170 g.



In humans, the excretory system consists of a pair of kidneys, one pair of ureters, a urinary bladder and a urethra

Towards the centre of the inner concave surface of the kidney is a notch called hilum through which renal artery and nerves enter. Whereas ureter and renal vein leave the kidney. Inner to the hilum is a broad funnel shaped space called the renal pelvis with projections called calyces.

Dorsal surface of the kidney is attached to the dorsal abdominal wall, so only its ventral surface is covered by visceral peritoneum. This type of kidney is called retro-peritoneal kidney or extra peritoneal kidney. Mammalian kidneys are bean shaped.

The outer layer of kidney is a tough capsule. Inside the kidney, there are two zones, an outer cortex and an inner medulla. The medulla is divided into a few conical masses (medullary pyramids) projecting into the calyces (sing.: calyx). The cortex extends in between the medullary pyramids as renal columns called Columns of Bertini.

- Kidneys are mesodermal in origin

- If one kidney is removed from the body of human being than the other one increases in size and try to perform the function of removed kidney also. It is an example of regeneration method called compensate hypertrophy

POST RENAL URINARY TRACT

Urine passes from the pelvis into the **ureter**. Both the ureters open through separate oblique openings into the **urinary bladder**. The oblique openings prevent the backflow of urine.

Externally, the bladder is lined by detrusor muscle, it is involuntary in nature while internally the bladder is lined by transitional epithelium or urothelium. This epithelium has great capacity to expand so that large volume of urine can be stored if required. Opening of urinary bladder is controlled by sphincters made of circular muscles. These normally remain contracted and during micturition these relax to release urine. (In rabbit a single sphincter is present while in human two sphincters, inner involuntary & outer voluntary, are present.)

Passage of urine :

Nephron → Collecting duct → Papilla → Renal calyx → Renal pelvis → Ureters → Urinary bladder → Urethra

During act of micturition urine leaves the urinary bladder and enters the membranous duct called **Urethra**.

The urethra leads to end of the penis in males and into the vulva in females. In males the urethra has three parts, prostatic, membranous & penile urethra respectively. (Prostatic urethra is absent in females, therefore both sphincters are present in membranous urethra)

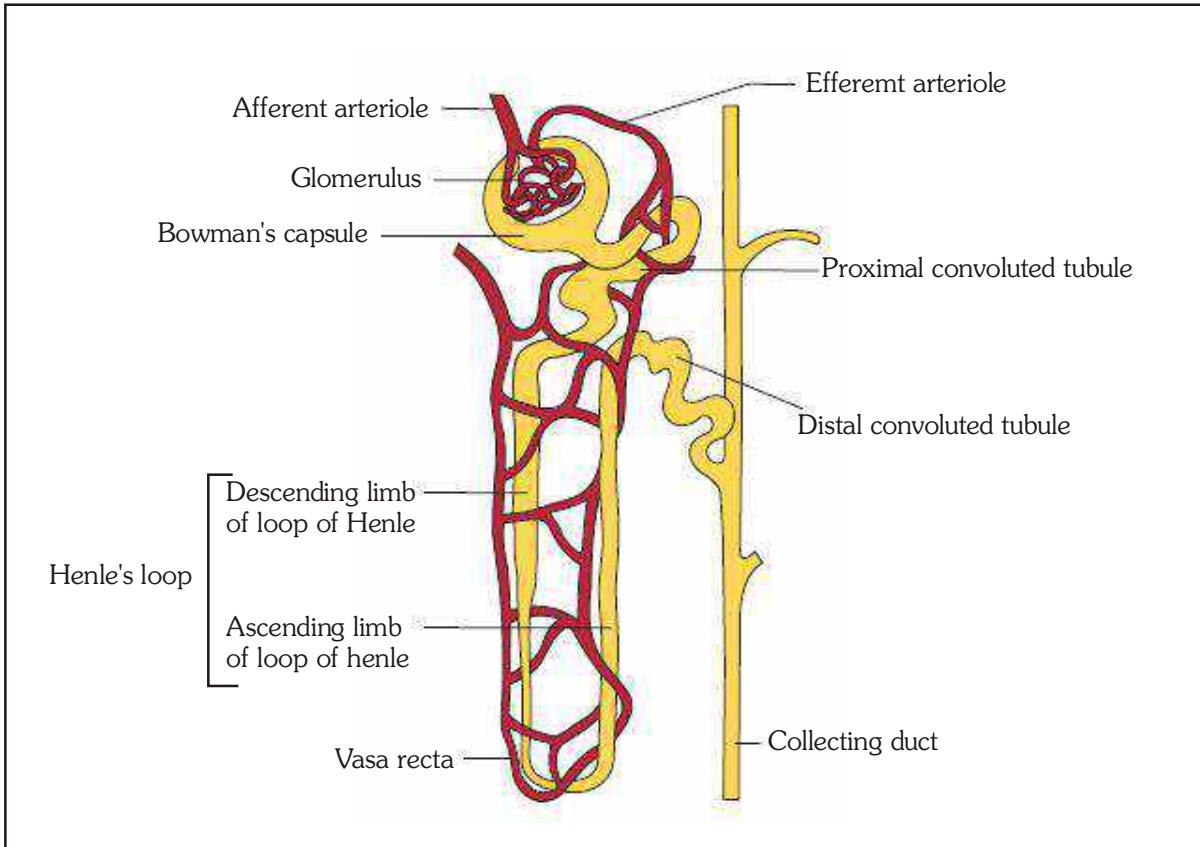
STRUCTURE OF NEPHRON

Each kidney has nearly one million complex tubular structures called **nephrons** (Figure), which are the functional units. Each nephron has two parts – the glomerulus and the renal tubule. Glomerulus is a tuft of capillaries formed by the afferent arteriole – a fine branch of renal artery. Blood from the glomerulus is carried away by an efferent arteriole.

The renal tubule begins with a double walled cup-like structure called **Bowman's capsule**, which encloses the glomerulus. Glomerulus alongwith Bowman's capsule, is called the malpighian body or renal corpuscle (Figure). The tubule continues further to form a highly coiled network – **proximal convoluted tubule** (PCT). A hairpin shaped **Henle's loop** is the next part of the tubule which has a descending and an ascending limb. The ascending limb continues as another highly coiled tubular region called **distal convoluted tubule** (DCT). The DCTs of many nephrons open into a straight tube called collecting duct, many of which converge and open into the renal pelvis through medullary pyramids in the calyces.

The Malpighian corpuscle, PCT and DCT of the nephron are situated in the cortical region of the kidney whereas the loop of Henle dips into the medulla. In majority of nephrons, the loop of Henle is too short and extends only very little into the medulla. Such nephrons are called cortical nephrons. In some of the nephrons, the loop of Henle is very long and runs deep into the medulla. These nephrons are called juxta medullary nephrons.

The efferent arteriole emerging from the glomerulus forms a fine capillary network around the renal tubule called the peritubular capillaries. A minute vessel of this network runs parallel to the Henle's loop forming a 'U' shaped vasa recta. Vasa recta is absent or highly reduced in cortical nephrons.

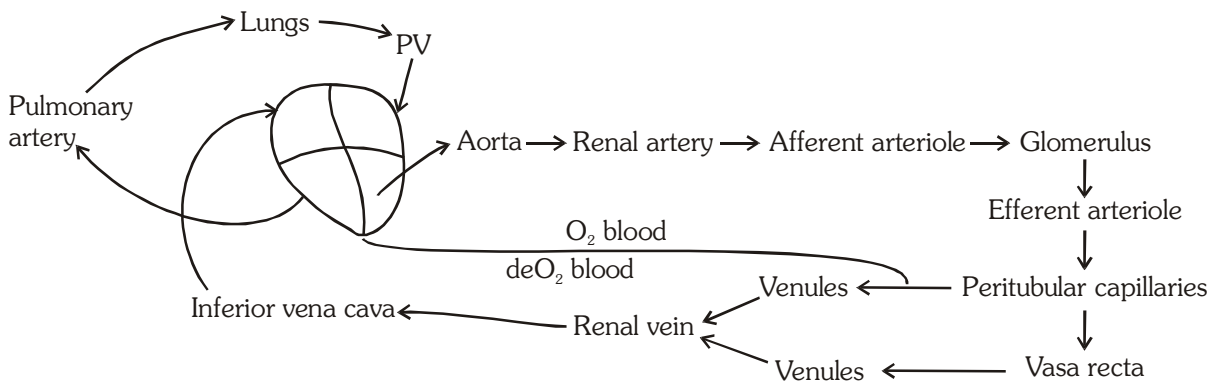


Types of nephron :

According to their position, nephrons are of two types.

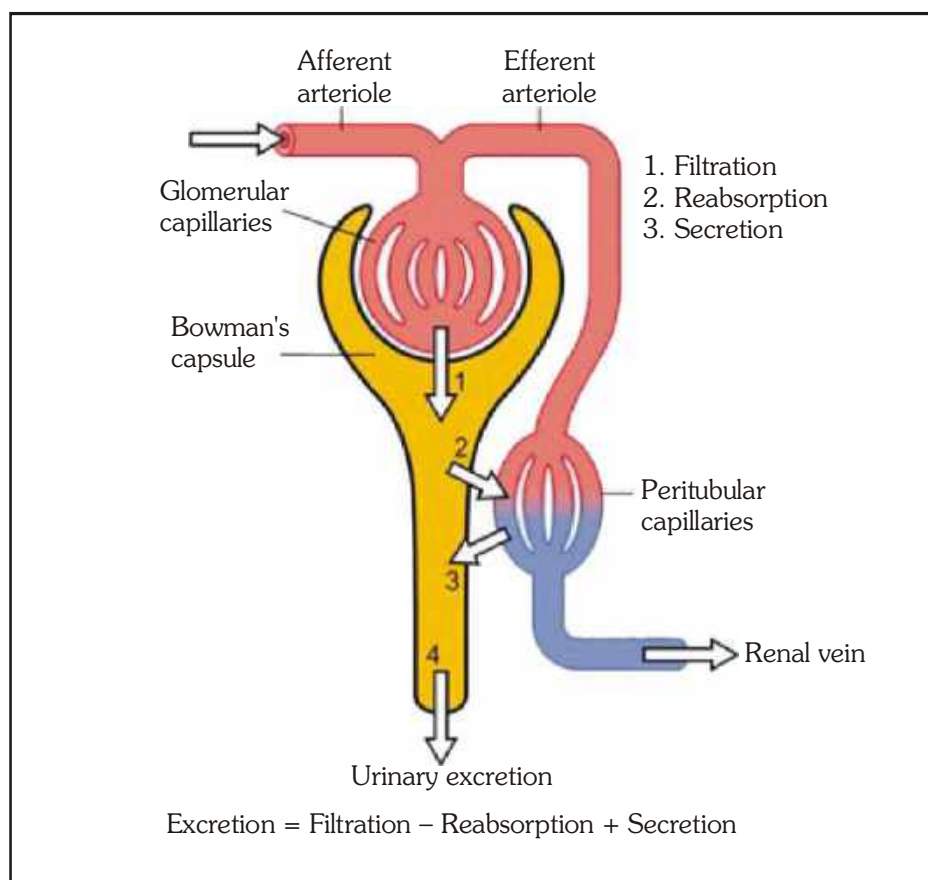
	Cortical nephrons		Juxtamedullary nephrons
1.	Constitute about 85% of total. (75 - 85%)	1.	About 15% of total. (15 - 25%)
2.	Malpighian corpuscles are located close to the kidney surface.	2.	Malpighian corpuscles are located at the junction of cortex and medulla.
3.	Their loop of Henle are mostly confined to cortex and a very small part of it runs in the medulla.	3.	The loop of Henle of these nephrons are long, dipping deep down into the medulla.
4.	Vasa recta is absent.	4.	Vasa recta present.

BLOOD FLOW IN KIDNEYS



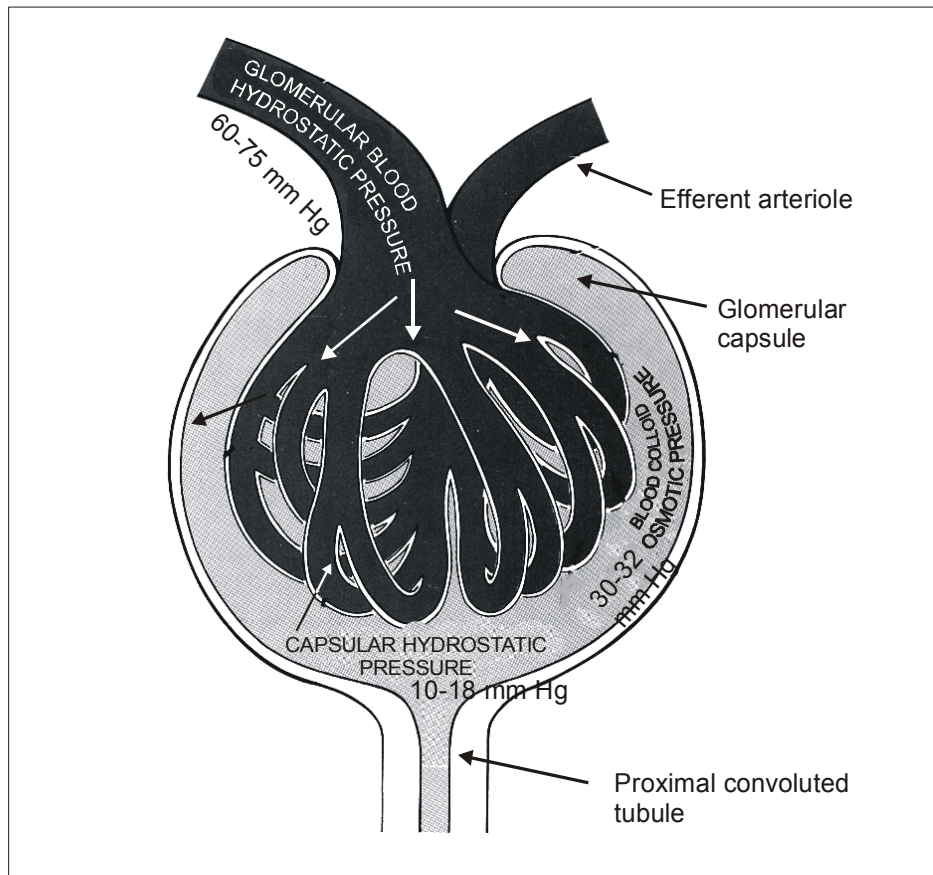
MECHANISM OF URINE FORMATION

Urine formation involves three main processes namely, glomerular filtration, reabsorption and secretion, that takes place in different parts of the nephron.



The first step in urine formation is the filtration of blood, which is carried out by the glomerulus and is called **glomerular filtration**. On an average, 1100-1200 ml of blood is filtered by the kidneys per minute which constitute roughly 1/5th of the blood pumped out by each ventricle of the heart in a minute. The glomerular capillary blood pressure causes filtration of blood through 3 layers, i.e., the endothelium of glomerular blood vessels, the epithelium of Bowman's capsule and a basement membrane between these two layers. The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called filtration slits or slit pores. Blood is filtered so finely through these membranes, that almost all the constituents of the plasma except the proteins pass onto the lumen of the Bowman's capsule. Therefore, it is considered as a process of **ultra filtration**.

The amount of the filtrate formed by the kidneys per minute is called **glomerular filtration rate (GFR)**. GFR in a healthy individual is approximately 125 ml/minute, i.e., 180 litres per day !

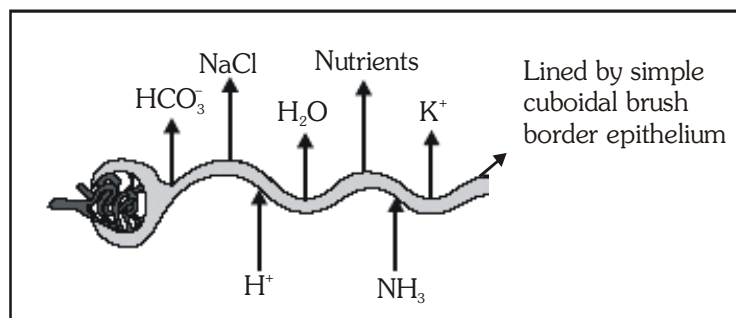


A comparison of the volume of the filtrate formed per day (180 litres per day) with that of the urine released (1.5 litres), suggest that nearly 99 per cent of the filtrate has to be reabsorbed by the renal tubules. This process is called **reabsorption**. The tubular epithelial cells in different segments of nephron perform this either by active or passive mechanisms. For example, substances like glucose, amino acids, Na^+ , etc., in the filtrate are reabsorbed actively whereas the nitrogenous wastes are absorbed by passive transport. Reabsorption of water also occurs passively in the initial segments of the nephron (Figure).

During urine formation, the tubular cells secrete substances like H^+ , K^+ and ammonia into the filtrate. Tubular secretion is also an important step in urine formation as it helps in the maintenance of ionic and acid base balance of body fluids.

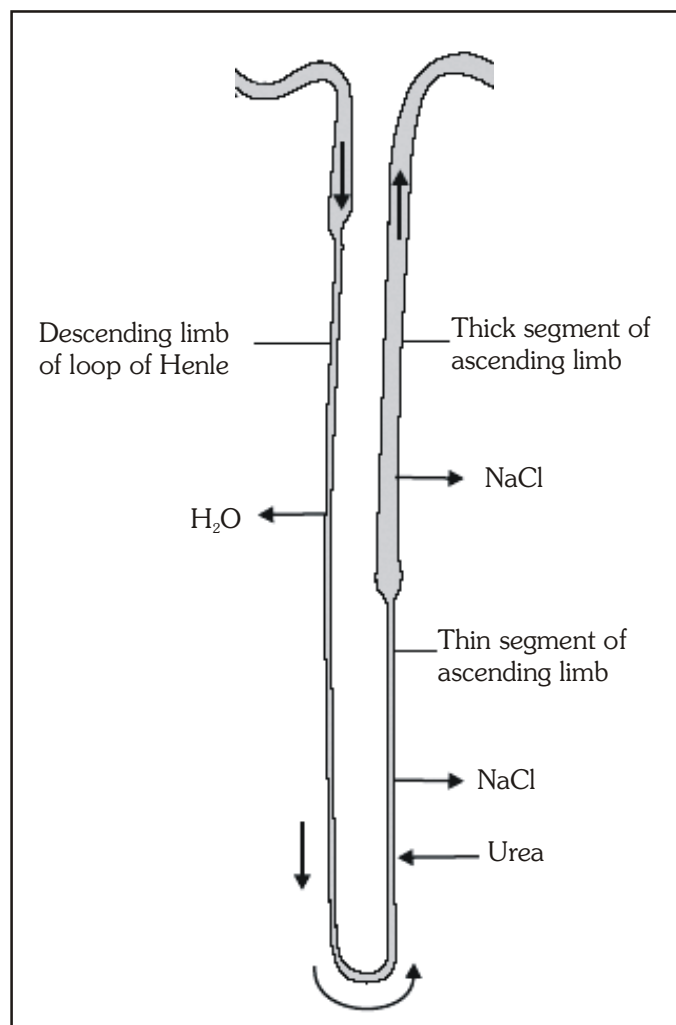
FUNCTION OF THE TUBULES

Proximal Convoluted Tubule (PCT): PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment. PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate and by absorption of HCO_3^- from it.

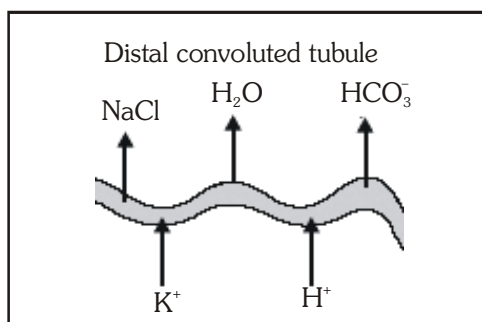


Henle's Loop : Reabsorption in this segment is minimum. However, this region plays a significant role in the

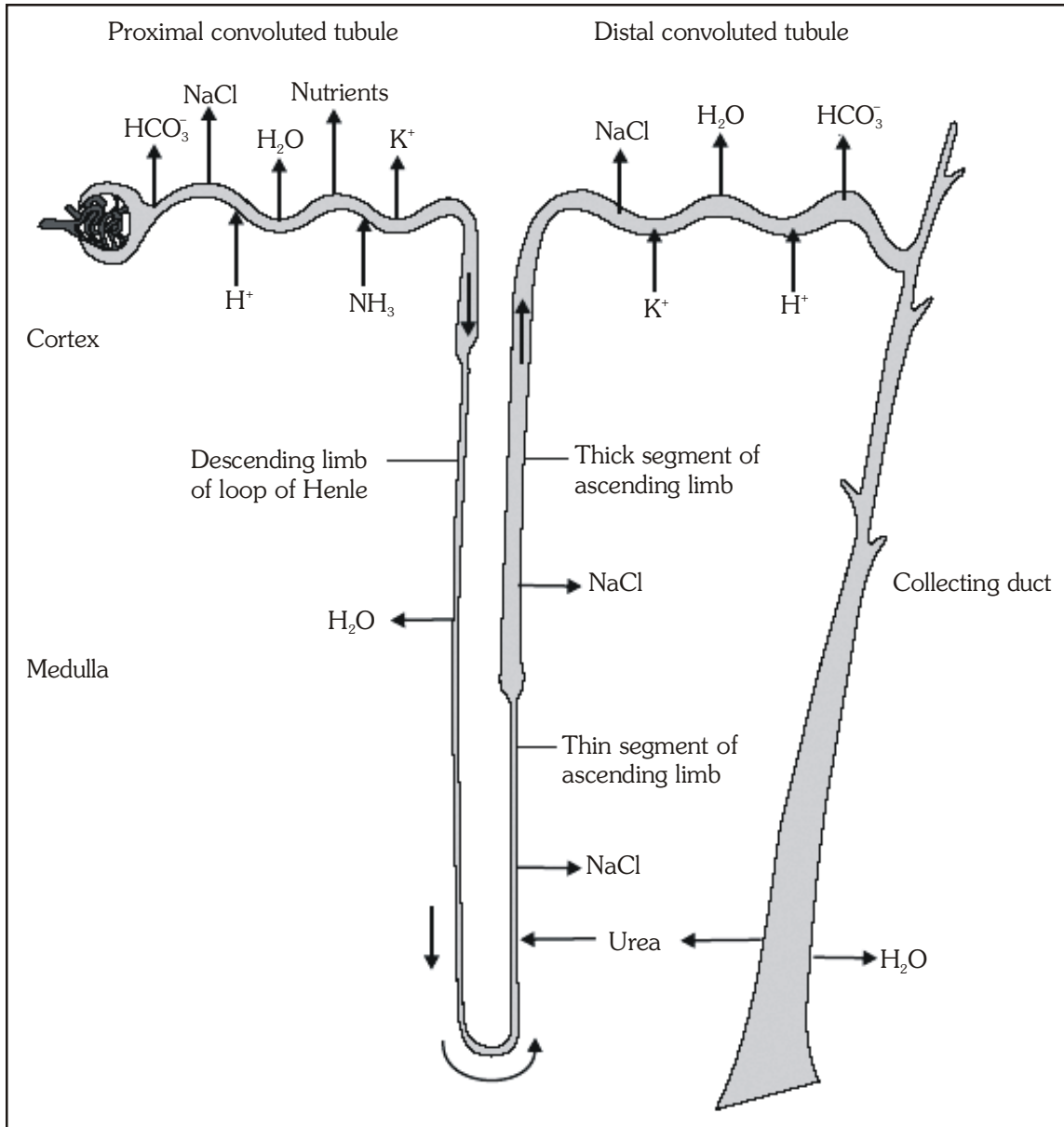
maintenance of high osmolarity of medullary interstitial fluid. The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes. This concentrates the filtrate as it moves down. The ascending limb is impermeable to water but allows transport of electrolytes actively or passively. Therefore, as the concentrated filtrate pass upward, it gets diluted due to the passage of electrolytes to the medullary fluid.



Distal Convoluted Tubule (DCT) : Conditional reabsorption of Na⁺ and water takes place in this segment. DCT is also capable of reabsorption of HCO₃⁻ and selective secretion of hydrogen and potassium ions and NH₃ to maintain the pH and sodium-potassium balance in blood.

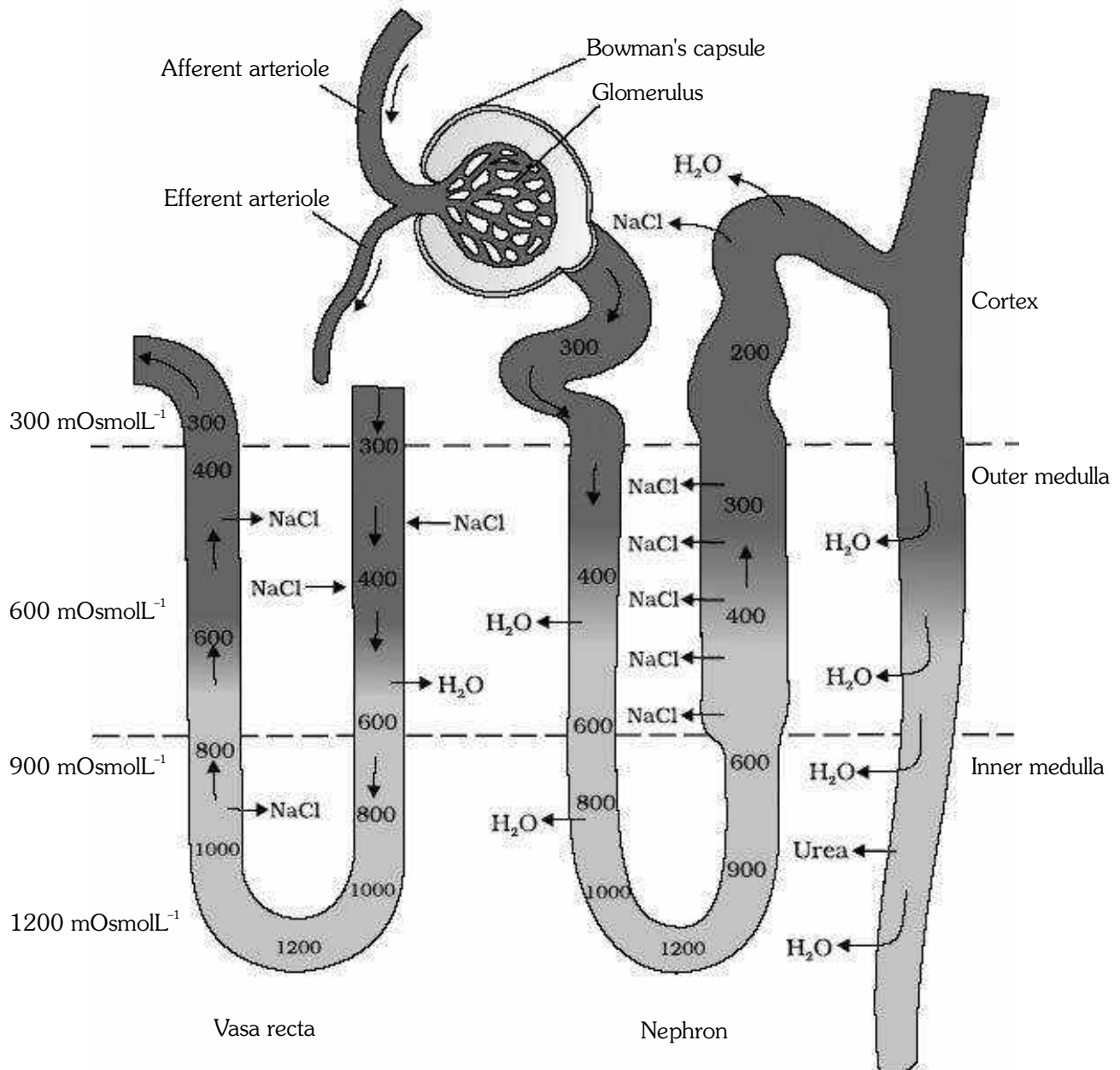


Collecting Duct : This long duct extends from the cortex of the kidney to the inner parts of the medulla. Large amounts of water could be reabsorbed from this region to produce a concentrated urine. This segment allows passage of small amounts of urea into the medullary interstitium to keep up the osmolarity. It also plays a role in the maintenance of pH and ionic balance of blood by the selective secretion of H⁺ and K⁺ ions.



MECHANISM OF CONCENTRATION OF THE FILTRATE

Mammals have the ability to produce a concentrated urine. The Henle's loop and vasa recta play a significant role in this. The flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a counter current. The flow of blood through the two limbs of vasa recta is also in a counter current pattern. The proximity between the Henle's loop and vasa recta, as well as the counter current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, i.e., from 300 mOsmolL⁻¹ in the cortex to about 1200 mOsmolL⁻¹ in the inner medulla. This gradient is mainly caused by NaCl and urea. NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa recta. NaCl is returned to the interstitium by the ascending portion of vasa recta. Similarly, small amounts of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule. The above described transport of substances facilitated by the special arrangement of Henle's loop and vasa recta is called the **counter current mechanism**. This mechanism helps to maintain a concentration gradient in the medullary interstitium. Presence of such interstitial gradient helps in an easy passage of water from the collecting tubule thereby concentrating the filtrate (urine). Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed.



Diagrammatic representation of a nephron and Vasa recta showing counter current mechanisms

REGULATION OF KIDNEY FUNCTION

(1) Renin Angiotensinogen Aldosterone System :

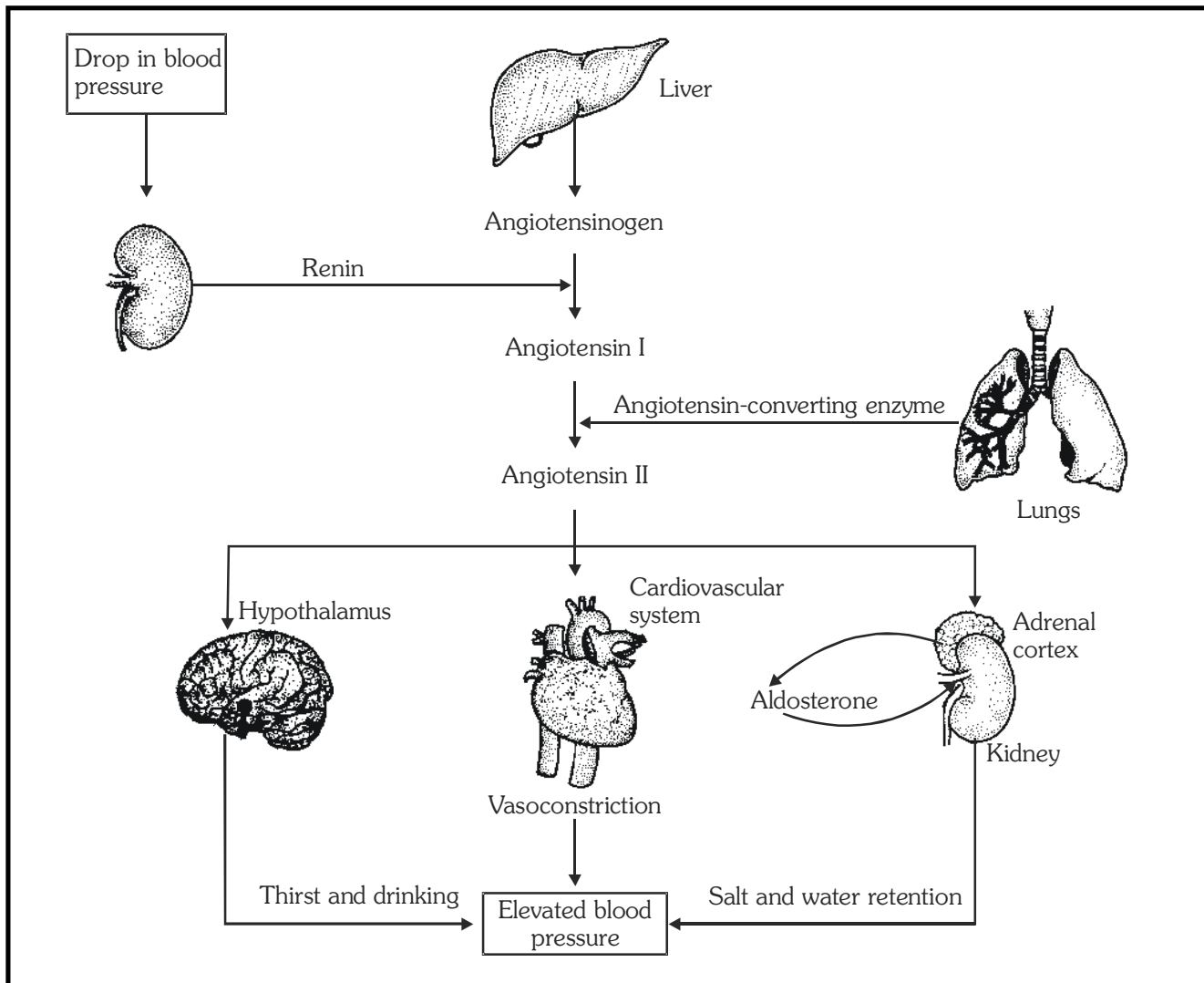
The functioning of the kidneys is efficiently monitored and regulated by hormonal feedback mechanisms involving the hypothalamus, JGA and to a certain extent, the heart.

Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration. An excessive loss of fluid from the body can activate these receptors which stimulate the hypothalamus to release antidiuretic hormone (ADH) or vasopressin from the neurohypophysis. ADH facilitates water reabsorption from latter parts of the tubule, thereby preventing diuresis. An increase in body fluid volume can switch off the osmoreceptors and suppress the ADH release to complete the feedback. ADH can also affect the kidney function by its constrictory effects on blood vessels. This causes an increase in blood pressure. An increase in blood pressure can increase the glomerular blood flow and thereby the GFR.

The JGA plays a complex regulatory role. A fall in glomerular blood flow/glomerular blood pressure/GFR can activate the JG cells to release **renin** which converts angiotensinogen in blood to angiotensin I and further to angiotensin II. Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and

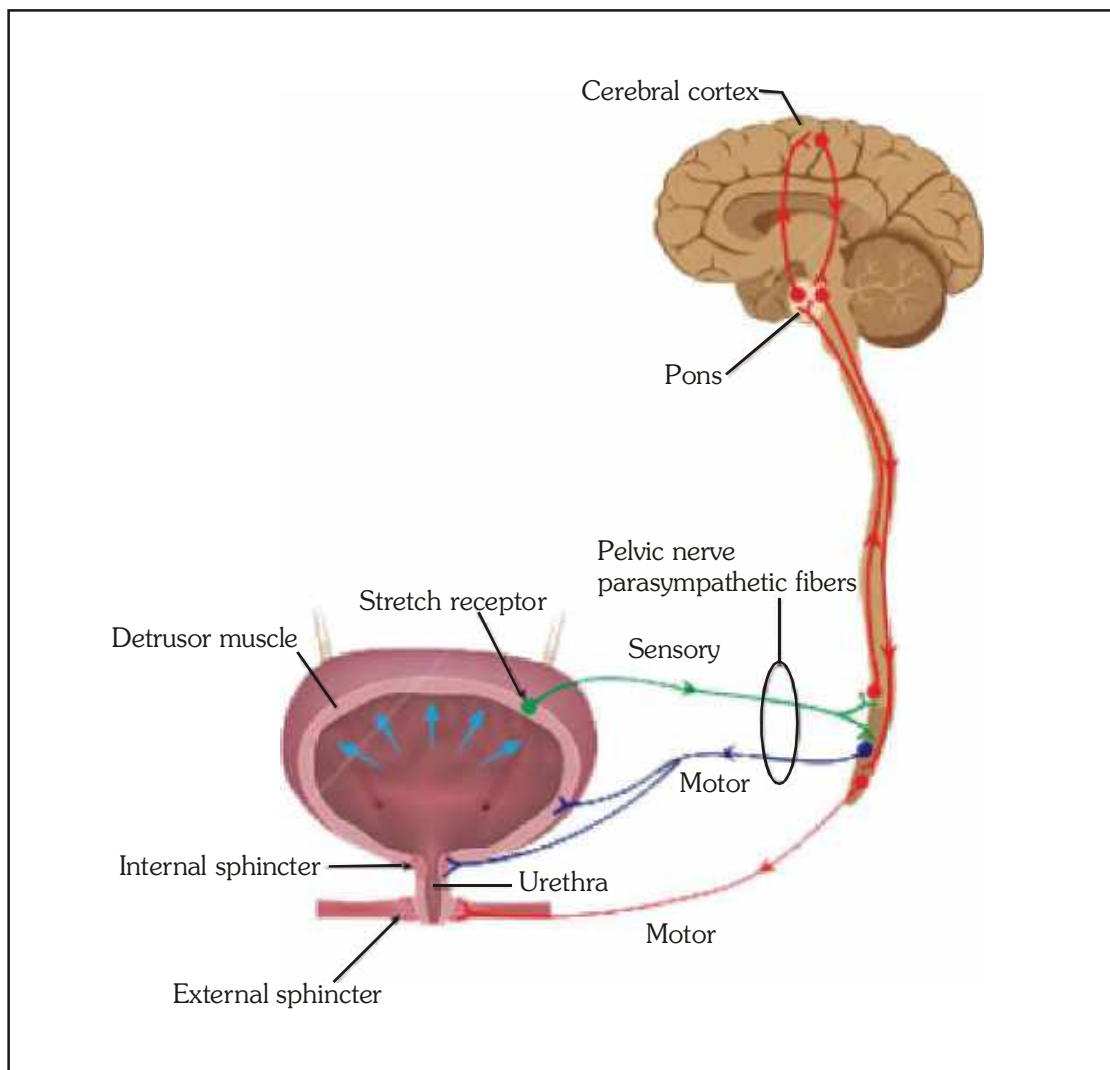
thereby GFR. Angiotensin II also activates the adrenal cortex to release Aldosterone. Aldosterone causes reabsorption of Na^+ and water from the distal parts of the tubule. This also leads to an increase in blood pressure and GFR. This complex mechanism is generally known as the **Renin-Angiotensin** mechanism.

An increase in blood flow to the atria of the heart can cause the release of **Atrial Natriuretic Factor** (ANF). ANF can cause vasodilation (dilation of blood vessels) and thereby decrease the blood pressure. ANF mechanism, therefore, acts as a check on the renin-angiotensin mechanism.



MICTURITION

Urine formed by the nephrons is ultimately carried to the urinary bladder where it is stored till a voluntary signal is given by the central nervous system (CNS). This signal is initiated by the stretching of the urinary bladder as it gets filled with urine. In response, the stretch receptors on the walls of the bladder send signals to the CNS. The CNS passes on motor messages to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine. The process of release of urine is called micturition and the neural mechanisms causing it is called the micturition reflex. An adult human excretes, on an average, 1 to 1.5 litres of urine per day. The urine formed is a light yellow coloured watery fluid which is slightly acidic (pH-6.0) and has a characteristic odour. On an average, 25-30 gm of urea is excreted out per day. Various conditions can affect the characteristics of urine. Analysis of urine helps in clinical diagnosis of many metabolic disorders as well as malfunctioning of the kidney. For example, presence of glucose (Glycosuria) and ketone bodies (Ketonuria) in urine are indicative of diabetes mellitus.



ROLE OF OTHER ORGANS IN EXCRETION

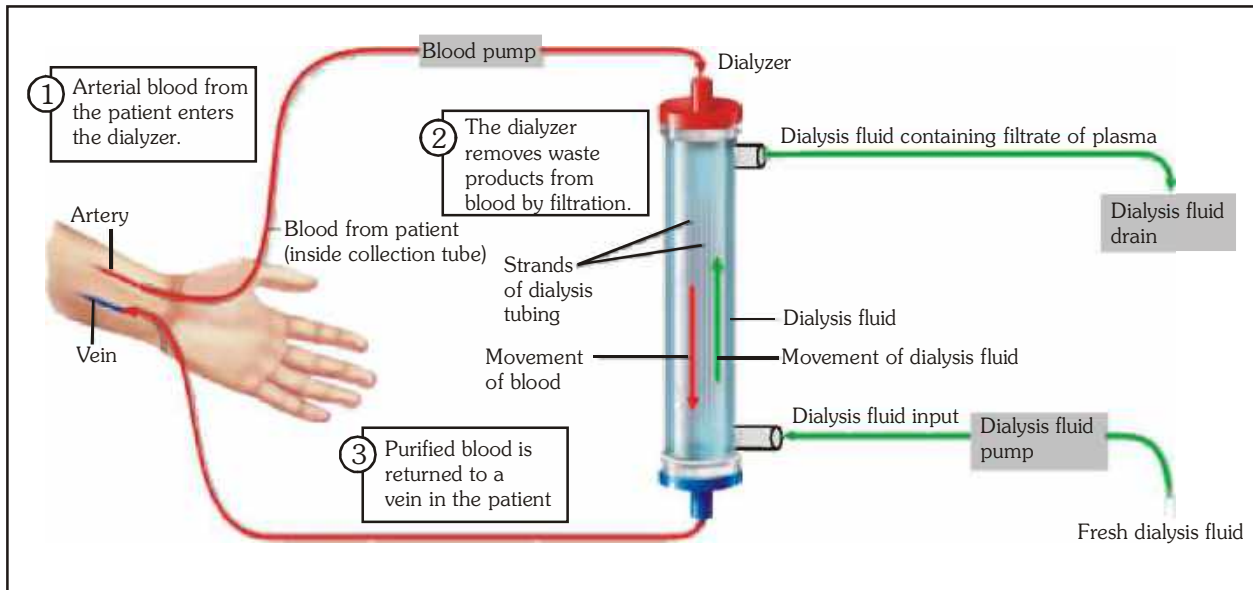
Other than the kidneys, lungs, liver and skin also help in the elimination of excretory wastes.

Our lungs remove large amounts of CO_2 (18 litres/day) and also significant quantities of water every day. Liver, the largest gland in our body, secretes bile-containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. Most of these substances ultimately pass out along with digestive wastes.

The sweat and sebaceous glands in the skin can eliminate certain substances through their secretions. Sweat produced by the sweat glands is a watery fluid containing NaCl , small amounts of urea, lactic acid, etc. Though the primary function of sweat is to facilitate a cooling effect on the body surface, it also helps in the removal of some of the wastes mentioned above. Sebaceous glands eliminate certain substances like sterols, hydrocarbons and waxes through sebum. This secretion provides a protective oily covering for the skin. Do you know that small amounts of nitrogenous wastes could be eliminated through saliva too?

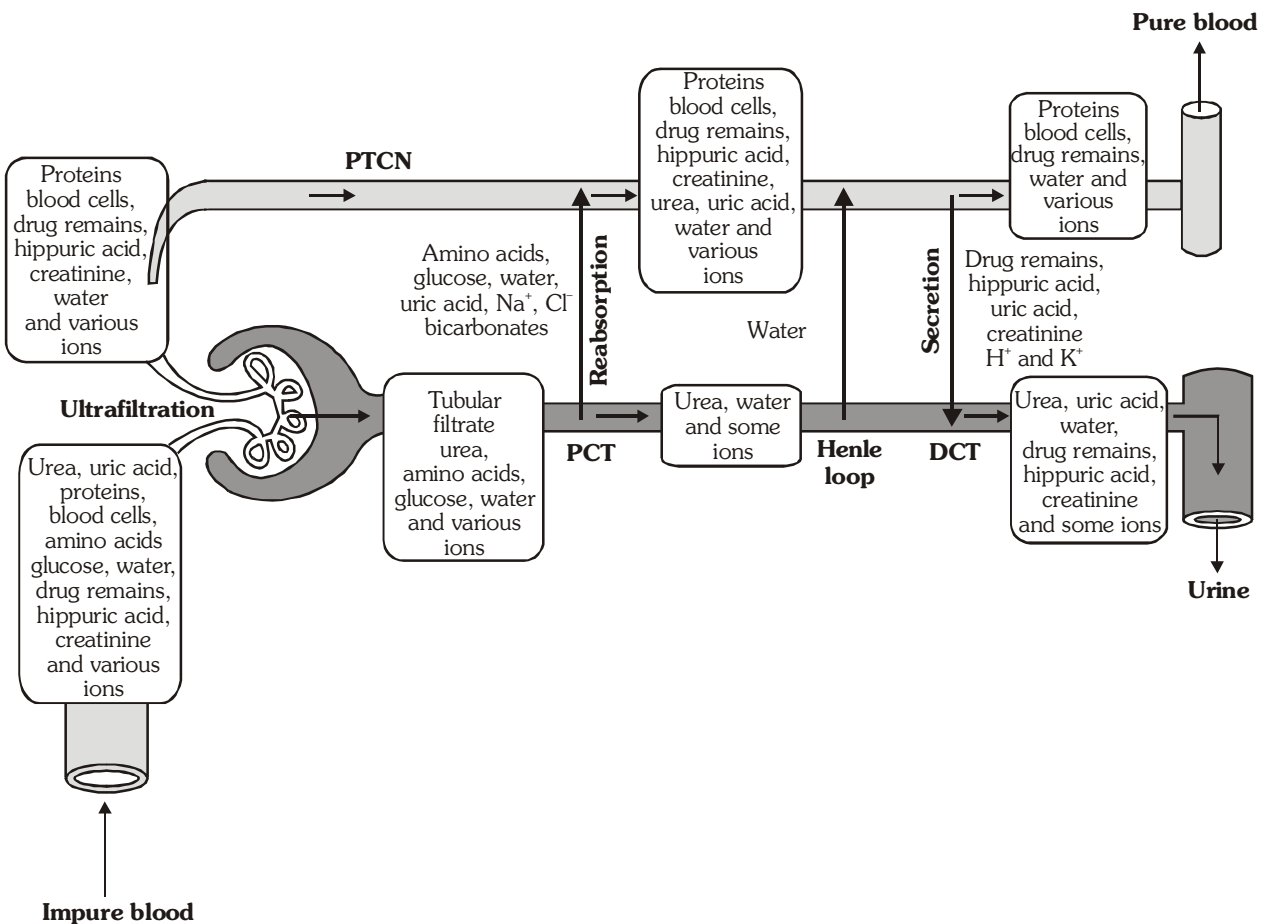
Hemodialysis

Malfunctioning of kidneys can lead to accumulation of urea in blood, a condition called **uremia**, which is highly harmful and may lead to kidney failure. In such patients, urea can be removed by a process called **hemodialysis**. Blood drained from a convenient artery is pumped into a dialysing unit after adding an anticoagulant like heparin. The unit contains a coiled cellophane tube surrounded by a fluid (dialysing fluid) having the same composition as that of plasma except the nitrogenous wastes. The porous cellophane membrane of the tube allows the passage of molecules based on concentration gradient. As nitrogenous wastes are absent in the dialysing fluid, these substances freely move out, thereby clearing the blood. The cleared blood is pumped back to the body through a vein after adding anti-heparin to it. This method is a boon for thousands of uremic patients all over the world.

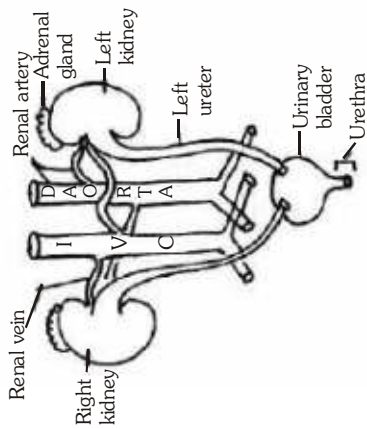


DISEASES RELATED WITH KIDNEY

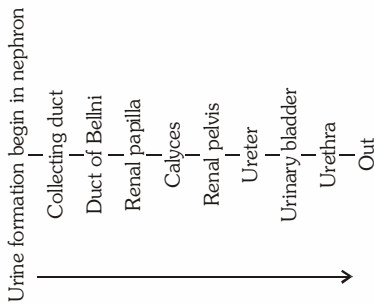
- 1. Renal failure :** It is a syndrome characterised by renal dysfunction, oliguria, anuria, sudden rise in metabolic waste products like urea & creatinine in blood (Uremia) . It is either of acute (sudden onset) or chronic (slow onset) nature.
- 2. Glomerulonephritis :** It is a disease where due to infection or injury in the basement membrane, the inflammation of glomerulus progressively leads to renal failure and death.
- 3. Diabetic nephropathy :** It is a complication due to diabetes mellitus where the kidney progressively gets damaged leading to death ultimately due to renal failure.
- 4. Urolithiasis :** Formation of calculi (stone) in the urogenital tract at any point. These calculi are made of calcium phosphate, uric acid., cystine or calcium oxalate.



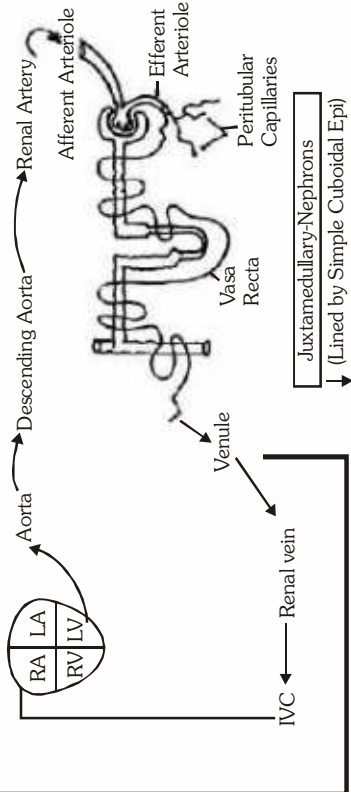
Human Excretory system



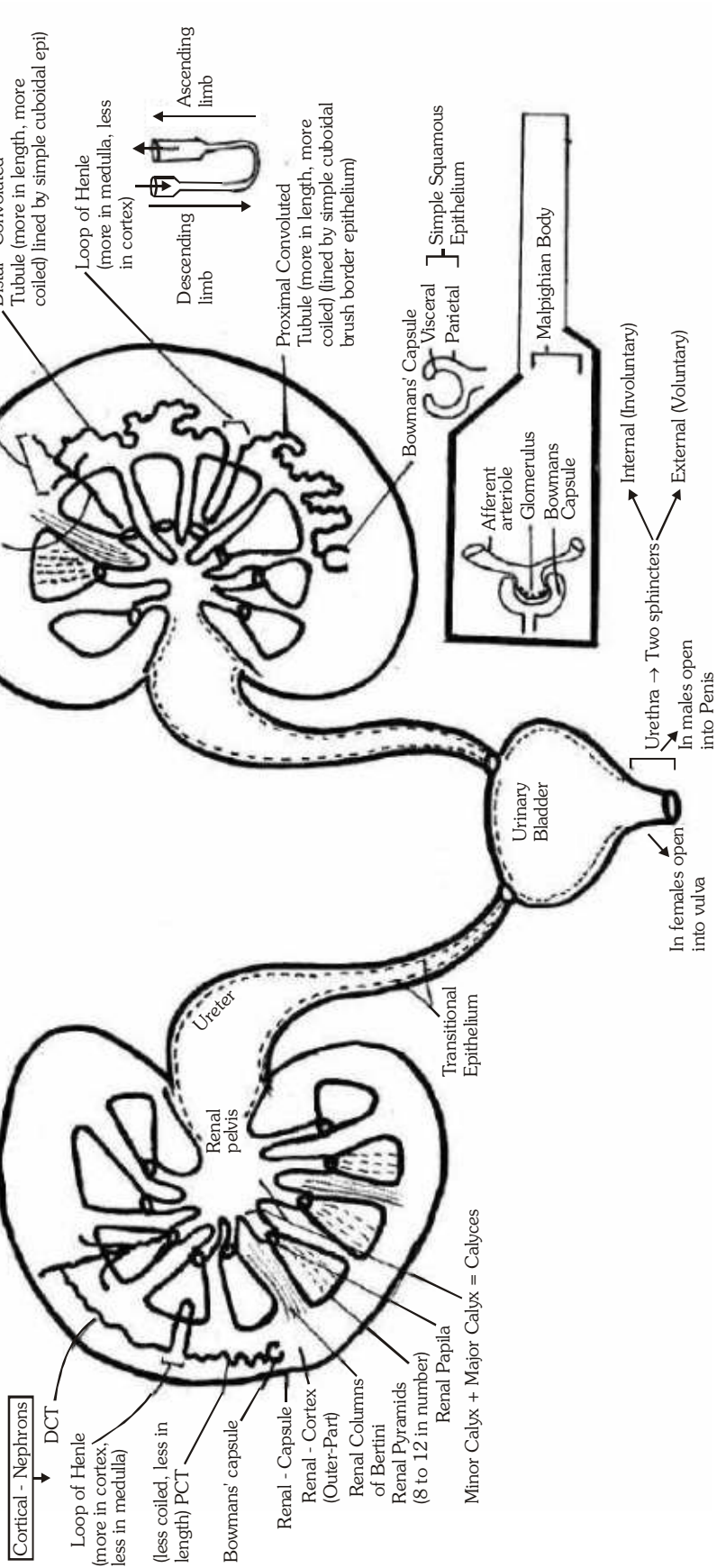
Path of Urine



Blood Flow in Kidney



• Both nephrons are found in both kidneys



EXERCISE

INTRODUCTION, KIDNEY, NEPHRON

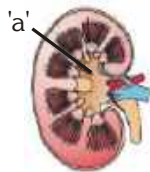
1. A terrestrial animal must be able to :
 - (1) excrete large amounts of salts in urine
 - (2) excrete large amounts of water in urine
 - (3) conserve water
 - (4) actively pump salts cut through the skin
2. Uricotelism is found in.
 - (1) Frogs and toads
 - (2) Mammals and birds
 - (3) Fishes and fresh water protozoans
 - (4) Birds, reptiles and insects
3. Match the columns and find out the correct combination

a Nephridia	p Hydra
b Malpighian tubules	q Leech
c Protonephridia	r Shark
d Kidneys	s Roundworm
	t Cockroach

 - (1) a - t, b - q, c - s, d - r
 - (2) a - q, b - s, c - t, d - p
 - (3) a - q, b - t, c - s, d - r
 - (4) a - s, b - q, c - p, d - t
4. In mammals the urinary bladder opens into
 - (1) Uterus
 - (2) Urethra
 - (3) Vestibule
 - (4) Ureter
5. Malpighian body is constituted by
 - (1) Glomerulus only
 - (2) Glomerulus and Bowman's capsule
 - (3) Glomerulus and efferent vessel
 - (4) Glomerulus, Bowman's capsule and efferent vessel
6. What is true about distal convoluted tubule ?
 - (1) Na⁺ reabsorption requires energy
 - (2) K⁺ reabsorption does not require energy
 - (3) Ammonia is excreted
 - (4) Water reabsorption requires energy
7. In kidney glomerulus is involved in
 - (1) Reabsorption of salts
 - (2) Urine collection
 - (3) Urine formation by blood filtration
 - (4) All the above
8. Function of loop of Henle is
 - (1) Conservation of water
 - (2) Formation of urine
 - (3) Filtration of blood
 - (4) Passage of urine
9. Concentration of urine depends upon which part of nephron ?
 - (1) Bowman's capsule
 - (2) Length of Henle's loop
 - (3) P.C.T.
 - (4) Network of capillaries arising from glomerulus
10. Reabsorption of water in nephrons occurs through:
 - (1) Osmosis
 - (2) Simple diffusion
 - (3) Filtration
 - (4) Active transport
11. Ureotelism is found in :
 - (1) Mammals
 - (2) Aquatic insects
 - (3) Tadpoles
 - (4) Birds
12. Which of the following will increase in blood if we remove liver from the body
 - (1) Ammonia
 - (2) Protein
 - (3) Urea
 - (4) Uric acid
13. Human being is :
 - (1) Ureotelic
 - (2) Uricotelic
 - (3) Ammonotelic
 - (4) 2 and 3 both
14. Excretory matter in birds and reptiles is :
 - (1) Urea
 - (2) Urea and uric acid
 - (3) Uric acid
 - (4) Ammonia and uric acid
15. Which animal excrete urea during metabolism of amino acids :
 - (1) Ureotelism
 - (2) Uricotelism
 - (3) Ammonotelism
 - (4) Aminotelism
16. Kidneys are excretory organs in :
 - (1) Chordates
 - (2) Only mammals
 - (3) Mammals, reptiles and amphibians
 - (4) Mammals, reptiles and birds
17. Functional unit of human kidney is :
 - (1) Nephron
 - (2) Pyramid
 - (3) Nephridia
 - (4) Loop of Henle
18. Loop of Henle is related with :
 - (1) Excretory system
 - (2) Reproductive system
 - (3) Nervous system
 - (4) Muscular system

- 19.** Renal corpuscles can be divided into
 (1) Bowman's capsule and glomerulus
 (2) Arteriole and glomerulus
 (3) Arteriole and Bowman's capsule
 (4) Afferent and efferent arteriole
- 20.** Blood leaving liver and moving to heart will have more concentration of
 (1) Bile (2) Urea
 (3) Glycogen (4) Amino acid
- 21.** With respect to mode of excretion, which type of organism bony fishes are :
 (1) Osmoconformers (2) Ammonotelic
 (3) Uricotelic (4) Ureotelic
- 22.** Consider the following statements
 A. Flame cells are excretory structures in flatworms
 B. Green glands are excretory organs in annelids
 C. Columns of Bertini are the conical projections of renal pelvis into renal medulla between the renal pyramids
 (1) A and B correct
 (2) B and C incorrect
 (3) A and C correct
 (4) A, B and C correct
 (5) A, B and C incorrect
- 23.** The excretory organs in cockroach is
 (1) Malpighian corpuscle
 (2) Malpighian tubules
 (3) Hepatic caecae metanephridia
 (4) Metanephridia
 (5) Green glands
- 24.** The region of the nephron found in the renal medulla is
 (1) Malpighian corpuscle
 (2) Proximal convoluted tubule
 (3) Distal convoluted tubule
 (4) Henle's loop
 (5) Glomerulus
- 25.** Basic unit of vertebrate kidney is –
 (1) Cell (2) Nephron
 (3) Neuron (4) Ommatidium
- 26.** Deamination occur in –
 (1) Kidney (2) Liver
 (3) Nephron (4) Both 1 and 2
- 27.** Longest loop of Henle is found in –
 (1) Kangaroo rat
 (2) Rhesus monkey
 (3) Opposum
 (4) All of these
- 28.** Excretory product of spider is –
 (1) Guanine (2) Ammonia
 (3) Uric acid (4) None of these
- 29.** Which one of these is not a part of uriniferous tubule?
 (1) Loop of Henle
 (2) Collecting duct
 (3) Bowman's capsule
 (4) Distal convoluted tubule
- 30.** Loop of Henle is found in
 (1) Lung (2) Liver
 (3) Neuron (4) Nephron
- 31.** Urea is produced from ammonia in the
 (1) Liver (2) Kidneys
 (3) Urinary bladder (4) Blood
- 32.** Which of the following sets of animals are uricotelic?
 (1) Fish, snake, fowl and man
 (2) Fish, frog, lizard and fowl
 (3) Crow, snake, crocodile and lizard
 (4) Camel, dog, monkey and man
- 33.** Majority of fresh water bony fishes are
 (1) Aminotelic (2) Ammonotelic
 (3) Ureotelic (4) Uricotelic
- 34.** Uricotelism is found in
 (1) Frog and toads
 (2) Mammals and birds
 (3) Birds, reptiles and insects
 (4) Fishes and fresh water protozoans
- 35.** The main function of loop of Henle is –
 (1) Passage of urine
 (2) Filtration of blood
 (3) Formation of urine
 (4) Conservation of water
- 36.** Uric acid is an excretory product of
 (a) Insects
 (b) Birds
 (c) Aquatic animals
 (d) Mammals
 (1) a and b are correct (2) b and d are correct
 (3) a, c and d are correct (4) a, b and c are correct
- 37.** The conversion of dangerous nitrogen waste into less toxic excretory matter is carried out in man in the –
 (1) Blood (2) Liver
 (3) Kidney (4) Skin

- 38.** Uric acid is the chief nitrogenous component of the excretory products of
 (1) Earth worm (2) Cockroach
 (3) Frog (4) Man
- 39.** Which is common to kidney and skeleton in mammals
 (1) Cortex (2) Medulla
 (3) Pelvis (4) Radius
- 40.** In uriniferous tubule part having maximum microvillous is
 (1) Bowman's capsule (2) PCT
 (3) Loop of Henle (4) DCT
- 41.** Human kidney is covered by peritoneum only on the ventral side. It is
 (1) Retroperitoneal
 (2) Abdominal
 (3) Peritoneal
 (4) Thoracic
- 42.** Which is the correct pathway for passage of urine in vertebrates ?
 (1) Renal cortex-----medulla-----urethra---- urinary bladder
 (2) Renal vein-----urethra----bladder----ureter
 (3) Collecting duct-----ureter-----bladder-----urethra
 (4) Pelvis-----medulla-----urinary bladder----urethra
- 43.** In the given diagram, what does "a" represent ?



