Brahmastra Academy

Celebrating Knowledge Progressively

GENERAL SCIENCE

BIOLOGY

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Trend Analysis (2016-2014)

BIOLOGY

S. No.	Chapter Name	2016 (I)	2015 (II)	2015 (I)	2014 (II)
1	Diversity in Living World	2	3	-	1
2	Cell and Cell Division	1	-	1	3
3	Constituents of Food (Biomolecules)	1	1	1	2
4	Structural Organisation of Plants and Animals	1	1	-	-
5	Plants Physiology and Reproduction	-	1	4	-
6	Human System-I	-	2	3	3
7	Human System-II	-	-	2	-
8	Health and Diseases	1	2	-	1
9	Economic Importance of Biology	-	1	-	-
10	Ecology, Biodiversity and Environment	2	2	1	1
	Total	**8**	**13**	**12**	**11**

01

BIOLOGY

DIVERSITY IN LIVING WORLD

Generally 3-4 questions are asked from this chapter. Questions are mostly based upon mammals, insector, cold-blooded and warm blooded animals, difference between member of phylums.

Biology (Gr. *Bios*–life; *logos*–study) is the branch of science, which deals with the study of living organisms. The term 'Biology' was first used by **Lamarck** and **Treviranus** in 1800. A Greek Philosopher, **Aristotle** is regarded as the Father of Biology. **Biology has been divided into three main branches**

(i) **Botany** (Gr. *Botane*–herbs) or **Phytology** Theophrastus is the Father of Botany.

(ii) **Zoology** (Gr. *Zoon*–animal; *logos*–study) Aristotle is the Father of Zoology.

(iii) **Microbiology** (Gr. *Microb*–minute; *bios*–life; *logos*–study) Antony van Leeuwenhoek is the Father of Microbiology. He firstly saw bacteria by his own made microscope.

LIVING AND NON-LIVING

Living beings are distinguished from non-living things on the basis of some fundamental characteristics. These include presence of protoplasm, cellular organisation or cellular structure, nutrition and metabolism, growth, reproduction and homeostatic response to environment.

Differences between Living and Non-living

Characters	*Living*	*Non-living*
Shape and size	A living body has its own kind of size and form.	Non-living objects do not have a form or size of their own.
Growth and development	All living organisms take the food material and utilise it for their growth and development.	There are no growth and development in non-living.
Metabolic activities	Metabolism (catabolism and anabolism) present.	Absent
Excretion	Waste products are excreted.	Excretion is absent.
Lifespan	Show a definite lifespan from birth to death.	Absent
Reproduction	Show reproduction.	Reproduction is absent.
Adaptability	Show adaptability to environment for survival.	Adaptability is absent.
Nutrition	Take food for performing different vital activities.	Nutrition is absent.
Movement and locomotion	Movement and locomotion are present.	Only mechanical movement is present by external forces.
Respiration	Cause breakdown of organic materials of the body and release energy for physiology.	May release heat on burning.
Irritability	Respond to stimuli.	No irritability.

Characteristics of Living Beings

There are some characteristics of living beings used to distinguish them from non-living things. These are as follows

(i) **Protoplasm** It is the physical basis of life. All the metabolic activities occurs inside the protoplasm. It is the most dynamic feature of a living being. Life is dependent upon this dynamic nature of protoplasm.

(ii) **Cell Structure** Living beings are made up of one or more cells. A cell is the structural and functional unit of life. It is the most peculiar feature of living organisms.

(iii) **Nutrition** Living beings require energy, that they can use for growth and development. They get this energy from food. Nutrition is the process by which organisms obtain energy from nutrients such as proteins, carbohydrates and fats. For examples, plants make food from water, minerals and CO_2 in the presence of sunlight with the help of chlorophyll.

(iv) **Metabolism** It is the sum total of all the chemical reactions taking place in an organism. Metabolism includes anabolism (making of substances) and catabolism (breaking of substances). Metabolism leads to energy production in an organisms.

(v) **Respiration** It is an important characteristic of all living beings. In this process, they take up oxygen and release carbon dioxide. By this process the energy stored in food, is released and it is utilised for various activities.

(vi) **Movement** All living things show movement. Animals show locomotion to search for food, shelter, mate, etc. Plants show movement of their parts or organs in response to a stimuli such as sunlight. In non-living organisms mechanical movement may be present.