- (1) Renal pyramid (2) Renal pelvis
 (3) Renal medulla (4) Renal cortex

- 44.** Which one of the following options gives the correct categorisation of six animals according to the type of nitrogenous wastes (A, B, C), they give out

	A AMMONOTELIC	B UREOTELIC	C URICOTELIC
(1)	Aquatic Amphibia	Frog, Humans	Pigeon, Lizards, Cockroach
(2)	Aquatic Amphibia	Cockroach, Humans	Frog, Pigeon, Lizards
(3)	Pigeon, Humans	Aquatic Amphibia, Lizards	Cockroach, Frog
(4)	Frog, Lizards	Aquatic Amphibia, Humans	Cockroach, Pigeon

PHYSIOLOGY OF URINE FORMATION

- 45.** Maximum reabsorption of useful substances from glomerular filtrate occurs in
 (1) Collecting tube
 (2) Loop of Henle
 (3) Proximal convoluted tubule
 (4) Distal convoluted tubule
- 46.** Effective filtration pressure in the glomerulus in kidney of man is about
 (1) +75 mm Hg (2) +10 mm Hg
 (3) +35 mm Hg (4) +50 mm Hg
- 47.** Under normal conditions which one is completely reabsorbed in the renal tubule ?
 (1) Urea (2) Uric acid
 (3) Salts (4) Glucose
- 48.** Total filtrate formed in 24 hours in human kidney is
 (1) 1.8 litres (2) 8.0 litres
 (3) 18 litres (4) 180 litres
- 49.** The mechanism of urine formation in nephron involves
 (1) Ultrafiltration (2) Reproduction
 (3) Diffusion (4) Osmosis
- 50.** Glomerular filtrate contains glucose in comparison to plasma
 (1) More (2) Same
 (3) Less (4) Nil
- 51.** Glucose is taken back from glomerular filtrate through
 (1) Active transport (2) Passive transport
 (3) Osmosis (4) Diffusion
- 52.** Reabsorption of chloride ions from glomerular filtrate in kidney tubule occurs by -
 (1) Active transport (2) Diffusion
 (3) Osmosis (4) Brownian movement
- 53.** In micturition,
 (1) Ureters contract (2) Urethra contracts
 (3) Urethra relaxes (4) Ureters relax
- 54.** The movement of ions against the concentration gradient will be-
 (1) Active transport (2) Osmosis
 (3) Diffusion (4) All

- 55.** Which one does not filter out from blood to Bowman's capsule in glomerular ultrafiltration ?
 (1) Amino acids (2) Polypeptide
 (3) Glucose (4) Fatty acids
- 56.** Blood filtered per minute in both kidneys is
 (1) 25 ml (2) 125 ml
 (3) 300 ml (4) 500 ml
- 57.** Which is finally reabsorbed in distal convoluted tubule?
 (1) Calcium (2) Potassium
 (3) Bicarbonate (4) Water
- 58.** Hippuric acid, creatinines and ketones are added to urine through :
 (1) Reabsorption (2) Glomerular filtration
 (3) Tubular secretion (4) Both 2 and 3
- 59.** The net pressure gradient that causes the fluid to filter out of the glomeruli into the capsule is –
 (1) 20 mm Hg (2) 50 mm Hg
 (3) 75 mm Hg (4) 30 mm Hg
- 60.** Glomerular filtrate contains
 (1) Blood without blood cells and proteins
 (2) Plasma without sugar
 (3) Blood with proteins but without cells
 (4) Blood without urea
- 61.** Glomerular hydrostatic pressure is present in
 (1) Tubules of kidney
 (2) Bowman's capsule
 (3) Glomerulus of uriniferous tubule
 (4) Malpighian tubule
- 62.** Which of the following is both osmoregulator as well as nitrogenous product
 (1) NH_3 (2) Urea
 (3) Uric acid (4) All of these
- 63.** Effective filtration pressure (EFP) in the glomerulus of kidney of man is about –
 (1) 10 mm Hg (2) 50 mm Hg
 (3) 75 mm Hg (4) 80 mm Hg
- 64.** The yellow color of urine is due to –
 (1) Urea (2) Uric acid
 (3) Urochrome (4) Bilirubin
- 65.** Average pH of human urine is –
 (1) 6.0 (2) 9.0 (3) 3.0 (4) 7.0
- 66.** First step in urine formation is–
 (1) Ultrafiltration
 (2) Tubular secretion
 (3) Selective secretion
 (4) Tubular reabsorption
- 67.** Which is not part of glomerular ultrafiltrate ?
 (1) Glucose (2) RBC
 (3) Amino acids (4) Minerals
- 68.** What is removed from the filtrate at loop of Henle?
 (1) Water (2) Amino acids
 (3) Glucose (4) Hormones
- 69.** In which part of the nephron the absorption of filtrate is maximum ?
 (1) Proximal convoluted tubule
 (2) Distal convoluted tubule
 (3) Glomerulus
 (4) Henle's loop.

REGULATION OF KIDNEY FUNCTION AND DISEASES

- 70.** Occurrence of excess urea in blood due to kidney failure is
 (1) Urochrome (2) Uraemia
 (3) Uricotelim (4) Uretolism
- 71.** Uremia is a disease when there is an excess of
 (1) Cholesterol in the blood
 (2) Glucose in the blood
 (3) Urea in the blood
 (4) None of the above
- 72.** Haemodialysis is also called artificial :
 (1) Liver (2) Lung
 (3) Heart (4) Kidney
- 73.** Kidney stones are formed by deposition of uric acid and :
 (1) Silicate (2) Minerals
 (3) Calcium carbonate (4) Calcium oxalate
- 74.** Renin is secreted by :
 (1) Cortex (2) Medulla
 (3) Juxta glomerular cells (4) Podocytes
- 75.** Which is a result of ADH deficiency :
 (1) Less urine
 (2) No urination
 (3) Less urine output
 (4) Increased water in urine
- 76.** RAAS secrete which of the following hormone
 (1) Mineralocorticoids (2) Glucocorticoids
 (3) Both 1 and 2 (4) None of these
- 77.** Which of the following is responsible for excretion of dilute urine
 (1) More secretion of insulin
 (2) Less secretion for vasopressin
 (3) More secretion of aldosterone
 (4) Less secretion of glucagon

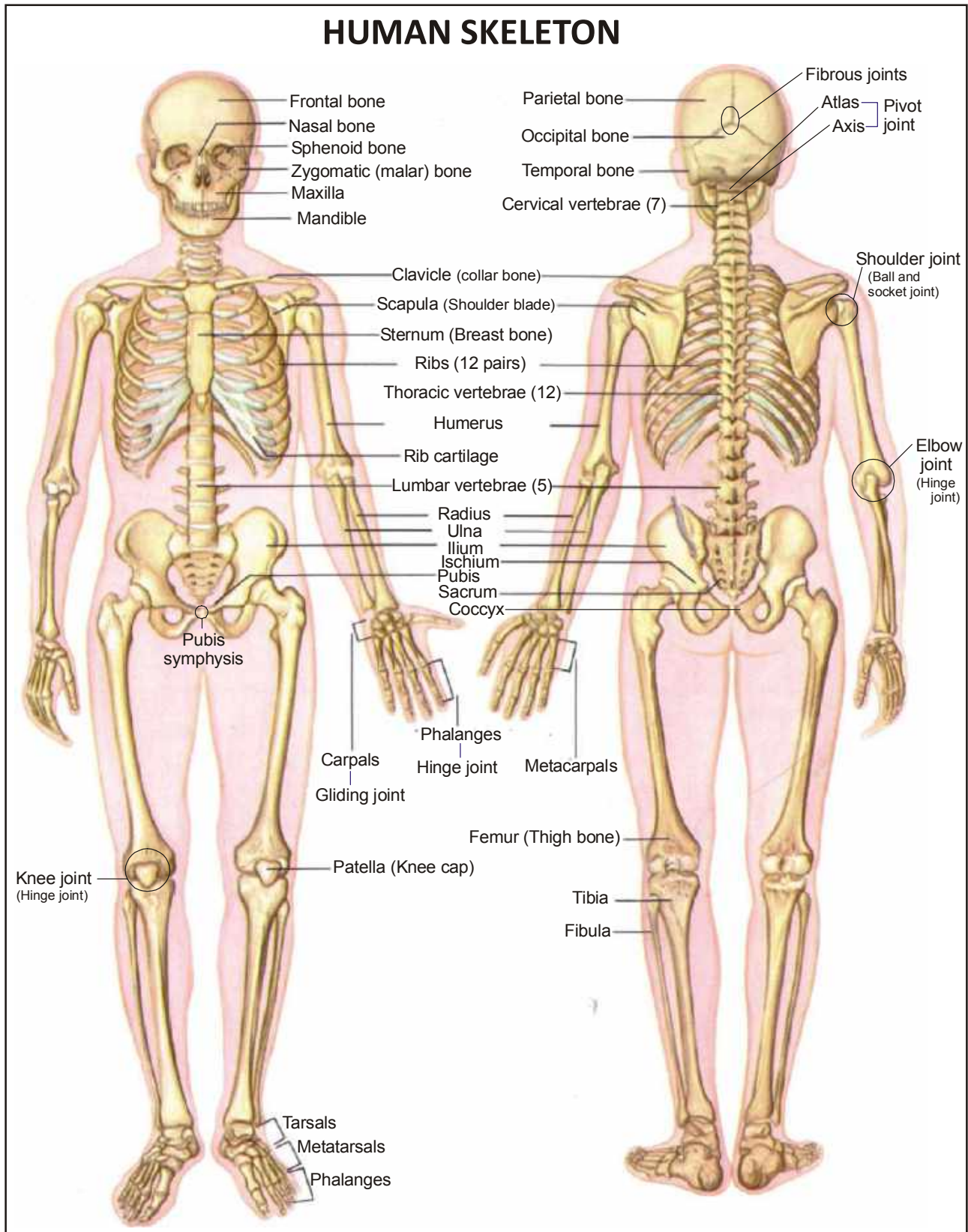
- 78.** Haematuria is –
 (1) RBC in urine (2) WBC in the urine
 (3) Both 1 and 2 (4) None of these
- 79.** Deficiency of vasopressin leads to –
 (1) Diabetes mellitus (2) Diabetes insipidus
 (3) Goitre (4) Myxoedema
- 80.** ADH acts on the –
 (1) Collecting tubules of kidney
 (2) Loop of Henle
 (3) Collecting ducts of testis
 (4) None of the above
- 81.** Haemodialysis is associated with
 (1) Liver (2) Spleen
 (3) Kidney (4) Stomach
- 82.** Absorption of H₂O in DCT is controlled by –
 (1) LH (2) ADH
 (3) ACTH (4) Oxytocin
- 83.** Anitdiuretic hormone is also called
 (1) Secretin
 (2) Vasopressin
 (3) Gastrin
 (4) Renin
- 84.** Glycosuria is the condition, where man
 (1) Eats more sugar
 (2) Excretes sugar in urine
 (3) Sugar is excreted in faeces
 (4) Has low sugar level in blood

ANSWER KEY

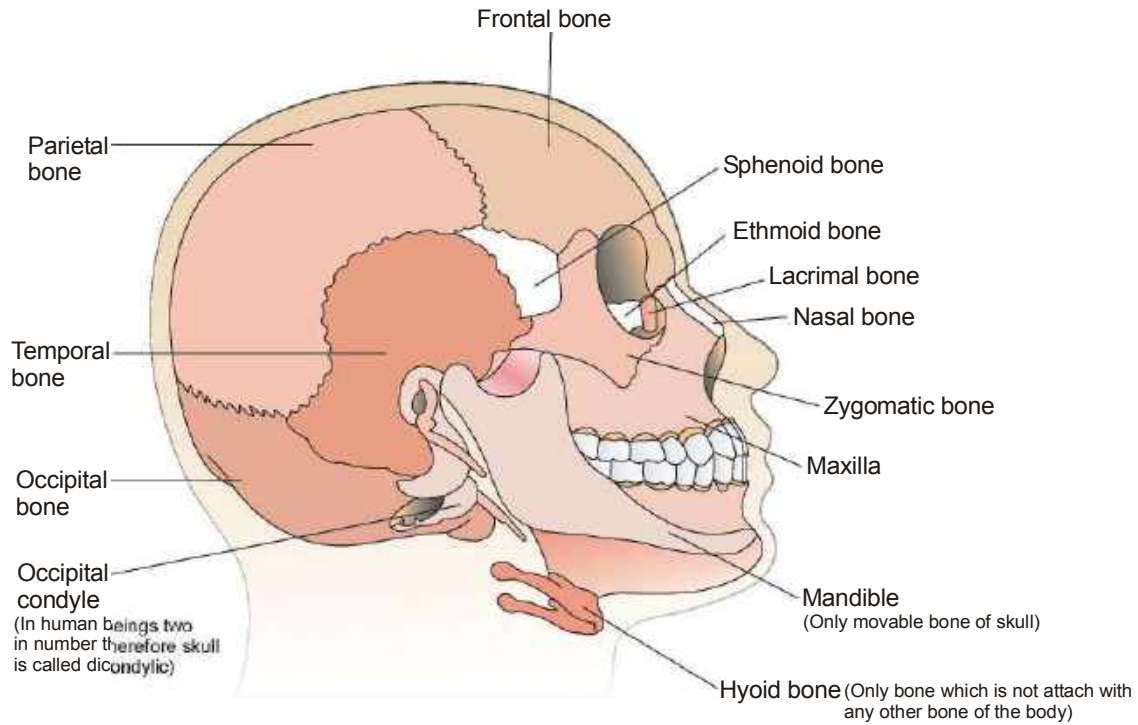
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	3	2	2	1	3	1	2	1	1	1	1	3	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	1	1	1	2	2	2	2	4	2	4	1	1	2	4
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	3	2	3	4	1	2	2	3	2	1	3	2	1	3
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	4	4	1	2	1	2	3	1	2	2	3	4	1	1
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	2	1	3	1	1	2	1	1	2	3	4	4	3	4
Que.	76	77	78	79	80	81	82	83	84						
Ans.	1	2	1	2	1	3	2	2	2						

LOCOMOTION AND MOVEMENT (SKELETAL SYSTEM)

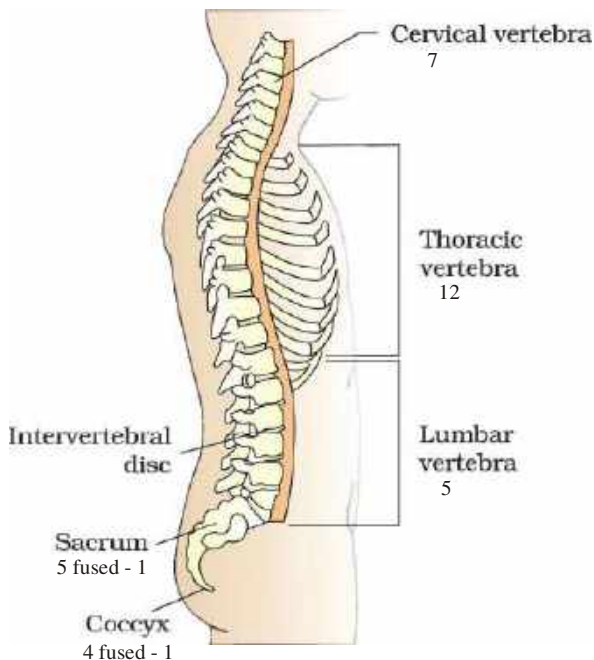
Skeletal system consists of a framework of bones and a few cartilages. This system has a significant role in movement shown by the body. Imagine chewing food without jaw bones and walking around without the limb bones. Bone and cartilage are specialised connective tissues. The former has a very hard matrix due to calcium salts in it and the latter has slightly pliable matrix due to chondroitin salts. In human beings, this system is made up of 206 bones and a few cartilages. It is grouped into two principal divisions – the axial and the appendicular skeleton.



HUMAN SKULL



VERTEBRAL COLUMN



Our vertebral column is formed by 26 serially arranged units called vertebrae and is dorsally placed. It extends from the base of the skull and constitutes the main framework of the trunk. Each vertebra has a central hollow portion (neural canal) through which the spinal cord passes.

First vertebra is the atlas and it articulates with the occipital condyles.

Second cervical vertebrae is axis vertebrae

Joint between atlas and axis is pivot joint

The vertebral column is differentiated into cervical 7, thoracic 12, lumbar 5, sacral (1-fused) and coccygeal (1-fused) regions starting from the skull.

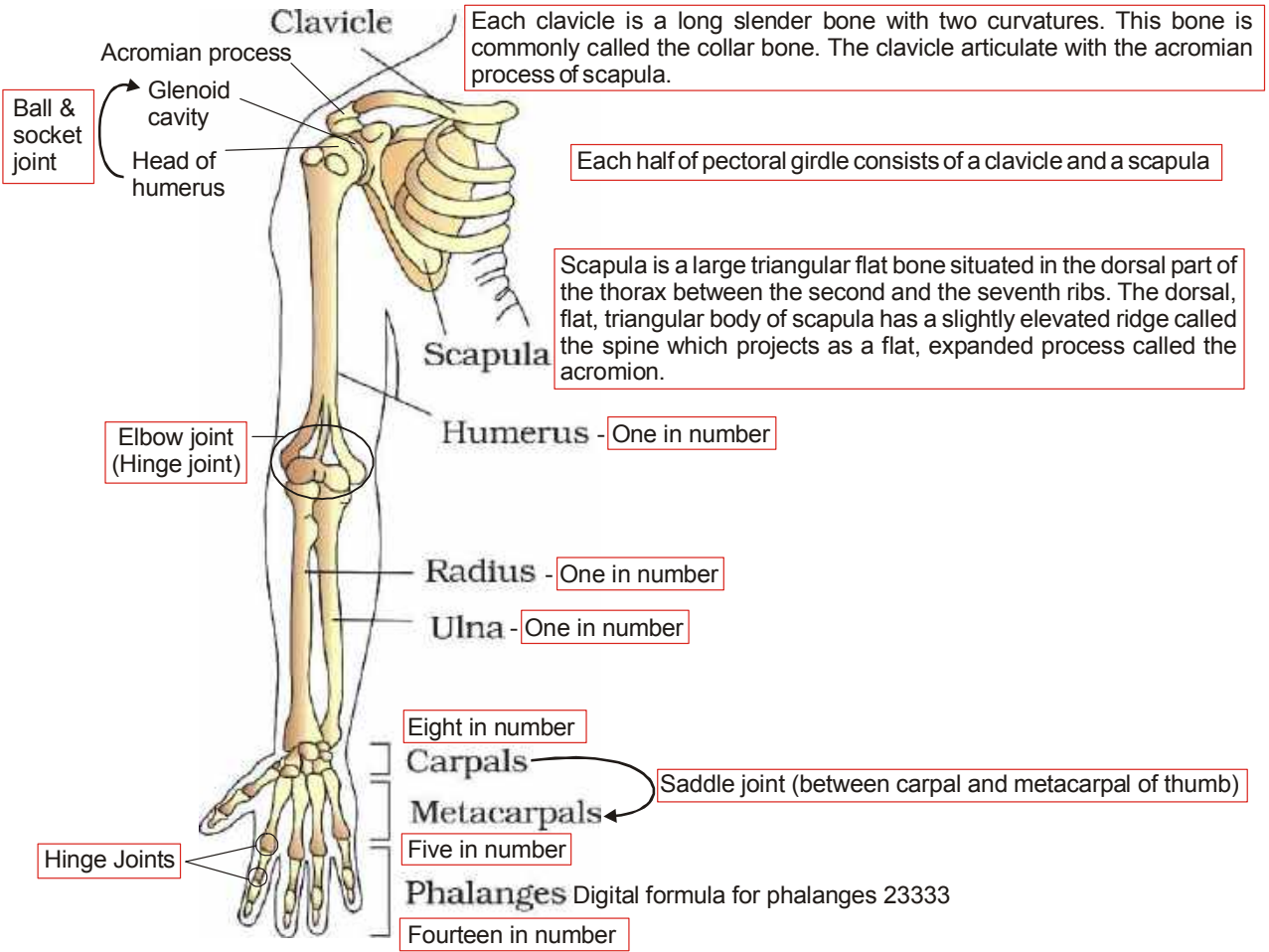
The number of cervical vertebrae are seven in almost all mammals including human beings.

The vertebral column protects the spinal cord, supports the head and serves as the point of attachment for the ribs and musculature of the back.

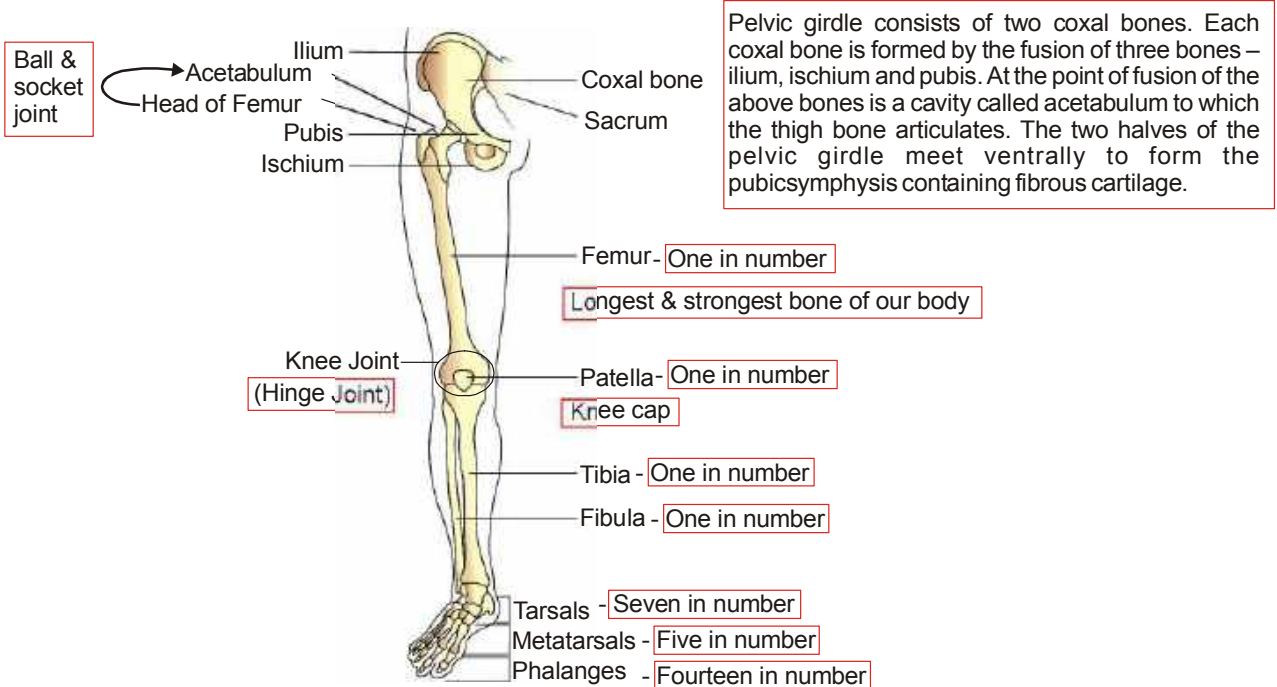
Human vertebral formula - $C_7Th_{12}L_5S_{(5)}Co_{(4)}$

The joint between the adjacent vertebrae in the vertebral column is cartilagenous joint and it permits limited movements.

RIGHT PECTORAL GIRDLE AND UPPER ARM. (FRONTAL VIEW)



RIGHT PELVIC GIRDLE AND LOWER LIMB BONES (FRONTAL VIEW)

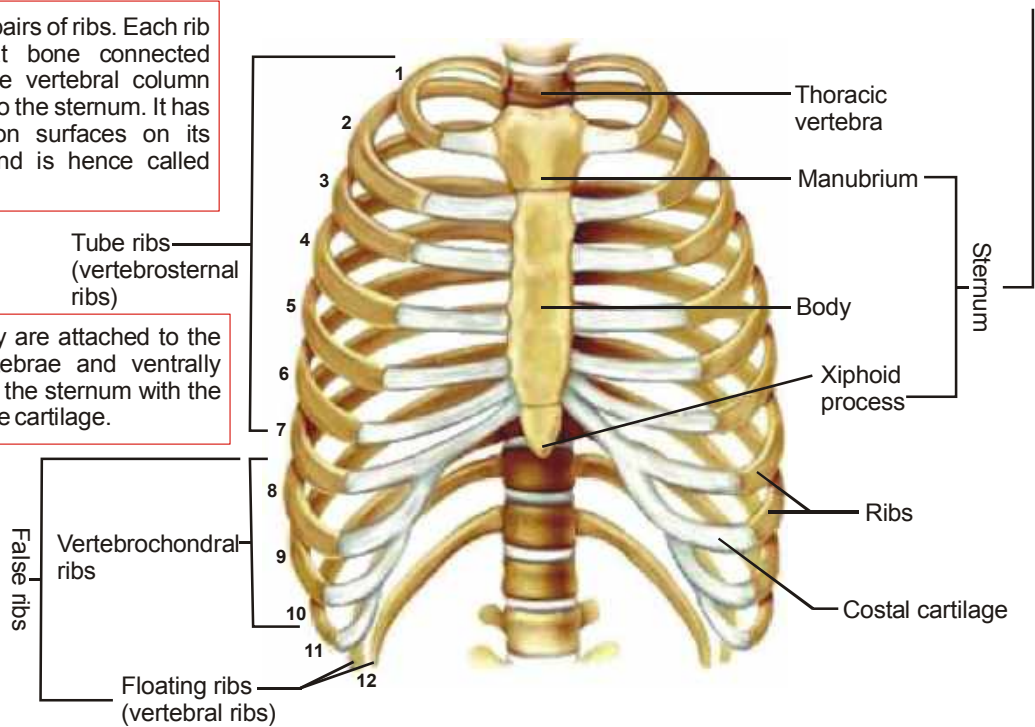


RIBS AND RIB CAGE

There are 12 pairs of ribs. Each rib is a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum. It has two articulation surfaces on its dorsal end and is hence called bicephalic.

Sternum is a flat bone on the ventral midline of thorax

Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage.



Skeleton

Exoskeleton

- Ectodermal in origin
- Dead eg. nails, horns, hooves, feathers, scales

Endoskeleton

- Mesodermal in origin
- Living eg. bones, cartilages

JOINTS

Joints are essential for all types of movements involving the bony parts of the body.

Locomotory movements are no exception to this. Joints are points of contact between bones, or between bones and cartilages. Force generated by the muscles is used to carry out movement through joints, where the joint acts as a fulcrum. The movability at these joints vary depending on different factors. Joints have been classified into three major structural forms, namely, fibrous, cartilaginous and synovial.

- 1. Fibrous joints (Synarthrosis)** do not allow any movement. This type of joint is shown by the flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium.
- 2. In cartilaginous joints (Amphiarthrosis)**, the bones involved are joined together with the help of cartilages. The joint between the adjacent vertebrae in the vertebral column is of this pattern and it permits limited movements.
- 3. Synovial joints (Diarthrosis)** are characterised by the presence of a fluid filled synovial cavity between the articulating surfaces of the two bones. Such an arrangement allows considerable movement. These joints help in locomotion and many other movements. Ball and socket joint (between humerus and pectoral girdle), Hinge joint (knee joint), Pivot joint (between atlas and axis), Gliding joint (between the carpals) and Saddle joint (between carpal and metacarpal of thumb) are some examples.

DISORDERS OF SKELETAL SYSTEM

Arthritis: Inflammation of joints.

Osteoporosis: Age-related disorder characterised by decreased bone mass and increased chances of fractures. Decreased levels of estrogen is a common cause.

Gout: Inflammation of joints due to accumulation of uric acid crystals.

EXERCISE

1. Talus, calcaneum are found in :-
 (1) Hind limb of frog (2) Hind limb of Human
 (3) Fore limb of man (4) Fore limb of rabbit
2. Part of pectoral girdle is:-
 (1) Ilium (2) Glenoid cavity
 (3) Acetabulum (4) Sternum
3. Obturator foramen present between:-
 (1) Ilium & Ischium (2) Ischium & Pubis
 (3) Ilium & pubis (4) None
4. Study of joints known as:-
 (1) Osteology (2) Arthrology
 (3) Craniology (4) Kinesiology
5. Pectoral girdle, pelvic girdle and limb bones constitute :
 (1) Visceral skeleton
 (2) Outer skeleton
 (3) Axial skeleton
 (4) Appendicular skeleton
6. Glenoid cavity is found in :
 (1) Pelvic girdle (2) Skull
 (3) Pectoral girdle (4) Sternum
7. Acromion process is part of :
 (1) Vertebral column (2) Pelvic girdle
 (3) Femur (4) Pectoral girdle
8. Pelvic girdle consists of :
 (1) Ilium
 (2) Ilium and ischium
 (3) Ilium, ischium and pubis
 (4) Ischium and pubis
9. Coracoid is a part of :
 (1) Forelimb (2) Skull
 (3) Scapula (4) Pelvic girdle
10. Cranium of man is made up of
 (1) 8 bones (2) 12 bones
 (3) 16 bones (4) 14 bones
11. Which of the following is a sesamoid bone ?
 (1) Pelvic (2) Patella
 (3) Pterygoid (4) Pectoral girdle
12. The number of floating ribs in human body
 (1) 6 pairs (2) 5 pairs
 (3) 3 pairs (4) 2 pairs
13. How many bones are present in human skull ?
 (1) 32 (2) 22 (3) 12 (4) 42
14. Which one of the following is the skull bone?
 (1) Atlas
 (2) Coracoid and frontal
 (3) Pterygoid and frontal
 (4) Aretynoid and pariental
15. Bones become fragile in
 (1) Gout (2) Osteoporosis
 (3) Arthritis (4) None of these
16. Symphysis is made of
 (1) Fibrocartilage (2) Synovial fluid
 (3) Elastic cartilage (4) Hyaline cartilage
17. Saddle joint occurs between
 (1) Carpal and first metacarpal
 (2) Femur and pelvic girdle
 (3) All the vertebrae
 (4) Phalanges
18. This joint is made for power?
 (1) Knee joint
 (2) Mandibular joint
 (3) Suture in cranium
 (4) Joint between vertebrae
19. Phalangeal formula for human forelimb is
 (1) 33233 (2) 33333
 (3) 33433 (4) 23333
20. Elbow joint is an example of
 (1) Ball and socket joint
 (2) Gliding joint
 (3) Hinge joint
 (4) Pivot joint
21. Innominate is
 (1) A nerve
 (2) An artery
 (3) A vein
 (4) A part of skeleton and an artery.

- 22.** Axis vertebra is identified by
 (1) Sigmoid notch (2) Odontoid process
 (3) Deltoid ridge (4) Centrum
- 23.** The smallest bone of the human body is
 (1) Humerus (2) Vertebra
 (3) Incus (4) Stapes
- 24.** This facial bone is unpaired
 (1) Lacrimal (2) Vomer
 (3) Nasal (4) Palatine
- 25.** It is an outcome of irregularities in metabolism of nitrogenous waste
 (1) osteoporosis (2) osteo-arthritis
 (3) gouty arthritis (4) rheumatoid arthritis
- 26.** Which of the following is correct for the given assertion (A) and reason (R)?
 Assertion (A) : Knee joint is hinge joint type joint.
 Reason (R) : Femur , patella and fibula are associated with knee joint.
 (1) Both (A) and (R) are true but (R) is the correct explanation of (A)
 (2) Both (A) and (R) are true but (R) is not the correct explanation of (A)
 (3) (A) is true statement but (R) is false.
 (4) Both (A) and (R) are false
- 27.** In human beings the cranium is formed by
 (1) ten bones of which two are paired
 (2) eight bones of which two are paired
 (3) fourteen bones of which six are paired
 (4) twelve bones of which four are paired
- 28.** Which of the following is wrong statement about hyoid bone?
 (1) one in number
 (2) U-shaped
 (3) Not attached with any other bone of the body
 (4) Present at the top of the buccal cavity
- 29.** The clavicle articulates with _____ of scapula
 (1) Acromian process
 (2) Glenoid cavity
 (3) Acetabulum cavity
 (4) Ball and socket joint
- 30.** Which one is a flat bone ?
 (1) Scapula (2) Carpal
 (3) Patella (4) Tarsals

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	2	2	4	3	4	3	3	1	2	4	2	3	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	1	1	4	3	4	2	4	2	3	3	2	4	1	1

LOCOMOTION AND MOVEMENT (MUSCLES)

Movement is one of the significant features of living beings. Animals and plants exhibit a wide range of movements. Streaming of protoplasm in the unicellular organisms like Amoeba is a simple form of movement. Movement of cilia, flagella and tentacles are shown by many organisms. Human beings can move limbs, jaws, eyelids, tongue, etc. Some of the movements result in a change of place or location. Such voluntary movements are called locomotion. Walking, running, climbing, flying, swimming are all some forms of locomotory movements. Locomotory structures need not be different from those affecting other types of movements. For example, in Paramecium, cilia helps in the movement of food through cytopharynx and in locomotion as well. Hydra can use its tentacles for capturing its prey and also use them for locomotion. We use limbs for changes in body postures and locomotion as well. The above observations suggest that movements and locomotion cannot be studied

separately. The two may be linked by stating that all locomotions are movements but all movements are not locomotions. Methods of locomotion performed by animals vary with their habitats and the demand of the situation. However, locomotion is generally for search of food, shelter, mate, suitable breeding grounds, favourable climatic conditions or to escape from enemies/predators.

TYPES OF MOVEMENT

Cells of the human body exhibit three main types of movements, namely, amoeboid, ciliary and muscular.

1. Amoeboid movement

Some specialised cells in our body like macrophages and leucocytes in blood exhibit amoeboid movement. It is effected by pseudopodia formed by the streaming of protoplasm (as in Amoeba). Cytoskeletal elements like microfilaments are also involved in amoeboid movement.

2. Ciliary movement

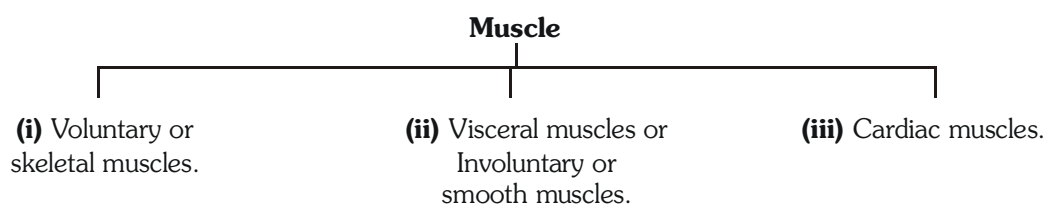
Ciliary movement occurs in most of our internal tubular organs which are lined by ciliated epithelium. The coordinated movements of cilia in the trachea help us in removing dust particles and some of the foreign substances inhaled alongwith the atmospheric air. Passage of ova through the female reproductive tract is also facilitated by the ciliary movement.

3. Muscular movement

Movement of our limbs, jaws, tongue, etc, require muscular movement. The contractile property of muscles are effectively used for locomotion and other movements by human beings and majority of multicellular organisms. Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems. In this chapter, you will learn about the types of muscles, their structure, mechanism of their contraction and important aspects of the skeletal system.

Development of muscle :-

- Origin of muscles is - **mesoderm** except few muscles.
- Muscle of Iris, ciliary body & myoepithelial cell of sweat gland develop from **Ectoderm**. main characteristics of muscle are excitability, contractility and extensibility.
- Muscles constitutes around 40% to 50% of adult body mass in an average healthy person.
- Three types of muscles are found in the body. (on the basis of position/location)



Striated	Non striated	Cardiac
1. They are present in upper limb & lower limb etc.	Iris of eye(Ciliary muscle of eye) Urinary bladder, Urinogenital tract, Dermis of skin – Erector pill muscle of dermis	They are present in walls of Heart
2. Cylindrical	Spindle in shaped	Cylindrical
3. Fibres Unbranched	Unbranched	Fibres are branched
4. Multi Nucleated fibres	Uninucleated	Uninucleated
5. Light and Dark band present	Absent	Present
6. Oblique bridges & Intercalated disc absent	Absent	Present
7. Controlled by CNS.	ANS	Both CNS + ANS
8. Blood supply abundant.	Less	Richly Blood supply
9. Soon fatigue.	Donot get fatigue	Never fatigued

1. VOLUNTARY MUSCLE

- They are related to the skeletal system. So also called as **skeletal muscles**.
- Transverse lines are found at regular interval. Hence these muscles are also called as **striped or striated muscle**
- Their contractions are controlled by will power of animal so also called **voluntary muscles**.

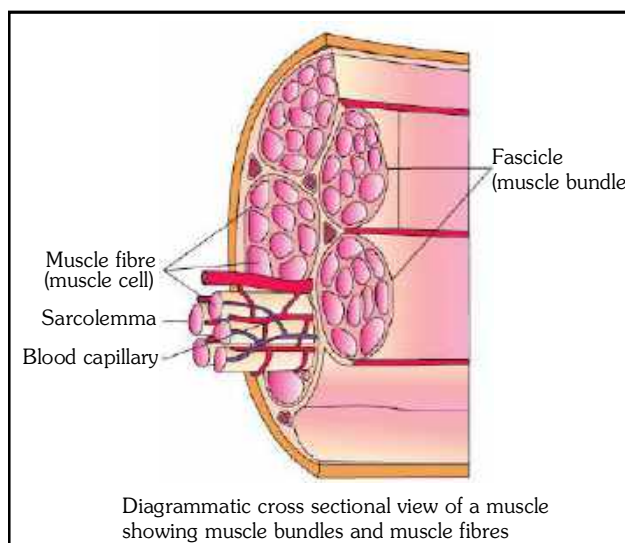
Tendon - The muscle fibres attached to a tough cord of connective tissue called **Tendon** & Tendon is further attached with a bone.

Epimysium - Muscle is also covered by a layer of collagenous connective tissue which is called as **Epimysium**. Many fasciculi combined to form a **muscle**.

Perimysium - Each Fasciculi is covered by a layer of connective tissue which is called **Perimysium**.

Fasciculi - Many muscle fibre are combined to form a group which is called **fasciculi**.

Endomysium - Muscle fibre is covered by a layer of connective tissue which is called **Endomysium**.

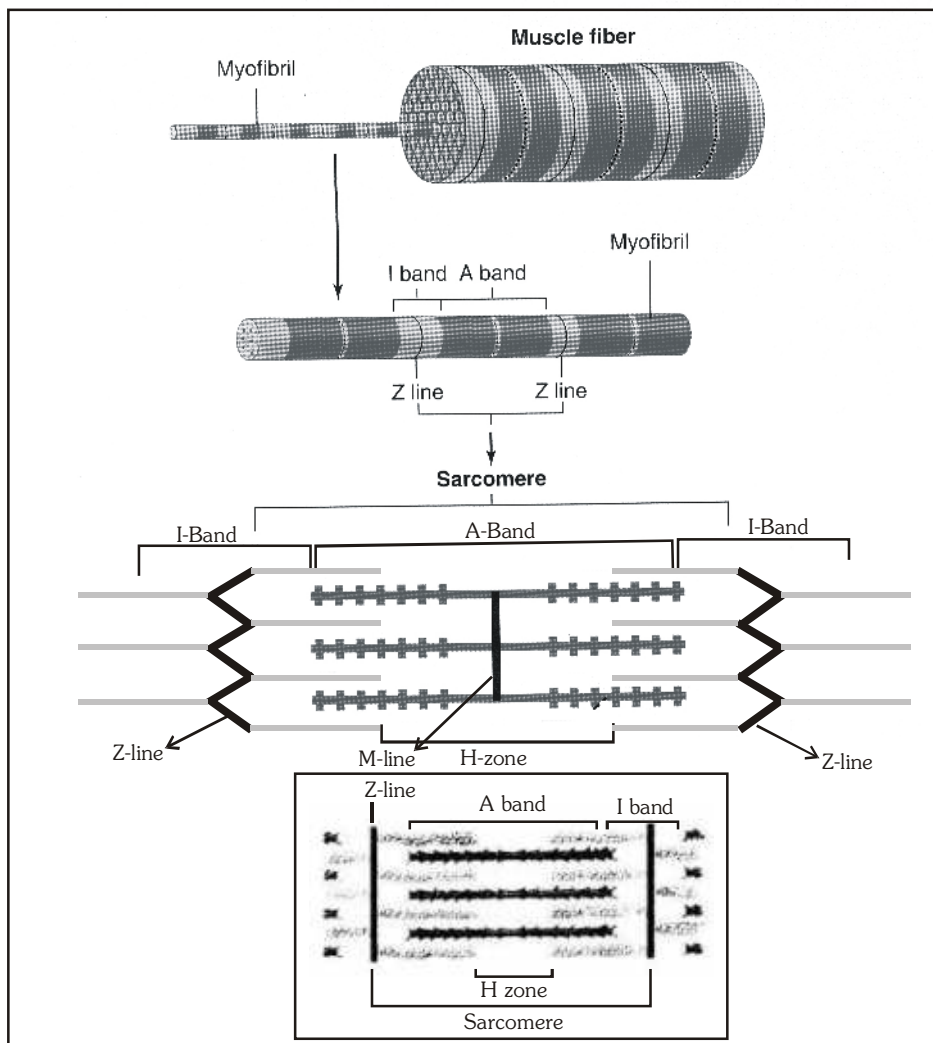


1.1 STRUCTURE OF MUSCLE FIBRE

Fine structure of muscle fibre.

Muscle fibre is a cylindrical or Tubular shape.

- The outer membrane of muscle fibre is called **sarcolemma**.
- This cell membrane contain collagen fibre.
- Each muscle fibre contain multinucleated sarcoplasm.
- Nucleus & sarcoplasm are found in peripheral part.



- A characteristic feature of the muscle fibre is the presence of a large number of parallelly arranged filaments in the sarcoplasm called myofilaments or **myofibrils**.
- Each myofibril has alternate dark and light bands on it. A detailed study of the myofibril has established that the striated appearance is due to the distribution pattern of two important proteins – **Actin** and **Myosin**.
- The light bands contain actin and is called I-band or Isotropic band, whereas the dark band called 'A' or Anisotropic band contains myosin.
- Both the proteins are arranged as rod-like structures, parallel to each other and also to the longitudinal axis of the myofibrils.
- Actin filaments are thinner as compared to the myosin filaments, hence are commonly called thin and thick filaments respectively. In the centre of each 'I' band is an elastic fibre called 'Z' line which bisects it.
- The thin filaments are firmly attached to the 'Z' line.
- The thick filaments in the 'A' band are also held together in the middle of this band by a thin fibrous membrane called 'M' line.

- The 'A' and 'I' bands are arranged alternately throughout the length of the myofibrils.
- The portion of the myofibril between two successive 'Z' lines is considered as the functional unit of contraction and is called a sarcomere.
- Sarcomere is **structural and functional unit** of voluntary muscle fibre.
Sarcomere = 1A band + two half I band
The Length of Sarcomere is 2.5 μm . (Actin rod = 1 μm , myosin = 1.5 μm)
- 1 Myosin filament is surrounded by 6 Actin filaments & 1 Actin filament is surrounded by 3 Myosin filament.

1.2 STRUCTURE OF CONTRACTILE PROTEINS :

• Actin protein :

Each actin (thin) filament is made of two 'F' (filamentous) actins helically wound to each other. Each 'F' actin is a polymer of monomeric 'G' (Globular) actins.

• Tropomyosin -

It is one type of contractile protein. In the relaxed state of the muscle situated in **such a way**, that the active sites remain covered by the Tropomyosin and attached at the terminal end of actin.

• Troponin -

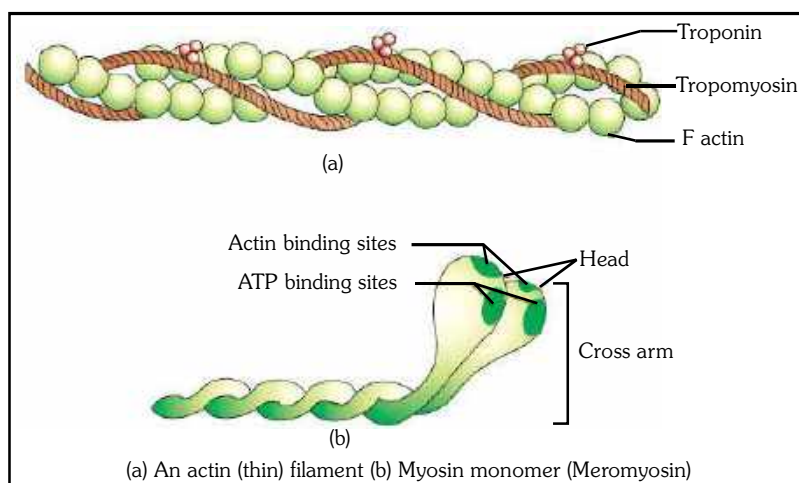
It is one type of protein which attached with one of ends of the tropomyosin molecules.

Troponin is made up of three subunit.

- | | | |
|-------------------|--------------------|---------------------------------|
| (a) Troponin I | (b) Troponin T | (c) Troponin C |
| (Inhibitory site) | (Tropomyosin site) | (Ca ⁺² binding site) |

• Myosin protein :

Each myosin (thick) filament is also a polymerised protein. Many monomeric proteins called Meromyosins constitute one thick filament. Each meromyosin has two important parts, a globular head with a short arm and a tail, the former being called the heavy meromyosin (HMM) and the latter, the light meromyosin (LMM). The HMM component, i.e.; the head and short arm projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament and is known as cross arm. The globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.



1.3 Mechanism of Muscle Contraction

SLIDING FILAMENT THEORY :

This theory is given by A.F. HUXLEY, H.E. HUXLEY & J. HANSEN

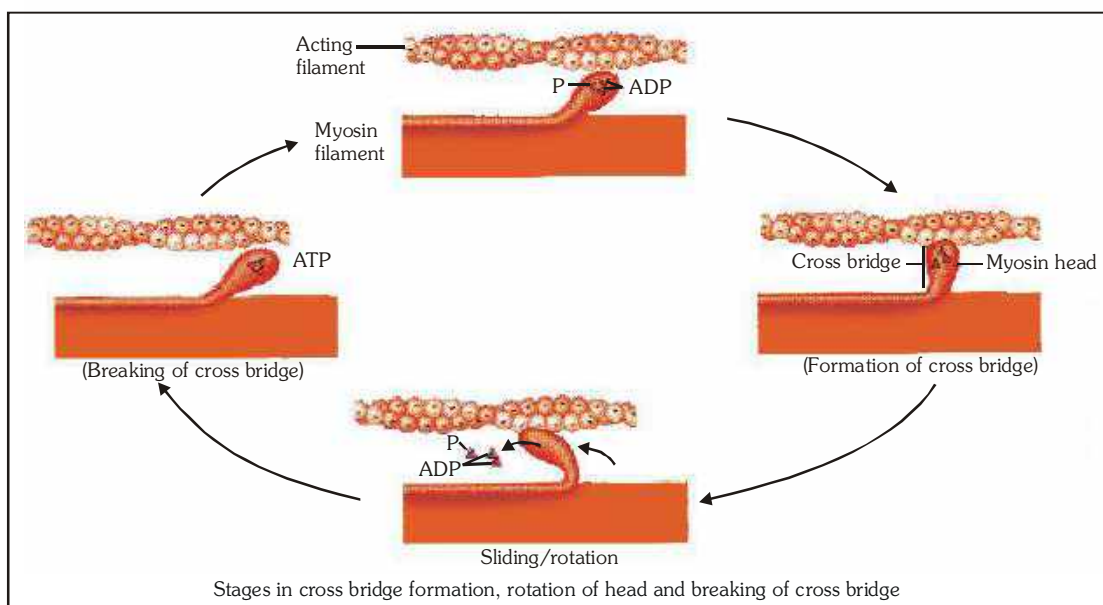
The junction of Nerve & muscle is called as neuromuscular junction.

Terminal branches of Axon of motor nerve is embedded into sarcolemma.

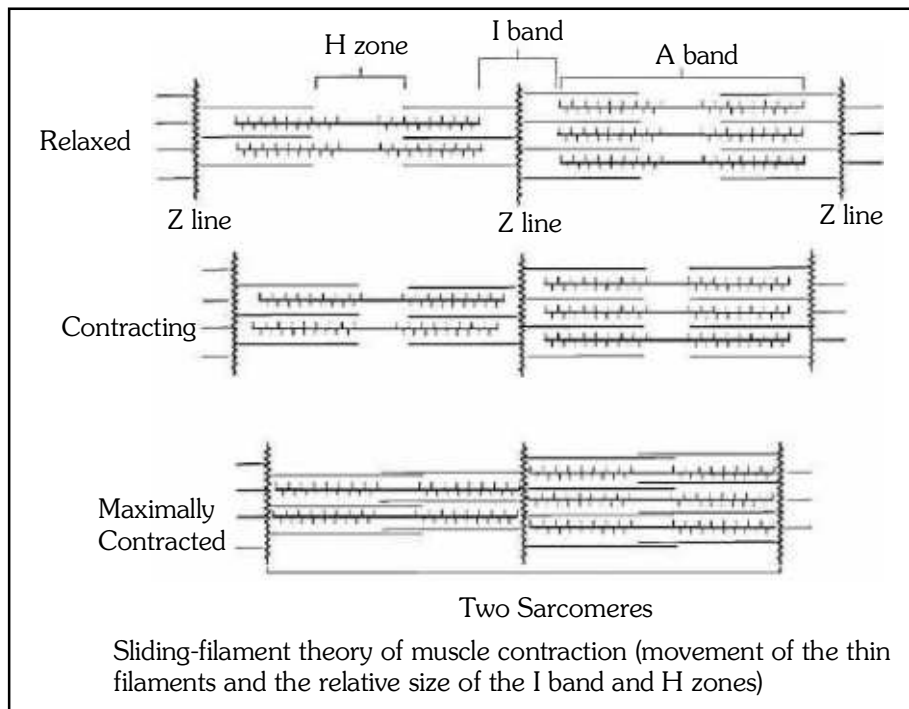
Sarcolemma invaginate inside & form a fimbriated structure which is called **synaptic gutter or subneural cleft**. The cell membrane of the bulbous terminal is called as the **pre junctional membrane** where as the cell membrane of muscle fibre which invaginates called **post junctional membrane**.

In terminal part of axon large number of vesicles & mitochondria are present. Each vesicle contains Acetylcholine in high concentration. In post junctional membrane, Acetylcholine receptor are present.

- Mechanism of muscle contraction is best explained by the sliding filament theory which states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.
- Muscle contraction is initiated by a signal sent by the central nervous system (CNS) via a motor neuron.
- A motor neuron alongwith the muscle fibres connected to it constitute a motor unit.
- The junction between a motor neuron and the sarcolemma of the muscle fibre is called the neuromuscular junction or motor-end plate.
- A neural signal reaching this junction releases a neurotransmitter (Acetyl choline) which generates an action potential in the sarcolemma.
- This spreads through the muscle fibre and causes the release of calcium ions into the sarcoplasm.
- Increase in Ca^{++} level leads to the binding of calcium with a subunit of troponin on actin filaments and thereby remove the masking of active sites for myosin.
- Utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites on actin to form a cross bridge or Actomyosin bridge.
- This pulls the attached actin filaments towards the centre of 'A' band.
- The 'Z' line attached to these actins are also pulled inwards thereby causing a shortening of the sarcomere, i.e., contraction.
- It is clear from the above steps, that during shortening of the muscle, i.e., contraction, the 'I' bands get reduced, whereas the 'A' bands retain the length.
- The myosin, releasing the ADP and P_i goes back to its relaxed state. A new ATP binds and the cross-bridge is broken.
- The ATP is again hydrolysed by the myosin head and the cycle of cross bridge formation and breakage is repeated causing further sliding.



- The process continues till the Ca^{++} ions are pumped back to the sarcoplasmic cisternae resulting in the masking of actin filaments.
- This causes the return of 'Z' lines back to their original position, i.e., relaxation.



- Contraction is caused by overlapping of actin filament over myosin filament – **sliding filament hypothesis**
- All the cross bridges move simultaneously in one direction so the actin filaments move vigorously towards H-zone.
- When cross bridge disrupted than myosin molecule detached & reattach the new active site of actin.
- **After muscle contraction H-zone disappears & length of sarcomere & I-band decreases by 20%. The length of A band remains unchanged.**

All processes are reversible, at the time of relaxation Ca^{++} goes into **L-tubules**.

Role of ATP -

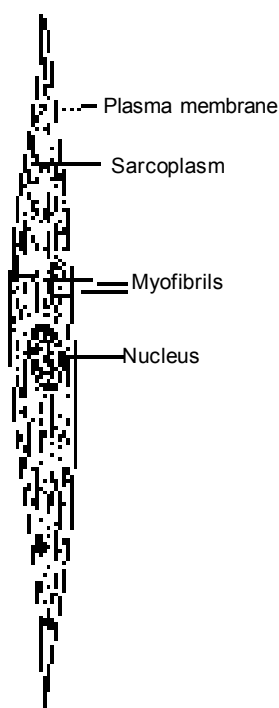
- (i) The Rotational movement of myosin head with in the groove.
- (ii) Deattachment of myosin head from the actin.

- The reaction time of the fibres can vary in different muscles. Repeated activation of the muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing fatigue.
- Muscle contains a red coloured oxygen storing pigment called myoglobin. Myoglobin content is high in some of the muscles which gives a reddish appearance. Such muscles are called the Red fibres. These muscles also contain plenty of mitochondria which can utilise the large amount of oxygen stored in them for ATP production. These muscles, therefore, can also be called aerobic muscles.
- Some of the muscles possess very less quantity of myoglobin and therefore, appear pale or whitish. These are the White fibres. Number of mitochondria are also few in them, but the amount of sarcoplasmic reticulum is high. They depend on anaerobic process for energy.

2. INVOLUNTARY MUSCLE

- It is not related to the skeleton so also called as **Non skeletal muscle**.
- These muscles are found in the visceral organ so are called as **visceral muscles or smooth muscles**.
- Transverse lines are absent so also called as **unstriated muscle**.
- Its contraction is not controlled by will power of animal. so it is called as **Involuntary muscle**.
- Autonomic nerves are connected to this type of muscle.

STRUCTURE OF SMOOTH MUSCLE FIBRE



Smooth muscle fibre

- It is spindle shaped.
- Cells are connected through gap junction.
- It contains uninucleated cytoplasm
- All cell organelles are found in cytoplasm.
- Contractile fibrils are found in the cytoplasm due to this reason this cytoplasm called **sarcoplasm**.
- This contractile fibre called as myofibril which found in scattered form.
- Myofibrils are made up of actin and myosin but remarkably less than skeletal muscle But filaments are not placed in a highly ordered pattern so striations are absent.
- Actin is more than myosin.
- Myofibril is functional unit** of involuntary muscle.
- The sarcoplasmic reticulum or L tubular system is not well developed. This makes the contraction of smooth muscles strongly dependent on the **ECF Ca^{++}** .
- Its contraction period is longer.
- It remain in contracted stage for longer period, due to this reason muscle called **Nonfatigue muscle**.

3. CARDIAC MUSCLE

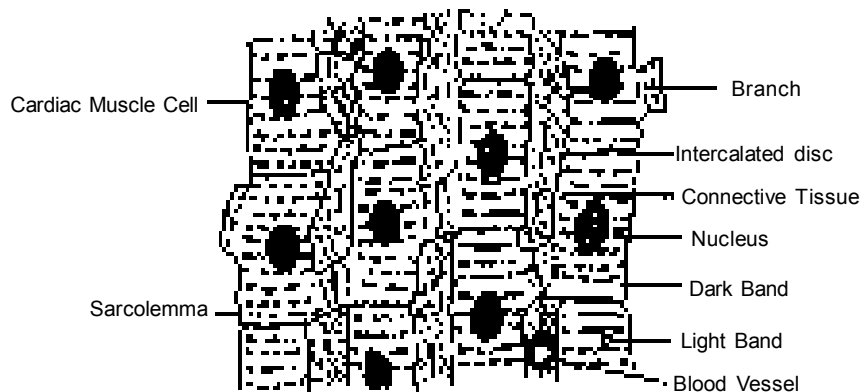
It is special type of muscle found only in heart so it is also called as cardiac muscle. On the basis of structure it is **striated type of muscle**. It is also cylindrical fibre. Fibres are branched. Many transverse septa are found in the muscle fibre which are called as **intercalated disc**. **Junctional region** b/w the cell membrane called intercalated discs and these are made up of sarcolemma.

Due to septa fibres are divided into many segments each segment is **Uninucleated**. Each segment called individuals cells.

Dark and light line also found in the muscle fibre. Intercalated disc, helps in the propagation of impulse and contraction. It is also **Nonfatigue type muscle**.

Its contraction is not controlled by will power of animal.

On the basis of function it is **involuntary type** and control by pacemaker (SA node, AV node and Purkinje fibres). Both central nerve and autonomic nerves are supplied to this type of muscle.



EXERCISE

1. Cross bridge are formed during :-
(1) Muscle contraction
(2) Nervous contraction
(3) Tissue regeneration
(4) All the above
2. During contraction of muscles :-
(1) Actin Filament slide over actin
(2) Myosin filament slide over actin
(3) Actin filament slide over myosin
(4) Myosin filament slide over actin
3. Purkinje fibres :-
(1) Muscle fibres (2) Nerve fibres
(3) Axon (4) Dendron
4. Mitochondria in cardiac muscles :-
(1) More than other muscles fibres
(2) Less than other muscles fibres
(3) Equal than other muscles fibres
(4) None
5. SA Node is :-
(1) Group of specialised muscle fibres
(2) Cartilage in node of heart
(3) Connective tissue node
(4) None
6. Rigor mortis is :-
(1) Contraction of muscles after death
(2) Contraction of muscles before death
(3) Shivering of muscles
(4) None
7. Red muscle fibres are more in :-
(1) Smooth muscles
(2) Skeletal muscles
(3) Cardiac muscles
(4) None
8. Unstriated muscle are also known as :-
(1) Visceral (2) Smooth
(3) Involuntary (4) All
9. Contractile unit of muscle fibres :-
(1) H line (2) Sarcomere
(3) H zone (4) None
10. Epimysium of muscles are made up of :-
(1) White fibrous connective tissue
(2) Adipose connective tissue
(3) Reticular connective tissue
(4) Areolar connective tissue
11. Myosin filament appear dark under microscope due to :-
(1) Dark colour
(2) Melanin colour
(3) Black colour
(4) Double refractive index
12. Contraction of shortest duration is of :-
(1) Heart (2) Eye lids
(3) Arm (4) Jaws
13. ATP-ase activity found in :-
(1) Myosin filament (2) Actin filament
(3) Both (4) None
14. Total No. of muscles in our body is :-
(1) 256 muscles (2) 639 muscles
(3) 400 muscles (4) 421 muscles
15. Longest smooth muscles are :-
(1) Intestine (2) Stomach
(3) Uterus (Pregnant) (4) Urinary bladder
16. Strongest muscles :-
(1) Thigh muscle (2) Leg muscle
(3) Arm muscle (4) Jaw muscle
17. Muscles of Iris & Ciliary body originate :-
(1) Ectoderm (2) Mesoderm
(3) Endoderm (4) All of above
18. Cardiac muscles Fibres :-
(1) Involuntary (2) Non-fatigue
(3) Striated like (4) All
19. Striated muscle fibres :-
(1) Trachea (2) Lung
(3) Leg (4) Gall bladder
20. Smooth muscles fibres :-
(1) Spindle shaped
(2) Unbranched & Involuntary
(3) UniNucleated
(4) All of above

- 21.** Basic unit of muscle contraction :-
 (1) Actin (2) Myosin
 (3) Sarcomere (4) Actomyosin
- 22.** Chemical Ions responsible for muscles contraction
 (1) Ca^{++} & K^+
 (2) Na^+ & K^+
 (3) Na^+ & Ca^{++}
 (4) Ca^{++} & mg^{++} Ions
- 23.** Sliding theory muscle contraction proposed by :
 (1) Hansen
 (2) Huxley
 (3) Bohr
 (4) Huxley, Huxlay & Hensen
- 24.** Smallest muscles in rabbit & man :-
 (1) Gluteus minimus (2) Stapedius
 (3) Sartorius (4) Gracilis
- 25.** In the thin filament of skeletal muscle fibre, a small globular protein that masks the active sites on the F-actin is
 (1) G-actin (2) Actin
 (3) Tropomyosin (4) Troponin
- 26.** Which of the following is important for muscle contraction and nerve impulse transmission ?
 (1) Ca^{+2} ion (2) mg^{+2} ions
 (3) Both A & B (4) Fe^{+2} ions
- 27.** During strenuous exercise, glucose is converted into
 (1) Starch (2) Glycogen
 (3) Lactic acid (4) Pyruvic acid
- 28.** A rabbit runs very fast but after some time feel tired because :
 (1) Formation of lactic acid in muscles
 (2) Formation of succinic acid in muscles
 (3) Loss of energy
 (4) None of the above
- 29.** The cytoplasmic segment of striated muscle fibre is termed :
 (1) Metamere
 (2) Neuromere
 (3) Sarcoplasm
 (4) Sarcomere
- 30.** Statements about the mechanism of muscle contraction are given below.
 I. Acetylcholine is released when the neural signal reaches the motor end plate.
 II. Muscle contraction is initiated by a signal sent by CNS via a sensory neuron.
 III. During muscle contraction isotropic band gets elongated.
 IV. Repeated activation of the muscles can lead to lactic acid accumulation.
 Identify the correct statement :
 (1) I and IV are correct
 (2) I and III are correct
 (3) II and III are correct
 (4) I and II are correct
- 31.** The sensation of fatigue in the muscles after prolonged strenuous physical work, is caused by
 (1) a decrease in the supply of oxygen
 (2) minor wear and tear of muscle fibres
 (3) the depletion of glucose
 (4) the accumulation of lactic acid
- 32.** Which of the following option shows correct order of some stages of muscle contraction from the beginning to the end of the process?
 (1) Stimuli → Neurotransmitter secretion → Release of Ca^{2+} → Cross bridges formation → Excitation of T-system → Sliding of actin filaments.
 (2) Stimuli → Neurotransmitter secretion → Excitation of T-system → Release of Ca^{2+} → Cross bridges formation → Sliding of actin filaments → 'H' band diminishes
 (3) Stimuli → Excitation of T-system → Neurotransmitter secretion → Cross bridges formation → Sliding of actin filaments → 'H' band diminishes
 (4) Stimuli → Neurotransmitter secretion → Cross bridges formation → Excitation of T-system → Sliding of actin filaments.
- 33.** What is the location of troponin in the process of muscle contraction ?
 (1) Attached to myosin filament
 (2) Attached to tropomyosin
 (3) Attached to myosin cross bridge
 (4) Attached to T-tubule

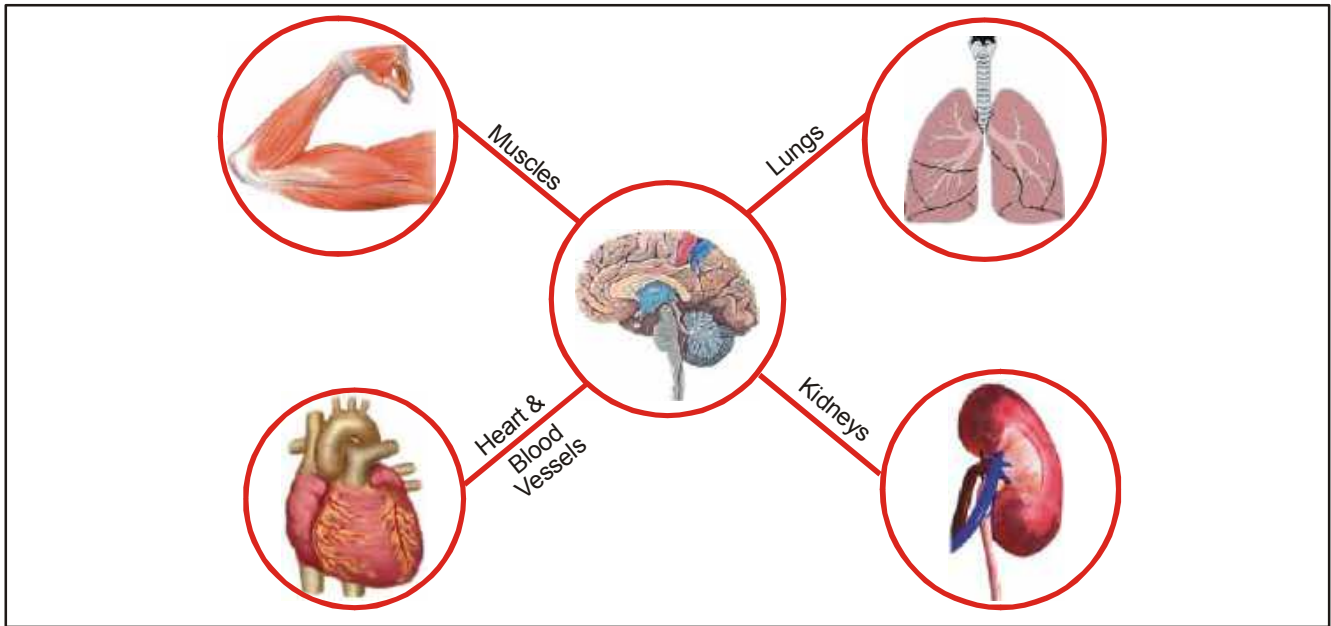
- 34.** Read the statements regarding muscle proteins.
- Actin is a thin filament and is made up of two F-actins
 - The complex protein, tropomyosin is distributed at regular intervals of troponin.
 - Myosin is a thick filament which is also a polymerized protein.
 - The globular head of meromyosin consists of light meromyosin (LMM).
- Which of the above statements are correct ?
- (1) I, II and III (2) I, II and IV
(3) I and III (4) II and IV
- 35.** Which one of the following is wrongly matched?
- Myosin - Contracting protein
 - Smooth muscle - voluntary muscle
 - Red muscle - Myoglobin
 - Troponin - Fibrous protein.
- 36.** In the thin filament of skeletal muscle fibre, a small globular protein that masks the active sites on the F-actin is :-
- G-actin (2) tropomyosin
 - troponin (4) myosin
- 37.** Which of the following statements is/are correct/incorrect ?
- A-bands of the muscle is dark and contain myosin.
 - I-bands are the light bands and contain actin.
 - During muscle contraction, the A-band contracts.
 - The part between the two Z-lines is called as sacromere.
 - The central part of thin filament, not overlapped by thick filament is called H-zone.
- (1) I, II, and III are correct, while IV and V are incorrect
(2) I, III, V are correct, while II, IV are incorrect
(3) I and II are correct, while III, IV and V are incorrect
(4) I, II and IV are correct, while III and V are incorrect.
- 38.** Troponin is a
- digestive enzyme (2) muscle protein
 - high energy reservoir (4) water soluble vitamin
- 39.** The contractive protein of skeletal muscle involving ATPase activity as
- tropomyosin (2) myosin
 - α -actinin (4) troponin
- 40.** Which statement is correct for muscle contraction?
- Length of H-zone is increased
 - Length of A-band remains constant
 - Length I-band gets increased
 - Length of two Z-lines get increased

ANSWER KEY

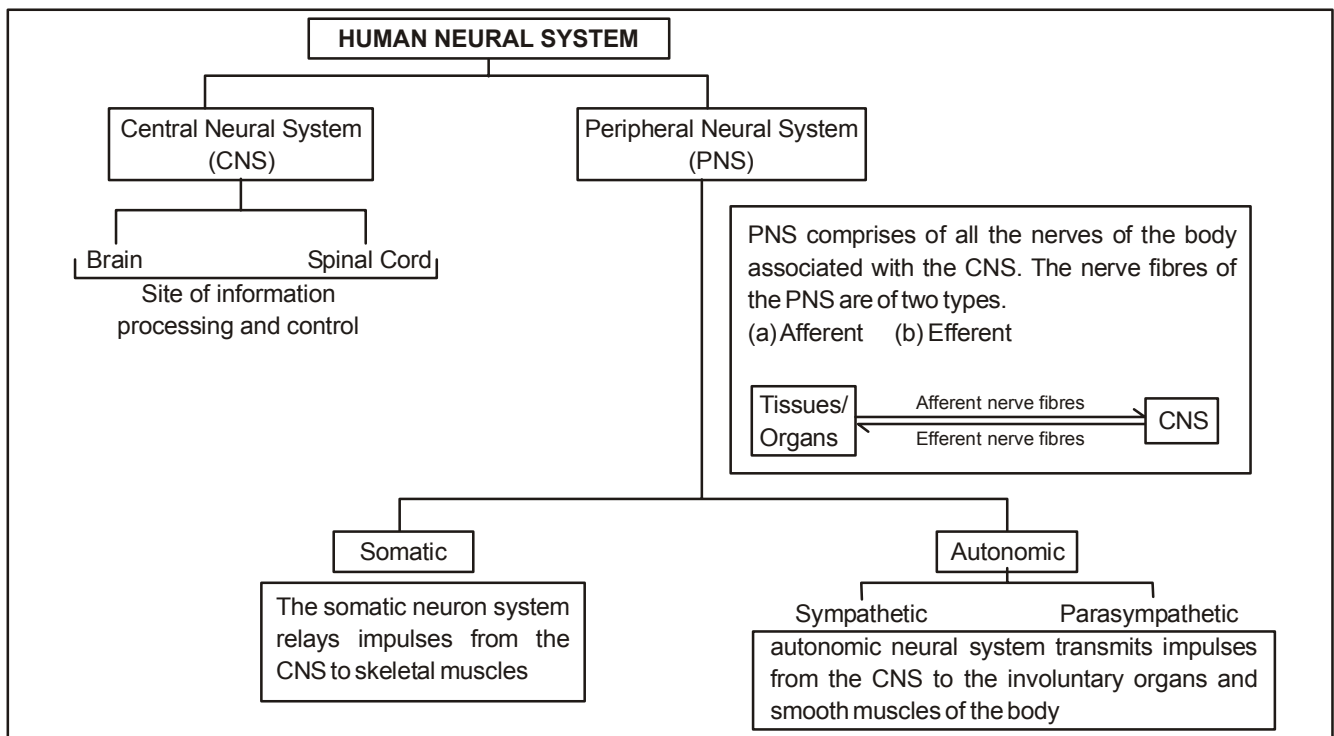
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Ans.	1	3	1	1	1	1	3	4	2	1	4	2	1	2	3
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	1	4	3	4	3	4	4	2	4	1	3	1	4	1
Que.	31	32	33	34	35	36	37	38	39	40					
Ans.	4	2	2	3	2	3	4	2	2	2					

NEURAL CONTROL AND COORDINATION

As you know, the functions of the organs/organ systems in our body must be coordinated to maintain homeostasis. Coordination is the process through which two or more organs interact and complement the functions of one another. For example, when we do physical exercises, the energy demand is increased for maintaining an increased muscular activity. The supply of oxygen is also increased. The increased supply of oxygen necessitates an increase in the rate of respiration, heart beat and increased blood flow via blood vessels. When physical exercise is stopped, the activities of nerves, lungs, heart and kidney gradually return to their normal conditions. Thus the functions of muscles, lungs, heart, blood vessels, kidney and other organs are coordinated while performing physical exercises in our body. The neural system and the endocrine system jointly coordinate and integrate all the activities of the organs so that they function in a synchronised fashion. (Integrated systems)



HUMAN NEURAL SYSTEM



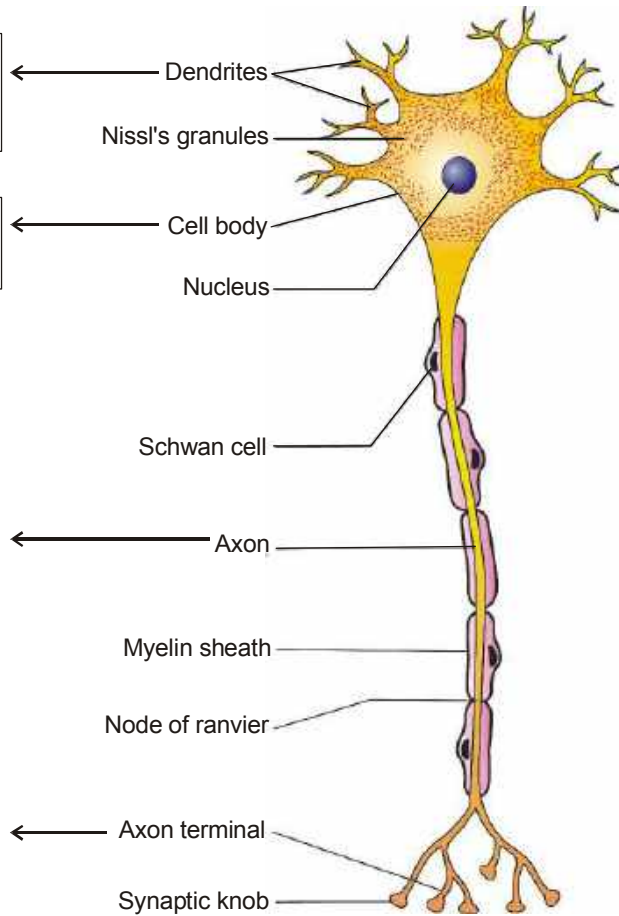
STRUCTURE OF A NEURON

Short fibres which branch repeatedly and project out of the cell body also contain Nissl's granules and are called dendrites. These fibres transmit impulses towards the cell body.

The cell body contains cytoplasm with typical cell organelles and certain granular bodies called Nissl's granules.

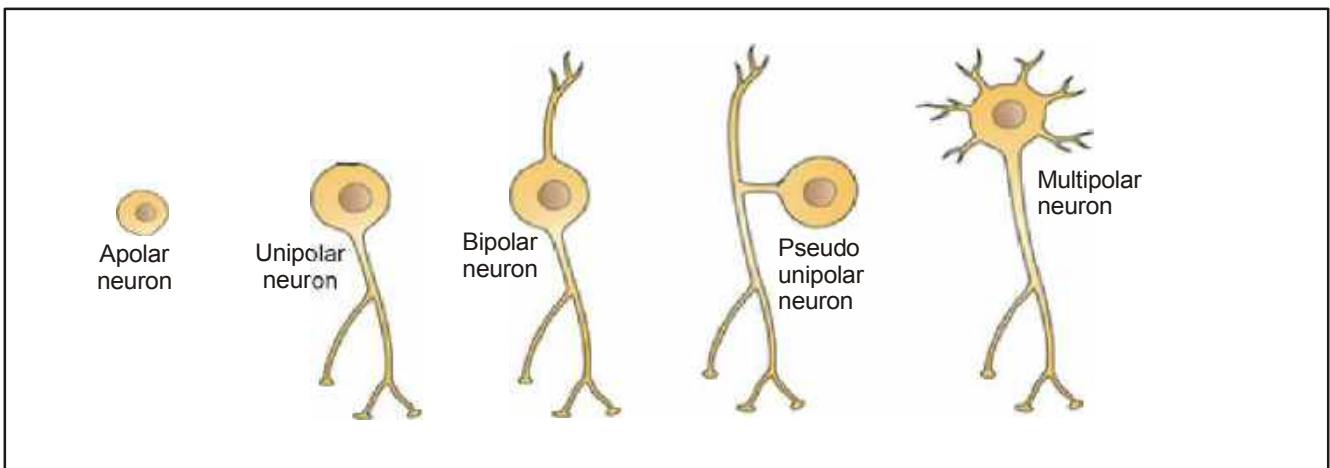
The axon is a long fibre, the distal end of which is branched.
 The axons transmit nerve impulses away from the cell body to a synapse or to a neuro-muscular junction. There are two types of axons, namely, myelinated and nonmyelinated.
 The myelinated nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. The gaps between two adjacent myelin sheaths are called nodes of Ranvier.
 Myelinated nerve fibres are found in spinal and cranial nerves.
 Unmyelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in autonomous and the somatic neural systems.

Branch of axon terminates as a bulb-like structure called synaptic knob which possess synaptic vesicles containing chemicals called neurotransmitters



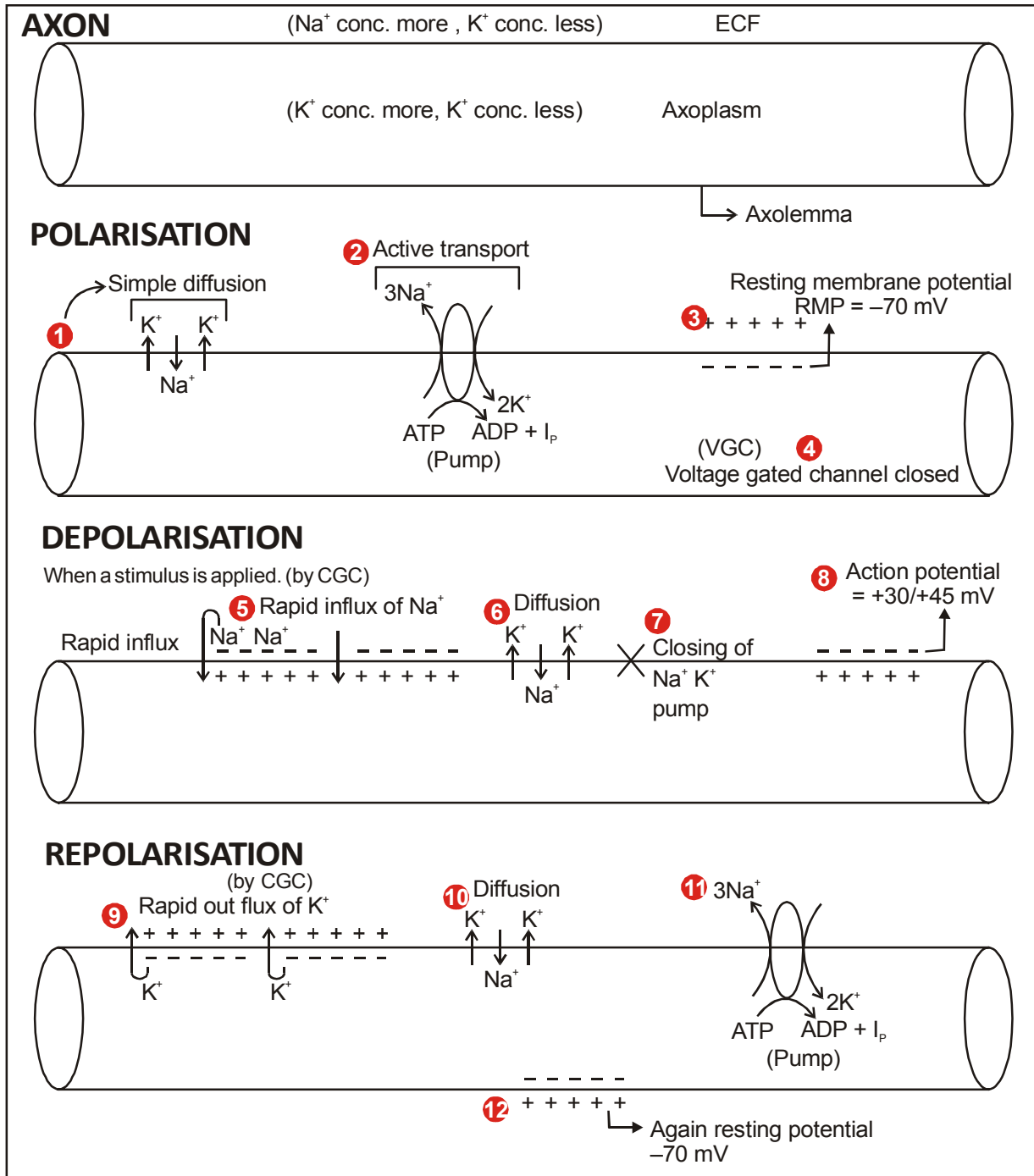
TYPES OF NEURONS

Based on the number of axon and dendrites, the neurons are divided into three types, i.e., multipolar (with one axon and two or more dendrites; found in the cerebral cortex), bipolar (with one axon and one dendrite, found in the retina of eye) and unipolar (cell body with one axon only; found usually in the embryonic stage). One more type of neuron are there - Apolar neurons (Only cell body is present) found in the Hydra.



GENERATION AND CONDUCTION OF NERVE IMPULSE

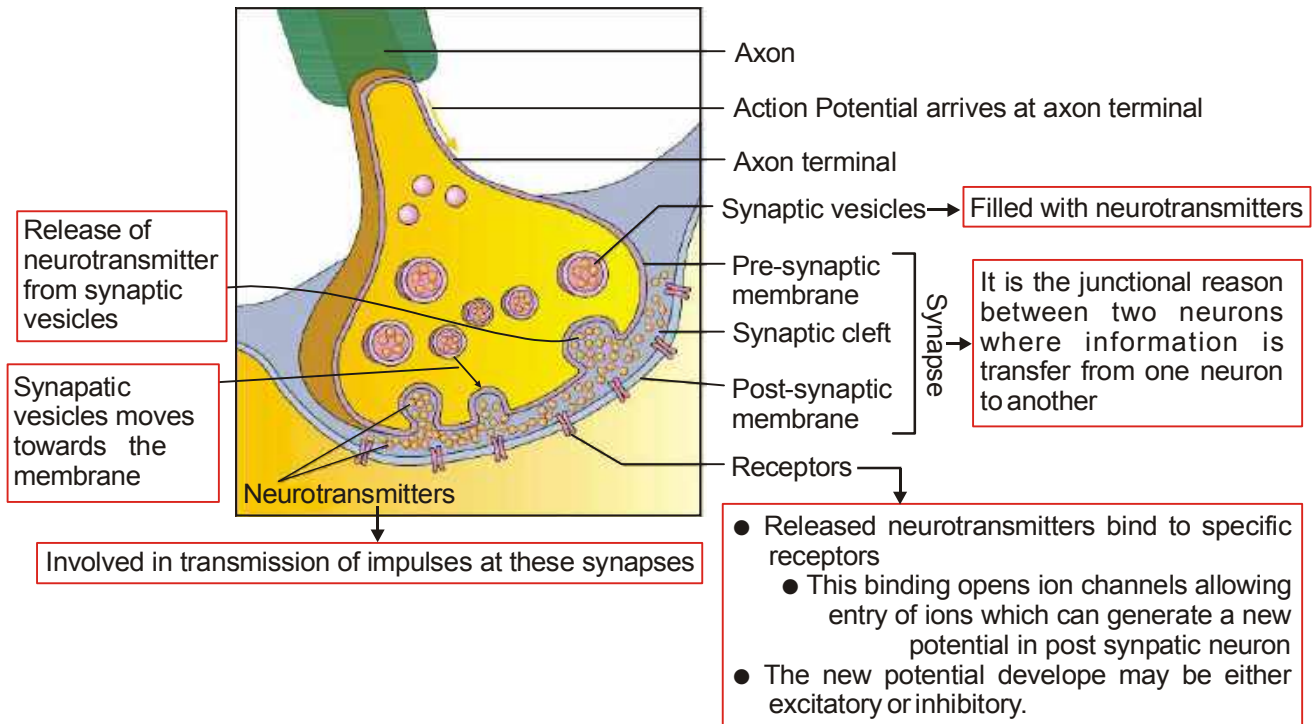
Neurons are excitable cells because their membranes are in a polarised state. Do you know why the membrane of a neuron is polarised? Different types of ion channels are present on the neural membrane. These ion channels are selectively permeable to different ions.



The rise in the stimulus-induced permeability to Na⁺ is extremely shortlived. It is quickly followed by a rise in permeability to K⁺. Within a fraction of a second, K⁺ diffuses outside the membrane and restores the resting potential of the membrane at the site of excitation and the fibre becomes once more responsive to further stimulation.

TRANSMISSION OF IMPULSES

A nerve impulse is transmitted from one neuron to another through junctions called synapses. Electrical current can flow directly from one neuron into the other across these synapses. Transmission of an impulse across electrical synapses is very similar to impulse conduction along a single axon.

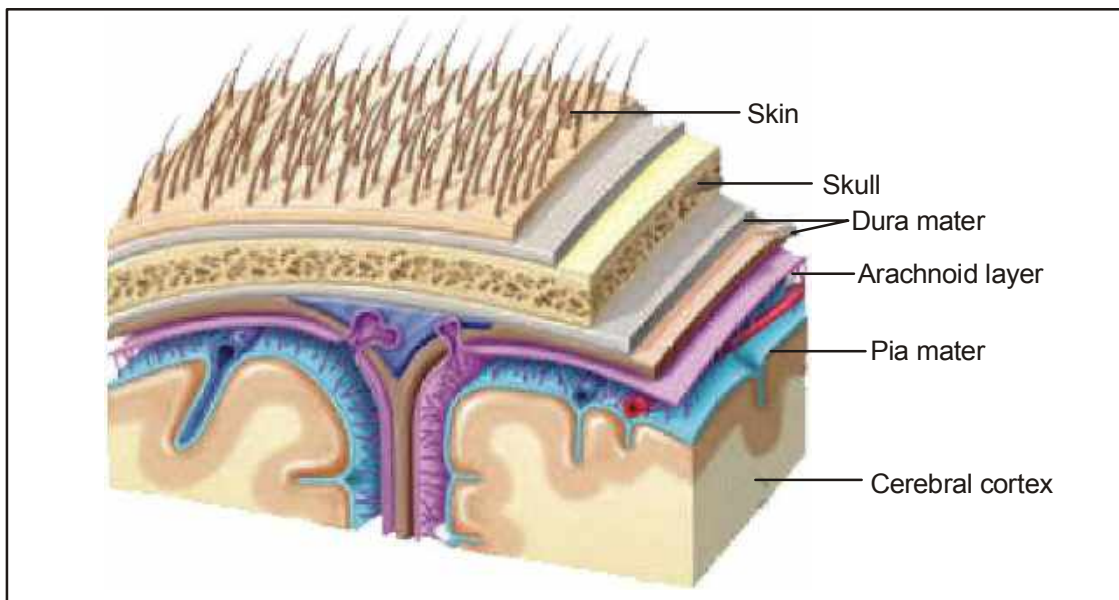
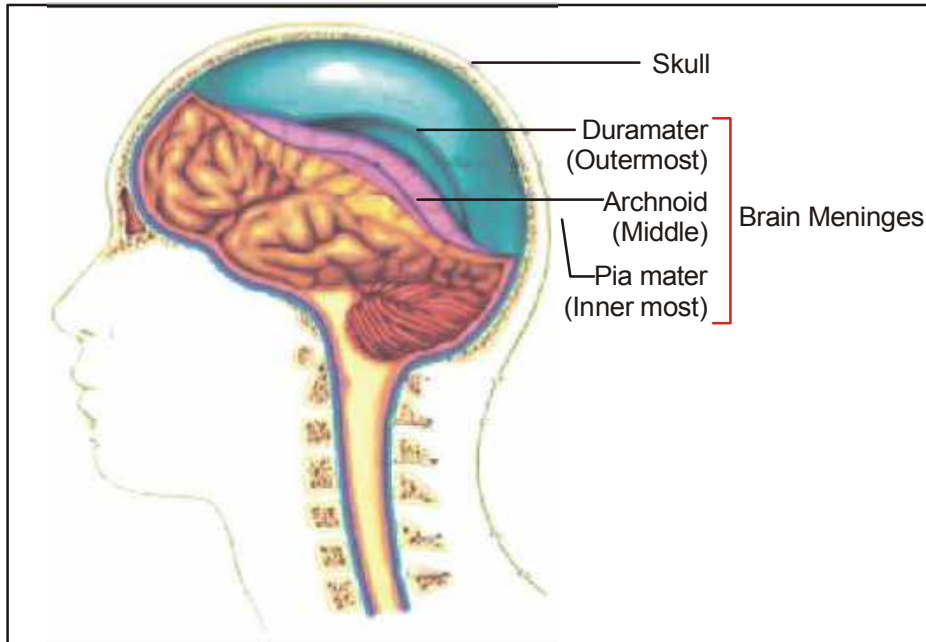


TYPE OF SYNAPSE

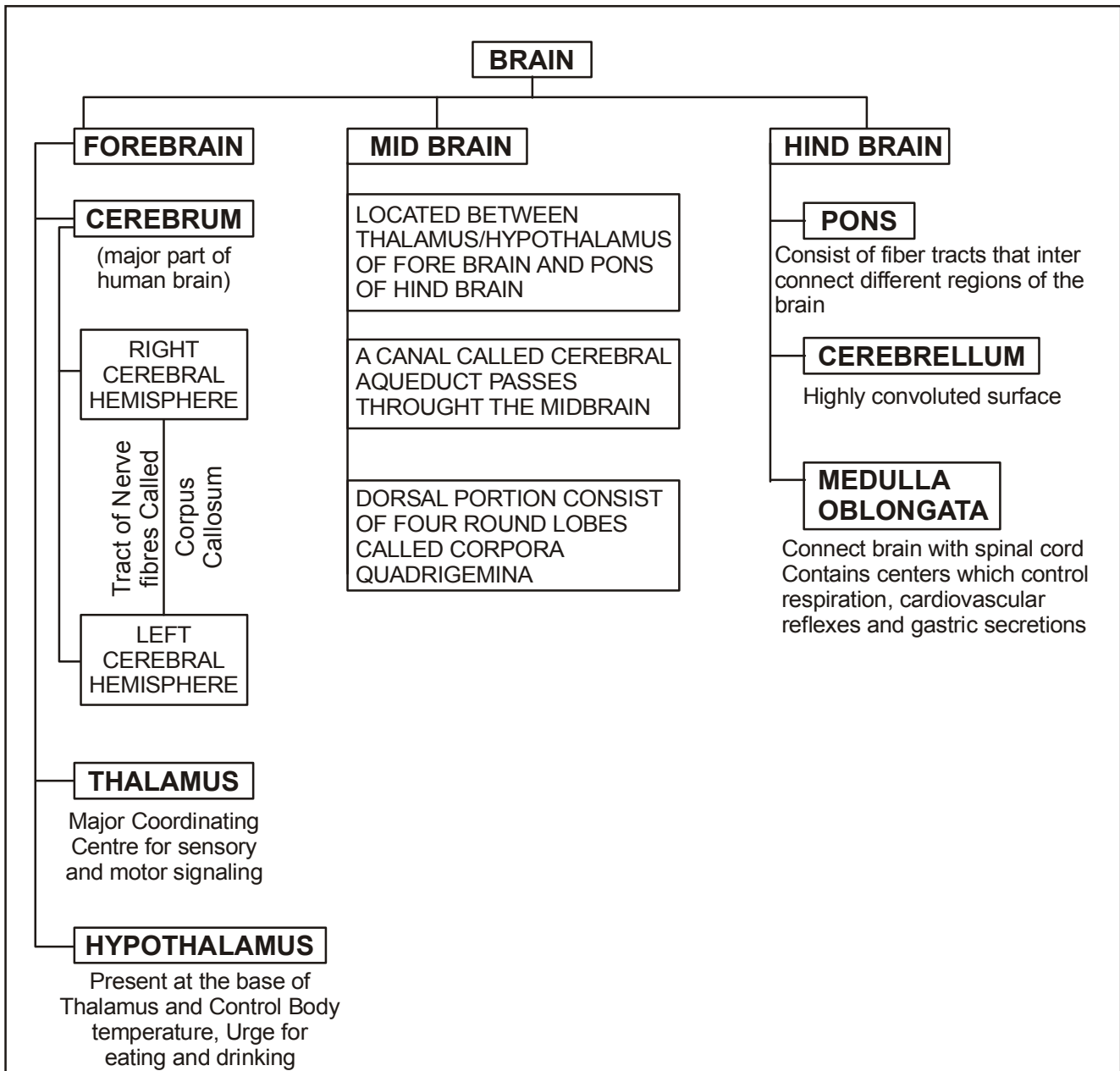
		Electrical	Chemical
(I)	Conduction	Fast	Slow
(II)	Synaptic cleft	0.2 nm	> 20 nm
(III)	Neurotransmitter in synaptic cleft	Absent	Present
(IV)	Synaptic delay	Absent	Present
(V)	Blocking	Can not be controlled	Controlled by neurotransmitter

Special point : Electrical synapses are rare in our body,

The brain is the central information processing organ of our body, and acts as the 'command and control system'. It controls the voluntary movements, balance of the body, functioning of vital involuntary organs (e.g. lungs, heart, kidneys etc.) thermoregulation, hunger and thirst, circadian (24 hour) rhythms of our body, activities of several endocrine glands and human behaviour. It is also the site for processing of vision, hearing, speech, memory, intelligence, emotions and thoughts.



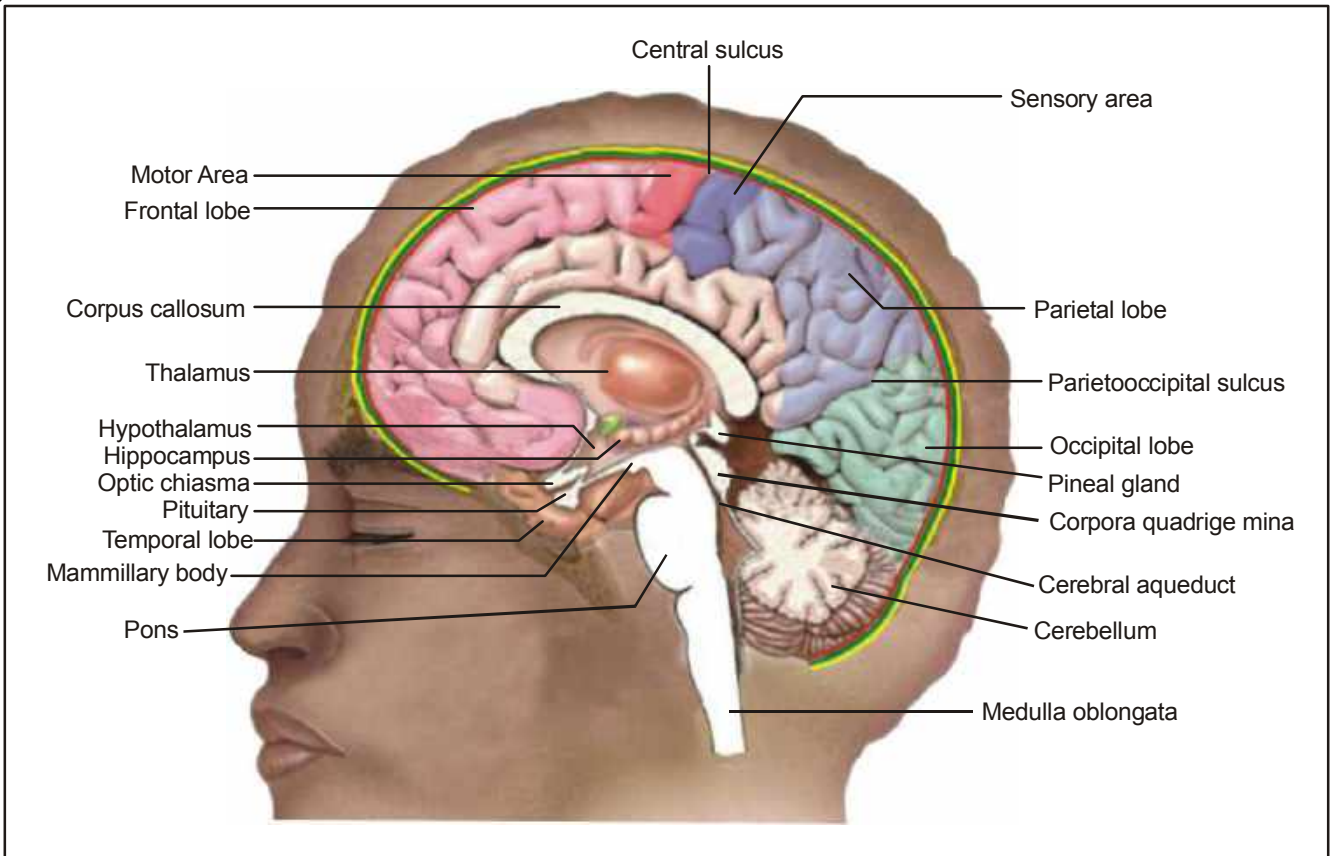
The human brain is well protected by the skull. Inside the skull the brain is covered by cranial meninges consisting of an outer layer called dura mater, a very thin middle layer called arachnoid and an inner layer (which is in contact with the brain tissue) called pia mater.



FOREBRAIN

The forebrain consists of cerebrum, thalamus and hypothalamus. Cerebrum forms the major part of the human brain. A deep cleft divides the cerebrum longitudinally into two halves, which are termed as the left and right cerebral hemispheres. The hemispheres are connected by a tract of nerve fibres called corpus callosum.

The layer of cells which covers the cerebral hemisphere is called cerebral cortex and is thrown into prominent folds. The cerebral cortex is referred to as the grey matter due to its greyish appearance. The neuron cell bodies are concentrated here giving the colour. The cerebral cortex contains motor areas, sensory areas and large regions that are neither clearly sensory nor motor in function. These regions called as the association areas are responsible for complex functions like intersensory associations, memory and communication. Fibres of the tracts are covered with the myelin sheath, which constitute the inner part of cerebral hemisphere. They give an opaque white appearance to the layer and, hence, is called the white matter.



Thalamus :- Relay centre, gate keeper of brain, pathway of sensory and motor signaling

Hypothalamus :- Regulation of temperature, urge of eating and drinking, biological clock.

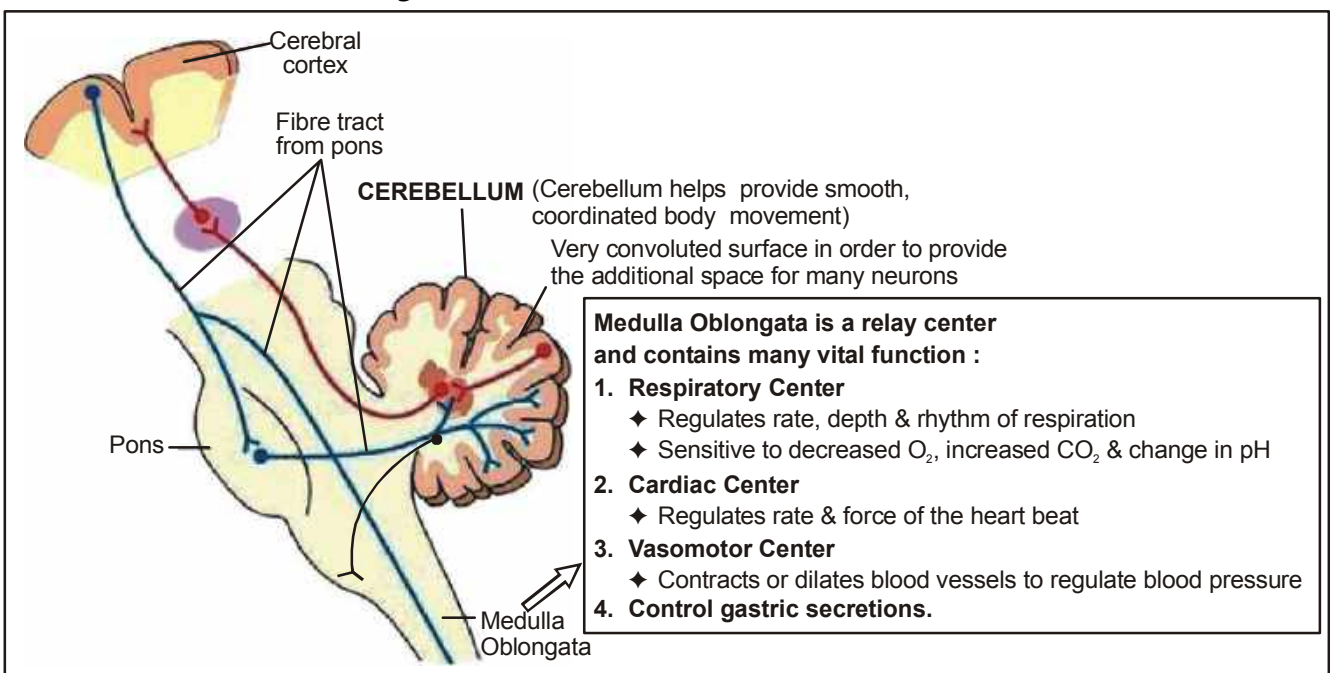
Hippocampus :- Part of limbic system, regulation of sexual behaviours, emotions pleasure, rage, excitement, fear and motivation.

Pons :- Fibres of tract which connects different region of brain.

Medulla oblongata :- Regulation of cardiovascular reflex respiration and gastric secretion.

HINDBRAIN

The hindbrain comprises pons, cerebellum and medulla (also called the medulla oblongata). Pons consists of fibre tracts that interconnect different regions of the brain.



PERIPHERAL NERVOUS SYSTEM

- All the nerves arising from brain and spinal cord are included in peripheral nervous system. Nerves arising from brain are called **cranial nerves**, and nerves coming out of spinal cord are called **spinal nerves**.
- 12-pairs** of cranial nerves are found in reptiles, birds and mammals but amphibians and fishes have only **10-pairs** of cranial nerves.

(A) CRANIAL NERVES

No.	Name	Nature	Function
I.	Olfactory	Sensory	Smell
II.	Optic	Sensory	Sight
III.	Oculomotor	Motor	Movement of eyeball
IV.	Trochlear	Motor	Movement of eyeball.
V.	Trigeminal (Dentist nerve)	Mixed	Teeth and Jaw muscles (mastication)
VI.	Abducens	Motor	Movement of eyeball
VII.	Facial	Mixed	Taste (ant' 2/3 part of Tongue) Facial expression
VIII.	Auditory	Sensory	Hearing and equilibrium.
IX.	Glossopharyngeal	Mixed	Taste (Posterior 1/3 part of tongue) & saliva secretion
X.	Vagus (Pneumogastric)	Mixed	Visceral sensations and movements.
XI.	Accessory spinal	Motor	Movement of pharynx, larynx.
XII.	Hypoglossal	Motor	Movement of tongue

(B) SPINAL NERVES

- In Human only **31 pairs** of spinal - nerves are found.
- Each spinal nerve is mixed type and arises from the roots of the horns of gray matter of the spinal cord. In dorsal root only afferent or sensory fibres and in ventral root efferent or motor fibres are found.
- Both the roots after moving for distance in the spinal cord of vertebrates combine with each other and come out from the Inter vertebral foramen in the form of spinal nerves.
- As soon as the spinal nerves come out of the inter vertebral foramen they divide into 3 branches :-
 - (i) **Ramus- dorsalis**] S.N.S. (Somatic nervous system)
 - (ii) **Ramus ventralis**]
 - (iii) **Ramus communicans** → A.N.S. [Sympathetic nervous system
Parasympathetic nervous system

GOLDEN KEY POINTS

- Longest cranial nerve is **Vagus nerve**.
- Largest cranial nerve is **Trigeminal nerve**.

- Smallest cranial nerve is **Abducens nerve**.
- Thinnest Cranial nerve **Trochlear nerve**.
- I, II and VIII cranial nerves are pure sensory nerves.
- III, IV, VI, XI and XII are pure motor cranial nerves.
- V, VII, IX, X are mixed cranial nerves.

AUTONOMIC OR VISCERAL NERVOUS SYSTEM

- The autonomic nervous system. *Viseral nervous system is a part of peripheral nervous system that comprises the whole complex of nerves, fibres, ganglia and plexuses by which impulses travel from the central nervous system to the viscera and from the viscera to central nervous system.* It controls activities inside the body that are normally involuntary, such as heart beat, peristalsis, sweating etc.
- It consists of motor neuron passing to the smooth muscle of internal organs. Smooth muscles are involuntary muscles. Most of the activities of the autonomic nervous system is controlled within the spinal cord or brain by reflexes known as **visceral reflexes** and does not involve the conscious control of higher centres of the brain.
- Overall control of the autonomic nervous system is maintained by centres in the **medulla** (a part of the hind brain) and **hypothalamus**.
- The autonomic nervous system is composed of two type of neurons.
 - (a) **preganglionic neuron** (myelinated)
 - (b) **post preganglionic neuron** (non myelinated)

Sites of ANS -

Involuntary muscles, Exocrine glands, Blood vessels, skin (Pilomotor muscles, Blood vessels, Sweat glands)

Divisions of ANS : There are the two division of the autonomic nervous system :-

- (a) **sympathetic** and
- (b) **parasympathetic**
 - (i) Sympathetic system is related with such visceral reactions. which increase the protection of body in adverse atmospheric conditions along with calorie consumption (Causes loss of energy).
 - (ii) Parasympathetic system is related with those reactions in which energy is conserved.

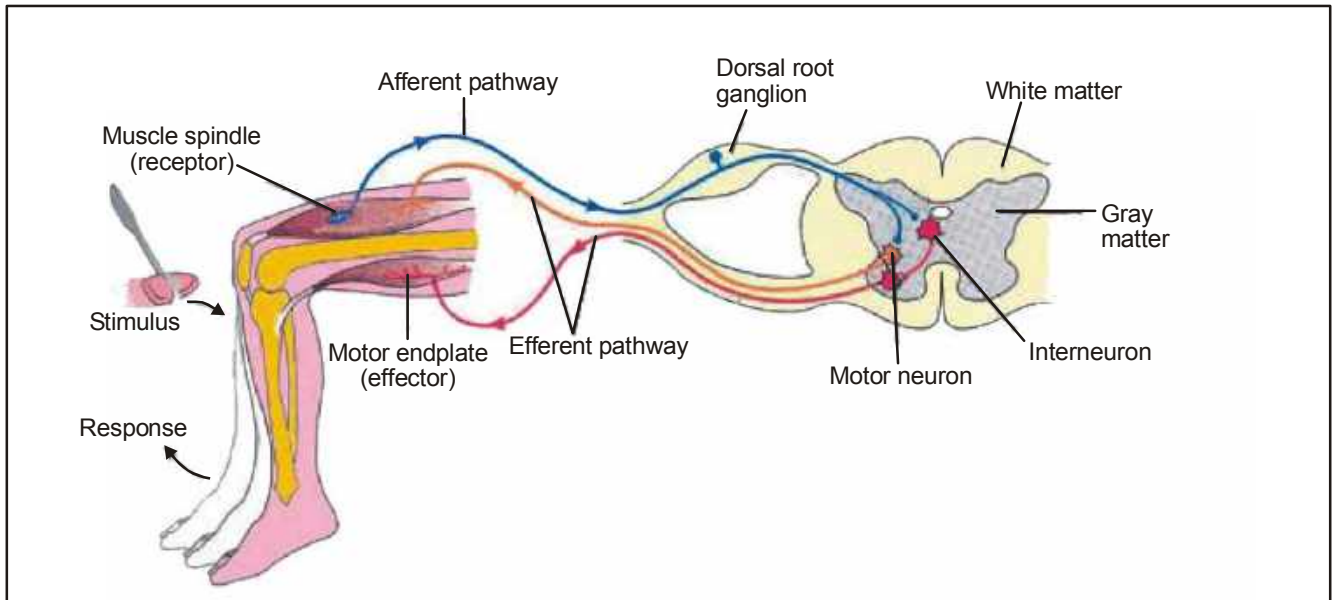
In this way, autonomic nervous system controls the activites of visceral organs double sided i.e. antagonistic to each other.

Autonomic Nervous Control of Visceral Organs

S. No.	Name of Visceral Organs	Affect of sympathetic nervous system	Affect of parasympathetic nervous system
1.	Secretion	Acetyl choline + sympathetin	Only acetylcholine
2.	Iris of eye	Dilates pupils	Constricts pupils
3.	Heart	Increases the rate of cardiac contraction	Inhibits the rate of cardiac contraction
4.	Secretion of adrenal gland	Stimulates adrenal secretion	Inhibits adrenal secretion
5.	Salivary secretion	Inhibits the secretion of saliva	Stimulates the secretion of saliva
6.	Lungs, trachea and bronchi	Dilates trachea bronchi & lungs for easy breathing	Constricts these organs during normal breathing.
7.	Alimentary canal	Inhibits peristalsis of alimentary canal.	Stimulates the peristalsis of alimentary canal
8.	Digestive glands.	Inhibits the secretion of these glands	Stimulates the secretion of the glands
9.	Sweat glands	Stimulates secretion of sweat.	Inhibits secretion of sweat.
10.	Arrector pilli muscles	Stimulates contraction of these muscles of skin, causing goose flesh	Relaxes Arrector pilli muscles.
11.	Urinary bladder	Relaxes the muscles of urinary bladder. (Inhibits Micturition)	Contracts the muscles for ejaculation of urine (Micturition).
12.	Anal sphincter	Closes anus by contracting anal sphincters. (Inhibits Defaecation)	Relaxes anal sphincter and opens the anus (Defaecation).
13.	External genitalia of male (penis)	Ejaculation	Erection

REFLEX ACTION AND REFLEX ARC

The entire process of response to a peripheral nervous stimulation, that occurs involuntarily, i.e., without conscious effort or thought and requires the involvement of a part of the central nervous system is called a reflex action.



REFLEX ACTION AND REFLEX ARC

You must have experienced a sudden withdrawal of a body part which comes in contact with objects that are extremely hot, cold pointed or animals that are scary or poisonous. The entire process of response to a peripheral nervous stimulation, that occurs involuntarily, i.e., without conscious effort or thought and requires the involvement of a part of the central nervous system is called a reflex action. The reflex pathway comprises at least one afferent neuron (receptor) and one efferent (effector or excitor) neuron appropriately arranged in a series (Figure 21.5). The afferent neuron receives signal from a sensory organ and transmits the impulse via a dorsal nerve root into the CNS (at the level of spinal cord). The efferent neuron then carries signals from CNS to the effector. The stimulus and response thus forms a reflex arc as shown below in the knee jerk reflex. You should carefully study Figure 21.5 to understand the mechanism of a knee jerk reflex.