(vii) **Growth** The increase in the shape, size and dry weight of living beings is called growth. Plants may grow indefinitely with the help of meristematic tissue. But in animals growth is definite and it stops at a certain age.

(viii) **Reproduction** All living being can produce offspring in a process called reproduction.

(ix) **Sensitivity and Adaptibility** All living beings can sense all the changes occuring around them. Thus, they are sensitive to different conditions and can also adapt to these conditions.

(x) **Excretion** In living beings, as a result of many chemical reactions, certain toxic substances are produced. Living beings can remove these substance in the process of excretion. It is defined as the removal of toxic materials, from the body of an organism.

(xi) **Life Cycle** All living organisms possess a definite life cycle, which is the cycle of birth, reproduction and ultimately death.

IMPORTANT FACTS

- All organisms are self regulatory in the steady state. This is known as homeostasis.
- Poikilothermic are the organisms, which maintains their body temperature by absorbing energy from the environment. e.g. Amphibians, reptiles, insects, etc.
- Homeothermic are organisms whose body temperature is maintained by environment automatically. e.g. mammals, Aves, etc.
- Hybernation is the winter sleep, in which organisms takes a long sleep is winter. While aestivation is the summer sleep.

LIFE SCIENCE

'Life Sciences' refers to the broad study of living organisms. It involves other branches of science such as physics, chemistry, mathematics also. This is necessary to study these branches in life sciences mainly because of following aspects

(i) All living organisms are made up of inorganic and organic molecules.

(ii) Inorganic compounds dissolve in water to form ions, which influence life activities.

(iii) The pH of living organisms is maintained by acid-base equilibrium.

(iv) The movement of molecules in and out of the cell is governed by diffusion and osmosis.

(v) Light plays an important role in inducing definite pattern of responses.

(vi) Living beings exchange their energy with surroundings hence, they are example of open system.

(vii) The science of mathematics and statistics help us in compiling and analysing biological data.

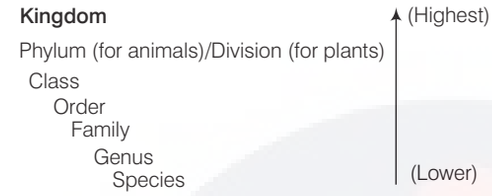
Classification of Living Organisms

Classifying the living organisms into different categories aid to the study of various organisms.

'Taxonomy' (Gr. *Taxis*–arrangement, *nomos*–law) is that branch of science, in which the means of identification and classification are studied.

- In the 18th century, a Swedish biologist **Carolus Linnaeus** developed a scheme of scientific classification and devised a system of scientific nomenclature. According to him, all organisms have some important characteristics in common and different from others in one or more ways. Based on these characteristics, organisms are placed in different categories. Linnaeus also proposed the binomial nomenclature in his book *Species Plantarum*.
- According to this, the scientific name of each organism is composed of two names, i.e. a **generic name** and a **species name**. The generic name begins with a capital letter and species name begins with a small letter, i.e. zoological name of the common housefly is *Musca domestica* and that of human is *Homo sapiens*. The botanical name of wheat is *Triticum aestivum.*

- While classifying organisms, they are grouped into different categories. For example, potato belongs to *Solanum* genus of family—Solanaceae, which comes under Solanales order of division—Eudicots of kingdom—Plantae. Each such category is known as a taxon, e.g. family, class, genus, etc. This hierarchial system or a series of classification was introduced by Linnaeus. The major categories of hierarchy are given below



- The basis of this hierarchy categorisation is to separate organisms on the basis of characteristics, i.e. from larger or higher to smaller and smaller groups to reach the basic unit of classification, i.e. species.
- The history of classification started from **Hippocrates** (460-377 BC) and till now different classification has been proposed. Some of them are as follows

Two Kingdom Classification

Carolus Linnaeus (1758) placed all the living organisms in two major kingdoms, i.e. Plantae for plants and Animalia for animals. This system is known as two kingdom system of classification. In this categorisation, the position of some organisms like *Euglena*, blue-green algae, fungi, etc., was debatable.

Four Kingdom Classification

Copeland (1956) divided the organisms into four kingdoms, i.e. Monera (bacteria and blue-green algae), Protista (red and brown algae, fungi and Protozoa), Plantae and Animalia. It is known as four kingdom system of classification. In it, the position of fungi in Protista was debatable.