EXERCISE

- Afferent nerve fiber conducts impulse from :-
(1) C.N.S. to effector (2) Receptor to C.N.S.
(3) Receptor to effector (4) Effector to receptor
- The nerves leading to the central nervous system are called :-
(1) Afferent (2) Efferent
(3) Motor (4) None
- Unit of nervous system :-
(1) Neuron (2) Neuroglia
(3) Axon (4) Cyton
- Integrative system in the body are :-
(1) Endocrine system (2) Nervous system
(2) Blood vascular system (4) Both 1 & 2
- Rapid integration of the functional activities in human is achieved by :-
(1) Nervous system (2) Endocrine system
(3) Blood (4) Muscular system
- Dendrites are associated with which system ?
(1) Nervous system (2) Digestive system
(3) Muscular system (4) Blood vascular system
- Intercellular communication in multicellular organism occurs through -
(1) Nervous system only
(2) Digestive system only
(3) Respiratory system only
(4) Both nervous and endocrine system
- Synaptic vesicles are found in -
(1) presynaptic neuron
(2) post synaptic neuron
(3) synaptic cleft
(4) none of these
- In a myelinated neuron, two adjacent myelin sheaths are separated by gaps called :
(1) nodes of Ranvier (2) synaptic cleft
(3) synaptic knob (4) neural plate
- Nissl's granules are found in :
(1) liver cells (2) nerve cells
(3) kidney (4) heart

NERVE IMPULSE CONDUCTION

- When a nerve fibers is stimulated the inside of the membrane becomes :-
(1) Filled with acetyl choline
(2) Negatively charged
(3) Positively charged
(4) Neutral
- Nerve impulses are initiated by nerve fibers only when the membrane shall become more permeable to :-
(1) Adrenaline (2) Phosphorus
(3) Sodium ions (4) Potassium ions
- When the axons membrane is positively charged outside and negatively charged inside, then the condition is known as :-
(1) Action potential
(2) Resting potential
(3) Active potential
(4) Differential potential
- Depolarization of axolemma during nerve conduction takes place because of-
(1) Equal amount of Na^+ & K^+ move out across axolemma
(2) Na^+ move inside
(3) More Na^+ outside
(4) None
- In the resting state of the neural membrane, diffusion due to concentration gradients, if allowed, would drive :-
(1) K^+ and Na^+ out of the cell
(2) Na^+ into the cell
(3) Na^+ out of the cell
(4) K^+ into the cell
- Repolarisation of Neuron is occurred due to:-
(1) Influx of Na^+
(2) Influx of K^+
(3) Efflux of Na^+
(4) Efflux of K^+
- Pre synaptic membrane is part of :
(1) Dendron
(2) Axon hillock
(3) Telodendria
(4) Soma

- 18.** Corpus callosum connects :-
 (1) Two cerebral hemisphere
 (2) Two optic lobes
 (3) Two olfactory lobes
 (4) Optic chiasma
- 19.** Outer most covering of brain is called :-
 (1) Choroid (2) Duramater
 (3) Piamater (4) Arachnoid
- 20.** Piamater is :-
 (1) Inner most meninge (2) Middle meninge
 (3) Outer meninge (4) None
- 21.** Which of the following is not a part of hind brain :-
 (1) Medulla oblongata (2) Thalamus
 (3) Cerebellum (4) Pons
- 22.** Which of the following is the part of mid brain ?
 (1) Cerebrum
 (2) Diencephalon
 (3) Corpora quadrigemina
 (4) None of these
- 23.** Which part of the brain regulates the body temperature, hunger and water balance :-
 (1) Hypothalamus
 (2) Infundibulum
 (3) Medulla oblongata
 (4) Pons veroli
- 24.** Column 'I' list the parts of human brain and column 'II' lists the functions. Match the two columns and identify the correct choice from those given -
- | | |
|------------------|---------------------------------------|
| Column I | Column II |
| (A) Cerebrum | (i) Controls the pituitary |
| (B) Cerebellum | (ii) Controls vision and hearing |
| (C) Hypothalamus | (iii) Controls the rate of heart beat |
| (D) Midbrain | (iv) Seat of intelligence |
| | (v) Maintains body posture |
- (1) A=v, B=iv, C=ii, D=i
 (2) A=iv, B=v, C=ii, D=i
 (3) A=v, B=iv, C=i, D=ii
 (4) A=iv, B=v, C=i, D=ii
- 25.** The correct sequence of meninges of brain from outside to inside is :
 (1) duramater → arachnoid → piamater
 (2) arachnoid → duramater → piamater
 (3) piamater → duramater → arachnoid
 (4) duramater → piamater → arachnoid
- 26.** Which of the following is not an organ of the central nervous system :-
 (1) Brain (2) Spinal cord
 (3) Medulla oblongata (4) Vagus
- 27.** Purely motor cranial nerve includes :-
 (1) I, V, VII (2) I, II, IV
 (3) III, IV, VI, XI (4) None of these
- 28.** Number of spinal nerves in human :-
 (1) 31 pairs (2) 32 pairs
 (3) 12 pairs (4) 37 pairs
- 29.** Stimulation of sympathetic nervous system causes :-
 (1) Constriction of blood vessels and high blood pressure
 (2) Dilation of bronchi & pupil
 (3) Erection of hair
 (4) All of the above
- 30.** Which one of the following is not an effect of sympathetic nervous system –
 (1) Dilation of pupil
 (2) Inhibition of peristalsis
 (3) Elevation of blood pressure
 (4) Stimulation for saliva secretion

REFLEX ACTION

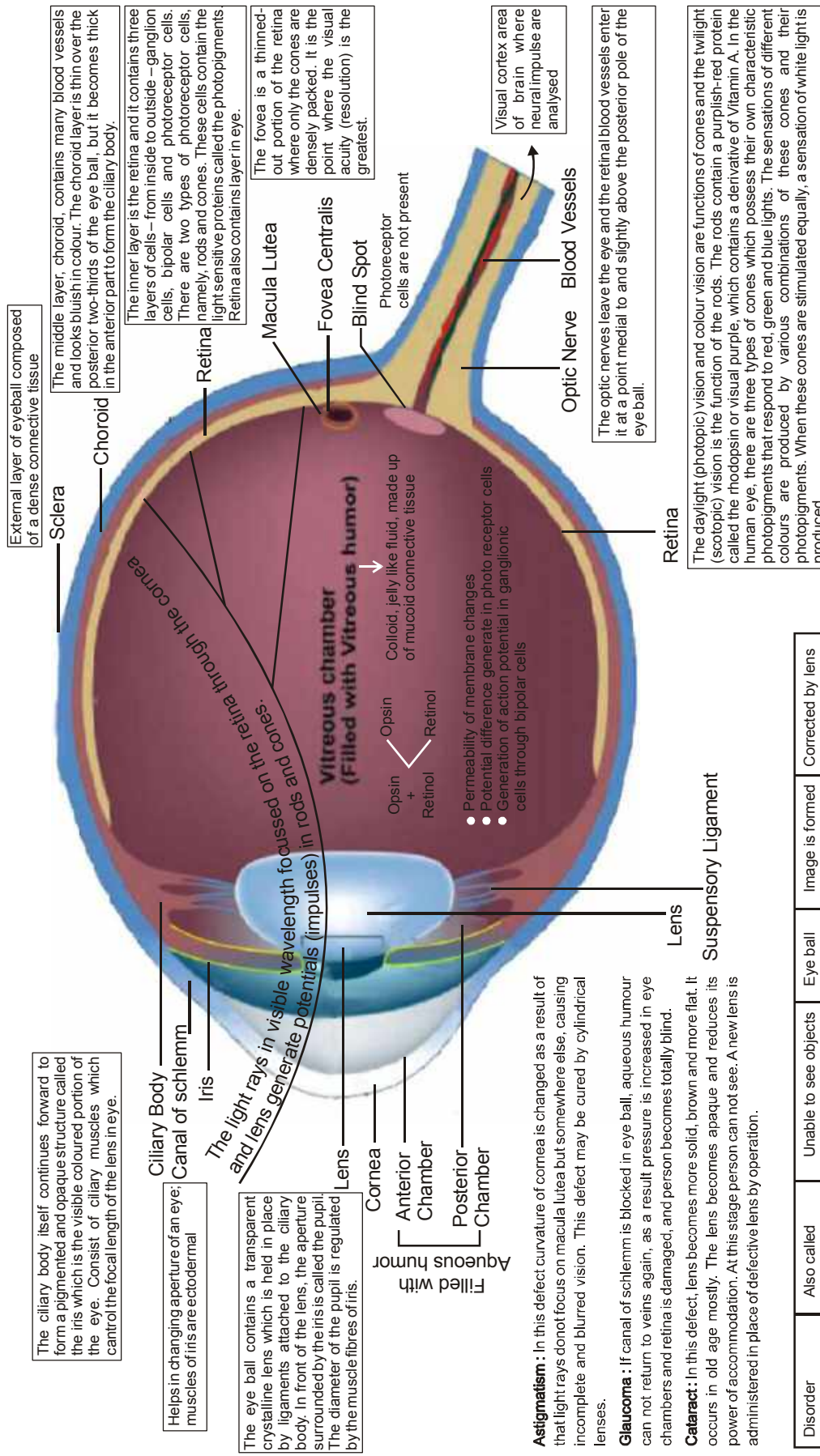
- 31.** Reflex arc consists of :
 (1) motor nerve
 (2) sensory nerve
 (3) both sensory and motor nerves
 (4) none of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	1	4	1	1	4	1	1	2	3	3	2	2	2
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	3	1	2	1	2	3	1	4	1	4	3	1	4	4
Que.	31														
Ans.	3														

SENSORY ORGANS (EYE)

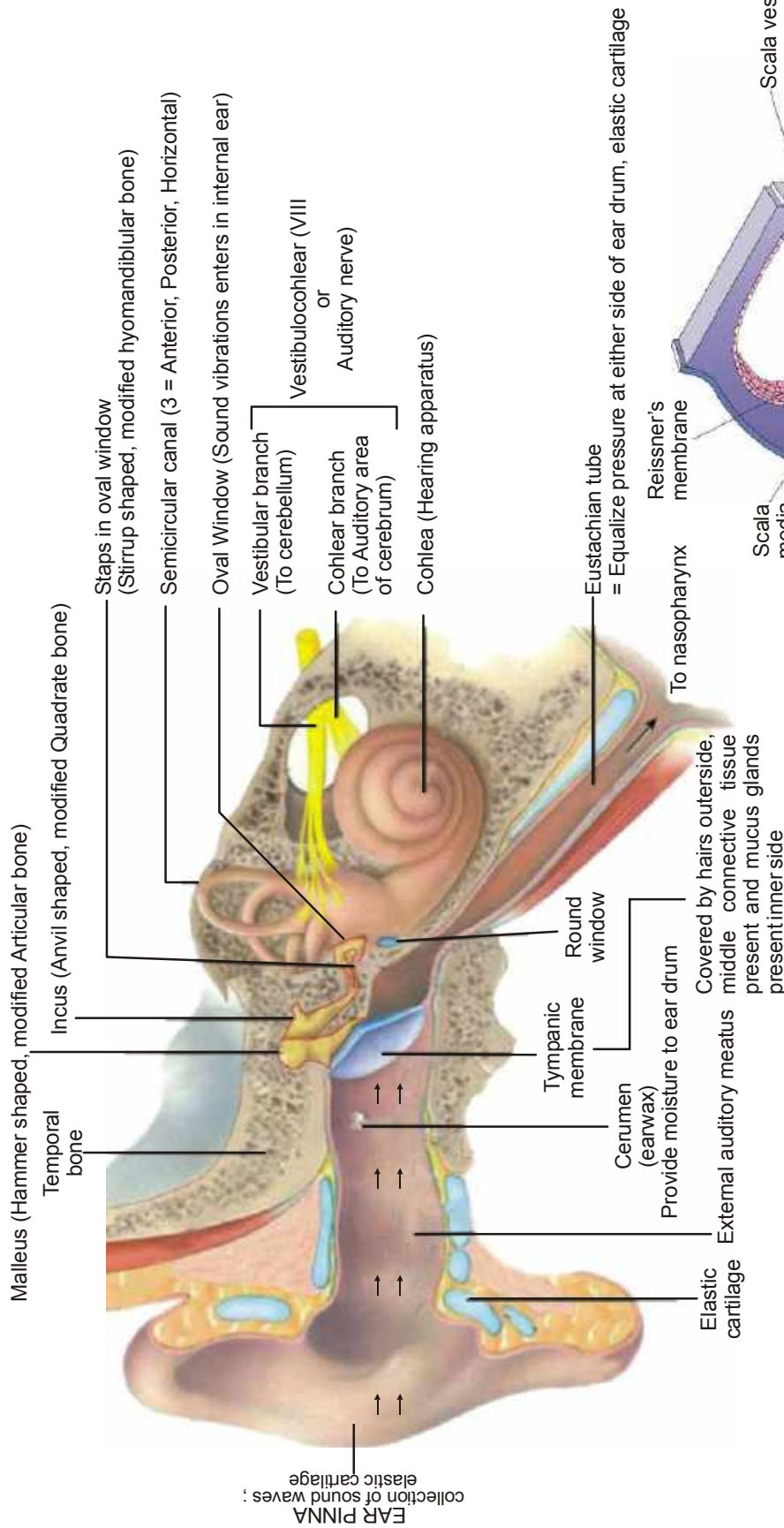
DIAGRAM SHOWING PARTS OF AN EYE AND MECHANISM OF VISION



Disorder	Also called	Unable to see objects	Eye ball	Image is formed	Corrected by lens
Myopia	Near/s short sightedness	At far distance	Enlarges	Before retina	Concave
Hyper-metropia	Farsightedness	At near to him/her	Shortens	Behind retina	Convex

SENSORY ORGANS (EAR)

DIAGRAM SHOWING PARTS OF AN EAR



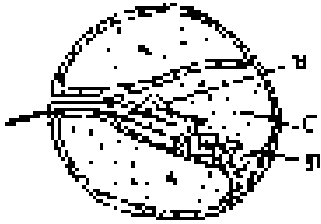
DIAGRAMMATIC REPRESENTATION OF THE SECTIONAL VIEW OF COCHLEA



EXERCISE

1. Aperture of an eye can be changed by :-
(1) Aqueous humor (2) Vitreous humor
(3) Ciliary muscles (4) Iris
2. Which is responsible for colour detection ?
(1) Cones (2) Rods
(3) Rods and cones (4) Choroid
3. The focal length of the lens in eye is controlled by
(1) Vitreous humor (2) Ciliary muscles
(3) Iris muscles (4) Pupil
4. Area of most active vision in eye where sharp image is formed is called :-
(1) Blind spot (2) Yellow spot
(3) Lens (4) Pupil
5. Blind spot in the eye is located :-
(1) In the center of pupil
(2) In the center of lens
(3) In fovea centralis
(4) Where optic nerves leaves retina
6. A small region on the retina of the eye which contains only cones is called :-
(1) Area centralis
(2) Fovea centralis
(3) Blind spot
(4) Ora serrata
7. Three layers in eye ball from inside to out side are -
(1) Retina, choroid, sclerotic
(2) Choroid, retina, sclerotic
(3) Sclerotic, choroid, retina
(4) Sclerotic, retina, choroid
8. In Glaucoma :-
(1) Eye ball elongates
(2) Eye ball shortened
(3) Fluid pressure increase in eye
(4) Cornea become opaque
9. The eye defect, Astigmatism can be corrected by using :-
(1) Convex lens (2) Concave lens
(3) Cylindrical lens (4) Surgery
10. Astigmatism is developed when -
(1) Lens become opaque
(2) Curvature of conjunctiva is changed
(3) Lens become nonflexible
(4) Curvature of cornea is changed
11. Organ of corti is found in :-
(1) Kidneys (2) Heart
(3) Nasal chamber (4) Internal ear
12. In mammals organ of corti occurs in :-
(1) Main canal (2) Ear canal
(3) Cochlear canal (4) Tympanum
13. "Organ of corti" is concerned with the sense of :-
(1) Smell (2) Hearing
(3) Taste (4) Equilibrium
14. Cochlea contains :-
(1) Scala vestibuli (2) Scala tympani
(3) Scala media (4) All the above
15. External auditory meatus contains the following gland :-
(1) Ceruminous gland
(2) Lachrymal gland
(3) Harderian gland
(4) Meibomian gland
16. Ear ossicle from inner side of middle ear are :-
(1) Malleus, Incus, stapes
(2) Stapes, Incus, Malleus
(3) Incus stapes & malleus
(4) Malleus, stapes, incus
17. Function of eustachian tube is to :-
(1) Provide air to the ear ossicles
(2) Remove dirt from the middle ear
(3) Keep middle ear in proper shape
(4) To maintain proper air pressure in middle ear and internal ear for protecting them from damage by loud sound

18. Given below is a diagrammatic cross section of a single loop of human cochlea :-



Which one of the following options correctly represents the names of three different parts ?

- (1) D : Sensory hair cells, A : Endolymph B: Tectorial membrane
- (2) A: Perilymph, B : Tectorial membrane C : Endolymph
- (3) B :Tectorial membrane, C :Perilymph, D: Secretory cells
- (4) C: Endolymph,D : Sensory hair cells, A : Serum

19. Passage connecting middle ear with pharynx is called :-

- (1) Cochlear canal
- (2) Vestibular canal
- (3) Tympanic canal
- (4) Eustachian canal

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	1	2	2	4	2	1	3	3	4	4	3	2	4	1
Que.	16	17	18	19											
Ans.	2	4	2	4											

CHEMICAL COORDINATION & INTEGRATION (ENDOCRINE SYSTEM)

You have already learnt that the neural system provides a point-to-point rapid coordination among organs. The neural coordination is fast but short-lived. As the nerve fibres do not innervate all cells of the body and the cellular functions need to be continuously regulated; a special kind of coordination and regulation has to be provided. This function is carried out by hormones. The neural system and the endocrine system jointly coordinate and regulate the physiological functions in the body.

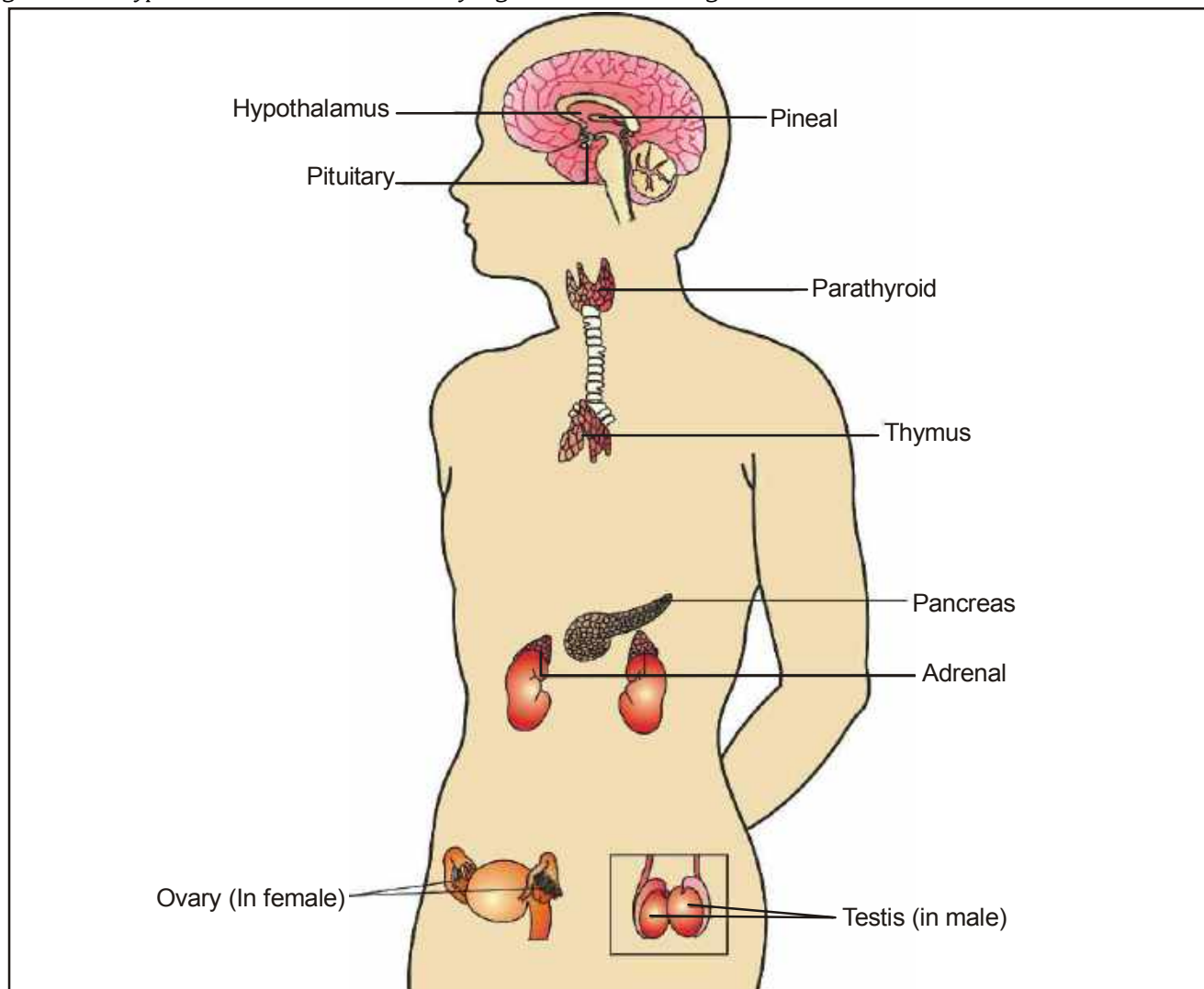
ENDOCRINE GLANDS AND HORMONES

Endocrine glands lack ducts and are hence, called ductless glands. Their secretions are called hormones. The classical definition of hormone as a chemical produced by endocrine glands and released into the blood and transported to a distantly located target organ has current scientific definition as follows: **Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in trace amounts.**

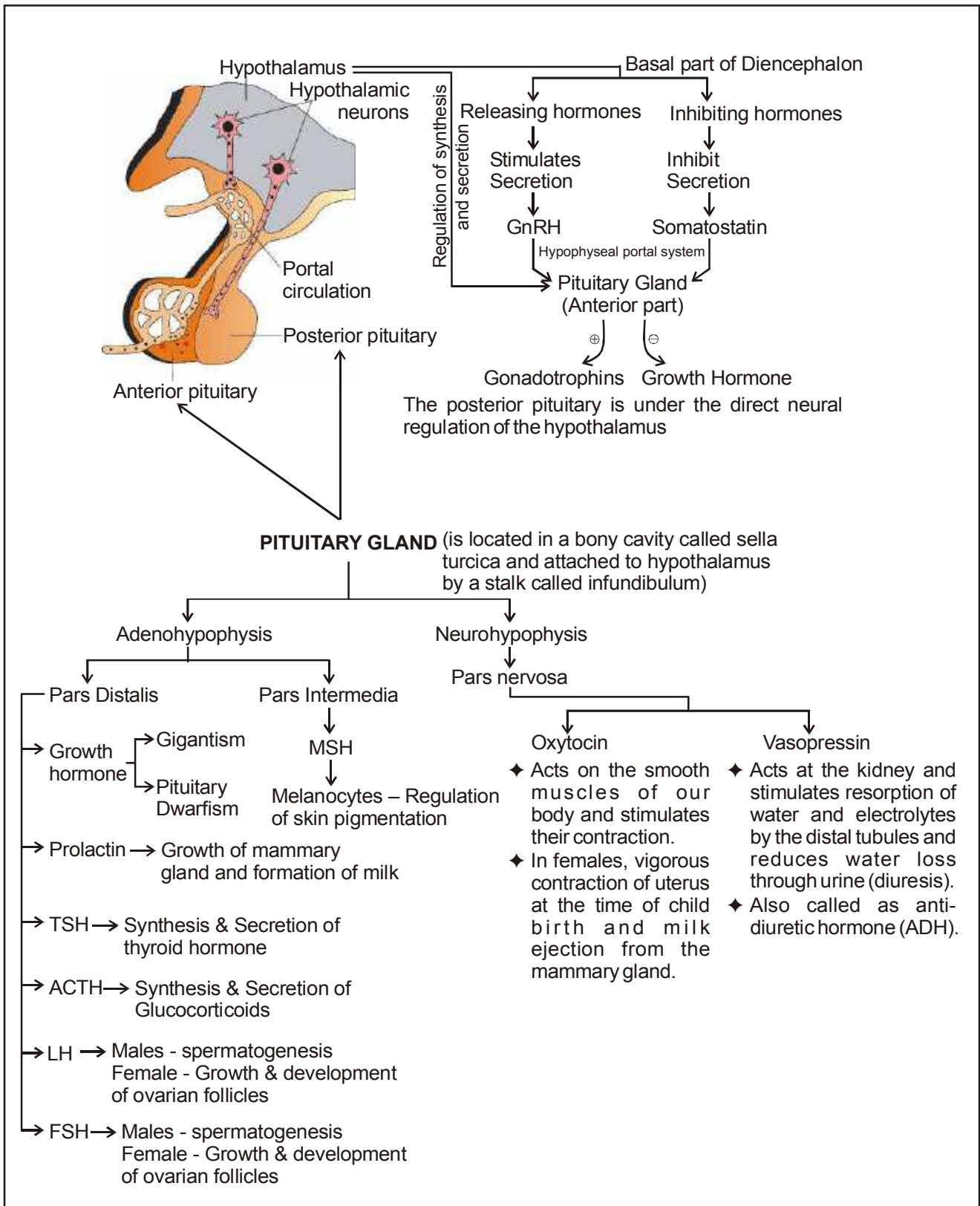
The new definition covers a number of new molecules in addition to the hormones secreted by the organised endocrine glands. Invertebrates possess very simple endocrine systems with few hormones whereas a large number of chemicals act as hormones and provide coordination in the vertebrates. The human endocrine system is described here.

HUMAN ENDOCRINE SYSTEM

The endocrine glands and hormone producing diffused tissues/cells located in different parts of our body constitute the endocrine system. Pituitary, pineal, thyroid, adrenal, pancreas, parathyroid, thymus and gonads (testis in males and ovary in females) are the organised endocrine bodies in our body. In addition to these, some other organs, e.g., gastrointestinal tract, liver, kidney, heart also produce hormones. A brief account of the structure and functions of all major endocrine glands and hypothalamus of the human body is given in the following sections.

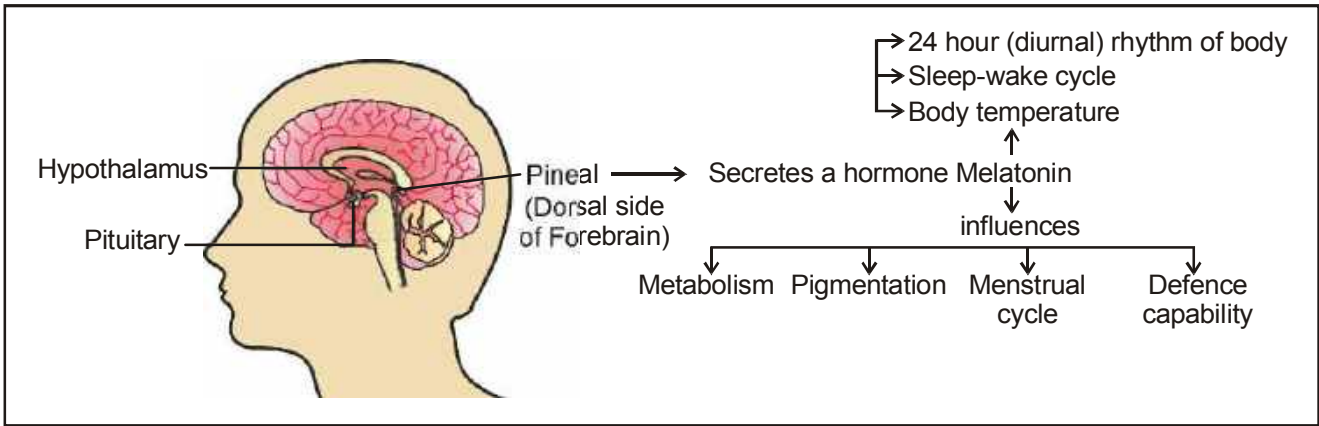


HYPOTHALAMUS AND PITUITARY GLAND



THE PINEAL GLAND

The pineal gland is located on the dorsal side of forebrain. Pineal gland secretes a hormone called melatonin. Melatonin plays a very important role in the regulation of a 24-hour (diurnal) rhythm of our body. For example, it helps in maintaining the normal rhythms of sleep-wake cycle, body temperature. In addition, melatonin also influences metabolism, pigmentation, the menstrual cycle as well as our defense capability.



Thyroid

- Two lobes on each side of trachea inter connected with a thin flap of connective tissue called Isthmus.
- Each thyroid follicle is composed of follicular cells enclosing a cavity.
- Iodine is essential for normal rate of hormone synthesis

Deficiency of iodine leads to:

- Enlargement of thyroid gland - Goitre
- Hypothyroidism → In adult women-irregular menstrual cycle.

During Pregnancy, Hypothyroidism leads to:

- Cretinism
- Mental retardation
- Low IQ
- Deaf mutism
- Abnormal skin

Thyroid hormones: Tetraiodothyronine, Thyrocalcitonin (Blood calcium level), Tri-iodothyronine

Cancer of thyroid gland → Rate of synthesis & secretion ↑ → Abnormal high levels → Hyper thyroidism

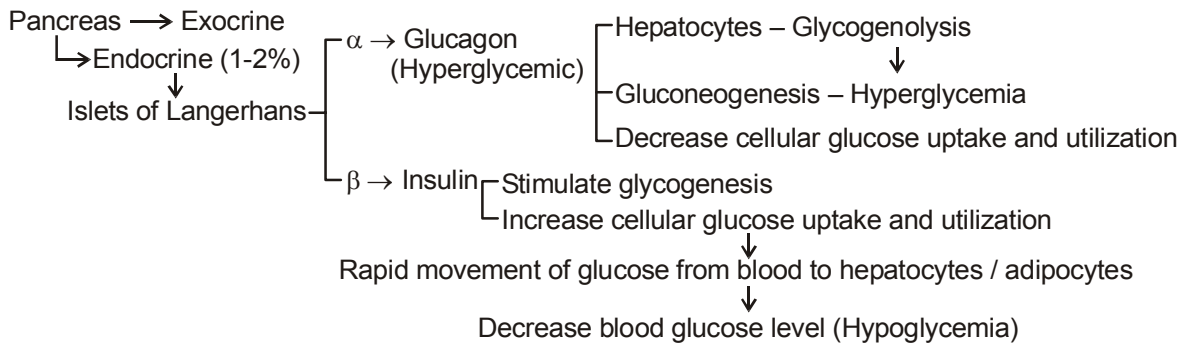
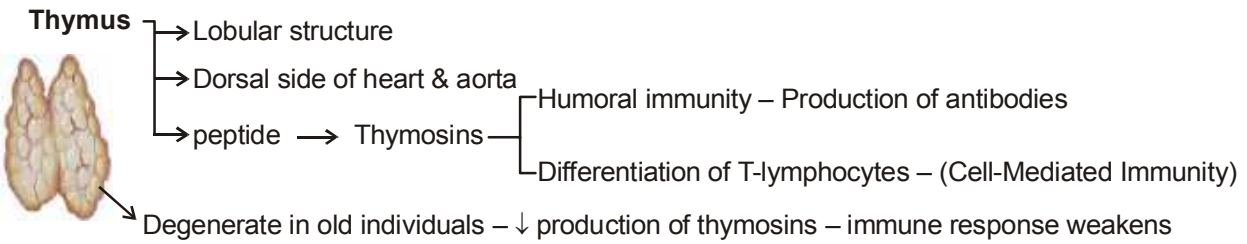
Thyroid Functions

- ◆ Regulation of B.M.R.
- ◆ Metabolism of carbohydrate, fat and proteins
- ◆ Supports Erythropoiesis
- ◆ Maintenance of H₂O & electrolyte balance

Parathyroid → Regulated by circulating levels of calcium ions → Parathyroid Hormone (Peptide in nature) → alongwith TCT → Ca²⁺ balance in the body

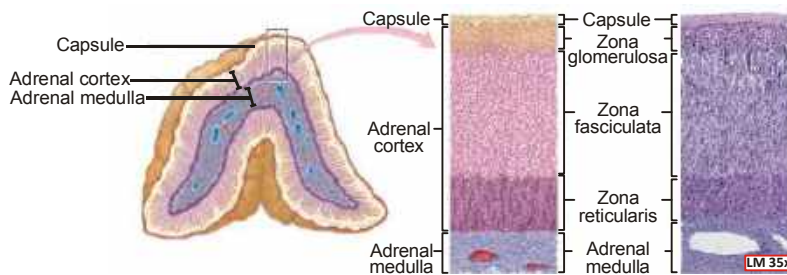
Parathyroid Hormone (PH) effects:

- ↑ Ca²⁺ level in blood
- Stimulate bone resorption
- Ca²⁺ ↑ reabsorption by renal tubules
- Ca²⁺ absorption from digested food (Hypercalcemic)

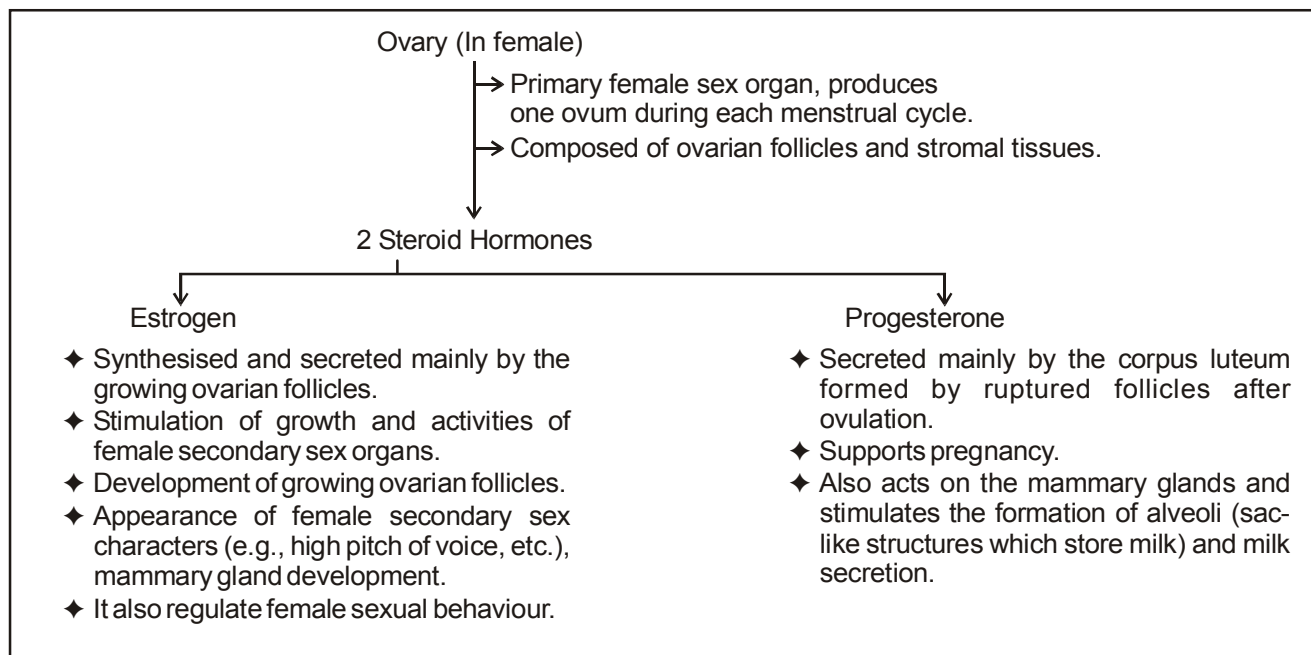


Prolonged hypoerglycemia leads to a complex disorder – Diabetes mellitus, characterised by glycosuria and ketone urea. Diabetes patients are successfully treated with Insulin

Adrenal gland



Feature	Adrenal Cortex	Adrenal Medulla
Adrenal Gland Location	Outer region of the gland	Inner region of the gland
Made of Stimulation	Hormonal (stimulated by ACTH from anterior pituitary)	Neural (stimulated by preganglionic axons from sympathetic division of ANS)
Hormones Produced	Corticosteroids : mineralocorticoids, glucocorticoids, gonadocorticoids	Epinephrine, norepinephrine
Effects of Hormones	Mineralcorticoids regulate the balance of electrolytes (e.g., Na ⁺ and K ions in the body) Glucocorticoids elevate blood glucose levels during longterm stressful situations (e.g., fasting, injury, anxiety), and stimulate the body to use fats and proteins as energy resources Gonadocorticoids release a small amount of androgens (male sex hormones)	Prolongs fight-or-flight response of the sympathetic division of the ANS



Testis (in male)

- ◆ Present in scrotal sac.
- ◆ Primary sex organ.
- ◆ Endocrine gland composed of stromal tissue and seminiferous tubules.
- ◆ Produce androgens mainly testosterone
- ◆ Androgens play a major stimulatory role in spermatogenesis.
- ◆ Hormones – Anabolic effects on protein and carbohydrate metabolism.

PANCREAS

Composite gland, both exocrine and endocrine gland.

The endocrine → 'Islets of Langerhans'. There are about 1 to 2 million Islets of Langerhans in a normal human pancreas representing only 1 to 2 per cent of the pancreatic tissue. The two main types of cells in the Islet of Langerhans are called α -cells and β -cells. The α -cells secrete a hormone called glucagon, while the β -cells secrete insulin.

Glucagon → peptide hormone → plays an important role in maintaining the normal blood glucose levels.

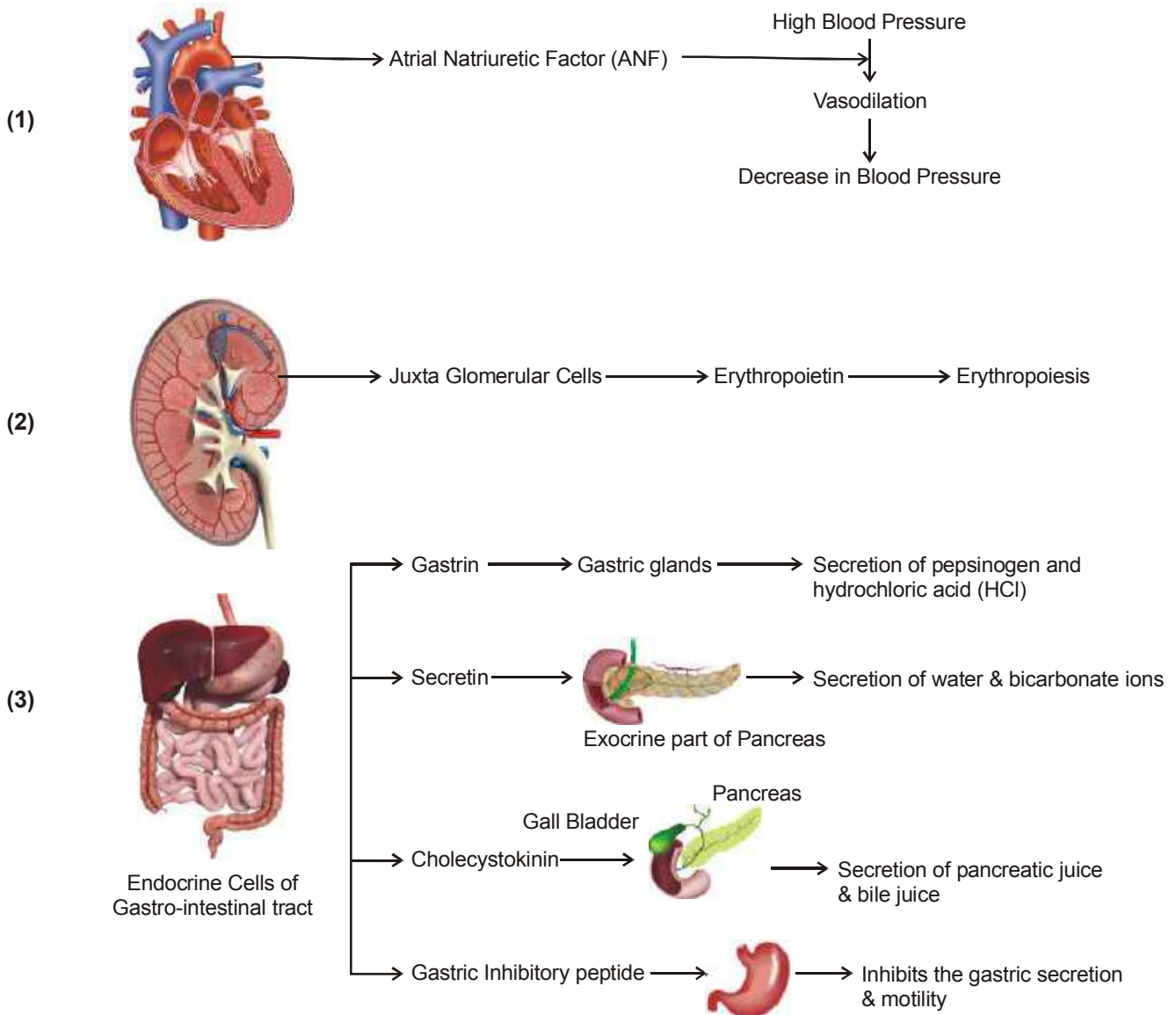
Glucagon acts mainly on the liver cells (hepatocytes) and stimulates glycogenolysis resulting in an increased blood sugar (hyperglycemia). In addition, this hormone stimulates the process of gluconeogenesis which also contributes to hyperglycemia. Glucagon reduces the cellular glucose uptake and utilisation. Thus, glucagon is a hyperglycemic hormone.

Insulin → peptide hormone → plays a major role in the regulation of glucose homeostasis. Insulin acts mainly on hepatocytes and adipocytes (cells of adipose tissue), and enhances cellular glucose uptake and utilisation. As a result, there is a rapid movement of glucose from blood to hepatocytes and adipocytes resulting in decreased blood glucose levels (hypoglycemia). Insulin also stimulates conversion of glucose to glycogen (glycogenesis) in the target cells.

The glucose homeostasis in blood is thus maintained jointly by the two – insulin and glucagons. Prolonged hyperglycemia leads to a complex disorder called diabetes mellitus which is associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies. Diabetic patients are successfully treated with insulin therapy.

HORMONES OF NON-ENDOCRINE GLANDS

Hormones are also secreted by some tissues which are not endocrine glands.



Several other non-endocrine tissue secrete hormones called growth factors, which are essential for the normal growth of tissue and their repairing / regeneration.

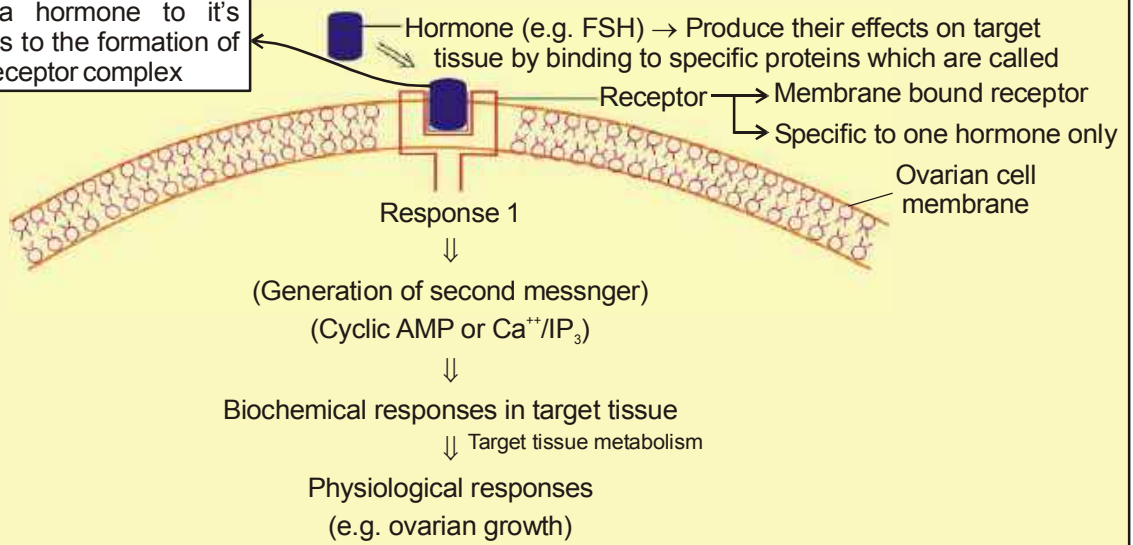
On the basis of chemical nature, hormones are grouped as -

- (i) Peptides, Polypeptide, Protein Hormone - insulin, glucagon, pituitary & hypothalamic hormones.
- (ii) Steroids - Cortisol, estradiol, testosterone, progesterone.
- (iii) Iodothyronines - Thyroid hormones.
- (iv) Amino acid derivatives - Epinephrine

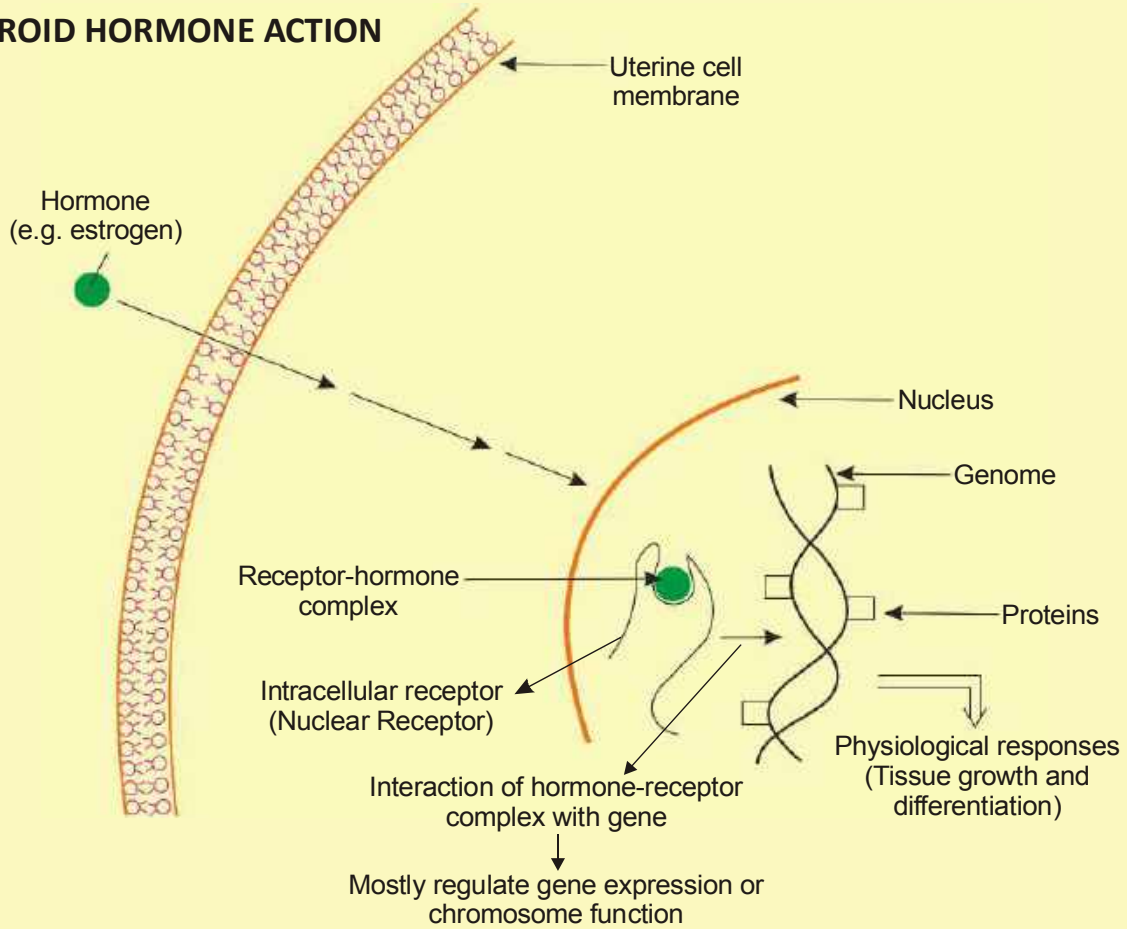
MECHANISM OF HORMONE ACTION

PROTEIN HORMONE ACTION

Binding of a hormone to its receptor leads to the formation of Hormone - Receptor complex



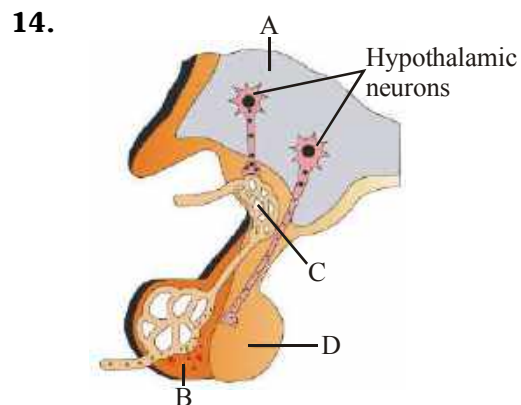
STEROID HORMONE ACTION



EXERCISE

1. A hormone is :-
 (1) An enzyme (2) Chemical messenger
 (3) Primary messenger (4) 2 and 3 both
2. Integrative system in the body are :-
 (1) Endocrine system
 (2) Nervous system
 (3) Blood vascular system
 (4) Both endocrine and nervous system
3. Endocrine glands can be defined as those glands which pour their secretion :-
 (1) Directly into blood (2) Into blood or ducts
 (3) When they are cut (4) into particular organ
4. The receptor for protein hormones are present on
 (1) Nucleus (2) Endoplasmic reticulum
 (3) Cytoplasm (4) Cell-surface
5. Hormones are :-
 (1) Internal secretion mostly discharged in the blood by endocrine glands
 (2) Secretion of exocrine glands
 (3) Chemical substances secreted into the gut
 (4) Inorganic catalysts
6. Hormones are :-
 (1) Produced in low amount
 (2) Easily diffusible
 (3) Non - antigenic
 (4) All
7. If receptor molecule is removed from target organ for hormone action, the target organ will :
 (1) Continue to respond but require higher concentration of hormone.
 (2) Continue to respond but in opposite way.
 (3) Continue to respond without any difference.
 (4) Not respond to hormone.
8. Pituitary gland does not control the secretory activity of :-
 (1) Thyroid (2) Adrenal cortex
 (3) Adrenal medulla (4) Testes
9. Which of the following controls spermatogenesis:-
 (1) FSH (2) LTH
 (3) LH (4) Vasopressin

10. Neurohypophysis releases :-
 (1) Vasopressin
 (2) Oxytocin
 (3) Oxytocin & prolactin
 (4) Vasopressin & oxytocin
11. Growth hormone is produced in :-
 (1) Adrenals (2) Thyroid
 (3) Pituitary (4) Thymus
12. Gonadotrophic hormone is produced by :-
 (1) Interstitial cells of testis
 (2) Adrenal cortex
 (3) Adenohypophysis
 (4) Posterior part of thyroid
13. The main function of prolactin hormone is to :-
 (1) Influence the activity of thyroid gland
 (2) Control development of graffian follicles
 (3) Initiate and maintain secretion of milk by mammary gland
 (4) Cause ejection of milk



Which of the following option in given table is correct identification of the structures labelled as A,B,C and D and their corresponding function in the above figure :-

(1)	(A)	Hypothalamus	Produces Prolactin hormone
(2)	(B)	Posterior pituitary	Release & FSH and LH
(3)	(C)	Portal circulation	Supply blood from hypothalamus to posterior pituitary
(4)	(D)	Posterior pituitary	Release oxytocin and vasopressin

- 15.** Vasopressin is related with :-
 (1) Concentration of urine
 (2) Quick digestion
 (3) Dilution of urine
 (4) Slow heart beat
- 16.** Oxytocin mainly helps in :-
 (1) Milk production (2) Child birth
 (3) Diuresis (4) Gametogenesis
- 17.** Stimulation of uterine contraction during child birth is brought about by :-
 (1) Adrenaline
 (2) Progesterone
 (3) Oxytocin
 (4) Prolactin
- 18.** FSH is produced by :
 (1) Adrenal cortex
 (2) Anterior lobe of pituitary gland
 (3) Middle lobe of pituitary gland
 (4) Posterior lobe of pituitary gland
- 19.** The basal metabolic rate (BMR) in body cells is regulated by :-
 (1) Parathyroid (2) Thyroid
 (3) Pituitary (4) Thymus
- 20.** Parathormone deficiency in man causes :-
 (1) Hyper calcemia (2) Hypocalcaemia
 (3) Goitre (4) All
- 21.** Cretinism is due to abnormal secretion of :-
 (1) Thyroid stimulating hormone
 (2) Thyroxine
 (3) Calcitonin
 (4) Parathormone
- 22.** The two lobes of thyroid gland are joined by a horizontal connection called :-
 (1) Inter thyroidal connective
 (2) Inter thyroidal commissure
 (3) Interme diary lobe
 (4) Isthmus
- 23.** Retention of sodium in body depends up on hormone from :-
 (1) Adrenal cortex
 (2) Adrenal medulla
 (3) Parathyroid
 (4) Thyroid
- 24.** Adrenal cortex also controls the carbohydrate metabolism through :-
 (1) Adrenaline (2) Noradrenaline
 (3) Glucocorticoids (4) Mineralo Corticoids
- 25.** Norepinephrin hormone is secreted from :-
 (1) Zona glomerulosa
 (2) Zonan fasciculata
 (3) Zona reticularis
 (4) Medulla of adrenal
- 26.** Which gland is concerned with salt equilibrium in body :-
 (1) Anterior pituitary (2) Pancreas
 (3) Adrenal (4) Thyroid
- 27.** Largest amount of iodine is found in :-
 (1) Adrenals (2) Liver
 (3) Thyroid (4) Testes
- 28.** Which gland prepares you for flight, fear and fight during adverse conditions :-
 (1) Thyroid (2) Parathyroid
 (3) Pituitary (4) Adrenals
- 29.** Temperature of body is controlled by which endocrine gland:-
 (1) Pituitary (2) Thyroid
 (3) Adrenal (4) Pancreas
- 30.** Corticosteroids are secreted by :
 (1) Adrenal gland (2) Pineal gland
 (3) Pituitary gland (4) Thyroid gland
- 31.** Aldosterone is secreted by :
 (1) Zona glomerulosa
 (2) Zona fasciculata
 (3) Zona reticularis
 (4) Zona pellucida
- 32.** Increase glucose level in human is called :
 (1) hypoglycemia
 (2) hyperglycaemia
 (3) hyposuria
 (4) hypersuria
- 33.** Parathormone is secreted during :
 (1) increased blood calcium level
 (2) decreased blood calcium level
 (3) increased blood sugar level
 (4) decreased blood sugar level

- 34.** ACTH is secreted by:
 (1) thyroid gland
 (2) thymus gland
 (3) pituitary gland
 (4) Islets of Langerhans
- 35.** Role of thymus in homosapiens is chiefly concerned with :-
 (1) Reproduction (2) Immunology
 (3) Calcium balance (4) Blood coagulation
- 36.** Melatonin is a hormone produced by :-
 (1) Adrenal gland (2) Pituitary gland
 (3) Pineal gland (4) Thymus gland
- 37.** Thymosin stimulates :-
 (1) Milk secretion (2) Erythrocytes
 (3) T-lymphocytes (4) Melanocytes
- 38.** A hormone with seat of activity in liver-changing glucose into glycogen is produced by :-
 (1) Pituitary (2) Thymus
 (3) Parathyroid (4) Pancreas
- 39.** Which gland is both exocrine as well as endocrine ?
 (1) Pituitary (2) Mammary gland
 (3) Thyroid (4) Pancreas
- 40.** Glucagon is secreted by :-
 (1) β (beta) cells of islets of langerhans
 (2) α (alphs) cells of islets of langerhans
 (3) β cells of pancreas
 (4) Adrenal cortex
- 41.** Which of the following is not function of insulin ?
 (1) Increase glycogenesis
 (2) Increase glycogenolysis
 (3) Increase up take of amino acid by liver and muscle
 (4) Promote oxidation of glucose
- 42.** Injection of Insulin to human leads to increased :-
 (1) Glucose level of blood
 (2) Glucose level of wine
 (3) Glucose level of cells
 (4) None of these
- 43.** Which hormone has anti insulin effect :-
 (1) Cortisol (2) Oxytocin
 (3) Aldosterone (4) Glucagon
- 44.** In old age, immune system becomes weak due to gradually degeneration of :-
 (1) Pineal gland
 (2) Parathyroid gland
 (3) Thymus gland
 (4) Adrenal gland
- 45.** Insulin is produced from :
 (1) α -cells (2) β -cells
 (3) Adrenal cortex (4) testes
- 46.** Insulin is related with :
 (1) Diabetes (2) Migrain
 (3) Jaundice (4) All of the above
- 47.** Estrogen is secreted by :-
 (1) Liver (2) Spleen
 (3) Ovaries (4) Pituitary
- 48.** Androgens are secreted by :-
 (1) Pituitary (2) Testes
 (3) Ovaries (4) Thyroid
- 49.** Progesterone hormone is secreted from :-
 (1) Placenta (2) Corpus luteum
 (3) Both 1 and 2 (4) None of these
- 50.** The "erythropoietin" hormone regulates :-
 (1) Blood pressure
 (2) Water level of blood
 (3) Glucose level of blood
 (4) Rate of formation of red blood cells
- 51.** Which of the following hormone is not secreted by gastro-intestinal tract ?
 (1) Gastrin (2) Secretin
 (3) Cholecystokinin (4) Erythropoetin
- 52.** Atrial wall of the heart muscle secretes a peptide hormone to reduce the blood pressure is:
 (1) Cholecystokinin
 (2) Erythropoetin
 (3) Atrial natriuretic factor
 (4) Epinephrine
- 53.** Secretin stimulates the activity of :-
 (1) Liver
 (2) Gastric gland
 (3) Pancreas
 (4) Gall-bladder

54. Hormone which is responsible for maintainance of pregnancy is :
- (1) Estrogen (2) Aldosteron
(3) Progesterone (4) Testosteron

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	4	1	4	1	4	4	3	1	4	3	3	3	4	1
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	2	3	2	2	2	2	4	1	3	4	3	3	4	2	1
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	2	2	3	2	3	3	4	4	2	2	3	4	3	2
Que.	46	47	48	49	50	51	52	53	54						
Ans.	1	3	2	3	4	4	3	3	3						

REPRODUCTION IN ORGANISMS

Life Span

The period from birth to the natural death of an organism is called its **life span**. Life span of organisms are not necessarily correlated with their size. The size of crows and parrots are not very different yet their life span [Crow (15 yr.), Parrot (140 yr.)] show a wide difference.

Reproduction

- Reproduction is a biological process in which an organism produces offspring similar to maintain continuity of its species, generation after generation.
- Reproduction leads to growth of population and increases the number of species.
- Major types of reproduction
 - Based on whether there is participation of one organism or two, reproduction is of two types asexual and sexual.

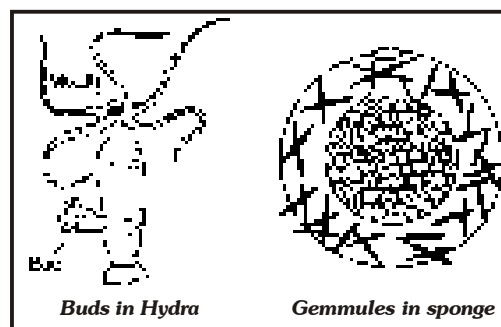
Asexual Reproduction

- **Definition** : When the offspring is produced by a single parent with or without the involvement of gamete formation, the reproduction is called asexual.
- **Occurrence** : Asexual reproduction is common in single celled organisms such as protozoans (e.g., *Amoeba*, *Paramecium*, *Euglena*), Sponges (e.g., *Sycon*), Coelenterates (e.g., *Hydra*), Flat worms (e.g., *Planaria*), Annelids (e.g., *Syllis*) etc.
- **Characteristics of Asexual Reproduction** : These are as follows :
 - (i) A single parent is involved (uniparental condition).
 - (ii) Gametes may or may not formed.
 - (iii) No fertilization.
 - (iv) There is usually mitotic cell division.
 - (v) Offsprings are genetically identical to the parent and called clones.
 - (vi) Multiplication occurs rapidly.
- **Types** : Asexual reproduction occurs in various ways :
 - (i) **Binary Fission** : In this process, the parent organism divides into two equal halves, each half forming an independent daughter organism. Binary fission involves mitosis. The resultant offsprings are genetically identical to the parent and each other. Examples : *Amoeba*, *Euglena*, *Paramecium*, *Planaria*, *Ceratium* etc.
 - (ii) **Multiple Fission** : In this process, the parent body divides into many daughter organisms. Examples : *Amoeba*, *Plasmodium*, *Monocystis* (all protozoans).
 - (iii) **Plasmotomy** : In this process, the multinucleate parent divides into many multinucleate individuals. Examples : *Opalina* and *Pelomyxa* (Protozoans).

- (iv) **Budding** : In this process, a daughter organism is formed from a small projection, the bud, arising from the parent body. It is of two types :

External Budding : In this type of budding, an outgrowth or bud grows externally on the surface of the body. The bud may split away from the parent and take up an independent existence. Example : (e.g., *Spongilla*) and a few marine sponges buds are formed within the parent's body. They are called **gemmules** (internal buds).

- (v) **Fragmentation** : In this process, the body of the parent breaks into pieces and then each piece develops into a whole organism. Example : It is common among certain flatworms, sponges and coelenterates.



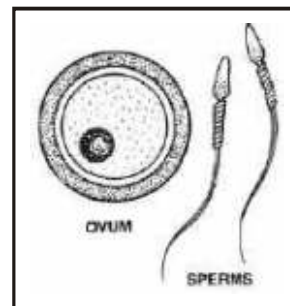
- **Significance of Asexual Reproduction** : Since there is no variation, it does not contribute to evolution of species. However, it involves rapid multiplication of the species.

Sexual Reproduction

- When an offspring is produced by two parents, (male and female), with the formation of gametes, it is known as sexual reproduction. It involves four processes :
 - Formation of haploid cells, the gametes, by gametogenesis (meiosis),
 - Fusion of two gametes leads to formation of diploid cells, the zygotes (fertilization),
 - Repeated mitotic divisions of the zygotes to form embryos (embryogenesis),
 - Growth of embryos into new individuals (development).
- **During sexual reproduction** : The offspring produced are not identical to their parents or fellows because there is fusion of male and female gametes.
- **Phases in Life** : There are three phases in an organism's life : juvenile phase, reproductive phase and senescent phase.
 - Juvenile phase/Vegetative phase** : All organisms have to reach a certain stage of growth and maturity in their life before they can reproduce sexually, that period of growth is called the juvenile phase. This phase is known as vegetative phase in plants. This phase is of different durations in different organisms.
 - Reproductive phase** : Starts after the juvenile phase and remains upto the stage when an organism is capable of reproduction. This phase is of variable duration in different organisms. Among animals, birds living in nature lays eggs seasonally while birds in poultry farms lay eggs throughout the year. In primates (monkeys, apes and humans) cyclic changes during the reproductive the year. In primates (monkeys, apes and humans) cyclical changes during the reproductive phase is called the menstrual cycle, whereas in non-primate mammals like cows, sheep, rate, deer, dogs, tiger, etc. such cyclical changes during reproduction are called oestrous cycle.
 - Senescent phase** is the last phase of the life span, which marks the end of the reproductive phase and the onset of the progressive deterioration in the body, ultimately leads to the death of the organism.
- Many mammals, especially those living in wild areas, exhibit oestrous/menstrual cycle only during favourable conditions in their reproductive life. Such animals are known as seasonal breeders. Many animals are reproductively active throughout their reproductive life and are known as continuous breeders.
- **Event in Sexual Reproduction** : These event may be grouped into three stages : Pre-fertilization, Fertilization and Post-fertilization events.

(1) Pre-fertilization Events :

- These events of sexual reproduction occur prior to the fusion (fertilization) of the male and female gametes. These events are **gametogenesis and gamete transfer**.
- **Gametogenesis :**
 - (i) It is the process of formation of two type of gametes—male and female. Gametes are haploid cells.
 - (ii) **Sexuality in Organisms :** In sexual reproduction cross fertilization or exogamy (fusion of gametes from two different individuals) occurs. Self fertilization is observed in *Taenia* (tapeworm). Self fertilization or endogamy (fusing gametes from the same individual) is common in plants.
 - (iii) Animals such as earthworm, sponge, tapeworm and leech are bisexual (hermaphrodites) and cockroach, frog, lizards, birds and mammals are unisexual.
- **Gamete Transfer :**
 - (i) After the formation of male and female gametes, they must be brought together for fertilization. In most of organisms male gamete is motile and the female gamete is nonmotile.
 - (ii) Unisexual animals have copulatory organs to transfer the male gametes. Transfer and coming together of gametes is essential for fertilization in sexual reproduction.

**(2) Fertilization :**

- Fertilization is the complete and permanent fusion of two gametes from different parents or from the same parent to form a diploid zygote. The process is also called syngamy.
- Syngamy occurs either in external medium (water) or inside the body of the organism. There are two types of gametic fusion; external syngamy or external fertilization and internal syngamy or internal fertilization.
 - (i) **External Syngamy :** When syngamy occurs outside the body of the organism, it is called external fertilization or external syngamy. An external medium such as water is required for this type of fertilization. In most aquatic organisms such as a majority of algae, fishes, and amphibians, external fertilization occurs. A major, disadvantage of this type of fertilization is that the offsprings are not protected from predators and their survival is threatened upto adulthood.
 - (ii) **Internal Syngamy :** When egg is formed inside the female body, where it fuses with the male gamete, it is called internal fertilization or internal syngamy. Higher animals such as reptiles, birds and mammals, internal fertilization occurs. The number of sperms produced is very large but there is a reduction in the number of eggs produced.

(3) Post Fertilization Events :

- The events in sexual reproduction that occur after fertilization (formation of zygote) are called post-fertilization events. These events may be described under two headings : zygote formation and embryogenesis.
 - (i) **Zygote formation :** After fertilization a diploid zygote is formed in all sexually reproducing organisms. In external fertilization, zygote is formed in the external medium (usually water) whereas in internal fertilization, it is formed inside the body of the organism. Further development of the zygote depends on the type of life cycle of the organism and its environmental conditions.

- (ii) **Embryogenesis** : The process of development of an **embryo** from a zygote is called **embryogenesis**. During embryogenesis the zygote undergoes **mitotic cell division** and **cell differentiation**. The cell division increases the number of cells while cell differentiation helps information of specialized cells and organs.

Significance of Sexual Reproduction

Since there are variations in sexual reproduction, it contributes to evolution of the species.

Parthenogenesis (Virgin Birth or virginal Reproduction)

- Development of an egg (ovum) into a complete individual without fertilization by a sperm is known as **parthenogenesis**.
- **Occurrence** : Parthenogenesis occurs in many invertebrates such as Rotifers (wheel animals), Arthropods, viz., Crustaceans (e.g., *Apus*, *Cypris*, *Daphnia*), insects (e.g., bees, wasps, beetles, ants, aphids, grasshoppers, weevils, gall flies) and Arachnids (e.g., spiders, ticks, mites.).
- Parthenogenesis is of two types : **natural** and **artificial**.
 - (I) **Natural Parthenogenesis** : It occurs regularly in the life cycle of certain animals. It may be complete, incomplete or paedogenetic.
 - (i) **Complete (Obligatory) Parthenogenesis** : It occurs in those animals which breed exclusively by parthenogenesis. there are no males and, therefore, such individuals are represented by females only. Example : *Lacerta saxicola armaniaca* (Caucassian rock Lizard).
 - (ii) **Incomplete (Cyclic) Parthenogenesis** : It is found in those animals in which both sexual reproduction and parthenogenesis occur. Example : In honey bees, fertilized eggs (zygotes) give rise to queens and workers (both are females) and unfertilized eggs (ova) develop into drones (males).
 - (iii) **Paedogenetic Parthenogenesis (Paedogenesis)**. When a larva produces a new generation of larvae by parthenogenesis, it is called paedogenetic parthenogenesis or paedogenesis. Example : Sporocysts (larvae) and radiae (larvae) of liver fluke.
 - (II) **Artificial Parthenogenesis** : In this type of parthenogenesis, the egg (ovum) is induced to develop into a complete individual by artificial stimuli. Artificial parthenogenesis may be induced by physical or chemical stimuli. Example : Eggs (ova) of annelids, molluscs, echinoderms (sea urchin, star fish), frogs, salamanders, birds (turkey) and even mammals (rabbit) may be induced by physical or chemical stimuli to develop parthenogenetically into complete individuals.

Significance of Parthenogenesis

(a) Advantages

- (i) It is a simpler and easier means of reproduction.
- (ii) It represents a method of rapid multiplication.
- (iii) It permits establishment of triploid and aneuploid chromosomal combination.
- (iv) It is a means of sex determination of animals such as in honey bees. Thus, it supports the chromosomal theory of sex determination.

(b) Disadvantages

- (i) It eliminates variation in population. So it does not play any role in organic evolution.

EXERCISE

1. The continuity of life is maintained by the process of
 (1) Respiration (2) Reproduction
 (3) Photosynthesis (4) Adaptation
2. The offspring produced through which of the following process are not exactly similar to their parents ?
 (1) Asexual reproduction (2) Sexual reproduction
 (3) Parthenogenesis (4) Ameiotic thelytoky
3. External fertilisation occurs in
 (1) Mammals (2) Birds
 (3) Reptiles (4) Bony fishes
4. The process refers to development of embryo is known as
 (1) Gametogenesis (2) Embryogenesis
 (3) Parthenogenesis (4) Oogenesis
5. Which of the following event is post fertilisation event?
 (1) Gametogenesis
 (2) Gamete transfer
 (3) Fertilisation
 (4) Embryogenesis
6. Match the column-A with column-B

Column-A	Column-B
(i) Budding	(a) Cockroach
(ii) Binary fission	(b) Hydra
(iii) Gemmule	(c) Amoeba
(iv) Gamete formation	(d) Sponge

(1) (i)-b, (ii)-c, (iii)-a, (iv)-d
 (2) (i)-b, (ii)-c, (iii)-d, (iv)-a
 (3) (i)-d, (ii)-a, (iii)-c, (iv)-b
 (4) (i)-d, (ii)-b, (iii)-c, (iv)-a
7. Which of the following statement incorrect ?
 (1) Asexual reproduction is a rapid mode of reproduction.
 (2) Embryogenesis involves cell division and cell differentiation.
 (3) The life spans of organisms correlated with their sizes.
 (4) Animals are either unisexual or bisexual.
8. Read the following four statements (A-D) :
 (A) In asexual reproduction, offspring produced with or without involvement of gametes
 (B) In asexual reproduction, clones are formed
 (C) Asexual reproduction is very common in single celled organisms
 (D) Budding in Hydra is a mode of sexual reproduction
 How many of the above statements are correct
 (1) Four (2) Three
 (3) Two (4) One

ANSWER KEY

Que.	1	2	3	4	5	6	7	8
Ans.	2	2	4	2	4	2	3	2

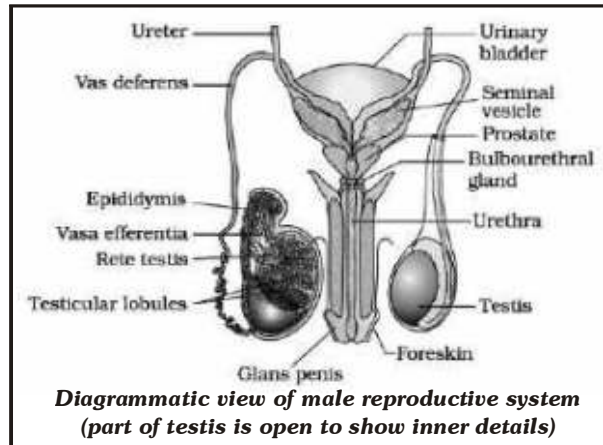
HUMAN REPRODUCTION

INTRODUCTION

Reproductive events in human :

- | | | |
|--------------------------------------------|-------------------------|-----------------------------|
| (i) Gametogenesis | (ii) Insemination | (iii) Fertilisation |
| (iv) Blastocyst formation and implantation | (v) Gestation/Pregnancy | (vi) Parturition / Delivery |

MALE REPRODUCTIVE SYSTEM (Situated in the Pelvis)



Primary Sex Organs (Gametes formation)

Testes

- (A) Paired, extra-abdominal, in scrotum (necessary temperature for spermatogenesis. Which is 2-3°C lesser than body)
- (B) 4-5 cm × 2-3 cm
- (C) Each with 250 lobules
Each lobule with 1-3 seminiferous tubules
Each tubule with
- Spermatogonia - male germ cells
 - Sertoli cells - nutrition to sperms
- (D) Between seminiferous tubules are interstitial cells (Leydig cells) for androgens.

Ovaries

- (A) Paired, endocrine gland, 2-4 cm long
- (B) Connected to surroundings by ligaments
- Epithelium
 - Stroma
 - Cortex
 - Medulla

Secondary Sex Organs

Accessory duct

- (A) Seminiferous tubules → Rete testes → Vasa efferentia (leave testes) → Epididymis → Vas deferens (Enters abdomen)

Urethral meatus ← Urethra ← Ejaculatory duct ← Seminal vesicle duct (with vas deferens)

- (B) Important → Storage and transport of sperms.

Penis

(A) Erectile tissue with enlarged glans penis and movable foreskin.

Accessory glands

(A) Seminal vesicles → 2

(B) Prostate → 1

(C) Bulbo urethral/cowper's → 2

Secretion → Fructose, Calcium, Enzymes

FEMALE REPRODUCTIVE SYSTEM

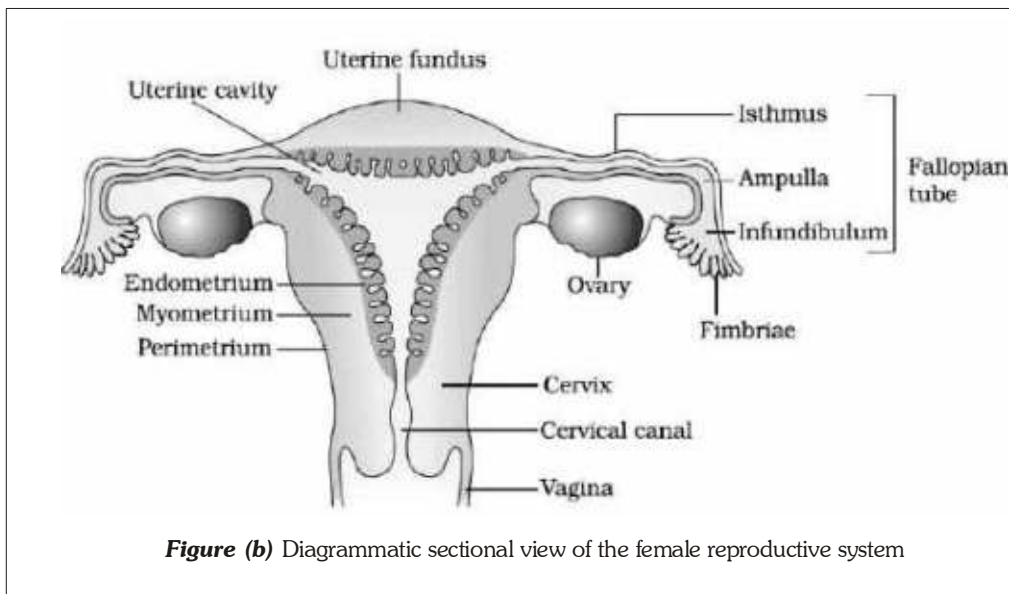


Figure (b) Diagrammatic sectional view of the female reproductive system

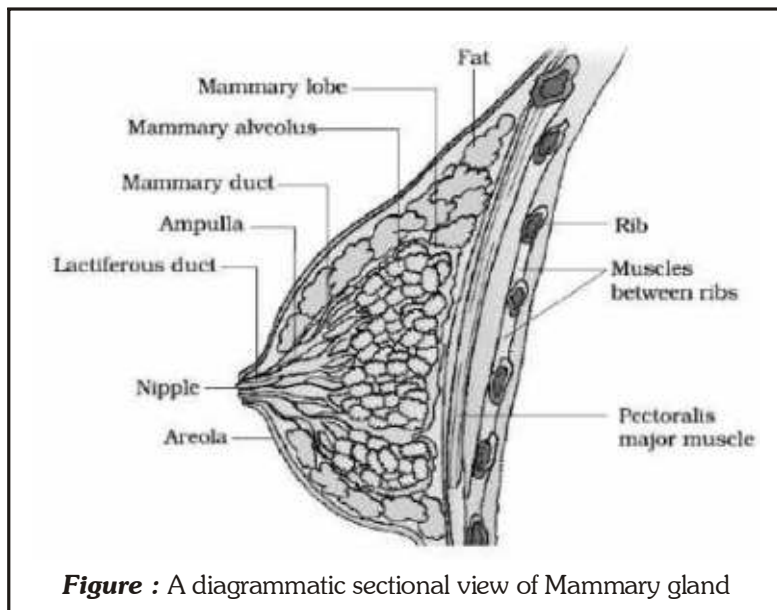


Figure : A diagrammatic sectional view of Mammary gland

Fallopian tubes (Oviducts 10-12 cms)

(A) Infundibulum with fimbriae

(B) Ampulla - wider

(C) Isthmus - narrow joins uterus

Uterus / Womb

- (A) Inverted pear with narrow cervix
 (B) Attached by ligament
 (C) Wall
- Perimetrium – Thin
 - Myometrium – Thick muscular
 - Endometrium
 - Glandular
 - Cyclic changes in menstrual cycle

External Genitalia

- (A) Mons pubis – fat cushion with hairs
 (B) Labia minora – surround vaginal orifice
 (C) Labia majora – surround labia minora
 (D) Clitoris – Erectile at upper junction of labia minora
 (E) Hymen
 - Partially covers vaginal orifice.
 - Presence/absence not a reliable indicator of virginity/sexual experience
- (F) Birth canal → Vagina and Cervix

Paired functional mammary gland

- (A) Variable fat
 (B) Glandular tissue
 15 – 20 lobes with alveoli → Mammary tubules → Ducts → Ampulla → Lactiferous duct → Outside

GAMETOGENESIS**Comparative study**

- (A) Beginning
 Spermatogenesis – Puberty (↑ GnRH)
 Oogenesis – I.U. life
- (B) **Steps**

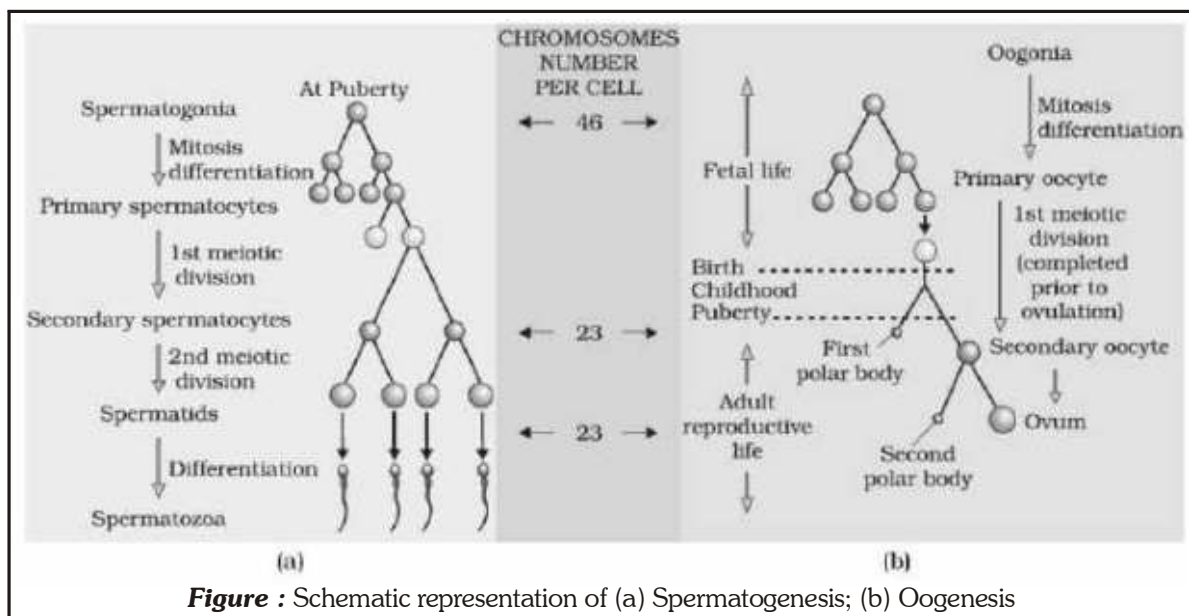
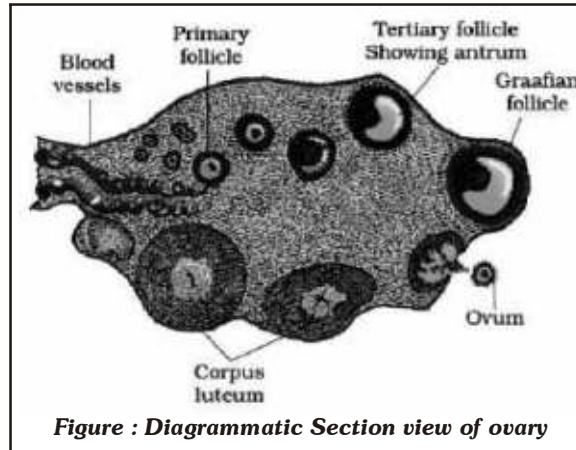


Figure : Schematic representation of (a) Spermatogenesis; (b) Oogenesis

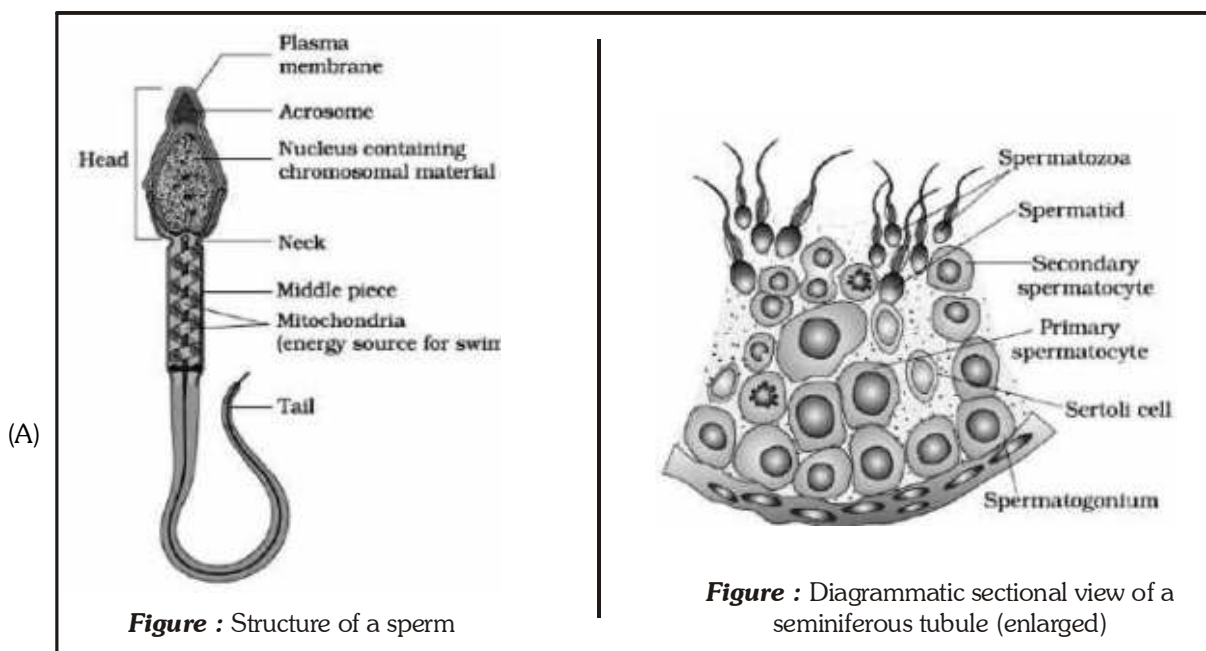
- (C) Number of gametes formed at the end
 Spermatogenesis – 4
 Oogenesis – 1
- (D) Number of gamete mother cells
 Spermatogenesis – new spermatozoa after birth
 Oogenesis – no new oogonia formed after birth

General Concept / Facts



- (A) Spermatids to sperms, this process is – Spermiogenesis
- (B) Sperms released from seminiferous tubules – Spermiation
- (C) LH stimulates leydig cells for – Androgens
- (D) FSH stimulates sertoli cell
- (E) At puberty each ovary has – 60,000 -80,000 primary follicles
- (F) Primary follicle → Sec. follicle → Tertiary follicle (antrum)
 - ↓
 - Corpus albicans ← Corpus luteum ← Graafian follicle (matured)
 - (if no fertilisation)
- (G) Developing follicle secretes – Estrogen
- (H) Corpus luteum secretes – Progesterone (mainly) and some estrogen.
- (I) Inhibin–Hormone secreted by sertoli cells of testis and by granulosa cells of ovary. Which give (-)ve feedback on anterior pitatary for FSH mainly.

Structure of Human Sperm

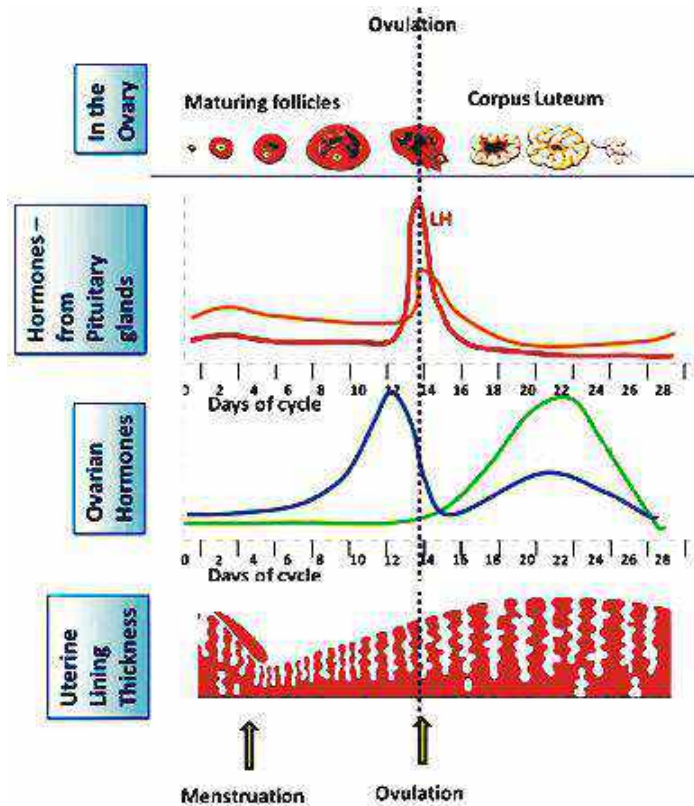


- (B) For normal fertility – 60% (out of 200 – 300 millions) sperms should have normal shape and size and at least 40% of them should show vigorous motility.

- (C) Acrosome (modification of golgi body) releases some enzyme which help in penetration of egg membranes for fertilization.

MENSTRUAL CYCLE

Events of Cycle (Average duration 28/29 days)



General Points Regarding Cycle

- (A) Ist menstruation at puberty – Menarche
 (B) Menstruation absence in
 – Pregnancy
 – Stress, Poor health
 (C) For ovulation – LH surge (about 14th day) is mandatory
 (D) Endometrial thickening by – Estrogen
 (E) Endometrial maintained – Progesterone
 (F) Cessation of cycle at around age of 50 years – menopause.
 (G) Average Blood loss during each M.C. is 40–80 ml.
 (H) After attaining menopause there is constant high level of Gonadotrophins. (FSH and LH)
 (I) Menstruation (shedding of uterine lining) occurs due to progesterone withdrawal.
 (J) M.C. = Ovarian cycle + Uterine cycle
 Ovarian cycle – By FSH and LH
 Uterine cycle – By estrogen and progesterone.

FERTILISATION AND IMPLANTATION

General points

- (A) At ovulation, secondary oocyte covered by → Zona pellucida and corona radiata.
 (B) Fertilization at → Ampulla, only if gametes reach there at same time.
 (C) XX is female and XY is male child.
 (D) Implantation of embryo other than usual site (uterus) is known as ectopic pregnancy.
 (E) Sperms are kept inactive in male body. But these become fully active in vagina (capacitation)

Events

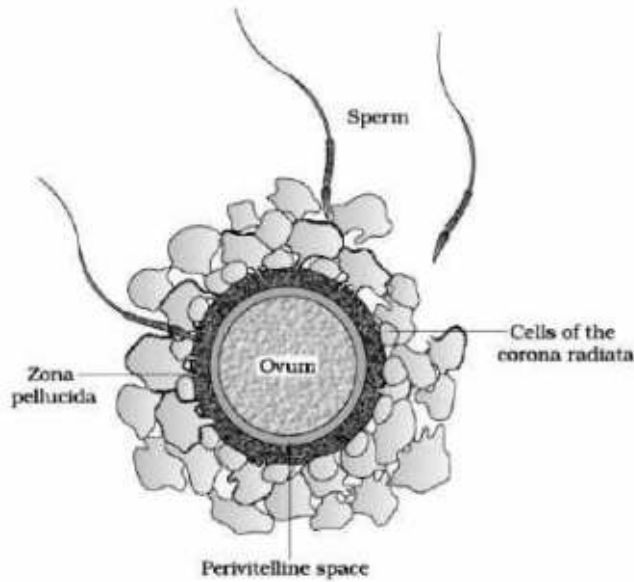
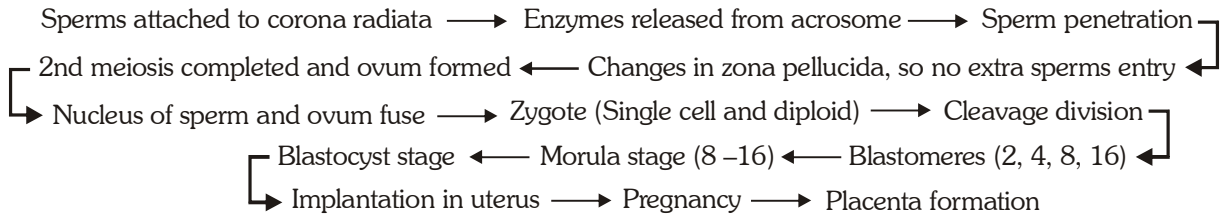


Figure : Ovum surrounded by few sperms

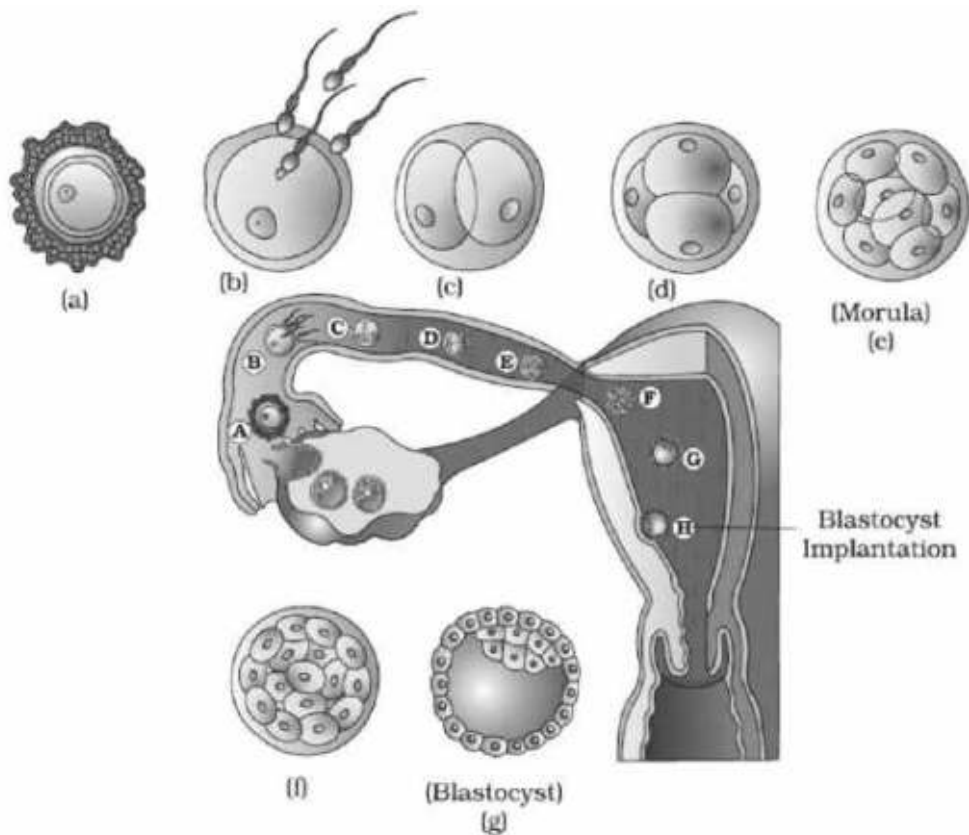


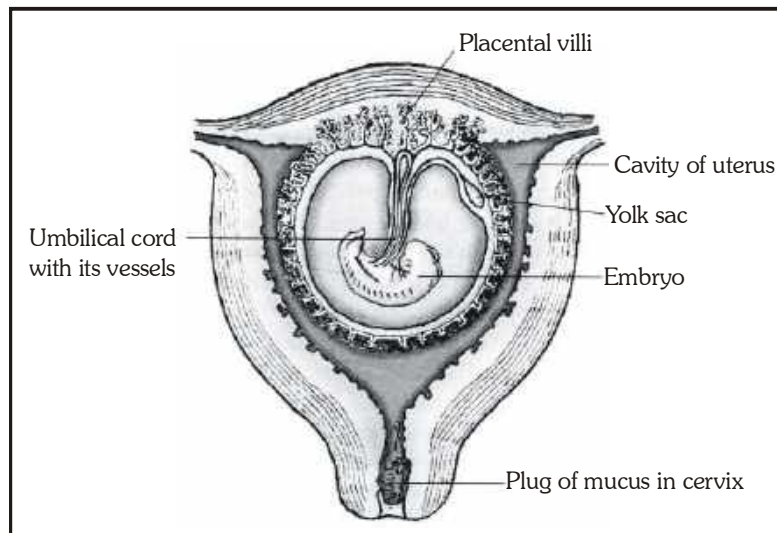
Figure : Transport of ovum, fertilisation and passage of growing embryo through fallopian tube

PREGNANCY AND EMBRYONIC DEVELOPMENT

General Points

- (A) Placenta
- Chorionic villi + maternal tissue
 - Gaseous exchange and excretion
 - Connects to embryo by umbilical cord
 - Endocrine gland – hCG, hPL, Estrogen, Progesterone
 - During pregnancy corpus luteum is maintained by HCG.
- (B) Hormones exclusive in pregnancy – hCG, hPL, Relaxin
- (C) Events of embryonic development
- Heart formation – 1 month
 - Limbs and digits – 2 month
 - Major organ systems – 3 month
 - First foetal movements and hairs on head – 5 month
 - Fine hairs, eye - lid separation - 6 month

PARTURITION AND LACTATION

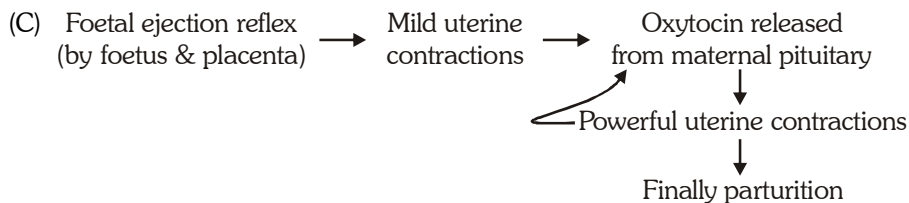


General Points

- (A) Period of pregnancy – Gestation period
- (B) Parturition is a – neuroendocrine mechanism
- (C) Milk production – by the help of prolactin after child birth.
- (D) First milk – Colostrum

Events

- (A) Period of pregnancy – Gestation period
- (B) Under the influence of cortisol of foetus, estrogen–Progesterone ratio is increased from placenta.



- (D) Prostaglandin are also formed in uterine wall during pregnancy.

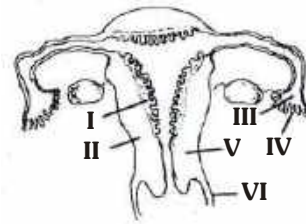
EXERCISE

1. Which one is a primary sex organ ?
(1) Scrotum (2) Penis
(3) Testis (4) Prostate gland
2. Secondary sex organ is
(1) Testis (2) Ovary
(3) Beard (4) Vas deferens
3. In mammals, the testes are located in
(1) Abdominal cavity
(2) Thoracic cavity
(3) Extra-abdominal cavity
(4) Pericardial cavity
4. Seminiferous tubules occur in the
(1) liver (2) kidney
(3) ovary (4) testis
5. Temperature of scrotum as compared to abdominal cavity is less by
(1) 1°C (2) 5°C
(3) 3°C (4) 10°C
6. Which is unpaired gland in male reproductive system of human ?
(1) Bartholin gland (2) Seminal vesicle
(3) Prostate gland (4) Cowper's gland
7. Spermatozoa are nourished during their development by
(1) Sertoli cells
(2) Interstitial cells
(3) Connective tissue cells
(4) None
8. Lower narrow end of uterus is called
(1) Urethra (2) Cervix
(3) Clitoris (4) Vulva
9. Endometrium is lining of
(1) Testis
(2) Urinary bladder
(3) Uterus
(4) Ureter
10. Clitoris is present at the upper junction of :-
(1) Labia majora
(2) Mons pubis
(3) Perineum
(4) Labia minora
11. Which piece of a sperm is called power house ?
(1) Head piece (2) Neck piece
(3) Middle piece (4) Tail piece
12. The acrosome plays a role in :-
(1) Fusion of nuclei of gametes
(2) Motility of sperm
(3) Penetration of sperm into ovum
(4) All of the above
13. Which part of the spermatid forms acrosome of sperm ?
(1) Mitochondria (2) Golgi body
(3) Nucleus (4) Lysosome
14. A mature sperm has
(1) A pair of flagella
(2) A nucleus, an acrosome and a centriole
(3) A nucleus, an acrosome, a pair of centrioles
(4) A nucleus, an acrosome, a pair of centrioles and a tail.
15. Graafian follicle are found in
(1) Testis of mammal
(2) Ovary of frog
(3) Ovary of cockroach
(4) Ovary of mammals
16. Graafian follicle contains
(1) Many oocytes
(2) Many sperms
(3) A single oocyte
(4) Site for egg fertilisation
17. In mammals, corpus luteum is found in which organ
(1) Brain (2) Ovary
(3) Liver (4) Eyes
18. Antrum is filled with fluid and is found in
(1) Bone-marrow of bone
(2) Cavity of brain
(3) Graafian follicle of ovary
(4) Pericardium of heart
19. Corpus luteum is
(1) Excretory (2) Endocrine
(3) Digestive (4) Reproductive
20. Ovulation hormone is :
(1) FSH (2) ICSH
(3) LH (4) Testosterone
21. Progesterone level falls leading to
(1) Gestation
(2) Menopause
(3) Lactation
(4) Menstruation

- 22.** In uterus, endometrium, proliferates in response to
 (1) Relaxin (2) Oxytocin
 (3) Progesterone (4) Oestrogen
- 23.** Polyspermy is normally prevented by
 (1) The fertilizin and antifertilizin reaction
 (2) Repulsion of excess number of sperm by ova
 (3) Inability of some sperm to penetrate ova
 (4) Formation of fertilization membrane
- 24.** Cell division in zygote is called -
 (1) Cleavage (2) Segmentation
 (3) Cellulation (4) All the above
- 25.** Cleavage start in
 (1) Fallopian tube (2) Uterus
 (3) Vagina (4) None
- 26.** Cells formed as a result of cleavage are called
 (1) Megameres (2) Micromeres
 (3) Blastoderm (4) Blastomeres
- 27.** Sugar fructose is present in the secretion of
 (1) Seminal vesicle (2) Perineal gland
 (3) Cowper's gland (4) Bartholin's gland
- 28.** Secretions from which one of the following are rich in fructose, calcium and some enzymes ?
 (1) Salivary glands
 (2) Female accessory glands
 (3) Male accessory glands
 (4) Liver
- 29.** Testes descent into scrotum in mammals for
 (1) Spermatogenesis
 (2) Fertilization
 (3) Development of sex organs
 (4) Development of visceral organs.
- 30.** During spermatogenesis how many spermatozoa are formed from a single primary spermatocyte
 (1) 1 (2) 2 (3) 4 (4) 8
- 31.** Pregnancy hormone is :-
 (1) Estrogen (2) Progesterone
 (3) LH (4) FSH
- 32.** During pregnancy, the urine of female would contain
 (1) LH (2) Progesterone
 (3) FSH (4) HCG
- 33.** Site of fertilization in mammal is
 (1) ovary (2) uterus
 (3) vagina (4) fallopian tube
- 34.** Solid ball of cell produced by repeated cleavage is called
 (1) Gastrula (2) Blastula
 (3) Morula (4) Neurula
- 35.** Placenta is the region where
 (1) Foetus is attached to mother by spermatic cord
 (2) Foetus is provided with mother's blood
 (3) Foetus receives nourishment from mother's blood
 (4) foetus is covered by membranes.
- 36.** The expulsion of completely developed foetus from the uterus is known as
 (1) ovulation (2) oviposition
 (3) gestation (4) parturition
- 37.** Parturition canal in female is called :
 (1) Uterus (2) Oviduct
 (3) Vagina (4) Urethra
- 38.** In parturition process, which of the following does not happen?
 (1) Oxytocin hormone is secreted by posterior pituitary
 (2) Relaxin hormone responsible for narrowing of pelvic cavity
 (3) Progesterone hormone secretion is stopped
 (4) General position of foetus is occipitoanterior.
- 39.** Foetal ejection reflex in human female is induced by :-
 (1) Differentiation of mammary glands
 (2) Pressure exerted by amniotic fluid
 (3) Release of oxytocin from pituitary
 (4) Fully developed foetus and placenta
- 40.** Oxytocin is mainly help in :-
 (1) Milk production
 (2) Child birth
 (3) Urine formation
 (4) Gametogenesis
- 41.** The *correct* sequence of spermatogenetic stages leading to the formation of sperms in a mature human testis is :-
 (1) Spermatogonia – Spermatid – Spermatocyte – Sperms
 (2) Spermatocyte – Spermatogonia – Spermatid – Sperms
 (3) Spermatogonia – Spermatocyte – Spermatid – Sperms
 (4) Spermatid – Spermatocyte – Spermatogonia – Sperms

- 42.** The part of Fallopian tube closest to the ovary is:
 (1) Ampulla (2) Isthmus
 (3) Infundibulum (4) Cervix
- 43.** The signals for parturition originate from :
 (1) Fully developed foetus only
 (2) Placenta only
 (3) Placenta as well as fully developed foetus
 (4) Oxytocin released from maternal pituitary
- 44.** The second maturation division of the mammalian ovum occurs :
 (1) In the Graafian follicle following the first maturation division
 (2) Shortly after ovulation before the ovum makes entry into the Fallopian tube
 (3) Until after the ovum has been penetrated by a sperm
 (4) Until the nucleus of the sperm has fused with that of the ovum
- 45.** If for some reason, the vasa efferentia in the human reproductive system get blocked, the gametes will not be transported from :-
 (1) Testes to epididymis
 (2) Epididymis to vas deferens
 (3) Ovary to uterus
 (4) Vagina to uterus
- 46.** The testes in humans are situated outside the abdominal cavity inside a pouch called scrotum. The purpose served is for :-
 (1) Maintaining the scrotal temperature lower than the internal body temperature
 (2) Escaping any possible compression by the visceral organs.
 (3) Providing more space for the growth of epididymis
 (4) Providing a secondary sexual feature for exhibiting the male sex.

- 47.** The figure given below depicts a diagrammatic sectional view of the female reproductive system of humans. Which one set of three parts out of I-VI have been correctly identified ?



- (1) (I) Endometrium, (II) Infundibulum, (IV) Fimbriae
 (2) (III) Infundibulum, (IV) Fimbriae, (V) Cervix
 (3) (IV) Oviducal funnel, (V) Uterus, (VI) Cervix
 (4) (I) Perimetrium, (II) Myometrium, (III) Fallopian tube
- 48.** In a normal pregnant woman, the amount of total gonadotropin activity was assessed. The result expected was :-
 (1) High levels of FSH and LH in uterus to stimulate endometrial thickening
 (2) High levels of circulating HCG to stimulate estrogen and progesterone synthesis
 (3) High level of circulating FSH and LH in the uterus to stimulate implantation of the embryo
 (4) High level of circulating HCG to stimulate endometrial thickening
- 49.** Several hormones like hCG, hPL, estrogen, progesterone are produced by :-
 (1) Fallopian tube (2) Pituitary
 (3) Ovary (4) Placenta
- 50.** Pregnancy test is done by presence of :-
 (1) hCG (2) hPL
 (3) Progesterone (4) LH

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	4	3	4	3	3	1	2	3	4	3	3	2	4	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	2	3	2	3	4	4	4	4	1	4	1	3	1	3
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	2	4	4	3	3	4	3	2	4	2	3	3	3	3	1
Que.	46	47	48	49	50										
Ans.	1	2	2	4	1										

REPRODUCTIVE HEALTH

Family planning refers to practices that help individual to attain certain objectives

- (i) To avoid unwanted Births
- (ii) To Bring about wanted birth
- (iii) To regulate the interval between pregnancies
- (iv) To determine the number of children in family

India is first country in world to initiate family planning programme in 1951. In 1977 it changed into family welfare programme "To improve the quality of life of people." "Reproduction and child health care (RCH) programmes"

Small family norm

- 1970 slogan was – “Do ya Teen Bas”
- 1980 slogan was – “Sons or Daughter - Two will do”
- “Second after 3 years”

CONTRACEPTIVE METHOD :

Method which prevent unwanted birth or pregnancies are called contraceptive methods. (two types)

- (1) Temporary method or spacing method
- (2) Terminal method

An ideal contraceptive should be user-friendly, easily available, effective and reversible with no or least side-effects. It also should in no way interfere with the sexual drive, desire and/or the sexual act of the user. A wide range of contraceptive methods are presently available which could be broadly grouped into the following categories, namely Natural/Traditional, Barrier, IUDs, Oral contraceptives, Injectables, Implants and Surgical methods.

(1) Temporary or Spacing Methods : Are of following types –

(i) Chemical Method :

In this method chemicals are used which are **spermicidal agent** or surface active agents which attach themselves to spermatozoa and **inhibit O₂ uptake** and kill sperm. Failure rate is approximately 30%.

Example :

- Vaginal Foam/tablets = 'Today'
- Cream or Jelly = “Nim - 76”

(Defence Institute of Physiology Allied Science Manufactured it)

These medicines are composed of chemicals like **ZnSO₄**, **KMnO₄**, **Boric acid**, **Lactic acid**, **Citric acid**. These chemicals completely destroy sperms so they are called as **spermicides**.

(ii) Barrier method : Ovum and sperms are prevented from physically meeting with the help of barriers.

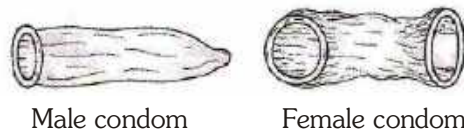
For Male :

- Condom -** Condoms are barriers made of thin rubber/ latex sheath that are used to cover the penis in the male or vagina and cervix in the female, just before coitus so that the ejaculated semen would not enter into the female reproductive tract. This can prevent conception. ‘Nirodh’ is a popular brand of condom for the male. Use of condoms has



Spermicide

increased in recent years due to its additional benefit of protecting the user from contracting STDs and AIDS. Both the male and the female condoms are disposable, can be self-inserted and thereby gives privacy to the user.



- Failure rate of male condoms = 10-14%
- Failure rate of female condom = 5-15%

Share
Rakshak]

For Female :

Diaphragms, cervical caps and vaults are also barriers made of rubber that are inserted into the female reproductive tract to cover the cervix during coitus. They prevent conception by blocking the entry of sperms through the cervix. They are reusable. Spermicidal creams, jellies and foams are usually used alongwith these barriers to increase their contraceptive efficiency.



Intra Uterine Devices (I.U.D.) : These devices are inserted by doctors or expert nurses in the uterus through vagina.

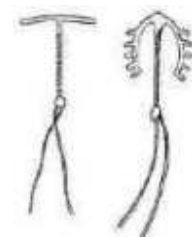
I.U.C.D. - Intra Uterine Contraceptive Devices :

1st IUCD was used by **Graffenberg**. It was a **Ag** made I.U.C.D. when it was put into the uterus, till it was there, the female wasn't pregnant.

Now **Cu** made IUCD are used.

IUDs are available as :-

- (i) Non-medicated IUDs : e.g. : Lippes loop
 - These devices are made of plastic or stainless steel only.
 - Lippes loop made of plastic (Polyethylene) impregnated with barium sulphate is still used in many part of world.
- (ii) Copper releasing IUDs : eg. : CuT, Cu7, Multiload 375
- (iii) Hormone releasing IUDs : eg. : Progestasert, LNG-20



CuT Multiload 375
Two IUCDS

Mechanism :

- Non-medicated IUDs, promote the phagocytic cells of uterus to phagocytosis of sperms within the uterus.
- Copper releasing IUDs, released Cu ions suppress sperm motility and the fertilizing capacity of sperms.

- The hormone releasing IUDs, make the uterus unsuitable for implantation and the cervix hostile to the sperms.
- IUDs are ideal contraceptives for the females who want to delay pregnancy and / or space children. It is one of most widely accepted methods of contraception in India.
- Failure rate of IUDs is approximately 1-3%

(iii) Hormonal Method :

This is the most effective method (almost 100% effective)

Most widely used contraceptive method. In this method oral pills, injections and implants are used.

Female oral pills are -

Mala-N, Mala-D - Daily oral pills

Failure rate = 0.1%

The daily oral pills are started preferably within the first five days of menstrual cycle.. For 1 to 21 days Hormonal pills are given and Iron or Fe pills are given in last 7 days for recovery of blood loss in menstruation flow and to maintain regularity of pills.



Hormone
implant
capsules

Hormone
injection

Composition of oral pill

(a) **Norethisterone acetate (Synthetic progesterone)**

- High concentration

(b) **Ethinyl estradiol (Synthetic Estrogen)**

- Low concentration



Oral contraceptive pills

Mechanism :

Action of oral pill is to **prevent the Ovulation** from ovary this is achieved by **blocking the pituitary secretion of gonadotropin (FSH and LH)** that is necessary for ovulation. Progesterone only preparations render the **cervical mucosa thick and scanty** this prevent / retard entry of sperms. So fertilization is absent.

Saheli - Weekly oral pills. Non-steroidal pill. (Developed by scientists at CDRI Lucknow)

- Few side effects and high contraceptive value.

- Failure rate = 1.83%

- Saheli chemical composition of centchroman is ormeloxifen. Ormeloxifen anti-estrogenic prevent implantation activity and cause contraception.

Injection - DMPA - (Depot - medroxy progesterone acetate) (Depot = slow release)

Implant - Norplant./Subcutaneous injection

In these Injections high level of progesterone Hormone is present which Inhibit secretion of gonadotropins so ovulation is absent.

Failure rate = 0-0.4%

Male Pill :

Gossypol - Made from cotton seeds. This pill **prevent spermatogenesis**. Now it has been banned because it causes permanent **azzospermia** (preventing spermatogenesis) **Progesterone hormone can be used in male oral pills.**

In July 2000 china made progesterone pills for male (first time in world).

Emergency contraceptive methods :-

Contraceptives methods which are used within 72 hours of unprotected sexual intercourse.

- (a) Emergency contraceptive pills - progesterone only pill.
eg. i-pill, unwanted-72 (LNG)
- (b) IUD-IUD can also be use as an emergency contraception.

Administration of progestogens or progestogen-estrogen combinations or IUDs within 72 hours of coitus have been found to be very effective as emergency contraceptives as they could be used to avoid possible pregnancy due to rape or casual unprotected intercourse.

(iv) Natural method : Work on the principle of avoiding chances of ovum and sperms meeting.

- (a) **Rhythm or Periodic abstinence method** – Ist **7 days after** Menstruation Cycle (M.C.) and **7 days before** M.C. is called **safe period** because in these 14 days ovum is absent in fallopian tubes. Hence fertilization usually does not occur.

Periodic abstinence is one such method in which the couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected. As chances of fertilisation are very high during this period, it is called the fertile period. Therefore, by abstaining from coitus during this period, conception could be prevented.

- (b) **Withdrawal or Coitus interruptus** – During sexual intercourse, male partner withdraws his penis from vagina just before ejaculation so as to avoid insemination.
- (c) **Lactational amenorrhea** – High concentration of prolactin may lead to inhibition of menstrual cycle in lactating mother. Lactational amenorrhea (absence of menstruation) method is based on the fact that ovulation and therefore the cycle do not occur during the period of intense lactation following parturition. Therefore, as long as the mother breast-feeds the child fully, chances of conception are almost nil. However, this method has been reported to be **effective only upto a maximum period of six months following parturition**. As no medicines or devices are used in these methods, side effects are almost nil. Chances of failure, though, of this method are also high.

(2) Terminal method :

It is a **surgical method/Sterilisation – Block gamete transport thereby prevent conception**. These techniques highly effective but their reversibility is poor.

Female sterilisation – 85%

Male sterilisation – 10 to 15%

For Male : Vasectomy

To cut of vas deferens. So ejection of sperm does not occur.

For Female : Tubectomy – To cut of fallopian tubes.

Tubal ligation – To ligate fallopian tubes.

Medical Termination of Pregnancy (M.T.P.) :-

It is relatively safe during the Ist trimester (upto 12 weeks of pregnancy) and more risk in IInd trimester. Intentional or voluntary termination of pregnancy before full term is called **medical termination of pregnancy** (MTP) or induced abortion. Nearly 45 to 50 million MTPs are performed in a year all over the world which accounts to 1/5th of the total number of conceived pregnancies in a year. Obviously, MTP has a significant role in decreasing the population though it is not meant for that purpose. Whether to accept / legalise MTP or not is being debated upon in many countries due to emotional, ethical, religious and social issues involved in it. **Government of India legalised MTP in 1971 with some strict conditions to avoid its misuse.** Such restrictions are all the more important to check indiscriminate and illegal female foeticides which are reported to be high in India.

Why MTP? Obviously the answer is to get rid of unwanted pregnancies either due to casual unprotected intercourse or failure of the contraceptive used during coitus or rapes. MTPs are also essential in certain cases where continuation of the pregnancy could be harmful or even fatal either to the mother or to the foetus or both.

Condition of MTP :

- (i) **Medical** – When pregnancy might endanger to mother's life.
- (ii) **Eugenic** – When child being born with serious illness.
- (iii) **Humanitarian** – Where pregnancy is result of rape.
- (iv) **Socioeconomic** – If mother is having more than 2 to 3 child.
- (v) **Failure of contraceptive devices.**

INFERTILITY :

If couples are unable to produce children inspite of unprotected sexual cohabitation up to 1 year this is called infertility. It is prevented by assisted reproductive technologies (ART).

It is two types -

- (i) **Invitro fertilisation** – If fertilisation occurs outside the body of female and after it, embryo is transfered into uterus or fallopian tube of surrogate mother or same mother, this is called embryo transfer. Two types of Invitro fertilisation –
 - (a) **Zygote Intra Fallopiun Transfer (ZIFT)** – Zygote or early embryos (with upto eight blastomer) could then be transfered into the fallopian tube of surrogate or same mother. This is called ZIFT.
 - (b) **Intra Uterine Transfer (IUT)** – If more than eight blastomers (commonly 32 cells stage) transfer into uterus, this is called IUT.
 - (c) **Intracytoplasmic sperm injection (ICSI)** – It is an another specialised procedure to form an embryo in the laboratory in which a sperm is directly injected into the cytoplam of ovum.
- (ii) **Invivo fertilisation** - If fertilisation occurs inside the body of female either natural or artificial this is called invivo fertilisation.
 - (a) **Gamete Intra Fallopian Transfer (GIFT)** – Transfer of an ovum collected from ovary into the fallopian tube of same female or female who can't produce one, but can provide suitable environment for fertilisation, this is called GIFT.
 - (b) **Artificial insemination** – If male is unable to inseminate the semen into vagina then semen is artificially introduced either into vagina or into the uterus of the female (intrauterine insemination).

Test-Tube Baby :

(In vitro fertilisation – (IVF - **fertilisation outside the body** in almost similar conditions as that in the body).
(In vivo fertilisation : (fusion of gametes within the female).

After the fusion of gametes zygote is formed which reaches the **32 celled stage within 24 hrs**. Now this embro (**blastocyst**) is transplanted in normal uterus of same mother or surrogate mother for further development after the completion of gestation period a normal child take birth.

1st Test tube baby : **England, 25 July, 1978, Louise Joy Brown**

India : Ist test tube baby is approved as '**Durga**'.

Amniocentesis : a foetal sex determination test based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo.

In the **14th or 15th week** of pregnancy with the help of long surgical needle, amniotic fluid is taken out from the uterus. In this fluid, few cell of embryo (skin, liver and placenta) are present.

They are tested to konw –

- (i) **Genetic disorder / chromosomal abnormalities like Down Syndrome**
- (ii) **Metabolic disorder (deficiency of protein, enzymes, hormones)**
- (iii) **Detection of Sex (Barr bodies)**

Statutory ban on amniocentesis for sex-determination to legally check increasing female foeticides.

EXERCISE

1. Amniocentesis is:-
 - (1) Analysis of chemical composition of fluids of pregnant woman
 - (2) Withdrawal of allantoic fluid from pregnant women
 - (3) An in vitro diagnosis
 - (4) Culturing of cells and study of metaphase chromosomes from amniotic fluid to identify chromosomal abnormality
2. What is correct about test tube baby:-
 - (1) Fertilization inside female genital tract and growth in test tube
 - (2) Rearing of prematurely born baby in incubator
 - (3) Fertilization outside and gestation inside womb of mother
 - (4) Both fertilization and development are effected outside the female genital tract
3. Study of abnormalities by taken out the amniotic fluid of embryo is called :-
 - (1) Endoscopy
 - (2) Amniocentesis
 - (3) Laproscopy
 - (4) Natal endoscopy
4. Which one is not legitimate for reducing birth rate:-
 - (1) Ban on marriages
 - (2) MTP
 - (3) Use of contraceptives
 - (4) Late marriages
5. Purpose of tubectomy is to prevent:-
 - (1) Egg formation
 - (2) Embryonic development
 - (3) Fertilization
 - (4) Coitus
6. Vasectomy is :-
 - (1) Cutting of fallopian tube
 - (2) Cutting of vasdeferens
 - (3) Factor of population growth
 - (4) None of these
7. An IUCD is:-
 - (1) Vasectomy
 - (2) Copper T
 - (3) Condom
 - (4) All above
8. A contraceptive is:-
 - (1) Condom, cervical cap and diaphragm
 - (2) Intrauterine device
 - (3) Pill
 - (4) All the above
9. A contraceptive pill contains:-
 - (1) Progesterone and estrogen
 - (2) Spermicidal salts
 - (3) Chemicals that cause automatic abortion
 - (4) Chemicals that prevent fertilization of ovum
10. The partner responsible for sex of the child is:-
 - (1) Male
 - (2) Female
 - (3) Both
 - (4) At times male & at times female
11. MTP is:-
 - (1) Multi trade practices
 - (2) Malthusian treatise on population
 - (3) Multiple temporary frequency
 - (4) Medical termination of pregnancy
12. A contraceptive pill prevents ovulation by:-
 - (1) Blocking fallopian tube
 - (2) Inhibiting release of FSH & LH
 - (3) Stimulating release of FSH & LH
 - (4) Causing immedediate degeneration of released ovum
13. Oral contraceptives contain :-
 - (1) Progesterone
 - (2) LH
 - (3) Oxytocin
 - (4) Steroles
14. Amniocentesis is used for determining :-
 - (1) Heart diseases
 - (2) Brain disease
 - (3) Hereditary disease of embryo
 - (4) All the above
15. Most important component of oral contraceptive is :-
 - (1) Thyroxine
 - (2) LH
 - (3) Progesteron
 - (4) AH
16. Tubectomy, a method of population control is performed on :-
 - (1) Both males & females
 - (2) Males only
 - (3) Females only
 - (4) Only pregnant females
17. Which is related to males :-
 - (1) I.U.C.D.
 - (2) Tubectomy
 - (3) Vasectomy
 - (4) None of the above

- 18.** Consider the statements given below regarding contraception and answer as directed thereafter:-
 (a) Medical Termination of Pregnancy MTP during first trimester is generally safe
 (b) Generally chances of conception are nil until mother breast-feeds the infant upto two years
 (c) Intrauterine devices like copper T are effective contraceptives
 (d) Contraception pills may be taken upto one week after coitus to prevent conception
 Which two of the above statements are correct ?
 (1) a, c (2) a, b (3) b, c (4) c, d
- 19.** Given below are four methods (A–D) and their modes of action (a–d) in achieving contraception. Select their correct matching from the four options that follow
- | Method | Mode of Action |
|---------------|-------------------------------------|
| A. The pill | (a) Prevents sperms reaching cervix |
| B. Condom | (b) Prevents implantation |
| C. Vasectomy | (c) Prevents ovulation |
| D. Copper T | (d) Semen contains no sperms |
- Matching :-
 (1) A – (c), B – (d), C – (a), D – (b)
 (2) A – (b), B – (c), C – (a), D – (d)
 (3) A – (c), B – (a), C – (d), D – (b)
 (4) A – (d), B – (a), C – (b), D – (c)
- 20.** First country of world which adopt family planning programme :-
 (1) Japan (2) USA
 (3) India (4) Bangladesh
- 21.** Govt. sponsored "family planning programme". started in:-
 (1) 1947 (2) 1951
 (3) 1977 (4) 1955
- 22.** Saheli , A female antifertility pill is used:-
 (1) Daily (2) Weekly
 (3) Quarterly (4) Monthly
- 23.** Test tube baby means a baby born when
 (1) It is developed in a test tube
 (2) It is developed through tissue culture method
 (3) The ovum is fertilised externally and there after implanted in the uterus
 (4) It develops from a non-fertilized egg
- 24.** What is the work of copper T-
 (1) To inhibit ovulation
 (2) To prevent fertilization
 (3) To inhibit implantation of blastocyst
 (4) To inhibit gametogenesis

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	2	1	3	2	2	4	1	1	4	2	1	3	3	3	3	1	3	3
Que.	21	22	23	24																
Ans.	2	2	3	2																

EVOLUTION

ORIGIN OF LIFE

Evolutionary Biology

It is the study of history of life forms i.e. the changes in flora and fauna that have occurred over millions of years on earth.

Theories for origin of life:

(1) Theory of special creation

- The greatest supporter of this theory was **Father Suarez**. This is a mythology based theory.
- This theory has three connotations-
 - (a) All living organisms that we see today were created as such.
 - (b) The diversity was always the same since creation and will be the same in future.
 - (c) The earth is about 4000 years old.
- All these ideas were strongly challenged during the nineteenth century based on observations of **Charles Darwin, Wallace** etc. They believed that life forms varied over the periods of time.
- From fossils records and their dating, we can conclude that earth is very old, not thousands of years as was thought earlier but billions of years old.

(2) Cosmic panspermia theory-

- Some scientists believe that life came from outer space.
- Early Greek thinkers thought units of life called **spores** were transferred to different planets including earth.
- '**Panspermia**' is still a favourite idea for some astronomers.

(3) Theory of spontaneous generation (Abiogenesis/Autogenesis) -

- This hypothesis was supported by ancient Greek philosophers.
- According to this theory life came out of decaying and rotting matter like straw, mud, etc. spontaneously.
- They believed that the mud of **Nile** river could give rise to fishes, frogs, crocodiles etc when warmed by light rays.

(4) Theory of biogenesis - Proposed by **Harvey & Huxley**

- They stated "Omnis vivum ex ovo or vivo", which means "New life can be originated on earth only by pre existing life."
- Experiments of **Francesco Redi, Lazzaro Spallanzani, and Louis Pasteur** etc supported the theory of biogenesis and disproved the abiogenesis. Experiment of Louis Pasteur is most renowned among all of these.
- Hence spontaneous generation theory was dismissed once and for all. However, this did not answer how the first life form came on earth.

Experiment of Louis Pasteur:

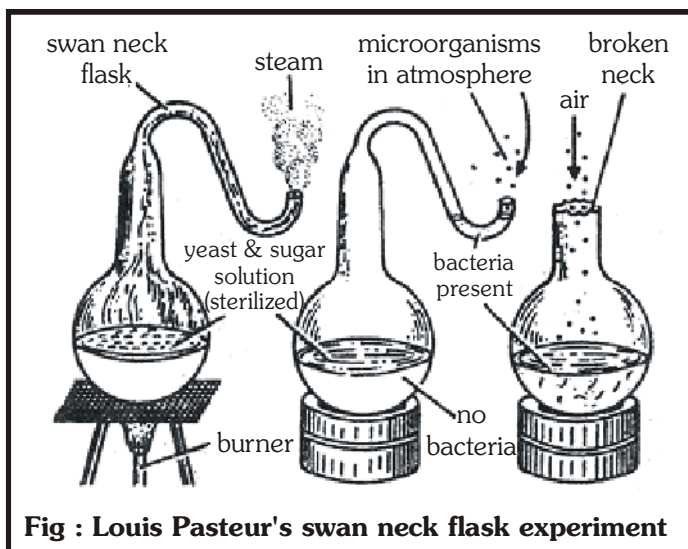
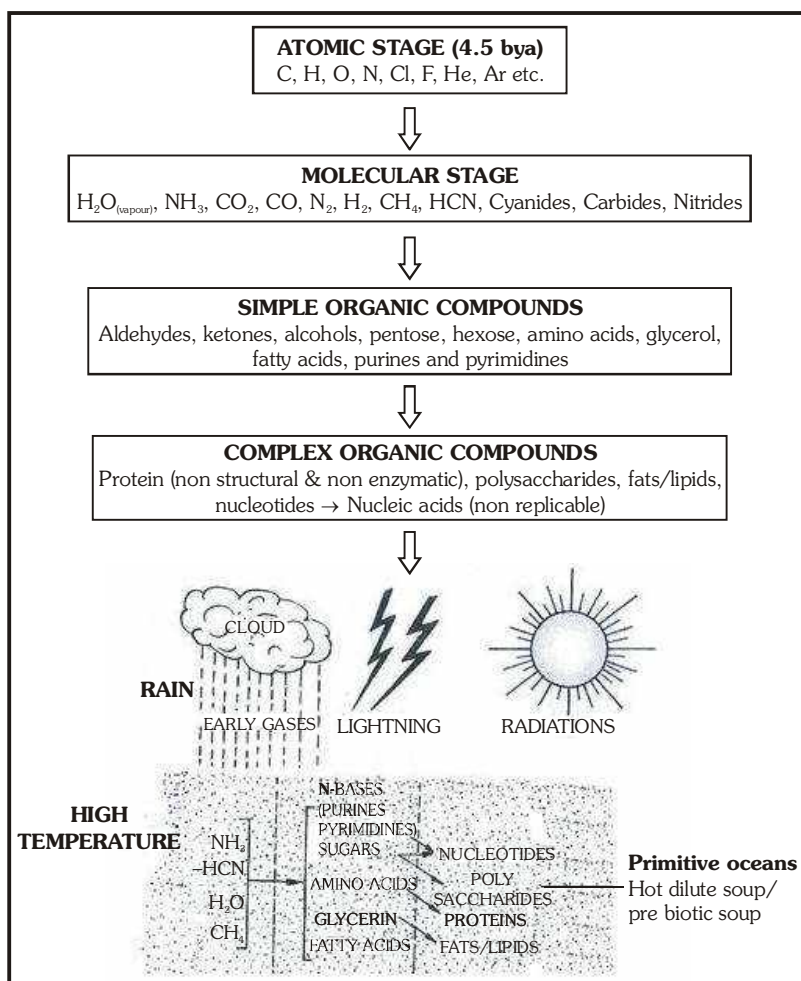
- His experiment is also known as '**Swan neck flask experiment**'.
- He prepared sterilized syrup of sugar and killed yeast by boiling them in flasks.
- He took two flasks one of broken neck and another of curved neck (swan neck flask/'S' shaped neck flask).
- He showed that in pre-sterilized swan neck flasks, life did not come from killed yeast because germ laden dust particles in the air were trapped by the curved neck which serves as filter while in another flask open to air (broken neck), new living organisms arose.

(5) **Oparin - Haldane theory (Modern theory)**

- Oparin of Russia and Haldane of England proposed that the first form of life could have come from **pre-existing non-living organic molecules (e.g. RNA, protein, etc.)** and that formation of life was preceded by chemical evolution, i.e., formation of diverse organic molecules from inorganic constituents.
- Oparin's theory was published in his book '**ORIGIN OF LIFE**'.
- First life originated in sea water, so water is essential for origin of life.

CHEMICAL EVOLUTION (Chemogeny)

- The primitive conditions on earth were **high temperature, volcanic storms, lightening and reducing atmosphere**.
- Early earth had free atoms of all those elements which are essential for formation of protoplasm (C, H, O, N etc.).
- Hydrogen was maximum among all of them.
- Due to high temperature hydrogen reacted with oxygen to form **water** and no free oxygen was left, which made the atmosphere reducing.
- Hydrogen also reacted with nitrogen and formed **ammonia**.
- Hence **Water and ammonia** were probably the first inorganic compounds formed on earth.
- **Methane (CH₄)** was the first organic compound.
- As the earth cooled down, the water vapour fell as rain, to fill all the depressions and form primitive oceans. During this, molecules continued to react with each other and formed various simple and complex organic compounds.

**Fig : Louis Pasteur's swan neck flask experiment**

- Now, the water of oceans became a rich mixture of macromolecules/ complex organic compounds. Haldane called it **Hot dilute soup/ pre biotic soup**.
- Hence the possibilities of life were established in the water of primitive oceans because these macromolecules (**Proteins, polysaccharides, fats/lipids, nucleic acids**) form the main components of protoplasm.

However we have no clear idea about how the first self replicating metabolic capsule of life arose, but many attempts were made to solve the mystery of arise of life on earth. From these macromolecules how first life was originated, will be studied in **Biological evolution**.

BIOLOGICAL EVOLUTION (Biogeny)

(a) **Origin of protobionts-**

- Macromolecules which were synthesized abiotically in primitive oceans later came together and formed large colloidal drop like structures named as **protobionts**.
- It is believed that they were the clusters of proteins, polysaccharides, lipids, nucleic acids etc.
- These protobionts were unable to reproduce but they could grow by absorbing molecules from their surroundings and can exhibit simple metabolism.

Protobionts were also synthesized artificially by some scientists in laboratory.

For example, **Oparin** prepared some protobionts without a lipid membrane and he called them **coacervates**.

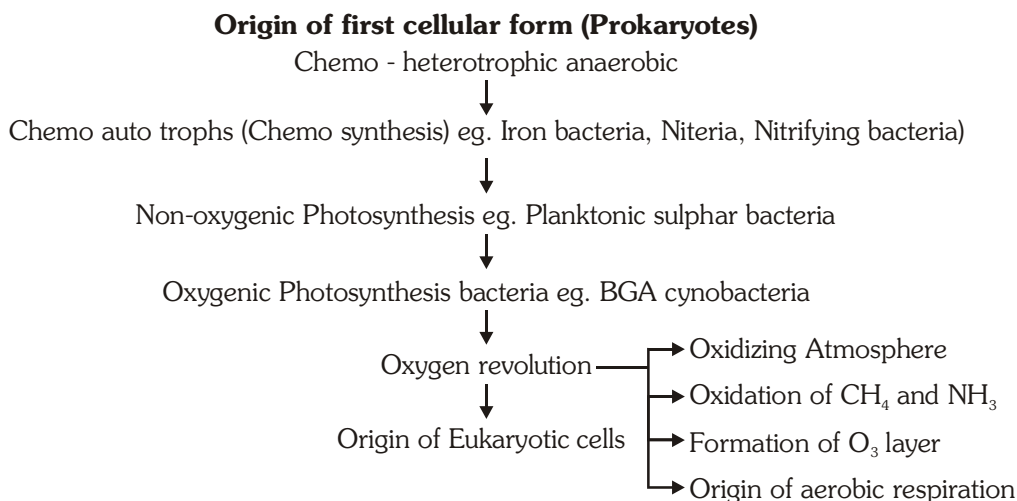
Similarly **Sydney Fox** synthesized some microscopic protenoid bodies with a lipid coat and called them **microspheres**.



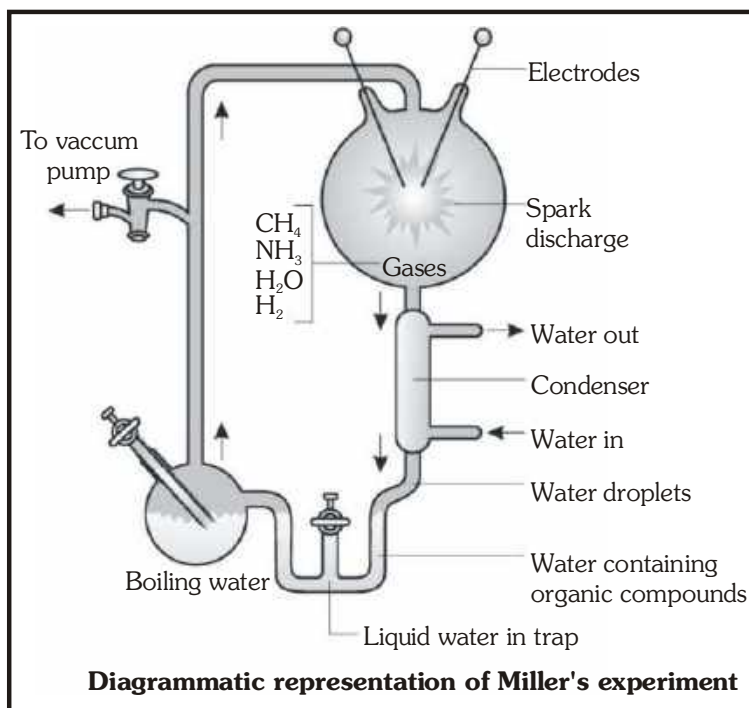
(b) **Origin of protocells (Eobionts)-**

- Nucleic acid developed the ability of self duplication due to a sudden change called **mutation**.
- Nucleic acid and proteins combined to form **nucleoproteins**. Nucleoproteins were the first sign of life.
- Clusters of nucleoproteins surrounded by lipid coat called **protocell**, the **first form of life**.
- These **first non-cellular forms of life** could have originated **3 billion years ago**.
- They would have been giant molecules (**RNA, Protein, Polysaccharides, etc.**). These capsules reproduced their molecules perhaps.

☞ **Altman (1980)** discovered that some RNA molecules have enzymatic activity, called as **ribozymes**. It means at the time of origin of life, RNA molecule could carry out all the processes of life (replication, protein formation etc) without the help of either protein or DNA. Hence this concept called as **RNA World**.

(c) **Origin of first cellular form (Prokaryotes) -****EVIDENCES IN FAVOUR OF CHEMICAL EVOLUTION****Harold Urey & Stanley Miller Experiment**

- In 1953, S.L. Miller, an American scientist created similar conditions at laboratory scale which were thought to be on primitive earth.
- He took CH_4 , NH_3 , H_2 (in ratio 2:1:2) and water vapour at 800°C in a large flask.
- He created **electric discharge** by using two tungsten electrodes as source of energy.
- He observed the formation of simple amino acids like glycine, alanine, and aspartic acid.
- In similar experiments other scientists observed, formation of sugars, nitrogen bases, pigment and fats.

**Evidences from meteorites**

- Analysis of meteorite contents also revealed similar compounds indicating that similar processes are occurring elsewhere in space.
- ☞ With these limited evidences, the first part of the conjectured story, i.e., chemical evolution was more or less accepted.
- ☞ This version of abiogenesis, i.e., the first form of life arose slowly through evolutionary forces from non-living molecules is accepted by majority. However, once formed, how the first cellular forms of life could have evolved into the complex biodiversity of today is the fascinating story that will be discussed in **organic evolution**.

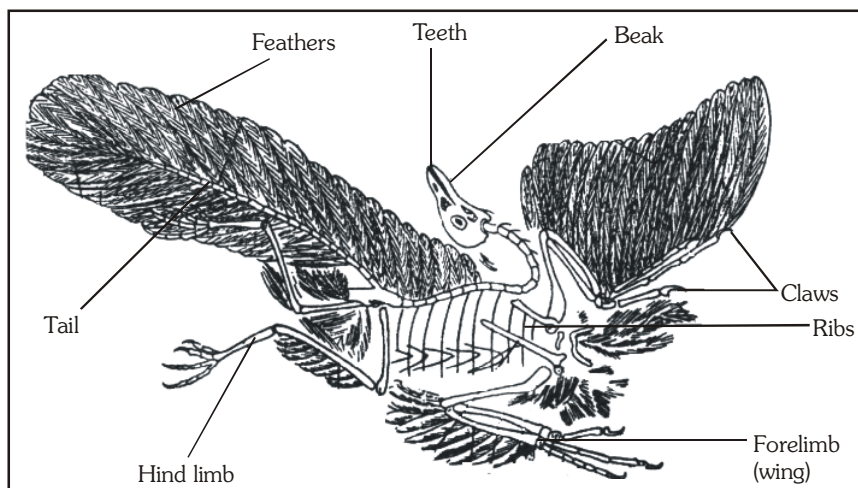
EVIDENCES OF ORGANIC EVOLUTION

Palaeontological evidences

- Study of **fossils** is called **palaeontology**.
- According to **Charles Lyell**, "Fossils are impression or remains of hard parts of life-forms found in rocks.
- Rocks form sediments and a cross-section of earth's crust indicates the arrangement of sediments one over the other during the long history of earth. Such types of rocks are called as **sedimentary rocks**.
- Mostly fossils are found in sedimentary rocks.
- Different-aged rock sediments contain fossils of different life-forms who probably died during the formation of the particular sediment.
- A study of fossils in different sedimentary layers indicates the geological period in which they existed.
- Some of them represent extinct organisms (e.g., Dinosaurs).
- The study shows that life-forms varied over time and certain life forms are restricted to certain geological time spans.
- New forms of life have arisen at different times in the history of earth. i.e. evolution has taken place.
- Generally, fossils found in older rocks are of simpler types and found in newer rocks are of complex type.
- By fossils we can study the evolutionary pedigree of animals like horse, elephants and man etc.
- **The geological history of earth closely correlates with the biological history of earth.**

There are several methods used to determine the age of fossils-

- (1) Uranium Lead method
- (2) Radio carbon method
- (3) Potassium argon method - this method is more commonly used to determine the age of older hominid fossils.
- (4) Electron spin resonance (ESR) method - this is the modern and most accurate technique.



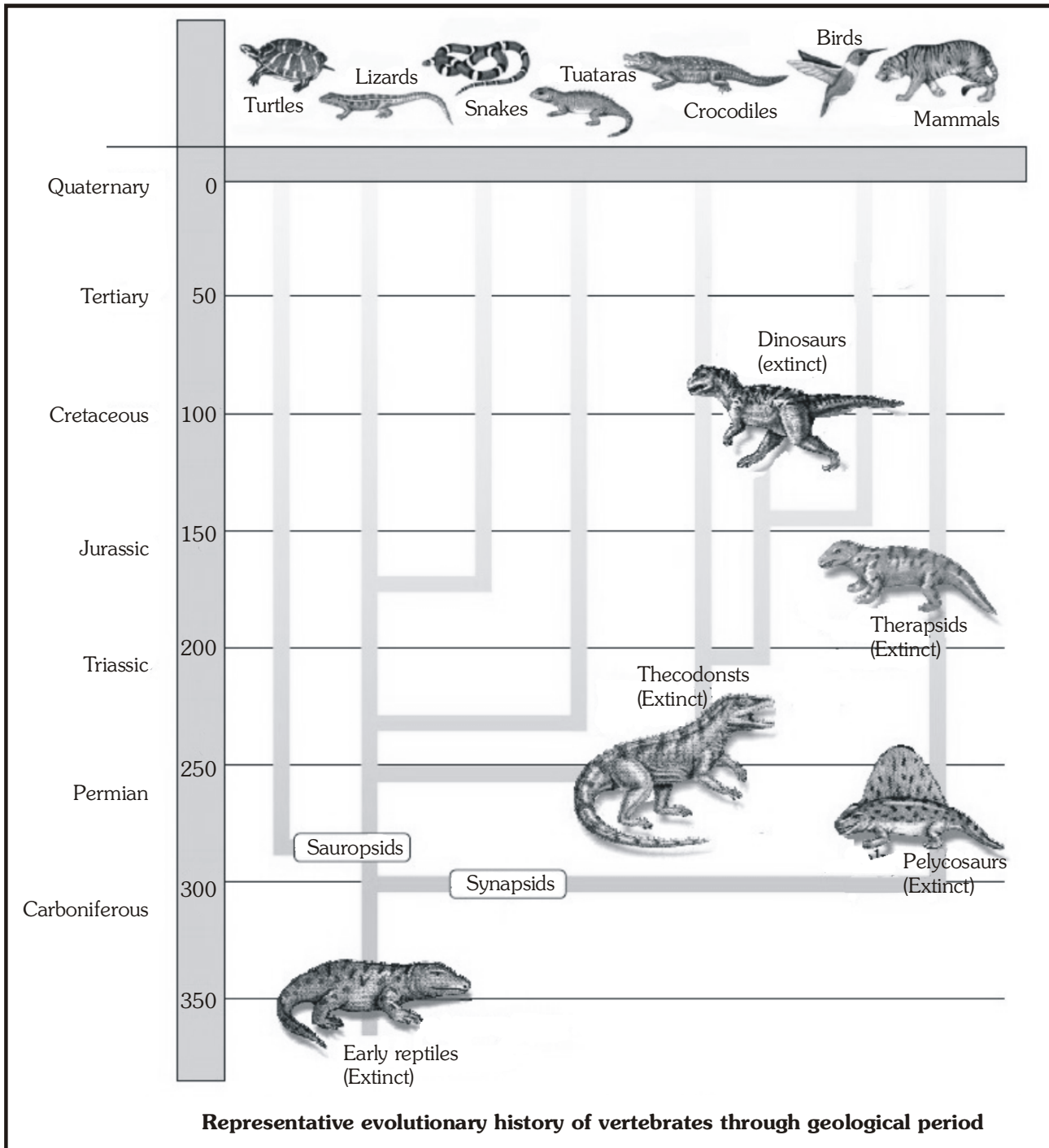
Archeoptaryx

GEOLOGICAL TIME SCALE			
Era	Period	Epochs	Life forms
COENOZOIC (Age of Birds, Mammals and Angiosperms)	QUATERNARY	Holocene (Age of Man)	Mental age, supremacy of man
		Pleistocene (ICE AGE)	Human appeared, social life of human started
	TERTIARY	Pliocene	Apelike ancestors of human appeared
		Miocene	
		Oligocene	Anthropoid apes evolved from monkeys Rise of monocots
		Eocene	Eohippus appeared
		Palaeocene	Origin of primates
ROCKY MOUNTAIN REVOLUTION			
MESOZOIC (Age of Reptiles)	CRETACEOUS		Extinction of Dinosaurs & archaeopteryx Origin of primitive placental mammals and Modern birds Angiosperms also appeared
	JURASSIC (Golden age of Dinosaurs)		Dominance of dinosaurs and origin of first toothed birds and marsupial mammals Gymnosperms and ferns also dominated
	TRIASSIC		Origin of dinosaurs and oviparous mammals

APPLACHIAN REVOLUTION			
PALAEOZOIC	PERMIAN		Origin of mammal like reptiles, first Gymnosperm appeared
	CARBONIFEROUS (Golden age of amphibians)		Amphibians were dominant and origin of reptiles (seymauria) First seed plant originated
	DEVONIAN (Golden age of fishes)		Fishes were dominant and origin of amphibians
	SILURIAN		Jawless fishes were dominant and Origin of true fishes
	ORDOVICIAN		Giant mollusks were dominant Origin of jawless fishes (1st vertebrates), origin of chordata
	CAMBRIAN		Trilobites (Extinct arthropods) were dominant
SECOND GREAT GEOLOGICAL REVOLUTION			
PROTEROZOIC			Origin of protozoa, sponges, coelenterate, annelida & mollusca
FIRST GREAT GEOLOGICAL REVOLUTION			
ARCHAEOZOIC			Prokaryotes originated and dominated (Era of invisible life) Eukaryotes also evolved
AZOIC			No life, Only chemical evolution took place

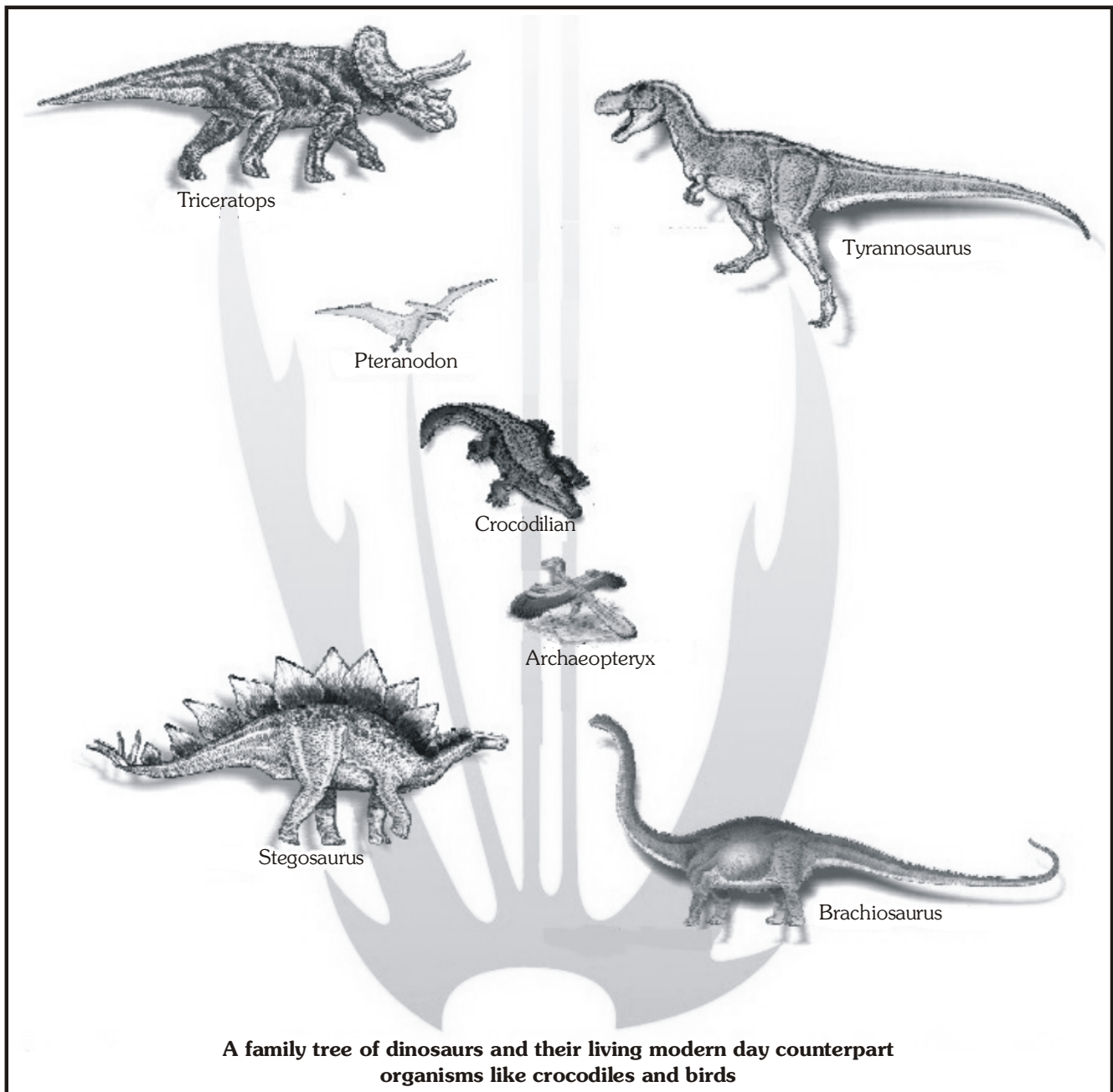
A brief account of evolution-

- About 2000 million years ago (mya) the first cellular forms of life appeared on earth.
- By the time of 500 mya, invertebrates were formed and became active.
- Jawless fishes probably evolved around 350 mya.
- Sea weeds and few plants existed probably around 320 mya.
- The first organisms that invaded land were plants. They were widespread on land when animals invaded land.



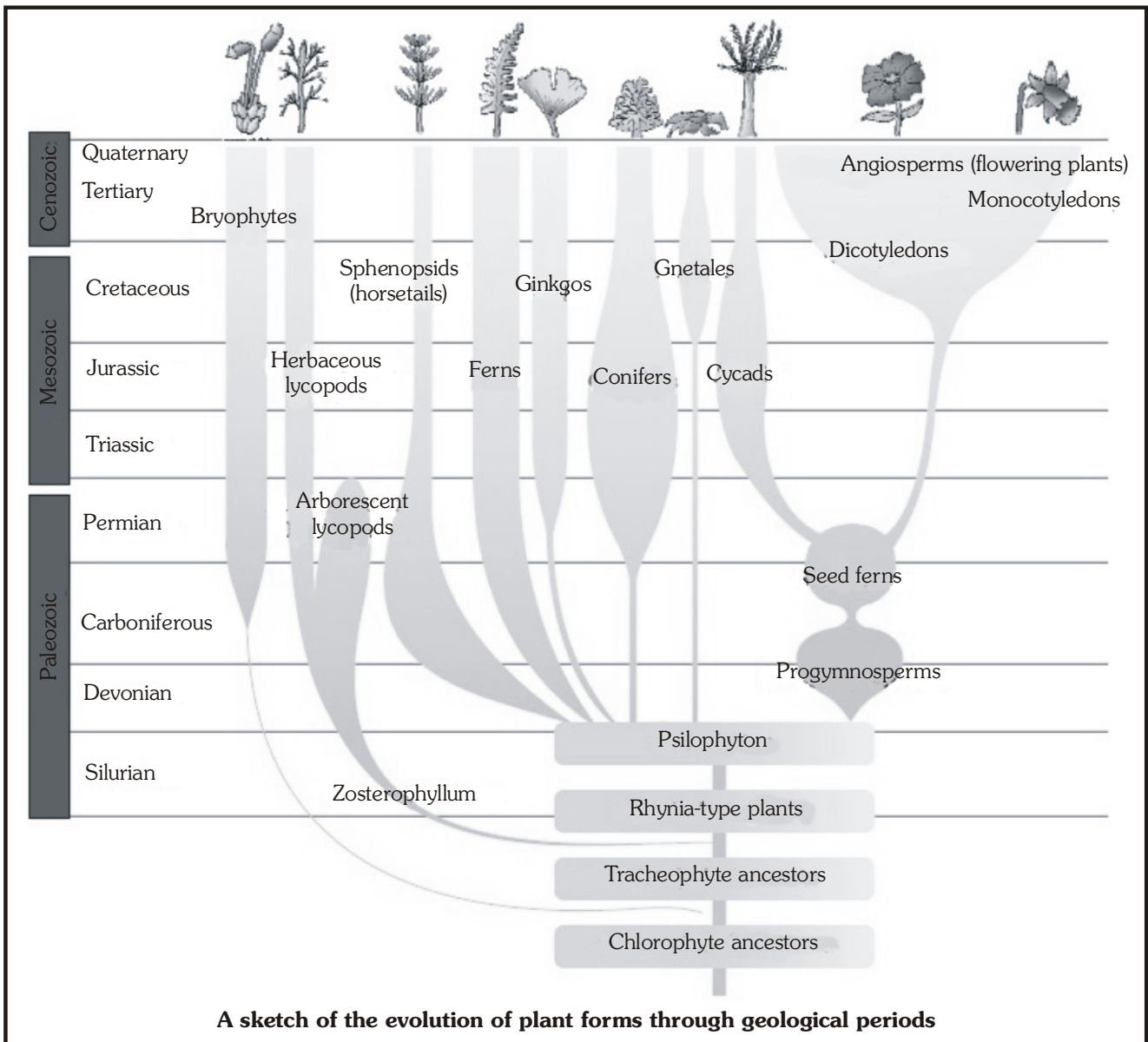
- Fish with stout and strong fins could move on land and go back to water. This was about 350 mya. In 1938, a fish caught in South Africa happened to be a **Coelacanth** which was thought to be extinct.

- These **Coelacanth** or **lobefins** evolved into the first amphibians that lived on both land and water. There are no specimens of these left with us. However, these were ancestors of modern day frogs and salamanders.
- The amphibians evolved into reptiles. They lay thick shelled eggs which do not dry up in sun unlike those of amphibians. Again we only see their modern day descendents, the turtles, tortoises and crocodiles.
- **Synapsids** were the mammal like early reptiles which gave rise to mammals.
- **Sauropsids** were the lizard like early reptiles which gave rise to different dinosaurs, modern reptiles and birds.



- In the next 200 million years or so, reptiles of different shapes and sizes dominated on earth.
- **Giant ferns (pteridophytes)** were present but they all fell to form coal deposits slowly.

- Some of the land reptiles went back into water to evolve into fish like reptiles probably 200 mya (e.g. **Ichthyosaurs**).
- The land reptiles were, of course, the dinosaurs. The biggest of them, was **Tyrannosaurus rex** about 20 feet in height and had huge fearsome dagger like teeth.
- About 65 mya, the dinosaurs suddenly disappeared from the earth. We do not know the true reason. This may happened due to (i) Climatic changes killed them or (ii) Most of them evolved into birds or (iii) Meteorites collisions killed them. The truth is still unknown.
- Small sized reptiles of that era still exist today.
- The first mammals were like shrews. Their fossils are small sized.
- Mammals were **viviparous** and protected their unborn young inside the mother's body. Mammals were **more intelligent** in sensing and avoiding danger at least.
- When reptiles came down mammals took over this earth.



Evidences from comparative morphology and anatomy

- Similarities and differences are found among organisms of today and those that existed years ago. Such similarities can be interpreted to understand whether common ancestors were shared or not.
- These similarities are of two types-

(A) Homology

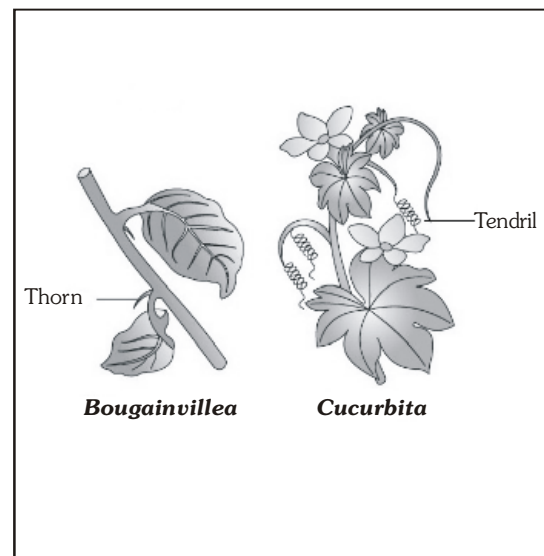
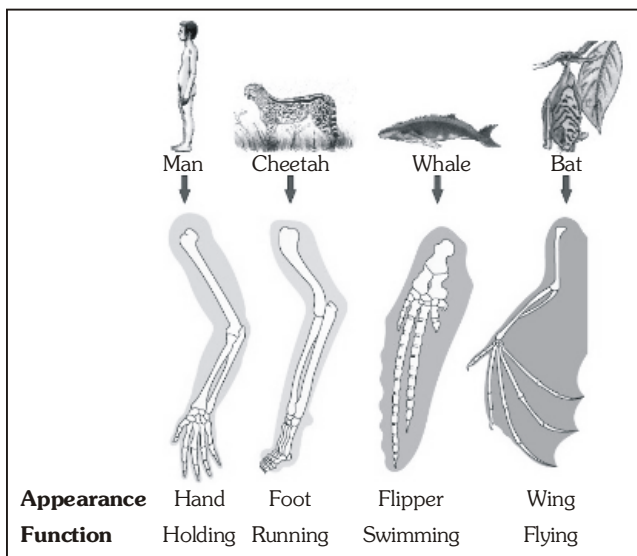
(B) Analogy

Homology

The organs which have common origin, embryonic development and same fundamental structure but perform similar or different functions are called as **Homologous organs** and this phenomenon is called Homology.

Examples of homologous organs:

- (i) **Forelimbs of mammals** - Whales, bats, Cheetah and human (all mammals) share similarities in the pattern of bones of forelimbs though these forelimbs perform different functions. In these animals, forelimbs have similar anatomical structure - all of them have humerus, radius, ulna, carpals, metacarpals and phalanges in their forelimbs.



- (ii) **Thorn of Bougainvillea and tendril of Cucurbita** both are modification of axillary bud.

(iii) **Vertebrate hearts or brains**

(iv) **Mouth parts of insects -**

Cockroach

(Biting & chewing)

Honey bee

(Chewing & lapping)

Mosquito

(Piercing & Sucking)

In each of these insects mouth parts comprise labrum, mandible maxilla etc.

(v) **Testes in male and ovaries in female**

(vi) **Potato and Ginger** - both are modified shoot

(vii) **Radish and Carrot** - both are modified roots

(viii) **Molecular homology** - Homology found at molecular level. For example the plasma proteins found in the blood of man and apes are similar.

- When the same structures develop along different directions due to adaptations to different needs, this is called as **divergent evolution**.
- Homology indicates **common ancestry** and based on divergent evolution.

Analogy

The organs which have different origin and fundamental structures but perform similar functions are called **Analogous organs** and this phenomenon is called as analogy.

Examples of analogous organs:

- Wings of butterfly and birds** - They are not anatomically similar structures though they perform similar functions i.e. used for flying.
- Eye of the octopus and of mammals**
- Flippers of Penguins and Dolphins**
- Sweet potato** (root modification) and **potato** (stem modification)
- Sting of bee and scorpion**
- Chloragogen cells of earthworm and liver of vertebrates**

- When different structures evolve for the same function due to the similar habitat, this is called **convergent evolution**.
- Analogy doesn't indicate common ancestry and it is based on convergent evolution where different group of organisms have similar adaptive features due to similar habitat or towards the same function, hence analogous structures are a result of convergent evolution.

Evidences from vestigial organs

- The organs which are present in reduced form and do not perform any function in the body but are functional in related animals are called vestigial organs.
- They are remnants of organs which were complete and functional in their ancestors.

e.g. Nictitating membrane

Muscles of pinna (auricular muscles)

Vermiform appendix (Caecum)

Coccyx

Canine teeth

Third molars (wisdom teeth)

Body hair

Nipples in males

Segmented muscles of abdomen

Evidences from Atavism (Reversion)

- Sometimes in some individuals such characters suddenly appears which were supposed to be present in their ancestors but were lost during the course of evolution, this phenomenon is known as atavism or reversion.
- Atavism proves that animals developing atavistic structures have evolved from such ancestors in which these structures were fully developed.

e.g. Tail in new born baby

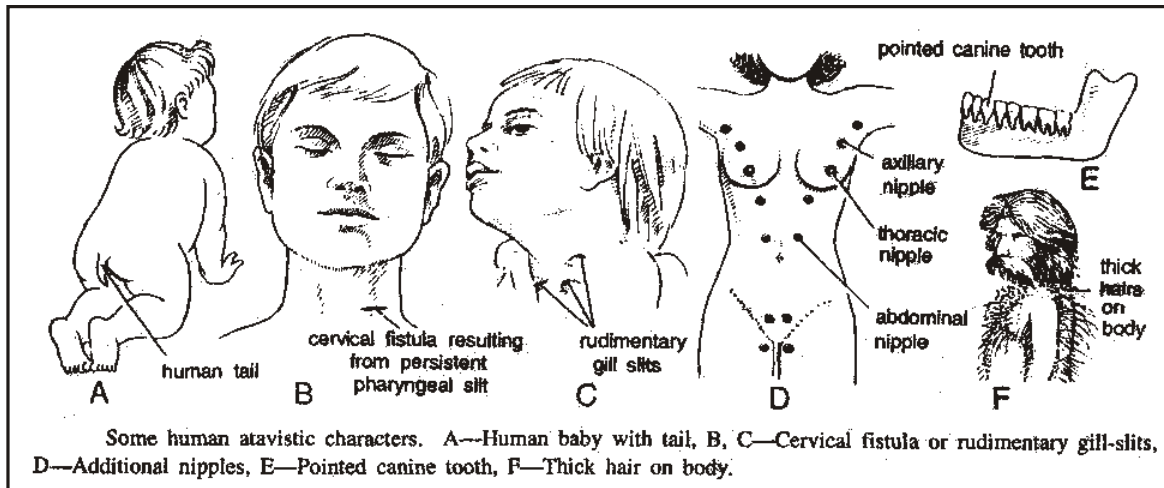
Extra long and pointed canine teeth

Functional auricular/pinna muscles

Long and thick body hair

Extra nipples in female

Cervical fistula (pharyngeal gills slits)



Evidences from embryology

- **Baer's law:** This was proposed by Von Baer (father of embryology). He stated that "in embryonic stages general characters appear firstly and specialized characters appear later".
 - Muller proposed '**Recapitulation theory**', According to which "**Ontogeny recapitulates phylogeny**".
 - In 1866, **Ernst Haeckel** explained it in detail and called it '**Biogenetic law**'.
 - It means an organism shows its ancestral adult stages during its embryonic development. In other words embryos of advanced species pass through stages represented by adult organisms of more primitive species.
- It shows that all organisms have common ancestry.
- Interestingly, **Von Baer** (1828) had disproven the 'Biogenetic law' before Haeckel invented it. He observed that embryos never pass through the adult stages of other animals, they resemble only the embryos of less complex animal means there are some stages, that related embryos do share.

Examples:

- (1) The tadpole larva of amphibians resembles with fishes. This indicates origin of amphibians from fishes.
- (2) During the development of heart in higher vertebrates like birds and mammals, it initially exhibits the 2-chambered states same as fishes. Later on, it develops into 3-chambered as in amphibians and reptiles and finally in the last embryonic stages it becomes 4-chambered as such in the adults. This proves that all vertebrates have evolved from common fish like ancestors and also that both birds and mammals have evolved from reptiles.

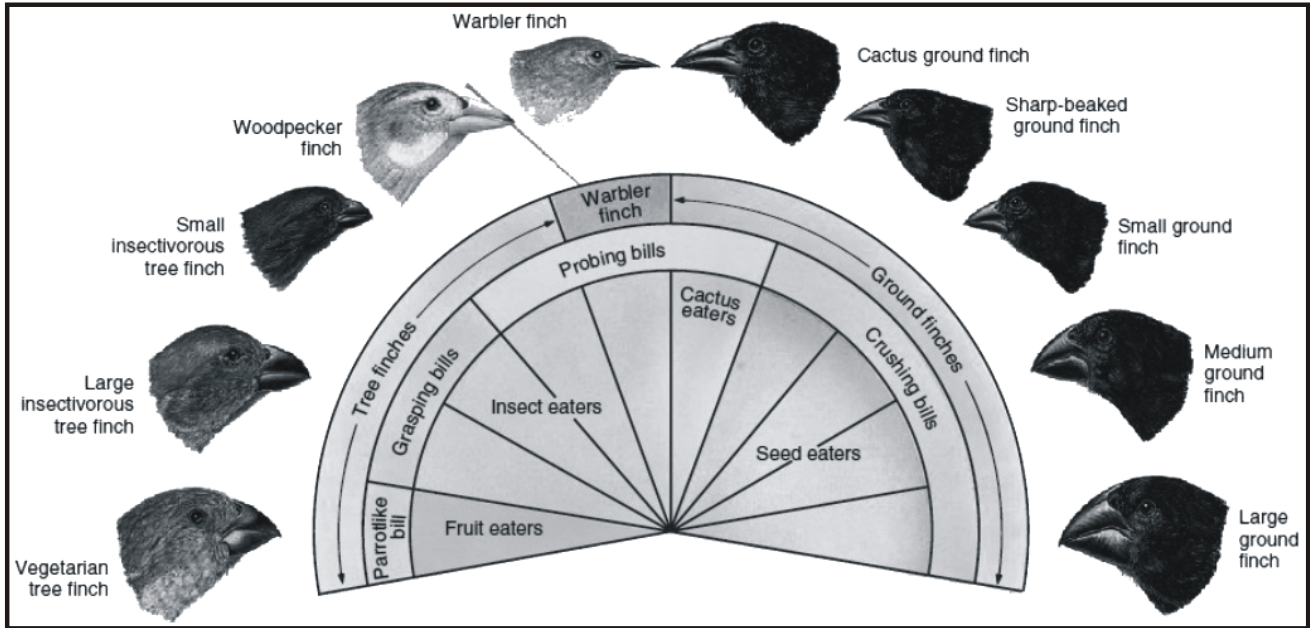
WHAT IS ADAPTIVE RADIATION/ADAPTIVE DIVERGENCE?

The process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called **adaptive radiation**. Both the homology and adaptive radiation are based on **Divergent evolution**.

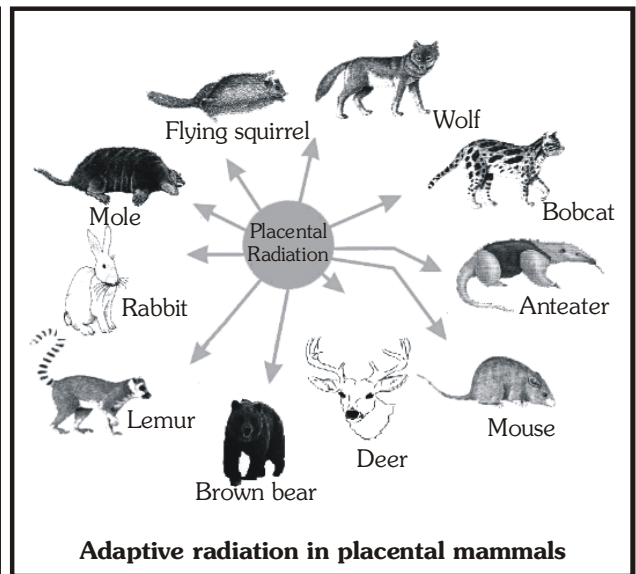
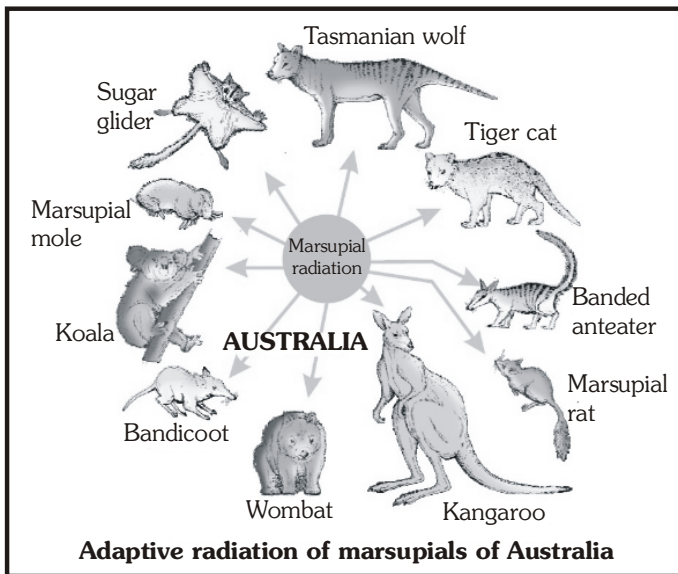
Examples:

- (1) **Darwin's finch** - During the journey of Galapagos Islands, Darwin observed an amazing diversity of creatures. Of particular interest, small black birds later called Darwin's Finches amazed him. Galapagos island is situated near south America which is a group of 22 smaller islands.

He realized that there were many varieties of finches at Galapagos island. All the varieties, he conjectured, evolved on the island itself. From the original **seed-eating** features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches.






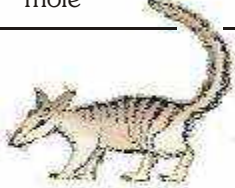


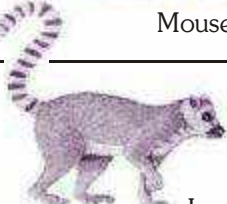







- (2) **Australian Marsupials** - A number of marsupials, each different from the other evolved from an ancestral stock, but all within the Australian island continent.
- (3) **Placental Mammals** - A number of placental mammals have evolved from a common ancestral type in other parts of world also. Placental mammals in Australia also exhibit adaptive radiation.



Convergent evolution or Adaptive convergence - When more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), one can call this **convergent evolution**.

Placental mammals in Australia also exhibit adaptive radiation in evolving into varieties of such placental mammals each of which appears to be 'similar' to a corresponding marsupial.

e.g. Wolf (placental) and Tasmanian wolf (marsupial)

Placental mammals	Australian marsupials
 Mole	 Marsupial mole
 Anteater	 Numbat (anteater)
 Mouse	 Marsupial mouse
 Lemur	 Spotted cuscus
 Flying squirrel	 Flying phalanger
 Bobcat	 Tasmanian tiger cat
 Wolf	 Tasmanian wolf
Picture showing convergent evolution of Australian Marsupials and placental mammals	

Parallel evolution- When adaptive convergence is found in closely related species, it is called as **parallel evolution**. Parallel evolution occurs when two independent but similar species evolve in the same direction and thus independently acquire similar characteristics.

(1) LAMARCKISM/ Theory of inheritance of acquired characters**Criticism of Lamarckism****(1) Weismann's Theory of Continuity of Germplasm:**

- Weismann cut off the tails of rats for as many as 22 generations and allowed them to breed, but tailless or reduced tailed rats were never born.
- On the basis of this experiment Weismann proposed the theory of continuity of germplasm.
- According to this theory -

Two types of protoplasm are present in an organism, **germplasm** and **somatoplasm**.

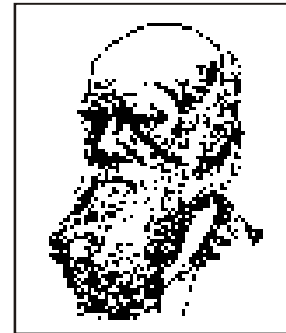
There is a continuity of germplasm and the variations influencing the germ cells are only inherited but the somatoplasm is not transmitted to the next generation, hence it does not carry variations to next generation.

(2) Boring of ear pinna and nose in Indian women is never inherited to the next generations.

(3) Chinese women used to wear iron shoes in order to have small feet, but they still have normal feet.

DARWINISM/Theory of Natural selection

- Charles Robert Darwin was born on 12th Feb. 1809 in England.
- Darwin travelled by **H.M.S. Beagle** ship, which left on 27 Dec. 1831 and returned on 02 Oct. 1836 through S. America, S. Africa, Australia & Galapagos Islands.
- Darwin was influenced by two books-
 - (i) "**Principles of population**" of **Malthus**
 - (ii) "**Principles of geology**" of **Charles Lyell**
- **Alfred Wallace**, a naturalist who worked in **Malay Archipelago** had also come to similar conclusions around the same time and he sent his conclusions to Darwin in form of a chart.
- This theory was later on explained by Darwin in his book '**On the origin of species by means of Natural selection**' (1859).

**Basic concepts of Darwinism**

- **Branching Descent** and **Natural Selection** are the two key concepts of Darwinian Theory of evolution.
- Natural selection is based on certain observations which are factual.
 - (i) **Over production:**
 - All organisms have the capability to produce enormous number of offspring or organisms (multiply in geometric ratio).
 - Hence, theoretically population size will grow exponentially if everybody reproduced maximally (this fact can be seen in a growing bacterial population) but the fact is that population sizes in reality are limited.

(ii) Struggle for existence:

- Natural resources are limited and populations are stable in size (except for seasonal fluctuation) means that there had been competition for resources. Only some survived and grew at the cost of others that could not flourish. This is called **struggle for existence**.
- It is of three types -
 - (a) Intra specific struggle:** It is competition among the individuals of same species for same needs like food, shelter and breeding. (Most acute type of struggle)
 - (b) Inter specific struggle:** It is the struggle among the individuals of different species for food and shelter.
 - (c) Environmental struggle:** This struggle is between the organisms and their environment. All organisms struggle with cold, heat, wind, rain, drought, flood etc.

(iii) Variations and heredity:

- Members of a population vary in characteristics (in fact no two individuals are alike) even though they look superficially similar i.e. population has built in variation in characteristics.
- Those characteristics which enable some to survive better in natural conditions (climate, food, physical factors, etc.) are called **adaptive or useful variations** while others are called as **non - adaptive or harmful variations**.
- The novelty and brilliant insight of Darwin was, he asserted that variations, which are heritable and which make resource utilisation better for few (adapted to habitat better) will enable only those to reproduce and leave more progeny.

(iv) Natural selection/ Survival of the fittest:

- Individuals with more adaptive variations are "better fit" than the individuals with less adaptive variations. Hence, those who are better fit in an environment would be selected by nature and leave more progeny than others. Darwin called it **natural selection** and implied it as a mechanism of evolution.
- **Fitness is the end result of the ability to adapt and get selected by nature.**
- The fitness, according to Darwin, refers ultimately and only to **reproductive fitness**.
- It is observed that all adult individuals of a population don't have equal chances of mating; some males with better phenotype are preferred by females. This is called **Sexual selection**.

(v) Origin of New species:

- As a result of heritable variations and natural selection there would be a change in population characteristic and hence new forms appears to arise.

Criticism of Darwinism

1. The main drawback of this theory is that Darwin didn't have the knowledge of genetics and he had no satisfactory explanation for the cause, origin and **inheritance** of variations.
2. This theory only explained the survival of fittest but was unable to explain the **arrival of fittest**.

Mutation Theory

- This theory was proposed by **Hugo de Vries** based on his work on **evening primrose (*Oenothera lamarckiana*)**.
- Large differences arising suddenly in a population are called mutations. Actually mutations are sudden changes of genetic material (DNA) and hence all are inheritable.
- In addition to recombination, mutation is another phenomenon that leads to variation in DNA.
- Mutation is a discontinuous source of variations and provides raw material for evolution.
- According to Hugo de Vries it is mutation which causes evolution and not the minor variations (heritable) that Darwin talked about.
- Mutations are **large, random** and **directionless** while Darwinian variations are **small** and **directional**.
- Evolution for Darwin was gradual while de Vries believed mutation caused speciation and hence called it **saltation** (single step large mutation).

Criticism-

- (i) Natural mutations are not very common as Hugo de Vries thought.
- (ii) Mutations are normally **recessive** & **harmful**, while the characters taking part in evolution are usually dominant.

NEODARWINISM/Modern synthetic theory of organic evolution-

- Neo-Darwinism is a modified form of Darwinism along with recent researches of **Weismann, De Vries, Stebbins, Dobzhansky, Sewall Wright, Mayr** etc.
- According to this theory following factors are responsible for formation of new species-

(i) Rapid multiplication**(ii) Limited food and space****(iii) Struggle for existence****(iv) Genetic variations**

- a) Gene recombination** - New combinations of genes which are usually caused by the crossing over during gametogenesis. It is continuous and common source of variation in a sexually reproducing population.
- b) Mutation** - Discontinuous source of variations
- c) Hybridization** - It is crossing of organisms which are genetically different in one or more traits.
- d) Gene migration & Gene flow** - When migration of a section of population to another place and population occurs, gene frequencies change in the original as well as in the new population. New genes/alleles are added to the new population and these are lost from the old population.

There would be a gene flow if this gene migration, happens multiple times.

- e) Genetic drift** - If the change in gene frequency occurs by chance, it is called genetic drift.

- (v) Natural Selection:** Natural selection is a process in which heritable variations enabling better survival are enabled to reproduce and leave greater number of progeny.

A critical analysis makes us believe that variation results in changed frequency of genes and alleles in future generation. Coupled to enhance reproductive success, natural selection makes it look like different population and lead to new species formation.

- (vi) Isolation:** Isolation is a segregation of populations by some barriers which prevent interbreeding. The reproductive isolation between the populations due to certain barriers leads to the formation of new species.

Genetic Drift (Sewall Wright effect) -

- Random change of gene/allelic frequencies in a population merely **by chance** is called genetic drift.
- It operates rapidly in **small population**.
- It is due to habitat fragmentation, isolation, natural calamities or any epidemics.
- Founder effect and bottleneck effect are two forms of genetic drift.

(a) Founder effect-

When a section of population get isolated or migrated or drifted from original population, than this section becomes genetically different from the original population due to change in allelic frequency because gene pool of this section may contain some alleles in a very low frequency or may lack a few alleles.

Sometimes the change in allelic frequency is so different in the new sample of population that they become a different species. The original drifted population becomes **founders** and the effect is called founder effect.

(b) Bottleneck effect-

Bottlenecks are the natural calamities like earthquakes, volcanic eruptions, floods, storms etc. A sudden change in the environment may drastically reduce the size of a population and now this population may be genetically different from the original population. Certain alleles may have more frequency among the survivors, others may be less, and some may be absent altogether.

If a population that has passed through a bottleneck ultimately recovers in size, it may have low levels of genetic variation for a long period of time and this may produce a new species.

HARDY-WEINBERG PRINCIPLE-

- In a given population one can find out the frequency of occurrence of alleles of a gene or a locus. This frequency is supposed to remain fixed and even remain the same through generations.
- This principle says that allele frequencies in a **randomly mating** population are stable and is constant from generation to generation. The **gene pool** (total genes and their alleles in a population) remains a constant. This is called **genetic equilibrium**. Sum total of all the allelic frequencies is 1.

$$p + q = 1$$

Where: p - Frequency of dominant allele (A)

q - Frequency of recessive allele (a)

- The binomial expansion of this equation is:

$$p^2 + 2pq + q^2 = 1$$

Where: p^2 - Frequency of individuals with genotype AA

q^2 - Frequency of individuals with genotype aa

$2pq$ - Frequency of individuals with genotype Aa

- When frequency measured, differs from expected values, then the difference (direction) indicates the extent of evolutionary change. Disturbance in genetic equilibrium, or Hardy-Weinberg equilibrium, i.e., change of frequency of alleles in a population would then be interpreted as resulting in evolution.
- Five factors are known to affect Hardy-Weinberg equilibrium. These are-
 1. Gene migration or gene flow
 2. Genetic drift
 3. Mutation
 4. Genetic recombination
 5. Natural selection

Examples of Natural Selection-

- (1) **Industrial Melanism** - This phenomenon was studied by **Bernard Kettlewell** in England.

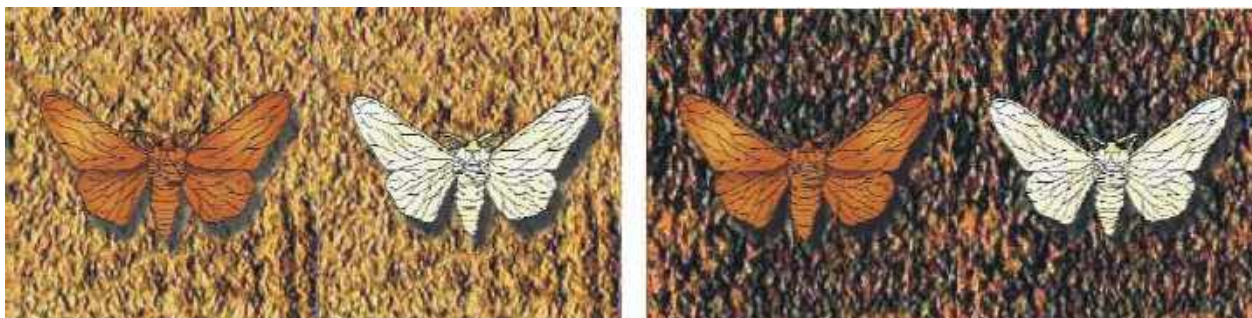


Figure showing white - winged moth and dark - winged moth (melanised) on a tree trunk
(a) In unpolluted area (b) In polluted area

- In a collection of moths (***Biston betularia***) made in 1850s, i.e., before industrialization set in, it was observed that there were more white-winged moths on trees than dark-winged or melanised moths.
 - However, in the collection carried out from the same area, but after industrialization, i.e., in 1920, there were more dark-winged moths in the same area, i.e., the proportion was reversed.
 - The explanation put forth for this observation was that '**predators will spot a moth against a contrasting background**'.
 - Before industrialization set in, thick growth of almost white-coloured lichen covered the trees - in that background the white winged moth survived but the dark-coloured moth were picked out by predators.
 - **Lichens can be used as industrial pollution indicators.** They will not grow in areas that are polluted.
 - During post industrialization period, the tree trunks became dark due to industrial smoke and soot. Under this condition the white-winged moth did not survive due to predators while dark-winged or melanised moth survived.
 - Hence, moths that were able to camouflage themselves, i.e., hide in the background, survived.
 - This understanding is supported by the fact that in areas where industrialization did not occur e.g., in rural areas, the count of melanic moths was low.
 - This showed that in a mixed population, those that can better-adapt, survive and increase in population size. Remember that no variant is completely wiped out.
- (2) **Drug resistance:** The drugs which eliminate pathogens become ineffective in the course of time because those individuals of pathogenic species which can tolerate them survive and flourish to produce tolerant/resistant population.

- ☞ Excess use of herbicides, pesticides, etc., has only resulted in selection of resistant varieties in a much lesser time scale. This is also true for microbes against which we employ antibiotics or drugs against eukaryotic organisms/cell. Hence, resistant organisms/cells are appearing in a very less time scale of months or years and not centuries. These are examples of evolution by **anthropogenic action**.
- ☞ This also tells us that evolution is not a directed process in the sense of determinism. It is a **stochastic process** based on chance events in nature and chance mutation in the organisms.

- (3) **Sickle cell anaemia and Malaria:**

- Individuals, homozygous for sickle cell anaemia die at an early stage due to anaemia and the individuals in which heterozygous condition is present for this character, the RBC become sickle shaped.
- In this type of RBC, malarial parasite can't have a normal growth and individuals become resistant towards malaria.

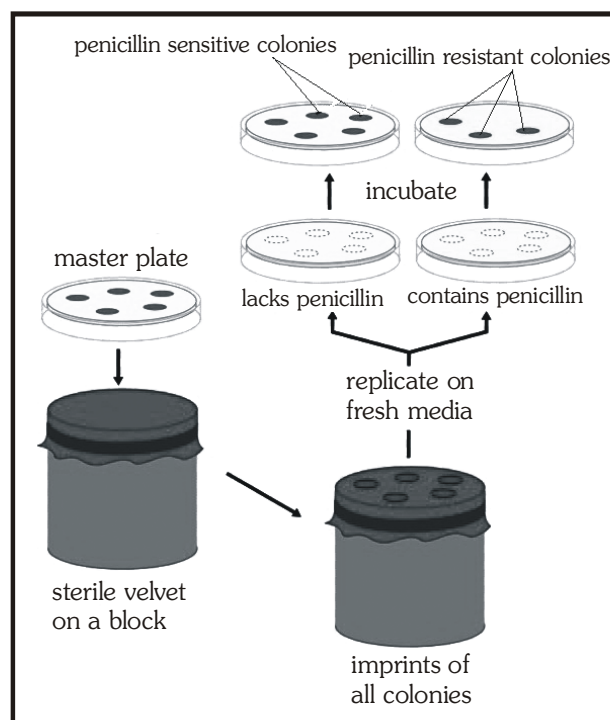
- The individuals with heterozygous condition have better chances of survival, hence are selected by nature.
- Thus the process of natural selection maintains the abnormal form of hemoglobin along with the normal form in a region where malaria is common. This type of selection is called **Balancing selection**. It means the preservation of genetic variability is maintained by the selection of heterozygote which is called **balanced polymorphism**. But this kind of balancing selection is found very rarely in nature.

GENETIC BASIS OF ADAPTATIONS/NATURAL SELECTION-

- The essence of Darwinian Theory about evolution is natural selection.
- The rate of appearance of new forms is linked to the life cycle or the life span.
- Microbes that divide fast have the ability to multiply and become millions of individuals within hours.
- A colony of bacteria (say A) growing on a given medium has built in variation in terms of ability to utilise a feed component. A change in the medium composition would bring out only that part of the population (say B) that can survive under the new conditions.
- In due course of time this variant population outgrows the others and appears as new species. This would happen within days.
- For the same thing to happen in a fish or fowl would take million of years as life spans of these animals are in years. Here we say that fitness of B is better than that of A under the new conditions.
- Fitness or adaptive ability is based on characteristics which are inherited. It has a genetic basis. Hence, **there must be a genetic basis for getting selected and to evolve**.
- Microbial experiments show that pre-existing advantageous mutations when selected will result in observation of new phenotypes. Over few generations, this would result in Speciation.

Lederberg's replica plate experiment:

- Performed by Joshua Lederberg & Esther Lederberg.
- They cultured the bacterial cells on agar plate and obtained many bacterial colonies. This multi colony agar plate is known as **master plate**.
- They prepared a **replica** of this master plate by gently pressing it on a velvet covered wooden block.
- Now they tried to prepare a replica on the agar plate which contains antibiotic penicillin. It was seen that some bacteria failed to grow on penicillin agar plate while some bacteria were able to grow and developed new colony.
- It was concluded that the bacteria which survived were penicillin resistant because they had penicillin resistant mutant gene which enabled them to survive in changed environment.
- It means mutations are pre adaptive and natural selection fixes them in a population over the generations.



Artificial Selection - Artificial selection is similar to natural selection except that the role of nature is taken over by man and the characters selected are of human use.

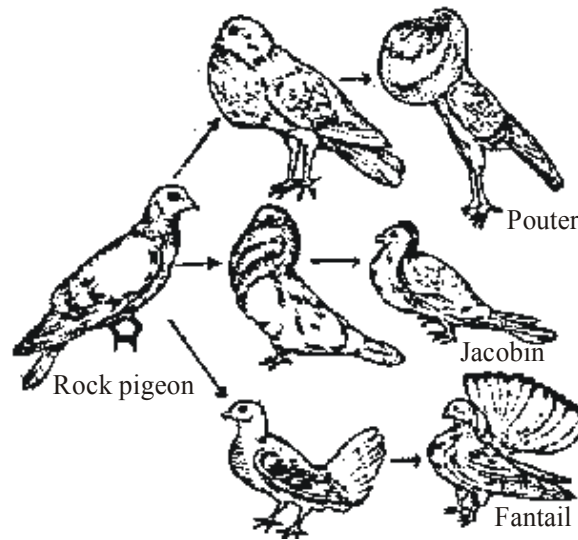
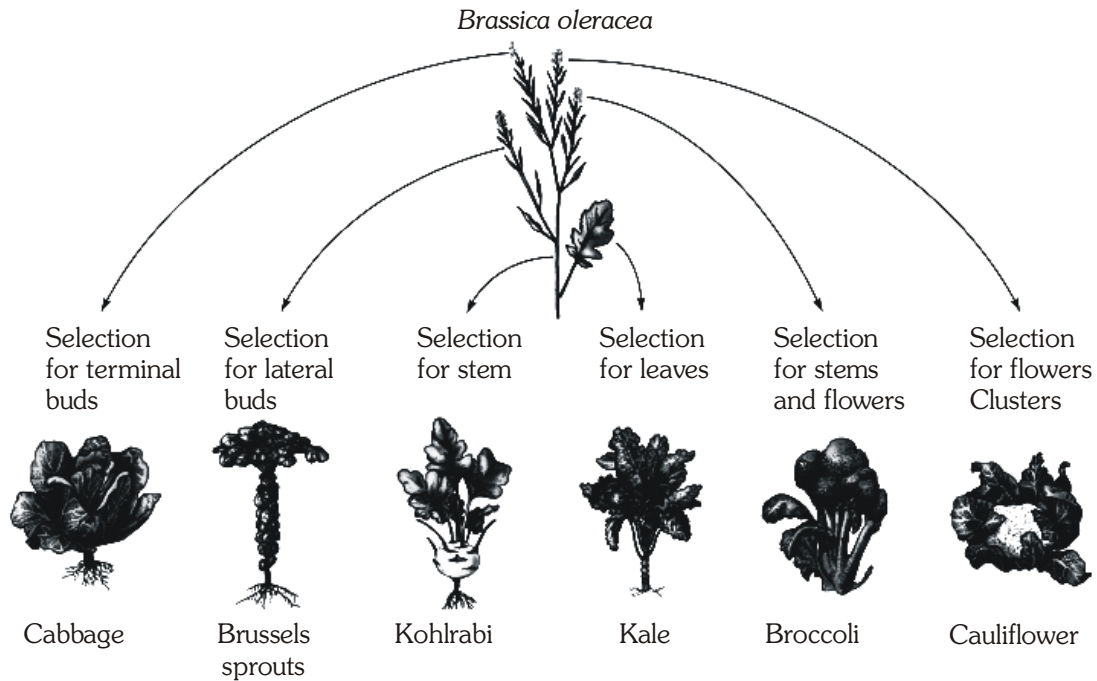


Fig.: Variations among breeds of domestic pigeons

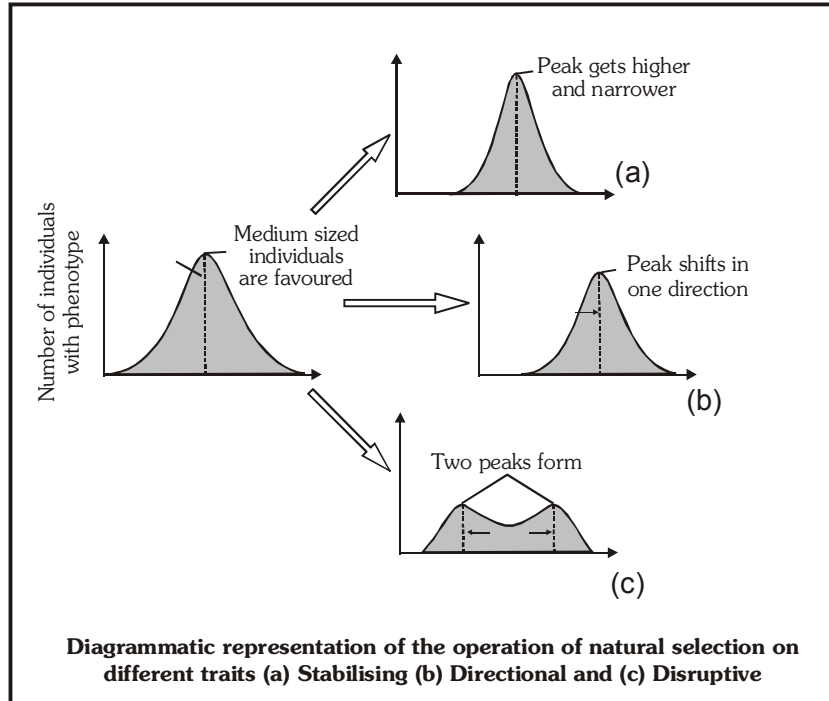
Types of Natural Selection

(1) Stabilizing selection:

- It favours the average or normal phenotype and eliminates the extreme variants.
 - After this natural selection mean value never change.
 - Peak gets higher and narrower because more individuals acquire mean character value.
 - Always operates in constant environment.
- e. g. **Mortality in human babies:** The optimum birth weight favoured by stabilizing selection is 7.3 pounds. New born infants less than 5.5 pounds and more than 10 pounds have the highest mortality rate.

(2) Directional/ Progressive selection:

- It favours one extreme value and eliminates another extreme value and average value.
 - After this natural selection mean value always changes.
 - Peak shifts in one direction because more individuals acquire value other than the mean character value.
 - Always operates in changing environment.
- e. g. (i) Industrial melanism
(ii) DDT resistance in pests

**(3) Disruptive selection:**

- In this natural selection members of both extreme are selected simultaneously and average value get rejected.
 - After this natural selection two peaks are formed because more individuals acquire peripheral character value at both ends of the distribution curve.
- e. g. **Shell pattern in limpets:** Shell patterns of limpets (marine molluscs) present a continuous, ranging from pure white to dark tan. The white or light coloured limpets camouflaged with white barnacles and tanned ones are protected on the tanned coloured rocks. Limpets of intermediate shell patterns, being conspicuous are preyed by predatory shore birds, resulting in disruptive selection.

SPECIATION-

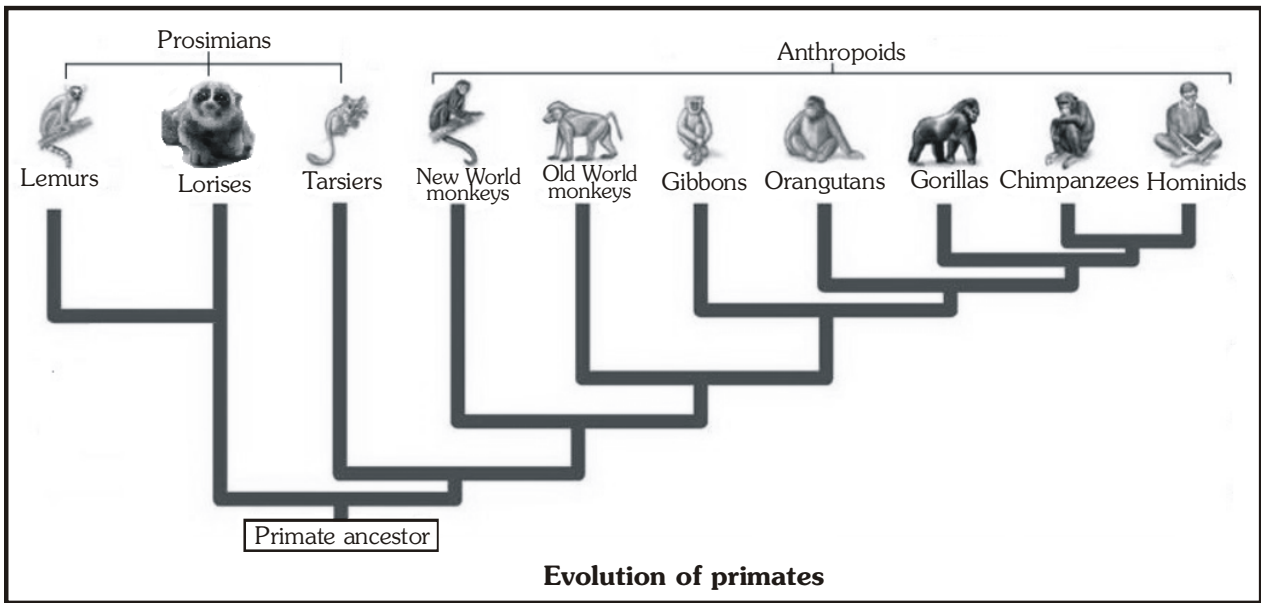
- Formation of one or more new species from an existing species is called speciation. Speciations are of two types-
 - (1) Divergent speciation
 - (2) Transformation speciation
- (1) Divergent speciation :** When one or more new species are formed from an ancestor species.
- (a) Allopatric speciation :** When a species split into two or more geographically isolated populations and these populations finally form a new species, It is called allopatric speciation e. g. Darwin finches.
- (b) Sympatric speciation :** In this type of speciation a sub population becomes reproductively isolated from its parental population. It is the formation of species without geographical isolation. e. g. mainly present in plants due to polyploidy.
- (2) Transformation speciation :** When an ancestor species changes into a new species.
- (a) Phyletic speciation :** Ancestor species changes into new species by gradual changes in thousands of years. e.g. *Eohippus* → *Mesohippus* → *Merychippus* → *Pliohippus* → *Equus*
- (b) Quantum speciation :** In this process suddenly major changes appears in ancestor species and ancestor species immediately changed into new species. No connective links are present in this type of speciation. It is caused by major mutation.

Is evolution a process or the result of a process?

The world we see, inanimate and animate, is only the success stories of evolution. When we describe the story of this world we describe evolution as a process. On the other hand when we describe the story of life on earth, we treat evolution as a consequence of a process called natural selection. We are still not very clear whether to regard evolution and natural selection as processes or end result of unknown processes.

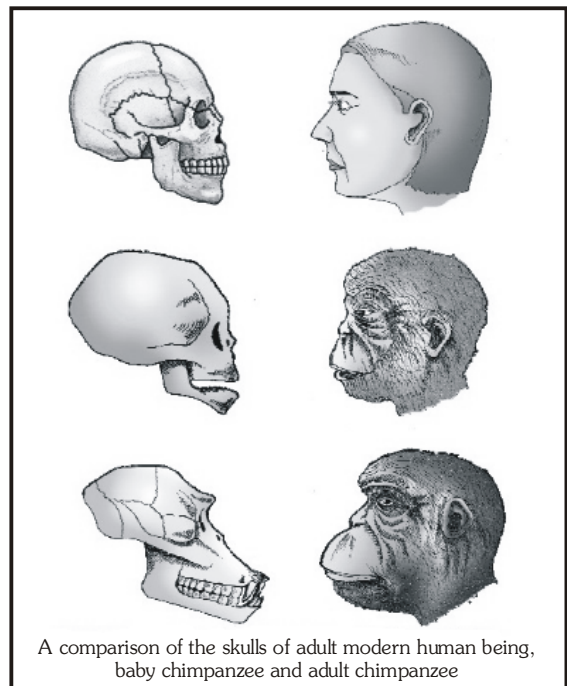
HUMAN EVOLUTION

- Human is a member of order Primata of class Mammalia.
- First real primate ancestors were **tree shrews**, originated in palaeocene epoch.



Evidences for Common Origin of Human & Apes:

- (1) **Chromosomal similarities:-**
 - Banding pattern of chromosome no. 3 & 6 of human and chimpanzee is 100% similar.
 - Number of chromosomes are approx same in human (46) and apes (48).
 - DNA content and DNA matching is same in both. This similarity is more than 99% with chimpanzee, 94% with Gibbon, 88% with Rhesus monkey.
- (2) The skull of baby chimpanzee is more like adult human skull than adult chimpanzee skull.
- (3) Composition of Hb is same in both. Only one amino acid is different in human and gorilla.
- (4) Blood group of AB series is present in both and plasma protein is also same.
- (5) Menstruation cycle is present in females of both.
- (6) Tail is absent in both and have grasping hands.



Human Evolution

(A) **Ape Fossils** - About 15 mya, primates called **Dryopithecus** and **Ramapithecus** were existing. They were hairy and walked like gorillas and chimpanzees.

(1) **Proconsul/ Dryopithecus:**

- It is considered as **common ancestor of man and apes**.
- *Dryopithecus* is considered as direct ancestors of modern day apes.
- They had **semi erect posture**, thick hair, U shaped jaws, larger and sharper teeth and were vegetarian.
- They walked on four legs and their forelimbs were longer than hind limbs.
- They were forest dwellers and spent most of the time on the trees.

(2) **Ramapithecus**

(3) **Shivapithecus**

Fossils discovered from Shivalik hills in India.

☞ **Ramapithecus was more man-like while Dryopithecus was more ape-like.**

(B) **Ape man fossils - Australopithecus**

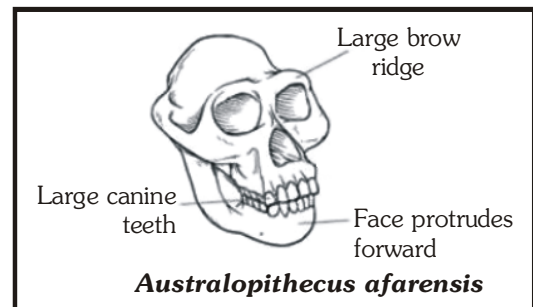
- **Prof. Raymond Dart** discovered a fossil of skull of 5-6 years old baby from the Pliocene rocks of **Tuang** region (S. Africa) and named it **Tuang baby**. Later he renamed it as **A. africanus (African apeman)**.
- 2 mya, **Australopithecines** probably lived in **East African grasslands**.
- Evidence shows they hunted with stone weapons but essentially **ate fruit**.
- It is also considered as connecting link between apes and man.

(i) **Ape like characters:**

- Less cranial capacity (**600 c.c.**)
- Thick growth of hair
- U shaped jaw (prognathous face)
- Larger and sharper teeth

(ii) **Man like characters:**

- Complete erect posture and Bipedal locomotion (**first man who stood erect**)
- Forelimbs shorter than hind limbs
- Vertebral column with distinct lumber curve



Few fossils of man-like bones have been discovered in Ethiopia and Tanzania. These revealed hominid features leading to the belief that about 3-4 mya, man-like primates walked in eastern Africa. They were probably not taller than 4 feet but walked up right.

(C) **Prehistoric Man**

A number of other species of Homo appeared and became extinct from time to time on the evolutionary sense before the origin of Homo sapiens. These extinct species are called as prehistoric species of man.

(1) **Homo habilis:**

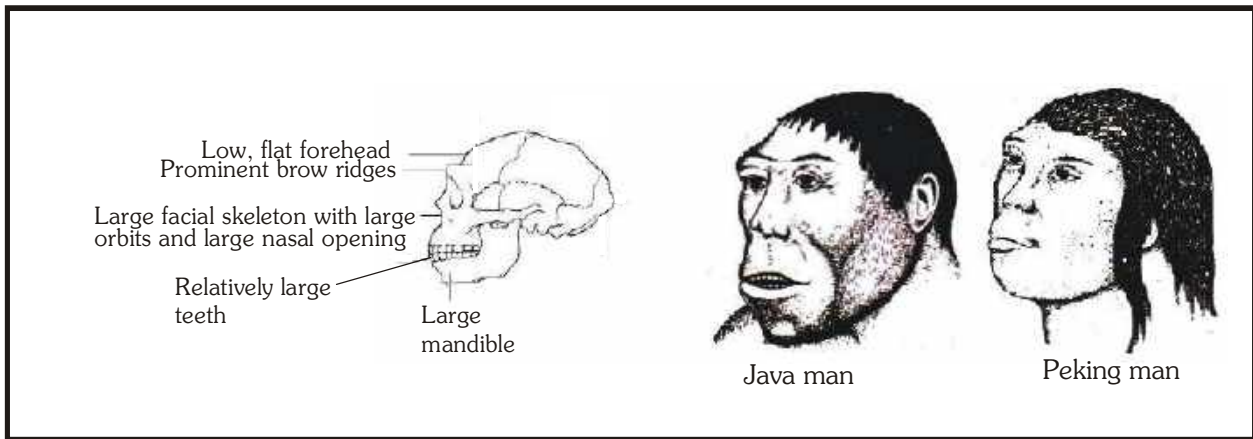
- First human like being
- First man who made tools of stones for hunting animals, hence called as **first tool maker man** or **Handy man**.
- They probably did not eat meat.
- The brain capacities were between **650-800cc**.
- Its fossils were discovered by Dr. Leakey from **2 million years old** rocks in Africa.
- They lived in caves.

(2) *Homo erectus*:

- They existed about 1.5 million years ago.
- They had large brain with a cranial capacity around **900cc**.
- They were cave dwellers and probably **ate meat**.
- Many subspecies are discovered of *Homo erectus* as given below

(a) Java man (*Homo erectus erectus*/*Pithecanthropus erectus*):

- Its fossils discovered in **Java** in 1891.
- **First man who used fire** for hunting, protection and cooking.
- They used tools of bones and stones.
- Their cranial capacity was 800-1000cc (**avg. 900cc**)
- They were omnivorous and cannibalism have also found.



(b) Peking man (*Homo erectus pekinensis*/*Sinanthropus erectus*):

- W.C. Pei discovered the fossils from China.
- They used fire for cooking meat and protection.
- They used sharp chisel shaped tools of stones/bones for cutting and killing animals.
- Their cranial capacity was 850-1300cc (**avg. 1050cc**)
- They were omnivorous and cannibalism have also found.

(c) Heidelberg man:

- Its fossil was recovered in form of lower jaw from Heidelberg in Germany.
- It is believed that this man was evolved as a branch from main line of evolution and got extinct after some time.

(3) *Homo sapiens*:

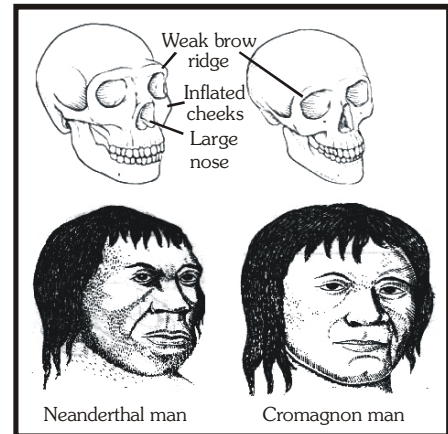
- Many subspecies are discovered of *Homo sapiens* as given below

(a) Neanderthal man (*Homo sapiens neanderthalensis*):

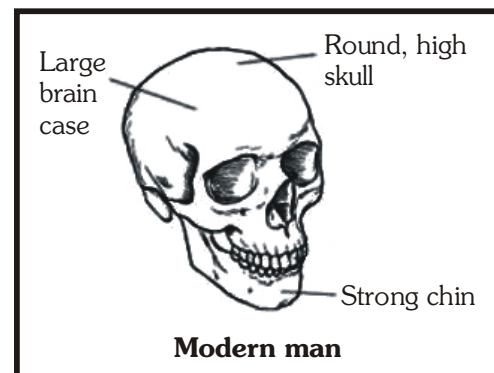
- They lived near east and central Asia between 1,00,000 - 40,000 years back, fossil was discovered by Fuhlrott in **Neanderthal valley of Germany**.
- They had a brain size of **1400cc** (same as modern man).
- They used hides (skin of animals) to protect their body.
- They **buried their dead** and probably believed in **immortality of soul**.
- They lived in huts and omnivorous by nature.
- Development of speech and language centre started.

(b) Cromagnon man (*Homo sapiens fossilis*):

- Origin and evolution 50,000 to 10,000 years ago.
- Fossils discovered by Mac Gregor from **Cromagnon rocks of France.**
- They had a cranial capacity of **1650 c.c.(maximum)**
- They lived in caves and **Omnivorous by nature.**
- They had larger forehead and well developed chin.
- Semi circular jaw and **orthognathous face.**
- Speech and language centre were well developed in them.
- They wore clothes of animal skin.
- This man was hunter and used domesticated dogs in hunting, Hence **domestication was started** by this man.
- They also **painted beautiful paintings** on **cave walls.** Pre-historic cave art developed about **18,000 years ago.**

**(c) Modern man (*Homo sapiens sapiens*):**

- During ice age between 75,000-10,000 years ago modern *Homo sapiens* arose.
- It arose in Africa and moved across continents and developed into distinct races (Caucasoid, Negroid, Mongoloid and Australoid).
- This is the **man of today** having a brain capacity of 1300 - 1600 c.c (**avg. 1450cc**).
- This man has well developed chin, well developed speech centre, smaller forehead and reduced body hair.
- Semi circular jaw and **orthognathous face.**
- It is omnivorous by nature.
- **Agriculture** was also started by this man. Agriculture came around **10,000 years back** and human settlements started.



EXERCISE

1. Primitive atmosphere was made up of the mixture of :
 - (1) Oxygen, ammonia, methane, water
 - (2) Hydrogen, ammonia, methane, oxygen
 - (3) Hydrogen, steam, methane, ammonia
 - (4) Oxygen, methane, water, nickel
2. Which compounds were formed in the direction of the origin of life :
 - (1) Urea, nucleic-acid
 - (2) Urea, amino-acid
 - (3) Proteins, nucleic-acid
 - (4) Protein, amino-acid
3. What is most important for origin of life :
 - (1) Carbon
 - (2) Oxygen
 - (3) Water
 - (4) Nitrogen
4. Pasteur succeeded in disproving the theory of spontaneous generation because :
 - (1) The laboratory was clean
 - (2) He pulled out the neck of flask into a tube
 - (3) He was lucky
 - (4) Yeast used in flask were dead
5. Oxygen in atmosphere has been formed by :
 - (1) Evaporation of water
 - (2) Photosynthesis of blue green algae
 - (3) Metabolism of microorganisms
 - (4) Decaying organisms
6. Who called larger colloidal particles of primitive sea as coacervates :
 - (1) Fox
 - (2) Oparin
 - (3) Empedocles
 - (4) Haldane
7. Who called water of primitive sea as pre biotic soup :
 - (1) Haldane
 - (2) Oparin
 - (3) Fox
 - (4) Huxley
8. Oparin's theory is based on :
 - (1) Artificial synthesis
 - (2) Spontaneous generation
 - (3) God's will
 - (4) All
9. Which biologist gave most logical biochemical theory of origin of life ?
 - (1) Urey
 - (2) Oparin
 - (3) Stanley Miller
 - (4) Haeckel
10. During the course of origin of life what was the sequence of substances which appeared on earth :
 - (1) Water, oxygen, nucleic acids, enzymes
 - (2) Amino acids, ammonia, phosphates, nucleic acids
 - (3) Glucose, amino acids, nucleic acids, proteins
 - (4) Ammonia, Amino acids, proteins, nucleic acids
11. It is believed that the first organisms which inhabited earth's surface were :
 - (1) Autotrophs
 - (2) Mixotrophs
 - (3) Heterotrophs
 - (4) Chromatotrophs
12. Who did an experiment to prove that "The organic compounds were the basis of life"?
 - (1) Darwin
 - (2) Stanley Miller and Harold C. Urey
 - (3) Melvin
 - (4) Fox
13. Due to discovery of which of the following in 1980, the evolution was termed as RNA world :
 - (1) m - RNA , t - RNA, r - RNA synthesise proteins
 - (2) In some virus RNA is genetic material
 - (3) RNA has enzymatic property
 - (4) RNA is not found in all cells
14. Which of the following is favorite idea of astronomers
 - (1) Special creation theory
 - (2) Cosmic panspermia
 - (3) Biogenesis
 - (4) Abiogenesis
15. During chemical evolution, key biological compounds were synthesised :-
 - (1) in the atmosphere
 - (2) along the ocean shore
 - (3) in the ocean
 - (4) none of the above
16. Big bang theory was proposed by :
 - (1) Kant
 - (2) Miller
 - (3) Lemaitre
 - (4) Darwin

17. Miller and Urey performed an experiment to prove the origin of life. They took gases NH_3 and H_2 along with :
- (1) N_2 and H_2O (2) H_2O and CH_4
 (3) CH_4 and N_2 (4) CO_2 and NH_3
18. Abiogenesis is the :
- (1) origin of life from non-living material
 (2) origin of life from living organism
 (3) origin of viruses and microbes
 (4) none
19. Which is vestigial organ in man :
- (1) Pinna (2) Pinna muscles
 (3) Ileum (4) Teeth
20. Which of the following set in man includes vestigial organs :
- (1) Coccyx, vermiform appendix and ear muscles
 (2) Body hair, atlas vertebra and ear muscles
 (3) Coccyx, wisdom tooth and patella
 (4) Body hair, cochlea, vermiform appendix and tongue.
21. Peripatus is connecting link between :
- (1) Mollusca and Arthropoda
 (2) Flat worms and annelida
 (3) Annelida and Arthropoda
 (4) Reptilia and Mammalia
22. According to Haeckel's biogenetic law :
- (1) Development of individual metazon shown embryonic characters of ancestors.
 (2) Ontogeny repeats phylogeny
 (3) Germplasm is immortal
 (4) Every organisms is produced by its parents
23. Which of the following set has homologous organs :
- (1) Hands of man, monkey and kangaroo and trunk of elephant
 (2) Wings of insects, birds and bats
 (3) Hind limbs of grasshopper, horse and bat
 (4) Mouthparts of cockroach, mosquito and honey bee
24. Which of the following organ in man is vestigial :
- (1) Pinna (2) Wisdom tooth
 (3) Fossa ovalis (4) Ileum
25. Who was the first to explain recapitulation theory :
- (1) Weismann (2) Haeckel
 (3) Darwin (4) Malthus
26. Connecting link between protozoa and one-celled plants is :
- (1) *Paramecium*
 (2) *Euglena*
 (3) *Amoeba*
 (4) *Trypanosoma*
27. Connecting link between annelida and mollusca :
- (1) Cuttle fish (2) *Octopus*
 (3) *Neopilina* (4) *Nautilus*
28. Which of the following sets do not have homologous organs :
- (1) Wings of mosquito and butterfly
 (2) Wings of butterfly and bat
 (3) Mouth parts of cockroach and butter fly
 (4) None of them
29. Wings of locust, pigeon, and bat are example of :
- (1) Vestigial organs (2) Analogous organs
 (3) Homologous organs (4) Exoskeleton
30. Homology is exhibited by :
- (1) Wings of butterfly, birds and bat
 (2) Paddle of whale, forearm of horse and forelimbs of man
 (3) Tail of monkey and bird
 (4) Sting of scorpion and honey bee
31. Golden age of Dinosaurs was during :
- (1) Cenozoic era (2) Palaeozoic era
 (3) Archeozoic era (4) Mesozoic era
32. Evolution of birds and mammals occurred in :
- (1) Eocene and oligocene periods
 (2) Silurian and devonian periods
 (3) Carboniferous and Permian periods
 (4) Cretaceous and triassic periods
33. The mesozoic era of earth is called the :
- (1) Age of amphibians
 (2) Age of armoured fishes
 (3) Age of primitive man
 (4) Age of ruling reptiles

- 34.** An era "age of birds and mammals" is :
 (1) Mesozoic (2) Palaeozoic
 (3) Cenozoic (4) Cretaceous
- 35.** Origin of life took place in which of the following era :
 (1) Mesozoic (2) Palaeozoic
 (3) Precambrian (4) Proterozoic
- 36.** Homologous organs are
 (1) Dissimilar origin and dissimilar structures
 (2) Dissimilar origin but similar functions
 (3) Similar origin with similar or dissimilar functions
 (4) Similar origin with dissimilar functions
- 37.** Human hand, wing of bat and flipper of whale represent
 (1) Analogous organs
 (2) Vestigial organs
 (3) Homologous organs
 (4) Evolutionary organs
- 38.** Dinosaurs disappeared during :
 (1) Jurassic (2) Triassic
 (3) Cretaceous (4) Permian
- 39.** A connecting link between reptiles and birds is :
 (1) Archaeopteryx (2) Platypus
 (3) Java Ape man (4) Whale
- 40.** Evolution of heart from one to two, three and four chambered proves :-
 (1) Biogenetic law of Haeckel
 (2) Lamarckism
 (3) Hardy weinberg's law
 (4) Neo Darwinism
- 41.** Mammals like reptile originated in:-
 (1) Jurassic (2) Triassic
 (3) Cretaceous (4) Permian
- 42.** Which is not a vestigial organ in man-
 (1) Third molar
 (2) Nails
 (3) Segmental muscles of abdomen
 (4) Coccyx
- 43.** Which evidence of evolution is related to Darwin's finches -
 (1) Evidences from biogeographical distribution
 (2) Evidences from vestigial organs
 (3) Evidences from embryology
 (4) Evidences from palaeontology
- 44.** Similarities in organisms with different genotype indicate :-
 (1) Microevolution
 (2) Macroevolution
 (3) Convergent evolution
 (4) Divergent evolution
- 45.** Potato and sweet potato :-
 (1) have edible parts which are homologous organs
 (2) have edible parts which are analogous organs
 (3) have been introduced in India from the same place
 (4) are two species of the same genus
- 46.** The first modern birds appeared during the :-
 (1) Cretaceous period (2) Jurassic period
 (3) Triassic period (4) Carboniferous period
- 47.** Fossils are :
 (1) animals living in burrows
 (2) remnants of extinct animals and plants
 (3) floating organisms
 (4) fast runners
- 48.** The age of fossils is determined by :
 (1) analysis of bones
 (2) radioactive c^{14} dating
 (3) electron microscopy
 (4) weighing the fossils
- 49.** Missing link in evolution is :
 (1) Peripatus (2) Limulus
 (3) Pheretima (4) Archaeopteryx
- 50.** Convergent evolution of two species is associated with:
 (1) analogous organs
 (2) recent common ancestor
 (3) homologous organs
 (4) different habitat
- 51.** Organs which have the same fundamental structure but are different in function, are called :
 (1) vestigial organs (2) homologous organs
 (3) analogous organs (4) homoplastic organs
- 52.** Wings of insects and wings of birds are the examples of :
 (1) Analogy (2) Homology
 (3) Serology (4) Mimicry

53. Archaeopteryx, a transitional fossil between birds and reptiles was discovered from the rocks of following period :
- (1) Jurassic (2) Archeozoic era
(3) Cretaceous (4) Triassic
54. Which of the following is not vestigial in man ?
- (1) Tail vertebrae (2) Nails
(3) Nictitating membrane (4) Vermiform appendix
55. Which one of the following is not a vestigial structure in *Homo sapiens* ?
- (1) Third molar (2) Epiglottis
(3) Plica semilunaris (4) Segmental muscle
56. Flippers of seal are modified :
- (1) fins (2) hindlimb
(3) forelimb (4) gills
57. Darwin's finches are an example of :
- (1) Divergent evolution
(2) Adaptive radiation
(3) Allopatric speciation
(4) All of these
58. Change with descent is the basis of which theory :
- (1) Recapitulation theory
(2) Oparin's theory
(3) Theory of organic evolution
(4) Cell theory
59. Name of the scientist who gave Mutation Theory :
- (1) Wallace (2) Malthus
(3) Darwin (4) De Vries
60. Darwin's Theory of Natural Selection was based on:
- (1) Inheritance of acquired characters
(2) Mutation
(3) Enormous rate of reproduction in organisms, struggle for existence and survival of the fittest
(4) Changes due to the use and disuse of organs
61. One of the revolutionary concepts in biology was Charles Darwin's 'Origin of Species'. It deals with
- (1) Gene mutation
(2) Use and disuse of organs
(3) Germplasm Theory
(4) Natural selection leading to the survival of the fittest
62. Which of the following is responsible for evolution according to Neo-Darwinism :
- (1) Mutation
(2) Natural selection
(3) Mutation and Natural selection
(4) Either (1) or (2)
63. Which is the most important factor for evolution of new species :
- (1) Geographic isolation (2) Extensive in-breeding
(3) Extensive out-breeding (4) None
64. Frequency of an allele in an isolated population may change due to :-
- (1) Genetic drift (2) Gene flow
(3) Mutation (4) Natural selection
65. Some bacteria are able to grow in Streptomycin containing medium due to -
- (1) Natural selection
(2) Induced mutation
(3) Reproductive isolation
(4) Genetic drift
66. Which of the following is important for speciation :
- (1) Seasonal isolation
(2) Reproductive isolation
(3) Behavioural isolation
(4) Tropical isolation
67. Genetic drift operates in :-
- (1) Small isolated population
(2) Large isolated population
(3) Fast reproductive population
(4) Slow reproductive population
68. De Vries gave his mutation theory on organic evolution while working on -
- (1) *Oenothera lamarckiana*
(2) *Drosophila melanogaster*
(3) *Pisum sativum*
(4) *Althea rosea*
69. Which of the following factors help in evolution but is not considered as the basic factor for evolution :
- (1) Isolation (2) Adaptation
(3) Variation (4) Mutation

- 70.** Factors helps in the formation of new species are :
- (1) competition and variation
 - (2) isolation and competition
 - (3) competition and mutation
 - (4) isolation and mutation
- 71.** The idea not related to the Darwinian evolutionary theory is :
- (1) survival of the best
 - (2) struggle for existence
 - (3) inheritance of acquired characters
 - (4) origin of species by natural selection
- 72.** Coverstone of theory of Darwin was :
- (1) natural selection
 - (2) inheritance of acquired characters
 - (3) omnis cellulae e cellulae
 - (4) higher productivity
- 73.** The chance of elimination of genes from a small population is an example of :
- (1) selection pressure
 - (2) speciation
 - (3) adaptation
 - (4) genetic drift
- 74.** Struggle for existence and survival of the fittest theories were given by :
- (1) Wallace
 - (2) Darwin
 - (3) Lamarck
 - (4) none of these
- 75.** Initiating force of evolution is :
- (1) Variation
 - (2) Natural selection
 - (3) Adaptation
 - (4) Competition
- 76.** According to the Neo-Darwinian theory which of the following is responsible for the origin of new species?
- (1) Mutations only
 - (2) Useful variations and natural selection
 - (3) Mutations together with natural selection
 - (4) Hybridization only
- 77.** Which of the following was not given by Darwin's theory of evolution ?
- (1) Struggle for existence
 - (2) Over production
 - (3) Natural selection
 - (4) Genetic drift
- 78.** Which primate is closest to man regarding organic evolution :
- (1) Gibbon
 - (2) Gorilla
 - (3) Sinanthropus
 - (4) Orangutan
- 79.** Which character applies to *Homo sapiens* :
- (1) Opposable toe
 - (2) Large canine
 - (3) Cranial capacity 1450 cc
 - (4) Chin prominence absent
- 80.** Which of the following statement is correct :
- (1) Proconsul was ancestor of man and ape
 - (2) Proconsul was ancestor of man and not of ape
 - (3) Apes were ancestor of man anatomically
 - (4) None of them
- 81.** Most recent man found as fossil was :
- (1) Java man
 - (2) Peking man
 - (3) Cro-magnon man
 - (4) Hiedelberg man
- 82.** What was the cranial capacity of java man :
- (1) 400 cc
 - (2) 650 cc
 - (3) 900 cc
 - (4) 1450 cc
- 83.** Which fossil man had cranial capacity almost equal to modern man :
- (1) *Australopithecus*
 - (2) Java ape man
 - (3) Neanderthal man
 - (4) Peking man
- 84.** Largest cranial capacity was found in :
- (1) Peking man
 - (2) Neanderthal man
 - (3) Java man
 - (4) Cro-magnon man
- 85.** Cro-magnon man was :
- (1) herbivorous
 - (2) frugivorous
 - (3) carnivorous
 - (4) omnivorous
- 86.** Which of the following is the most primitive ancestor of man ?
- (1) *Homo habilis*
 - (2) *Ramapithecus*
 - (3) *Australopithecus*
 - (4) *Homo neanderthalensis*
- 87.** *Homo habilis* refers to :
- (1) Wandering species
 - (2) Ancient man
 - (3) Modern man
 - (4) Tool-maker
- 88.** Which of the following statement is true:-
- (1) *Homo erectus* is direct ancestor of *Homo sapiens*
 - (2) Neanderthal man is direct ancestor of modern man
 - (3) *Australopithecus* is direct ancestor of modern man
 - (4) Fossils of Cromagnon man first found in Ethopia

- 89.** Which of the following is the closer relative of man:-
 (1) Chimpanzee (2) Gorilla
 (3) Oranguttan (4) Gibbon
- 90.** Which of the following is correct order of the evolutionary history of man :-
 (1) Peking man, *Homo sapiens*, Neanderthal man, Cromagnon man
 (2) Peking man, Neanderthal man, *Homo sapiens*, Cromagnon man
 (3) Peking man, Heidelberg man, Neanderthal man, Cromagnon man
 (4) Peking man, Neanderthal man, *Homo sapiens*, Heidelberg man
- 91.** According to fossils which are discovered up to present time, origin and evolution of man was started from which country :
 (1) France (2) Java (3) Africa (4) China
- 92.** The banding pattern of chromosomes of 3 and 6 of human beings and chimpanzee shows that they had :
 (1) common origin
 (2) different origin
 (3) same number of chromosomes
 (4) similar blood groups
- 93.** Which of the following ancestor of man was fond of painting and weapons making :
 (1) Neanderthal man
 (2) Cromagnon man
 (3) Java man
 (4) Peking man
- 94.** The scientific name of *Homo erectus erectus* has been given to :
 (1) Cromagnon man (2) Neanderthal man
 (3) Java ape man (4) Peking man
- 95.** Closest ancestor to modern man was :
 (1) Neanderthal man
 (2) Homo habilis
 (3) Cro-magnon man
 (4) *Australopithecus*
- 96.** The cranial capacity of Peking man was about :
 (1) 900 cc (2) 1660 cc
 (3) 1075 cc (4) 1450 cc
- 97.** Ancestor of man who first stood erect was :
 (1) *Australopithecus* (2) Cro-magnon man
 (3) Java man (4) Peking man

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	3	3	2	2	2	1	1	2	4	3	2	3	2	3
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	2	1	2	1	3	2	4	2	2	2	3	2	2	2
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	4	4	3	3	3	3	3	1	1	4	2	1	3	2
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	2	4	1	2	1	1	2	2	3	4	3	4	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	4	3	1	1	1	2	1	1	2	4	3	1	4	2	1
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Ans.	3	4	3	3	1	3	3	3	4	4	2	4	1	1	3
Que.	91	92	93	94	95	96	97								
Ans.	3	1	2	3	3	3	1								

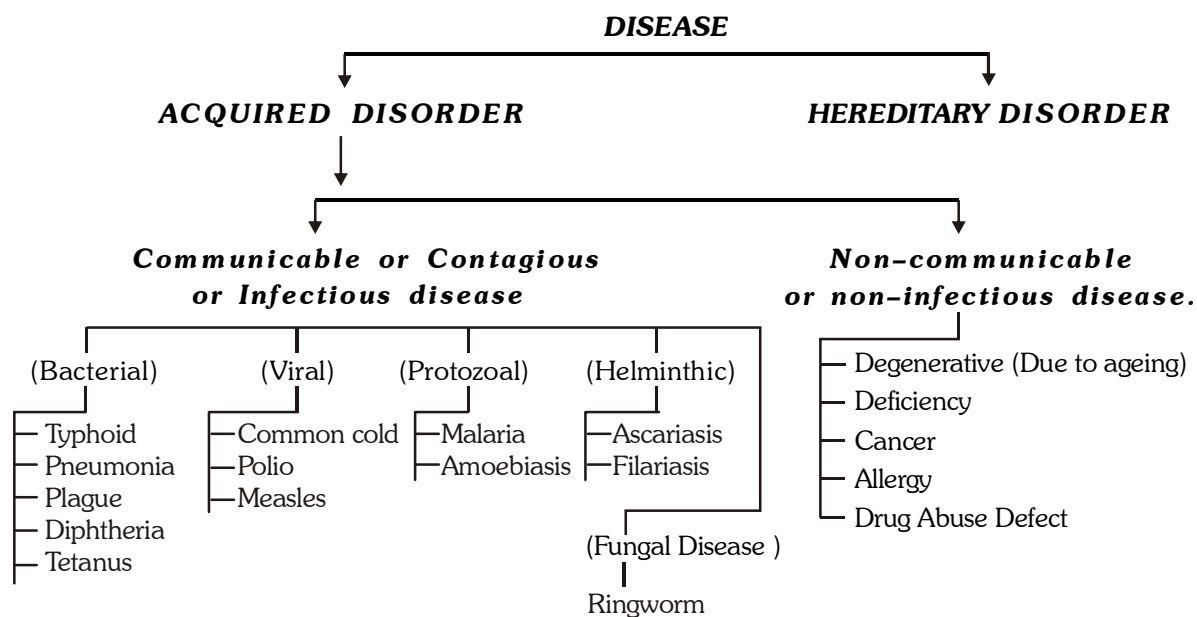
HUMAN HEALTH AND DISEASES

1.0 INTRODUCTION

- Health, for a longer time, was considered as a state of body and mind where there was a balance of certain 'humors'. This is what early Greeks like Hippocrates as well as Indian Ayurveda system of medicine asserted. It was thought that persons with '**blackbile**' belonged to hot personality and would have fevers. The discovery of blood circulation by **William Harvey** using experimental method and the demonstration of **normal body temperature in persons with blackbile using thermometer disproved the 'good humor' hypothesis of health.**
- In later years, biology stated that mind influences, through neural system and endocrine system, our immune system and that our immune system maintains our health. Hence, mind and mental state can affect our health. Of course, health is affected by – **Genetic disorders, Infections and Life style**
- The term **health** is very frequently used by everybody. *How do we define it?* Health does not simply mean 'absence of disease' or 'physical fitness'. It could be defined as a state of complete **physical, mental and social well-being**. When people are healthy, they are more efficient at work. This increases productivity and brings economic prosperity. Health also increases longevity of people and reduces infant and maternal mortality.
- Balanced diet, personal hygiene, regular exercise, yoga, awareness about diseases, vaccination (immunisation), proper disposal of wastes, control of vectors and maintenance of hygienic food and water resources are necessary for achieving good health.

2.0 COMMON DISEASES IN HUMANS

- Disease can be broadly grouped into following categories

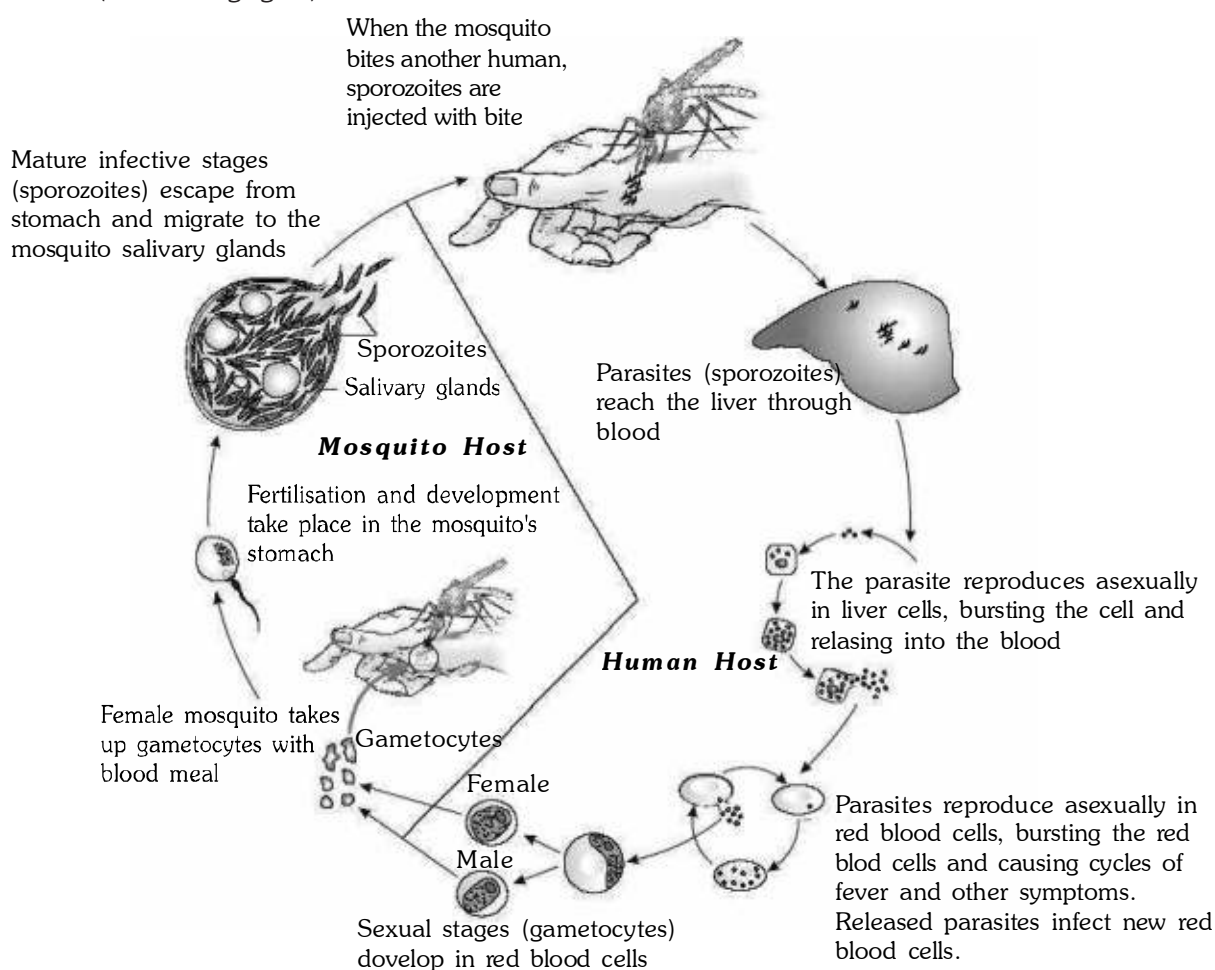


- Salmonella typhi** is a pathogenic bacterium which causes **typhoid** fever in human beings. These pathogens generally enter the **small intestine** through **food and water contaminated** with them and migrate to other organs through blood. **Sustained high fever (39° to 40°C), weakness, stomach pain, constipation, headache and loss of appetite** are some of the common symptoms of this disease. Intestinal perforation and death may occur in severe cases. Typhoid fever could be confirmed by **Widal test**. A classic case in medicine, that of **Mary Mallon** nicknamed **Typhoid Mary**, is worth mentioning here. She was a cook by profession and was a typhoid carrier who continued to spread typhoid for several years through the food she prepared.
- Bacteria like **Streptococcus pneumoniae** and **Haemophilus influenzae** are responsible for the disease **pneumonia** in humans which infects the **alveoli (air filled sacs) of the lungs**. As a result of the infection, the alveoli get filled with fluid leading to severe problems in **respiration**. The symptoms of pneumonia include fever, **chills, cough and headache**. In severe cases, the **lips and finger nails** may turn **gray to bluish in colour**. A healthy person acquires the infection by inhaling the droplets/aerosols released by an infected person or even by sharing glasses and utensils with an infected person.

- **Dysentery, plague, diphtheria**, etc., are some of the other bacterial diseases in man.
- **Rhino viruses** cause one of the most infectious human ailments – the **common cold**. They **infect the nose** and **respiratory passage but not the lungs**. The common cold is characterised by **nasal congestion** and **discharge, sore throat, hoarseness, cough, headache, tiredness**, etc., which usually last for 3-7 days. Droplets resulting from cough or sneezes of an infected person are either inhaled directly or transmitted through **contaminated objects** such as pens, books, cups, doorknobs, computer keyboard or mouse, etc., and cause infection in a healthy person.

2.3 Protozoan Diseases

- **Plasmodium**, a tiny protozoan is responsible for Malaria. Different species of **Plasmodium** (**P. vivax, P. malaria** and **P. falciparum**) are responsible for different types of malaria. Of these, malignant malaria caused by **Plasmodium falciparum** is the most serious one and can even be fatal. Let us take a glance at the life cycle of **Plasmodium**. **Plasmodium** enters the human body as **sporozoites (infectious form)** through the bite of infected female **Anopheles mosquito**. The parasites initially multiply within the liver cells and then attack the red blood cells (RBCs) resulting in their rupture. The rupture of RBCs is associated with release of a toxic substance, **haemozoin**, which is **responsible for the chill and high fever** recurring every three to four days. When a female **Anopheles** mosquito bites an infected person, these parasites enter the mosquito's body and undergo further development. The parasites multiply within them to form sporozoites that are stored in their **salivary glands**. When these mosquitoes bite a human, the sporozoites are introduced into his/her body, thereby initiating the events mentioned above. It is interesting to note that the malarial parasite requires two hosts – human and mosquitoes – to complete its life cycle. The female **Anopheles** mosquito is the vector (transmitting agent) too.



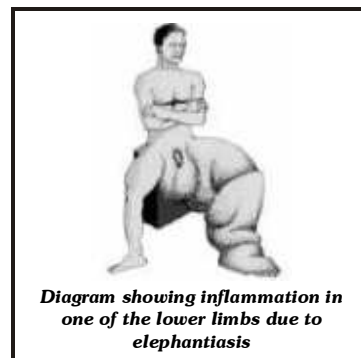
Stages in the life cycle of Plasmodium

- **Entamoeba histolytica** is a protozoan parasite **in the large intestine** of human which causes **amoebiasis (amoebic dysentery)**. **Symptoms** of this disease include constipation, abdominal pain and cramps, stools with excess mucous and blood clots. **Houseflies** act as **mechanical carriers** and serve to transmit the parasite from faeces of infected person to food and food products, thereby **contaminating** them. Drinking water and food contaminated by the faecal matter are the main source of infection.

2.4 Helminth Diseases

- **Ascaris**, the "common round worm" and **Wuchereria**, the "filarial worm", are some of the helminths which are known to be pathogenic to man.

- *Ascaris*, an intestinal parasite causes **ascariasis**. Symptoms of these disease include **internal bleeding, muscular pain, fever, anemia** and **blockage of the intestinal passage**. The eggs of the parasite are excreted along with the faeces of infected persons which contaminate soil, water, plants, etc. A healthy person acquires this infection through **contaminated water, vegetables, fruits**, etc.



- **Wuchereria** (*W. bancrofti* and *W. malayi*), the filarial worms cause a slowly developing chronic inflammation of the organs in which they live for many years, usually the **lymphatic vessels of the lower limbs** and the disease is called **elephantiasis** or **filariasis**. The **genital organs** are also often affected, resulting in gross deformities. The pathogens are transmitted to a healthy person through the bite by the female mosquito vectors.

2.5 Fungal Disease (Dermatophytoses)

- Many **fungi** belonging to the genera **Microsporum, Trichophyton** and **Epidermophyton** are responsible for **ringworms** which is one of the **most common infectious diseases** in man. Appearance of **dry, scaly lesions on various parts** of the body such as **skin, nails and scalp** are the main symptoms of the disease. These lesions are accompanied by intense itching. Heat and moisture help these fungi to grow, which makes them thrive in skin folds such as those in the groin or between the toes. Ringworms are generally acquired from soil or by using towels, clothes or even the comb of infected individuals.



2.6 AIDS (Acquired Immuno Deficiency Syndrome)

The word AIDS stands for Acquired Immuno Deficiency Syndrome.

This means **deficiency of immune system, acquired during the lifetime of an individual indicating that it is not a congenital disease**. 'Syndrome' means a group of symptoms. AIDS was first reported in 1981 and in the last twenty-five years or so, it has spread all over the world killing more than 25 million persons. It is characterised by **decrease in number of helper T-cells**. Also called **slim disease**. It was first detected in homosexual males in USA (1981) at Disease control centre Atlanta. In India first AIDS case was reported in 1986 from chennai.

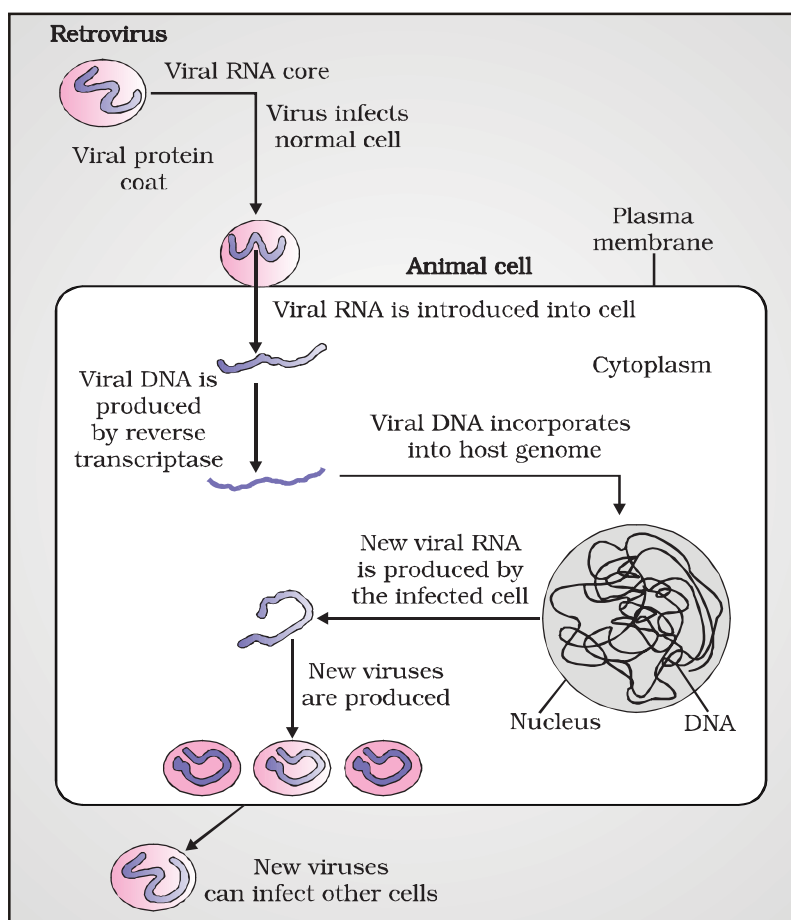
2.6.1 Misconceptions

AIDS do not spread through more touch, physical contact, hugging, kissing, sharing meals, shaking hands, mosquito bites, coughing, sneezing looking after AIDS patients.

HIV spreads only through body fluids and transmission of HIV-infection generally occurs by (a) sexual contact with infected person, (b) by transfusion of contaminated blood and blood products, (c) by sharing infected needles as in the case of intravenous drug abusers and (d) from infected mother to her child through placenta.

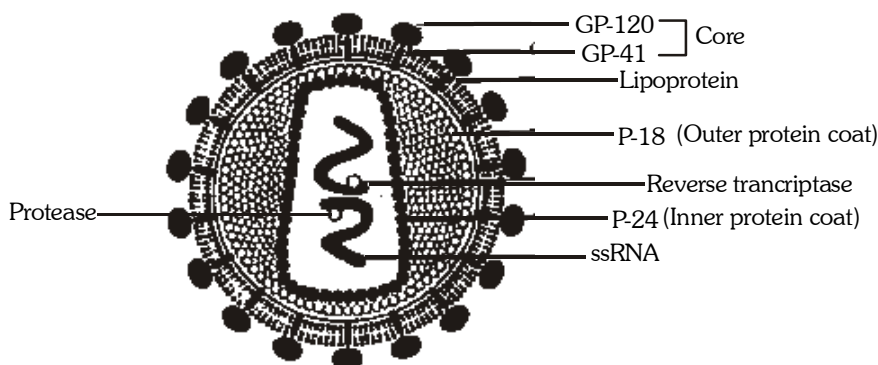
2.6.2 Pathogenicity

- After getting into the body of the person, the virus enters into macrophages where RNA genome of the virus replicates to form viral DNA with the help of the enzyme **reverse transcriptase**. This viral DNA gets incorporated into host cell's DNA and directs the infected cells to produce virus particles. The macrophages continue to produce virus and in this way acts like a **HIV factory**. **Simultaneously**, HIV enters into helper T-lymphocytes (T_H), replicates and produce progeny viruses. The progeny viruses released in the blood attack other helper T-lymphocytes. This is repeated leading to a progressive decrease in the number of helper T-lymphocytes in the body of the infected person. During this period, the person suffers from bouts of fever, diarrhoea and weight loss. Due to **decrease in the number of helper T lymphocytes**, the person starts suffering from infections that could have been otherwise overcome such as those due to bacteria especially Mycobacterium, viruses, fungi and even parasites like Toxoplasma. The patient becomes so immuno-deficient that he/she is unable to protect himself/herself against these infections.



Structure :

- Retro virus (Lenti virus family)
- Core has 2 identical molecules of SSRNAs, enzymes (reverse transcriptase, protease)



Symptoms :

Asymptomatic phase : There is always a time lag between the infection and appearance of AIDS symptoms. This period may vary from a few months to many years usually 5 to 10 years. There is no antibody, protection in 1st **(2-12 weeks)** so infectivity of patients or activeness of virus is maximum in this period. This period is called Window Period (No specific symptom appears in this phase so ELISA test is negative in **window period**)

AIDS related complex (ARC) : mild form of HIV, swollen lymph nodes, bouts of fever, repeated episodes of diarrhoea, weight loss, prolonged cough. Patient becomes fully immune deficient in this period. T-lymphocytes or CD_4 count $< 200 \times 10^6$ /litre (normal CD_4 count $> 900 \times 10^6$ per/litre) and now this condition is called full blown AIDS.

- Full blown AIDS**
- = Tuberculosis by **Mycobacterium avium**.
 - = Candidiasis of mouth and oesophagus by **Candida albicans**
 - = Pneumonia by fungus **Pneumocystis carinii**
 - = Cancer of skin and lymph nodes (Kaposi's sarcoma), HIV acts as an oncovirus.
 - = Encephalitis by **Toxoplasma gondii**

Most of infections are due to opportunistic infections, appear when immunity becomes weak.

Investigation :

Screening test : (ELISA) Enzyme linked immunosorbent assay.

Confirmatory tests : Western blot test which detects antibodies, in patient's serum.

Treatment : Treatment of AIDS with anti-retroviral drug is partially effective.

Prevention :

As AIDS has no cure, prevention is the best option. Moreover, **HIV infection**, more often, **spreads due to "conscious behaviour patterns"** and is not something that happens inadvertently, like pneumonia or typhoid. Of course, infection in blood transfusion patients, new-borns (from mother) etc., may take place due to poor monitoring. The only excuse may be ignorance and it has been rightly said – **"don't die of ignorance"**.

- Education : **NACO** (National AIDS Control Organisation) has been set up under health family welfare ministry. (**NGOs** / Non government organisation also playing their important role)
- Screening of blood,
- Ban on prostitution, Safer sex and awareness about use of condoms.
- Use of disposables
- Sterilization of Razors, blades and dental equipments.
- AIDS patients need help and sympathy instead of being shunned by society.

It is a malady that can only be tackled by society and medical fraternity acting together to prevent spread of the disease.

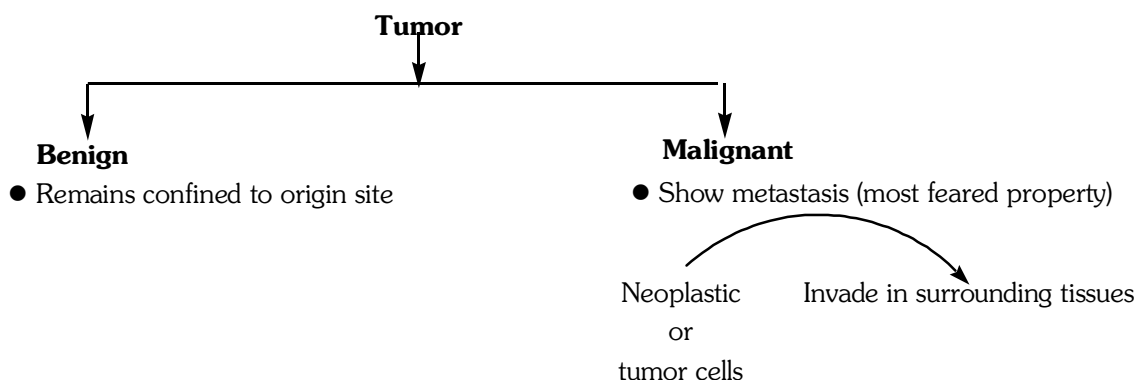
2.7 Cancer

- Cancer is one of the most dreaded diseases of human beings and is a major cause of death all over the globe. More than a million Indians suffer from cancer and a large number of them die from it annually. The mechanisms that underlie development of cancer or oncogenic transformation of cells, its treatment and control have been some of the most intense areas of research in biology and medicine.

Uncontrolled, Abnormal and **excessive mitotic** division of cells is called **cancer** (Crab = cancer).

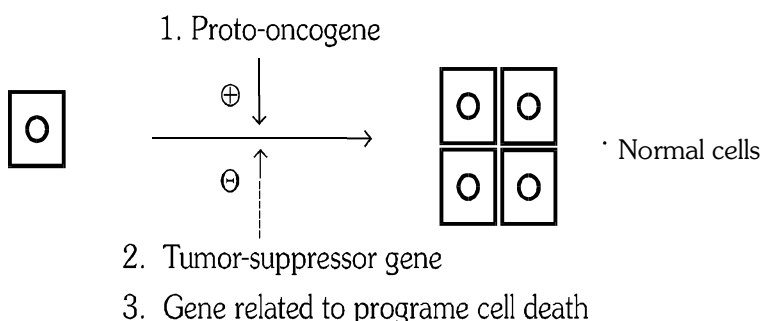
Study of cancer is called **oncology**

This abnormal and undifferentiated cells are called **cancerous cells**.

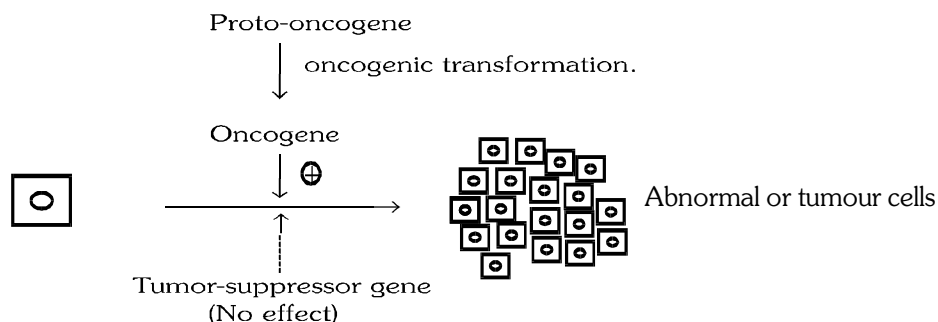


- Normal mechanism of body growth –**

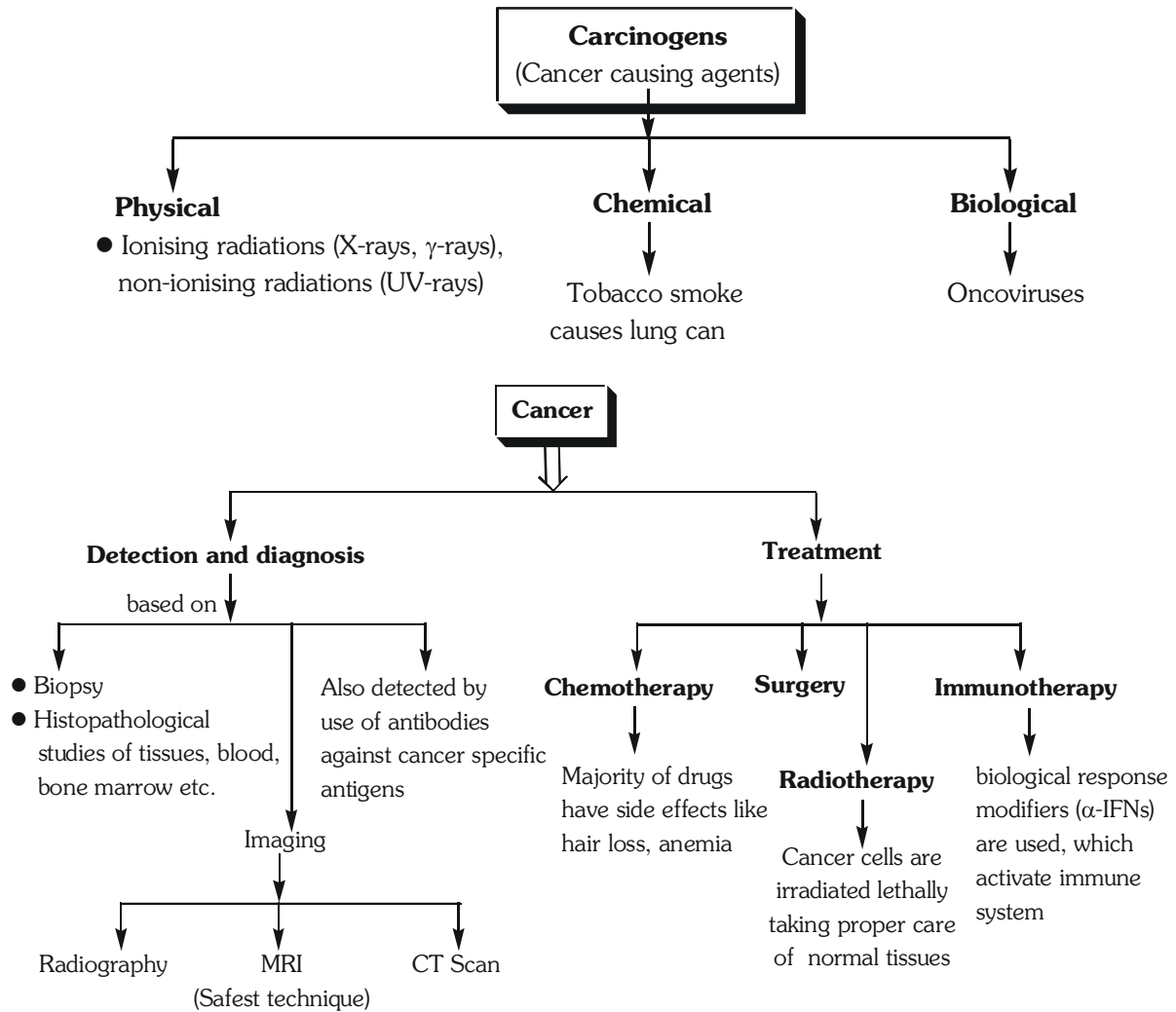
Normal cell division regulation by proto-oncogenes and it is suppressed by tumour suppressor gene.



Transformation of a normal cell into cancer cell if the regulation is upset.



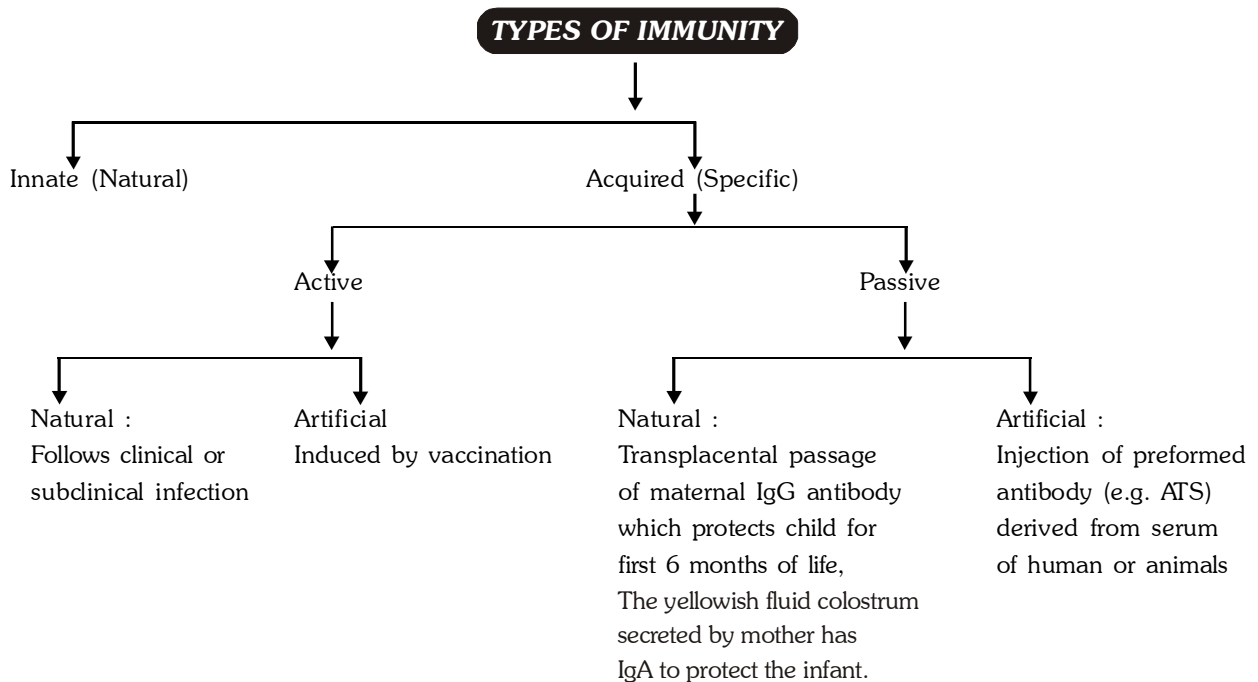
Cancer cells don't show **contact inhibition** phenomenon which is shown by normal cells (when normal cells contact with other cells they inhibit uncontrolled growth by activation of tumour suppressor gene of cells).



- most of cancer are treated by combination therapy of surgery, radiation and anti cancerous drug.

3.0 Immunity

- Body resistance against diseases is called immunity.



3.1 Innate/Congenital Immunity

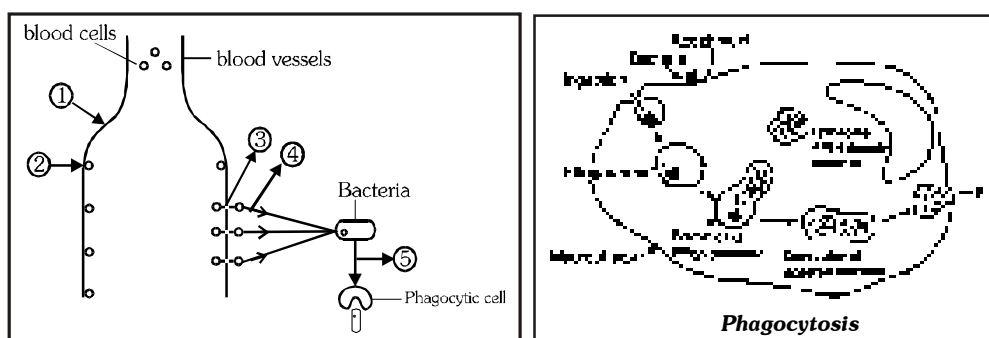
- It is **present by birth** and In most of animal, It is first line of defence of body. It is made up of following barriers.

(A) **Anatomical / Physical Barrier** : It is made up of two parts : **Skin and Mucosal surface**

(B) **Physiological Barriers** : it is made up of **Fever, pH of body, Secretions** like **lysozyme enzyme** and **Interferon**. Interferon are Anti-viral protein made up to 270 amino acids secreted by virus infected cells and stimulates the adjacent cells to produce the Translation Inhibiting Protein (T.I.P.)

(C) **Phagocytic / Cellular Barrier** :- Phagocytosis is exhibited by some types of WBC's which are called phagocytes. Most important phagocytes are **macrophages** and **Neutrophils**. Monocytes are liberated at the site of infection these later converted into macrophages. **Macrophages** are large irregular shaped cells that engulf microbes, virus, cellular debris etc in response to an infection.

Steps of Phagocytosis – (1) Vasodilation (Blood stasis), (2) Adhesion, (3) Migration or diapedesis, (4) Chemotaxis (Neutrophils or Monocytes), (5) Phagocytosis



(D) **Inflammatory Barrier** :

Inflammation : Local response of living mammalian tissue to injury due to any agent. It is the body defence reaction in order to eliminate or limit the spread of infectious agent.

Inflammation is characterised by **Redness (Rubor/Erythema), Heat (Calor), Swelling (Tumor/Oedema) and Pain (Dolor)**

(E) **NK-Cell / Cellular barrier** :

It is a large granular lymphocyte cell.

During this process apart from the phagocytes, another type of cells called **Natural killer cells** kill virus infected cells and tumour cells of body by creating perforin linked pores in the plasma membrane of target cells (i.e. infected cells). Water enters through these pores causing swelling and bursting of the diseased cells.

3.2 Acquired Immunity

It is the resistance that an individual acquires during life. This is generated in response to an exposure to the microorganism in question. This type of immunity is found only in vertebrates. It is also called Adaptive or specific immunity. This immunity is **acquired after birth** by experience. This immunity recognise and selectively eliminate the pathogen.

- The Features of Acquired immunity** are **Specificity, Diversity, Discrimination between self and non-self** and **Memory**.

When a pathogen enter inside the body, body takes longer times to recognise and respond to it this is called **primary immune response** but the memory of this encounter remain in immune system. When this pathogen enters second time inside the body, body immune system rapidly recognise this pathogen and respond quickly to it. This is called **secondary immune response (Anamnestic)**. This is based on memory of immune system.

Difference between active and passive immunity

Active immunity		Passive immunity	
1.	Produced actively by the immune system of host	1.	Received passively by the host and the host's immune system does not participate.
2.	Induced by infection or by contacts with immunogen, e.g. vaccines.	2.	Conferred by introduction of ready-made antibodies.
3.	Immune response-durable and effective	3.	Immune response-short lived and less effective.
4.	Immunity develops only after a lag period	4.	Immunity effective immediately.
5.	Immunological memory present. Subsequent challenge with booster dose more effective.	5.	No immunological memory. Subsequent administration of antibody less effective due to "immune elimination"
6.	Serves no purpose in immunodeficient host.	6.	Applicable in immunodeficient host
7.	Used for prophylaxis to increase body resistance.	7.	Used for treatment of acute infection.

• **Active Immunity :**

This immunity develops **after infection or vaccination.**

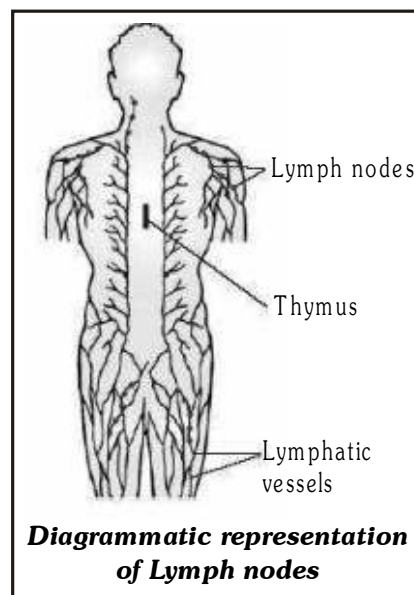
Active immunity is formed by **lymphocytes**, lymphocytes are produce in **bone marrow (Haematopoiesis)**. After production some of lymphocytes migrates from bone marrow to thymus cells and mature as **T-cells (Thymus cell)**.

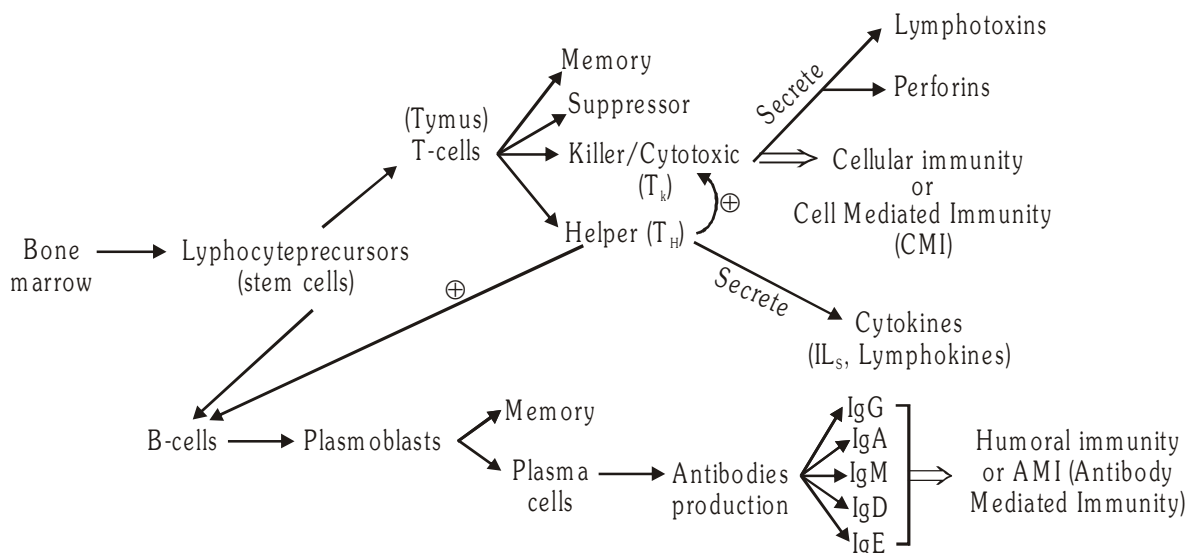
Lymphoid organs are the organs where origin and/or maturation and proliferation of lymphocytes occur. The primary lymphoid organs are **bone marrow** and **thymus** where immature lymphocytes differentiate into antigen-sensitive lymphocytes. After maturation the lymphocytes migrate to secondary lymphoid organs like **spleen, lymph nodes, tonsils, Peyer's patches of small intestine and appendix**. The secondary lymphoid organs provide the sites for interaction of lymphocytes with the antigen, which then proliferate to become effector cells.

The bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced. The thymus is a lobed organ located near the heart and beneath the breastbone. The thymus is quite large at the time of birth but keeps reducing in size with age and by the time puberty is attained it reduces to a very small size. Both bone-marrow and thymus provide micro-environments for the development and maturation of T-lymphocytes. The spleen is a large beanshaped organ. It mainly contains lymphocytes and phagocytes.

It acts as a filter of the blood by trapping blood-borne microorganisms. Spleen also has a large reservoir of erythrocytes. The lymph nodes are small solid structures located at different points along the lymphatic system. Lymph nodes serve to trap the micro-organisms or other antigens, which happen to get into the lymph and tissue fluid. Antigens trapped in the lymph nodes are responsible for the activation of lymphocytes present there and cause the immune response.

There is lymphoid tissue also located within the lining of the major tracts (respiratory, digestive and urogenital tracts) called **mucosal associated lymphoid tissue (MALT)**. It constitutes about 50 per cent of the lymphoid tissue in human body.





Based on these two type of lymphocytes there are **two types** of active immune system.

(1) **C.M.I.S.** → Cell mediated immune system or Cellular immunity

This immune system is based on T-cells. (60-70%)

There are 5 type of cell :

When pathogens enter inside the body first macrophage interact with them and activates T_H -cell by releasing cytokines or ILs or monokines.

(i) **Helper T-cell** → This activated helper cell stimulates the killer T-cell and B-cell and these killer & B-cell start dividing and produce clone (group of similar cells) this phenomenon is called **clonal selection**. They produce *lymphokines* (messenger molecules) which cause accumulating of WBCs to the affected site. T_H -cells also stimulate B-cells to produce antibodies and facilitate the action of other T-cells.

(ii) **Killer T-cell** : These cell or clone of these cell **destroy the infected cells or target cell** and kill the pathogen and also the **cancerous cells** by secreting Lymphotoxic substances and secrete lymphokines which attracts phagocytes.

These are responsible for cell-mediated immunity. They also destroy transplanted, tumour cells and other foreign cells.

(iii) **Suppressor Cells (TS)** :- These suppress the functions of T_C and T_H cells. B-cells and plasma cells are also affected by T_S cells by synthesising suppressor factors and suppress the entire immune system for attacking the own body

(iv) **Memory T-cell** : They don't kill the pathogen or don't form the antibodies but these cell **retain the memory** of every encounter.

They converts into effector cells (T_C) on later encounter with specific antigen even after several years.

(2) **A.M.I.S.** (Antibody mediated immune system or humoral immunity)

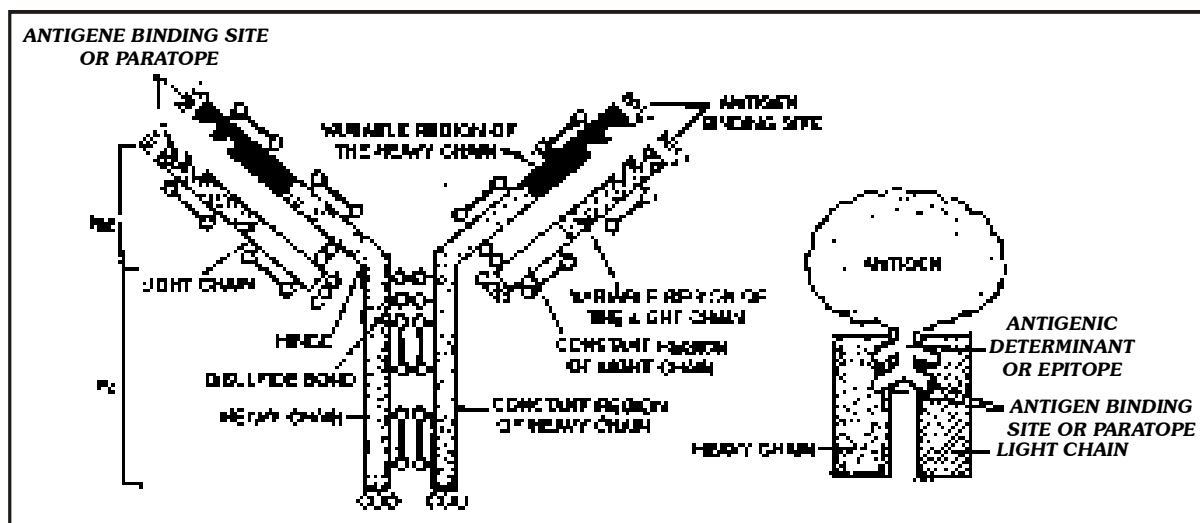
This immune system is **based on B-lymphocyte** (10-20%) and these B-lymphocyte secrete the antibody.

Antibody or Immunoglobulin : These are complex glycoprotein molecule made up of 4 polypeptide chains two light and two heavy chains.

These two chain held together by **disulphide bond** in shape of Y molecule, represented as **H2L2**.

Two **top tips** of this molecule bind with antigen [large and complex foreign molecules mainly proteins that activate the specific immunity] like **lock and key fashion** and make antigen-antibody complex.

STRUCTURE AND Type of Antibodies –



Type of antibodies – I_gA, I_gG, I_gM, I_gE and I_gD

4.0 Vaccine

- Vaccine is suspension of **inactivated pathogens** or **antigenic protein of pathogen** which is taken orally or injected to provide immunity for that pathogen.
- **History :**
 - (i) **Edward Jenner (1796)** noticed that milkmaid did not suffer from small pox but they had scabs of cow pox. He transport the material from sore of milkmaid who was suffering from cow pox to the young body of 8 year old. After sometime he injected live small pox material into that boy, but symptoms of disease did not appear. He tried this procedure on other person and got success. He gave the term vaccination for this process.
- **Principle of vaccination :**
 - The principle of vaccination and immunisation is based on the property called ‘memory’ of the immune system.
 - The vaccine generates antibodies that neutralise the toxin/pathogen and also produces memory **B-cells** and **T-cells** , which recognise the pathogen in subsequent encounters and produce antibodies.
 - If a quick immune response is needed as in tetanus infection, preformed antibodies or antitoxin is injected into the patient; this type of immunisation is called passive immunisation.

When a antigenic material is injected in a healthy person, it **generate antibodies and memory cell** as a **primary immune response**. When this active pathogen enter second time inside this body of vaccinated person memory cells **rapidly recognise** and respond with massive production of lymphocytes and antibodies. So it destroys pathogen rapidly and disease does not appear. Person become **resistant** for that disease after vaccination.

6.0 Immune system disorder

• Hyper Sensitive Disorder or Allergy

When a person show hyper response or hyper sensitiveness for a common antigen or agent then it is called allergy. The agents which cause allergy are called allergen. Common allergens can be pollen grains, food (egg, fish), medicines (penicilline), cold, heat, sunlight, fibres etc.

The exaggerated response of the immune system to certain antigens present in the environment is called allergy. The substances to which such an immune response is produced are called allergens. The antibodies produced to these are of IgE type. Common examples of allergens are mites in dust, pollens, animal dander, etc. Symptoms of allergic reactions include sneezing, watery eyes, running nose and difficulty in breathing. Allergy is due to the release of chemicals like histamine and serotonin, from the mast cells. For determining the cause of allergy, the patient is exposed to or injected with very small doses of possible allergens, and the reactions studied. The use of drugs like anti-histamine, adrenalin and steroids quickly reduce the symptoms of allergy. Somehow, modern-day life style has resulted in lowering of immunity and more sensitivity to allergens—more and more children in metro cities of India suffer from allergies and asthma due to sensitivity to the environment. This could be because of the protected environment provided early in life.

Examples :

- (i) **Bronchial Asthma** : It is common manifestation of allergy. It is allergy of lungs when an allergen enters inside the body by inhalation. It comes in contact with respiratory tube. This is characterised by the spasm of the smooth muscles present in the walls of the bronchiole. It is generally caused due to the hypersensitivity of the bronchiole to the foreign substances present in the air passing through it. The mucous membranes on the wall of the air passage start secreting excess amount of mucous, which may clog the bronchi, as well as bronchiole.

Symptoms : coughing and difficulty in breathing mainly during expiration. (Wheezing)

- (ii) **Hay Fever** : Mucosa of eyes and upper respiratory passage become hyper secretory in response to **allergen (pollen grain)**.

• Auto immune disorder

When the immune system does not discriminates between self and non-self antigen, antibodies are formed against the self antigen these antibodies destroy the self antigen and also the self tissue of the body. So, the antibody formation against self antigen is called. Auto immunity

- **Memory-based acquired immunity evolved in higher vertebrates** based on the ability to differentiate foreign organisms (e.g., pathogens) from self-cells. While we still do not understand the basis of this, **two corollaries** of this ability have to be understood. **One**, higher vertebrates can distinguish foreign molecules as well as foreign organisms. Most of the experimental immunology deals with this aspect. **Two**, sometimes, due to genetic and other unknown reasons, the body attacks self-cells. This results in damage to the body and is called **auto-immune** disease. Rheumatoid arthritis which affects many people in our society is an auto-immune disease.

Example :

- (i) **Myasthenia gravis** :
- (ii) **Pernicious (Destructive) anemia** :
- (iii) **Hashimoto disease** :
- (iv) **Rheumatoid arthritis** :
- (v) **I.D.D.M** :
- (vi) **Multiple sclerosis** :
- (vii) **Vitiligo (VIII) Psoriasis**

8.0 DRUGS ABUSE

Surveys and statistics show that use of drugs and alcohol has been on the rise especially among the youth. This is really a cause of concern as it could result in many harmful effects. Proper education and guidance would enable youth to safeguard themselves against these dangerous behaviour patterns and follow healthy lifestyles.

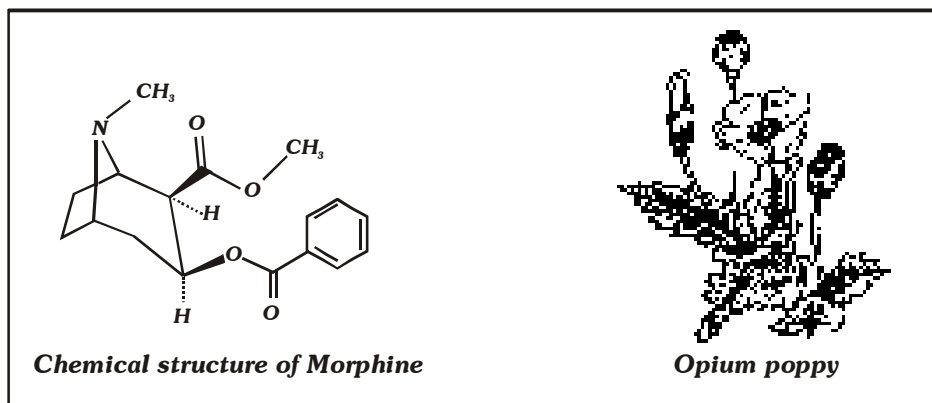
The drugs, which are commonly abused are opioids, cannabinoids and coca alkaloids. Majority of these are obtained from flowering plants. Some are obtained from fungi like LSD.

LSD (Lysergic acid diethyl amides) is a dangerous hallucinogen, obtained from fruiting body of a fungus (*Claviceps purpurea*).

(a) **Opioids** : (Eg ; Morphine, Heroin, etc.)

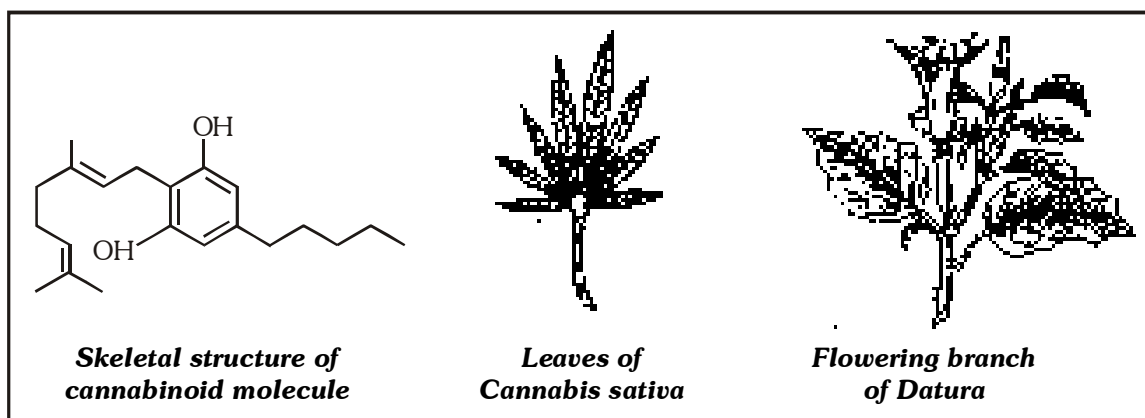
Opioids are the drugs, which bind to specific opioid receptors present in our central nervous system and gastrointestinal tract. **Heroin** commonly called smack is chemically **diacetylmorphine** which is a white, odourless, bitter crystalline compound. This is obtained by acetylation of morphine which is extracted from the latex of poppy plant **Papaver somniferum**. Generally taken by snorting and injection, heroin is a depressant and slows down body functions.

Morphine is a very effective sedative and painkiller, and is very useful in patients who have undergone surgery.



(b) **Cannabinoids**

These are a group of chemicals, which interact with cannabinoid receptors present principally in the brain. Natural cannabinoids are obtained from the inflorescences of the plant **Cannabis sativa**. The flower tops, leaves and the resin of cannabis plant are used in various combinations to produce marijuana, hashish, charas and ganja. Generally taken by inhalation and oral ingestion, these are known for their effects on cardiovascular system of the body. These days cannabinoids are also being abused by some sports persons

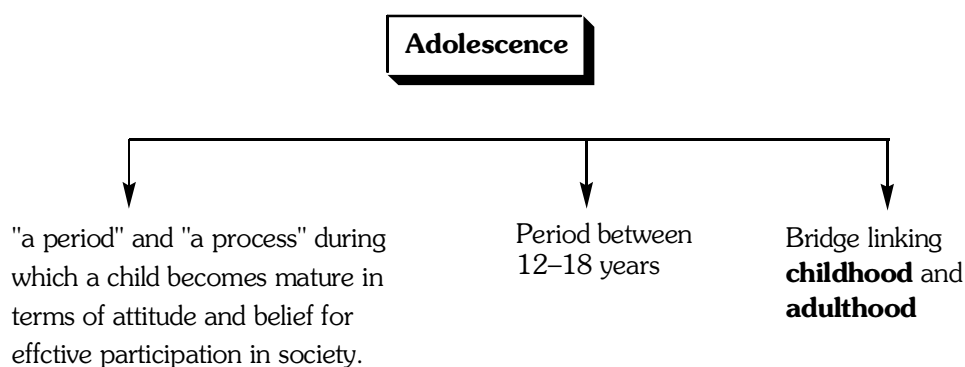


(c) **Coca alkaloid or cocaine**

These are obtained from coca plant **Erythroxylum coca**, native to South America. It interferes with the transport of the neuro-transmitter dopamine. Cocaine, commonly called **coke** or **crack** is usually snorted. It has a potent stimulating action on central nervous system, producing a sense of euphoria and increased energy. Excessive dosage of cocaine causes hallucinations.

Other well-known plants with hallucinogenic properties are Atropa belladonna and Datura.

- Drugs like barbiturates, amphetamines, benzodiazepines and other similar drugs, that are normally used as medicines to help patients cope with mental illnesses like depression and insomnia, are often abused.
- Several plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe. When these are taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes **drug abuse**.

9.0 ADOLESCENCE AND ALCOHOL ABUSE

- **Adolescence** means both '**a period**' and '**a process**' during which a child becomes mature in terms of his/her attitudes and beliefs for effective participation in society. The period between **12-18 years** of age may be thought of as adolescence period.
- In other words, adolescence is a **bridge linking childhood and adulthood**. Adolescence is accompanied by several biological and behavioural changes. Adolescence, thus is a very vulnerable phase of mental and psychological development of an individual.
- Curiosity, need for adventure and excitement, and experimentation, constitute common causes, which motivate youngsters towards drug and alcohol use.
- A child's natural curiosity motivates him/her to experiment. This is complicated further by effects that might be perceived as benefits, of alcohol or drug use. Thus, the first use of drugs or alcohol may be out of curiosity or experimentation, but later the child starts using these to escape facing problems.
- Of late, stress, from pressures to excel in academics or examinations, has played a significant role in persuading the youngsters to try alcohol and drugs.
- The perception among youth that it is 'cool' or progressive to smoke, use drugs or alcohol, is also in a way a major cause for youth to start these habits.
- Television, movies, newspapers, internet also help to promote this perception. Other factors that have been seen to be associated with drug and alcohol abuse among adolescents are unstable or unsupportive family structures and peer pressure.

- **Alcohol and Alcoholism**

It affects the central nervous system alcohol is a depressant.

- (1) Ethyl alcohol is consumed as fermented beverages with low content of alcohol (beer, wine) and as distilled beverages with a relatively high alcohol percentage (Brandy, Rum, Whisky, Gin).
- (2) This alcohol is rapidly absorbed from the wall of stomach and enters the blood stream within minutes of ingestion.

In the liver alcohol is converted into a more toxic substance **acetaldehyde**.

- **Effects of Alcohol Drinking**

- (1) Alcohol psychosis

Effects of Drug/Alcohol Abuse

- The **immediate adverse effects** of drugs and alcohol abuse are manifested in the form of reckless behaviour, vandalism and violence. **Excessive doses of drugs** may lead to coma and death due to respiratory failure, heart failure or cerebral hemorrhage.
- A **combination of drugs** or their intake along with alcohol generally results in overdosing and even deaths.
- The most common warning signs of drug and alcohol abuse among youth include drop in academic performance, unexplained absence from school/college, lack of interest in personal hygiene, withdrawal, isolation, depression, fatigue, aggressive and rebellious behaviour, deteriorating relationships with family and friends, loss of interest in hobbies, change in sleeping and eating habits, fluctuations in weight, appetite, etc.
- There may even be some **far-reaching implications** of drug/alcohol abuse. If abuser is unable to get money to buy drugs/alcohol he/she may turn to stealing. The adverse effects are just not restricted to the person who is using drugs or alcohol. At times, a drug/alcohol addict becomes the cause of mental and financial distress to his/her entire family and friends.
- Those who take drugs **intravenously** (direct injection into the vein using a needle and syringe), are much more likely to acquire serious infections like AIDS and hepatitis B. The viruses, which are responsible for these diseases, are transferred from one person to another by sharing of infected needles and syringes. Both AIDS and Hepatitis B infections are chronic infections and ultimately fatal. **AIDS and Hepatitis B are transmitted through infected blood and both are STDs.**
- The use of alcohol during adolescence may also have **long-term effects**. It could lead to heavy drinking in adulthood. The chronic use of drugs and alcohol damages nervous system and liver (**cirrhosis**). The use of drugs and alcohol during pregnancy is also known to adversely affect the foetus.
- Another **misuse of drugs** is what certain sportspersons do to enhance their performance. They (mis)use **narcotic analgesics**, anabolic steroids, diuretics and certain hormones in sports to increase muscle strength and bulk and to promote aggressiveness and as a result increase athletic performance.
- The **side-effects** of the use of anabolic steroids **in females** include masculinisation (features like males), increased aggressiveness, mood swings, depression, abnormal menstrual cycles, excessive hair growth on the face and body, enlargement of clitoris, deepening of voice.

In males it includes acne, increased aggressiveness, mood swings, depression, reduction of size of the testicles, decreased sperm production, potential for kidney and liver dysfunction, breast enlargement, premature baldness, enlargement of the prostate gland. These effects may be permanent with prolonged use.

- In the adolescent male or female, **severe facial and body acne**, and **premature closure of the growth centres of the long** bones may result in stunted growth.

Prevention and Control

- The age-old adage of '**prevention is better than cure**' holds true here also.
- It is also true that habits such as smoking, taking drug or alcohol are more likely to be taken up at a young age, more during adolescence.

Hence, it is best to identify the situations that may push an adolescent towards use of drugs or alcohol, and to take remedial measures well in time. In this regard, the parents and the teachers have a special responsibility. Parenting that combines with high levels of nurturance and consistent discipline, has been associated with lowered risk of substance (alcohol/drugs/tobacco) abuse. Some of the measures mentioned here would be particularly useful for prevention and control of alcohol and drugs abuse among adolescents

- (i) **Avoid undue peer pressure**
- (ii) **Educating and counselling**
- (iii) **Seeking help from parents and peers**
- (iv) **Looking for danger signs**
- (v) **Seeking professional and medical help**

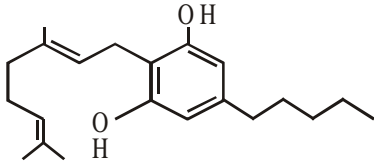
EXERCISE

1. Immunisation is based on :-
 (1) Memory of individuals
 (2) Pathogenic power
 (3) Phagocytosis
 (4) Memory of immune system
2. Widal test is employed for detecting –
 (1) Pneumonia (2) Malaria
 (3) Typhoid (4) Cholera
3. *Haemophilus influenzae* causes :-
 (1) Typhoid (2) Plague
 (3) Pneumonia (4) Influenza
4. *Plasmodium* enters the human body as :-
 (1) Female *Anopheles* mosquito
 (2) Sporozoite
 (3) Trophozoite
 (4) Haemozoin
5. Toxin which is responsible for chill and high fever during malaria :-
 (1) Haematin (2) Haemoglobin
 (3) Haemozoin (4) Heam
6. House flies are mechanical carriers of :-
 (1) Amoebiasis (2) Malaria
 (3) Common cold (4) Plague
7. Diagram showing ringworm affected area of skin. Which given pathogen is not related with disease?



- (1) *Microsporum*
- (2) *Trichophyton*
- (3) *Epidermophyton*
- (4) *Wuchereria*
8. AIDS is due to :-
 (1) Reduction in number of helper T-cells
 (2) Lack of interferon
 (3) Reduction in number of killer T-cells
 (4) Autoimmunity
9. Nucleic acid in HIV :-
 (1) ss RNA (2) ds RNA
 (3) ss DNA (4) ds DNA

10. The best diagnosis of cancer is done by :-
 (1) Biopsy
 (2) X-ray
 (3) Microscopic examination of body fluids
 (4) Surgery
11. Carcinoma is a cancer of :-
 (1) Lymphocytes
 (2) Connective tissue
 (3) Erythrocytes
 (4) Ectoderm and endoderm
12. Carcinoma refers to :-
 (1) Malignant tumours of the connective tissue
 (2) Malignant tumours of the skin
 (3) Benign tumours of the colon
 (4) Benign tumours of the connective tissue
13. Causative factor of cancer is called :-
 (1) Oncogenes (2) Radiogens
 (3) Estrogens (4) Carcinogens
14. Interferon :-
 (1) Kills the virus in virus infected cell
 (2) Kills the virus and destroy cancerous cell
 (3) Stimulates the T.I.P. (Translation Inhibiting protein)
 (4) Antibacterial
15. Antigen is :-
 (1) Substances which stimulates the production of venom
 (2) Vaccine
 (3) Antibody production stimulating agent
 (4) Part of the body defence system
16. Which is a primary lymphoid organ :-
 (1) Bone marrow and spleen
 (2) Spleen and thymus
 (3) Bone-marrow and tonsils
 (4) thymus gland and bone marrow
17. Neutrophils and monocytes are important cells participating in :-
 (1) Phagocytosis
 (2) Perforin production
 (3) Passive immunity
 (4) Antibody production

- 18.** Immune system retains the memory of which response in vaccination process :-
 (1) Passive immunization response
 (2) Primary immune response
 (3) Secondary immune response
 (4) All the above
- 19.** Surgical removal of thymus of a new born shall result in failure to mature -
 (1) Monocytes (2) B - lymphocytes
 (3) T - lymphocytes (4) Basophils
- 20.** Vaccine is :-
 (1) Type of antibody
 (2) Inactivated antigen
 (3) Inactivated pathogen
 (4) Activated pathogen
- 21.** Immunisation is based on :-
 (1) Memory of individuals
 (2) Pathogenic power
 (3) Phagocytosis
 (4) Memory of immune system
- 22.** True statement about hepatitis B vaccine is
 (1) Produced by recombinant DNA technology
 (2) Produced in E.coli
 (3) Formation of antibody polypeptide of pathogen
 (4) Whole pathogen is given
- 23.** Tobacco chewing results in :-
 (1) Mouth cancer (2) Lung cancer
 (3) Bone cancer (4) Leukaemia
- 24.** Opium is obtained from :-
 (1) *Thea sinensis* (2) *Coffea arabica*
 (3) *Oryza sativa* (4) *Papaver somniferum*
- 25.** Marijuana, Ganja, and LSD are :-
 (1) Narcotics (2) Hallucinogens
 (3) Stimulants (4) Medicines
- 26.** LSD is obtained from :-
 (1) *Cannabis* (2) *Claviceps*
 (3) *Fusarium* (4) *Nostoc*
- 27.** *Cannabis sativa* (Hemp) yields:-
 (1) Bhang (2) Charas
 (3) Ganja (4) All the above
- 28.** In the liver, alcohol is converted into which toxic substance:-
 (1) Formic acid (2) Acetaldehyde
 (3) Nicotine (4) Urea
- 29.** 
- Diagram is showing, skeletal structure of :-
 (1) Morphine molecule
 (2) Cannabinoid molecule
 (3) Opioid molecule
 (4) Coca alkaloid
- 30.** Which measure would be particularly useful for prevention and control of alcohol and drug abuse among adolescents ?
 (a) Avoid undue peer pressure
 (b) Seeking professional and medical help
 (c) Looking for danger sign
 (d) Education and counselling
 (e) Seeking help from parents and peers
 (1) a, b, d (2) a, c, d, e
 (3) c, e (4) a, b, c, d, e

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	3	2	3	1	4	1	1	1	4	2	4	3	3
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	1	2	3	3	4	1	1	4	2	2	4	2	2	4

Animal Breeding

- Breeding of animals is an important aspect of animal husbandry. Animal breeding aims at increasing the yield of animals and improving the desirable qualities of the produce.
- **Breed** : A group of animals related by descent and similar in most characters like general appearance, features, size, configuration, etc., are said to belong to a breed.
- **Types of Breeding** :
 - (i) **Inbreeding** : Inbreeding refers to the mating of more closely related individuals within the same breed for 4-6 generations. The breeding strategy is as follows – superior males and superior females of the same breed are identified and mated in pairs. The progeny obtained from such matings are evaluated and superior males and females among them are identified for further mating. A superior female, in the case of cattle, is the cow or buffalo that produces more milk per lactation. On the other hand, a superior male is the bull, which gives rise to superior progeny as compared to those of other males. Inbreeding increases **homozygosity**. Thus inbreeding is necessary if we want to evolve a pureline in any animal. Inbreeding also exposes harmful recessive genes that are eliminated by selection. It also helps in accumulation of superior genes and elimination of less desirable genes. Therefore, this approach, where there is selection at each step, increases the productivity of inbreed population. However, continued inbreeding, especially close inbreeding, usually **reduces fertility** and even **productivity**. This is called **inbreeding depression**. Whenever this becomes a problem, selected animals of the breeding population should be mated with unrelated superior animals of the same breed. This usually helps restore fertility and yield.
 - (ii) **Out-breeding** : Out-breeding is the breeding of the unrelated animals, which may be between individuals of the same breed (but having no common ancestors), or between different breeds (cross-breeding) or different species (inter-specific hybridisation).

Apiculture

- Maintenance of hives of honeybees for the production of honey.
- Each colony has more than 40,000 to 50,000 individual consisting of 3 casts.

SOCIAL ORGANISATION :

- (1) **Queen** : Develops from unfertilized egg feeds on royal jelly
 - Function Reproduction
 - Legs and wings short but crop is long
 - (2) **Drone** : 100 in one hive
 - Salivary & wax secreting glands absent
 - Develops from unfertilized egg
 - Helps in fertilization
 - (3) **Worker** : Maximum in hive & smallest
 - Wing and mouth parts are very strong
 - Mouth parts & legs modified for collection of nectar.
- **Important species of Honey-bees** :
 - (i) **Apis dorsata (Rock bee)**- It is also named as saarang bee. It is of largest size and produces highest yield of honey. However, it is of highly aggressive nature and migratory species, which is not suitable for rearing by man.
 - (ii) **Apis indica (Indian Mona-bee)**- It lives across the whole country of India and is smaller in size than saarang-bee, It is mild in nature, so that it is easily manageable during rearing. Mona-bee yields about 3-4 kg. of honey per hive.
 - (iii) **Apis florea (Bhringa-bee)**- This bee is smallest in size and of timid nature.
 - (iv) **Apis mellifera (European bee)**- This bee is of mild nature. It yields more honey than mona-bee. It is the most useful bee for commercial purpose. The Italian variety of this species is by far the most important variety.
 - **Communication by dance**

Those bees which go out for search of food have highly developed visual & taste sense for correct recognition of route. **Bees recognised their route with the help of position of sun & smell of flowers.**

Bees communicate with each other so that all other members also find the food source.

Karl Von Frish in 1969 explained the "Dance of honeybee" and he got noble prize for that.

– The following type of dances can be seen in honey bees.

1. **Round Dance** : This dance indicates that the food source is about less than 75m from a hive.
2. **Tail wagging Dance** : With the help of this dance bees give the information of that food source at a very far distance. In it direction & distance of food source are indicated according to the position of sun.

- **Honey** - It is an aromatic viscid, sweet material consists of 17% water, sugar protein, minerals vitamins etc.

- | | | |
|-------------|-----------------------|---------------------------------------------------------|
| i. Water | ii. Fructose | iii. Glucose |
| iv. Sucrose | v. Enzymes & pigments | vi. Ash |
| | | vii. Vitamins - B ₁ , B ₆ , C & D |

- **Bee wax**

- It is very useful by product of bee keeping industry
- It is obtained from bee hives
- This is a secretion of worker bees abdominal glands

LAC CULTURE

- Lac is resinous secretion of last segment of *Laccifer (Tachardia) lacca* or Lac insect
- The insect is parasite lives and breeds on the following host plants

- **Lac Insect :**

- They secrete a gum like substance which covered them from all the sides & after that a 1-2 inch thick layer is formed around the branches.
- In India the largest lac producing state is Jharkhand
- India produces 75% of the total world production
- The lac is a secretory product of lac glands
- The secretion covers the body of insect
- Lac is used in printing industry, preparation of gramophone records, electrical appliances, in varnish, polish bangles, cosmetics, lacwax & lacdye

- **Composition of Lac**

FISHERIES

- Fishery is an industry devoted to the catching, processing or selling of fish, shellfish or other aquatic animals. A large number of our population is dependent on fish, fish products and other aquatic animals such as prawn, crab, lobster, edible oyster, etc., for food.

* Some of the freshwater fishes which are very common include **Catla, Rohu and common carp**.

* Some of the marine fishes that are eaten include – **Hilsa, Sardines, Mackerel and Pomfrets**.

- Pisciculture is rearing catching & management of fishes.
- Culture fishery is the raising of fishes in tanks & ponds.
- Capture fishery is management of catching of fish without actually raising them.
- India is at present the 6th foremost sea food producing nations in the world.

Blue Revolution is an effort to increase fish yield in India.

- **By-Product of fishing industry :**

1. **Isinglass** : It is a high grade collagen produced from air bladder or swim bladder of certain fishes like cat fishes & carps. The isinglass prepared in Russia is of best quality.
2. **Fish oil** –
 - Dry oil is obtained from Salmon & Herring.
 - Semi dry oil from carps. Liver oil contains vit A, D, E & C.
3. **Shagreen** – Skin of some fishes like shark & rays are used for covering card cases, jewel boxes, scabboards etc. The skin of cod salmon and other fishes are also tanned and converted into leather.
4. **MOET (Multiple Ovulation Embryo Transfer Technology)**
 - Animal is administered with FSH to induce superovulation mated with an elite bull;
 - Fertilized eggs at 8 - 32 cells stages are recovered non surgically transferred to surrogate mothers.

Main Infectious diseases of Domestic animals

Disease (s)	Pathogens	Symptoms
A. Bacterial diseases		
1. Anthrax	<i>Bacillus anthracis</i>	Blood mixed frothy secretion from external openings of body, increased respiratory rate.
2. Hemorrhagic septicaemia	<i>Pasteurella multocida</i>	High fever, pneumonia, respiratory distress, lameness (pain during walking), septicemia.
3. Black quarter	<i>Clostridium chauvoei</i>	Fever, swelling in neck.
4. Brucellosis	<i>Brucella abortus</i>	Placental swelling, abortion, reduced fertility.
5. Bovine tuberculosis	<i>Mycobacterium bovis</i>	Tubercle nodes in lungs and lymph nodes respiratory distress.
6. Botulism	<i>Clostridium botulinum</i>	Paralysis of jaw, neck, leg, muscles, increased salivation, respiratory blockage.
7. Tetanus	<i>Clostridium tetani</i>	Stiffness in jaw and legs, opisthotonus. (excessive strain in neck region)
B. Viral diseases		
1. Rinderpest	<i>Paramyxo-virus</i>	High fever, stomatitis, severe diarrhoea
2. Foot and Mouth Disease (FMD)	<i>Picornavirus</i>	Fever, Lesions in mouth, hoof, mammary glands and teats.
3. Cowpox	<i>Orthopox-virus</i>	Rashes on mammary glands and teats, low fever, reduced appetite.
4. Rabies	<i>Rhabdo-virus</i>	Changed behaviour, high excitability, madness, paralysis.
C. Protozoa born diseases		
1. Babesiosis	<i>Babesia sps.</i>	Jaundice, urine red and frothy, high fever haemoglobinuria.
2. Trypanosomiasis	<i>Trypanosoma evansi.</i>	High fever, anaemia, animal lean and
3. Theileriosis	<i>Theileria sps.</i>	Swelling in lymph nodes, high fever, anaemia.
D. Helminth born diseases		
1. Ascariasis	<i>Neoscaris vitulorum</i>	Liver damage and fibrosis, swelling in lungs, intestinal obstruction
2. Fascioliasis	<i>Fasciola sps.</i>	Bleeding from liver, anaemia, fibrosis of bile duct.
3. Trichuriasis	<i>Trichuris sps.</i>	Severe diarrhoea, decreased appetite
E. Fungal diseases		
1. Ringworm	<i>Trichophyton sps.</i>	Alopecia, patches on skin, pus in infected area.
2. Aspergillosis	<i>Aspergillus sps.</i>	Lesions in lungs, respiratory system disorders, abortion.
3. Aflatoxicosis	<i>Aspergillus flavus</i>	Decreased appetite, liver damage, bloody diarrhoea, anaemia.

EXERCISE

- | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. Fish used in biological control of mosquito is –
 (1) Gambusia (2) Hilsa
 (3) Scalophagus (4) Gold Fish</p> <p>2. Silk is produced by –
 (1) Larva (2) Cocoon
 (3) Larva & adult moth (4) Adult moth</p> <p>3. Queen is specified for –
 (1) Administration (2) Making hive
 (3) Egg laying (4) Collection of food</p> <p>4. Ranikhet disease is associated with :
 (1) Honey Bee (2) Hens
 (3) Fishes (4) Pigs</p> <p>5. Which among the following is secondary product of Honey Bee ?
 (1) Honey (2) Pollen
 (3) Bee wax (4) Propolis</p> <p>6. Nagpuri buffalo is :
 (1) Milker (2) Draught cattle
 (3) Dual purpose (4) Grazer</p> | <p>7. Exotic breeds of poultry are :
 (1) White Leghorn and Rhode Island Red
 (2) Rhode Island Red and Aseel
 (3) Plymoth and Aseel
 (4) White Leghorn and Aseel</p> <p>8. MOET (Multiple Ovulation Embryo Transfer) is method of :
 (1) Fish cultivation
 (2) Hybridisation of cattle
 (3) Birth control
 (4) Cloning of sheep</p> <p>9. Who is the father of white revolution in India?
 (1) Banda Vasudev Rao (2) Verghese Kurien
 (3) M. S. Swaminathan (4) Norman E. Borlaug</p> |
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ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9
Ans.	1	1	3	2	1	1	1	2	2