Five Kingdom Classification

RH Whittaker (1969) classified the organisms into five major kingdoms, i.e. Monera, Protista, Fungi, Plantae and Animalia on the basis of cell structure, plant body organisation, nutrition mode, reproduction and ancestral relationships.

It is called five kingdom system of classification. This was the first kingdom system classified the debatable organism in proper place. The major differences in the characteristics of different kingdoms are as follows

Comparison of Five Kingdom Proposed by Whittaker (1969)

Features	*Monera*	*Protista*	*Fungi*	*Plantae*	*Animalia*
Type of cell	Prokaryotic (nucleus without nuclear membrane)	Eukaryotic (nucleus with nuclear membrane)	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Non-cellulosic present and made from polysaccharide (polymer of glucose)	Present in some	Present and made from chitin	Present and made from cellulose	Absent
Organisation of body	Cellular level	Cellular level	Multicellular but loose tissue	Tissue/organ level	Tissue/organ/ organ system level
Membrane around nucleus	Absent and nucleoid is present	Present	Present	Present	Present
Type of nutrition	Autotropic mode present (preparation of food by own)	Autotrophic mode present	Autotrophic mode absent	Autotrophic mode present	Autotrophic mode absent
	Heterotrophic mode present (depend for food on others)	Heterotrophic mode present	Heterotrophic mode present	Heterotrophic mode absent	Heterotrophic mode present
Organisms	Bacteria	Plant, fungus and animal like organism	Various fungus	Algae, moss, fern, gymnosperm and flowering plants	All animals

KINGDOM–MONERA

- Kingdom–Monera includes the small, simple, microscopic organisms that are found everywhere. These are mostly unicellular and prokaryotic organisms, which do not have a true (well defined) nucleus and organelles, e.g. bacteria, mycoplasma.
- **Bacteria** are major/main organisms of this kingdom. They lack true nucleus and present in each and every habitat including some extreme area like hot springs, snow and deep oceans. They are known as the scavengers of earth.

Bacteria are of two types

(i) Archaebacteria (ii) Eubacteria

- Bacteria can also be distincted on the basis of nutrition the bacteria may be **autotrophic** (self food producing) or **heterotrophic** (taking food from others).
- Similarly, on the basis of shape, they can be cocci (sphere-shaped), bacilli (rod-shaped), spirilli (spiral-shaped), vibrio (comma-shaped), actinomycetes (branched). In 1884, **Christian Gram** proposed, a staining technique to distinguish bacteria. This technique is known as Gram staining. Based on this, bacteria can be either Gram positive or Gram negative.

KINGDOM–PROTISTA

Kingdom–Protista includes all eukaryotic single-celled organisms. They have well defined nucleus and other membrane bound organelles. Members of this kingdom are mostly marine. They mostly possess cillia or flagella for moving. They can be either autotrophic or heterotrophic.

KINGDOM–FUNGI

- Fungi is a group of unique organism that are heterotrophic eukaryotic. They possess a cell wall made of chitin. These organisms derive their nutrition from dead-decaying substances. Hence, are saprotrophic. They lack chlorophyll. Body of a fungus is made up of filaments (thread-like) called **hyphae**, which form a network called **mycellium**. Reproduction takes place by fragmentation (asexual) and sexual.
- Fungi are usually found in mutualistic relationships with other organisms. For example, lichen is a symbiotic organism having a fungal and an algal partner. The fungus provide shelter to the algae and algae provides nutrition to fungi, e.g. *Parmellia*, *Usnea*, etc.

Mushroom

These are used as food due to their flavour, protein and vitamin contents. *Agaricus campestris* is common edible mushroom, whereas *Amanita phylloidos* is poisonous in nature.

KINGDOM–PLANTAE

- Kingdom–Plantae includes all plants. These are eukaryotic, multicellular organisms. They possess a cell wall made of cellulose. They are autotrophic, i.e. they can make their food in sunlight with the help of chlorophyll by a process called as **photosynthesis**.
- First level of classification among plants depends on whether the plant body possess well-differentiated distinct components or not.
- Next level is based on the presence or absence of special vascular tissues for the transport of water and other substances. Further classification takes into account the ability to bear seeds and whether seeds are enclosed within fruits or not.
- Thallophyta, Bryophyta and Pteriodophyta comes under Crypotogamae division of kingdom–Plantae.
- Cryptogamae are those organisms, which do not have visible sex organs and seeds, i.e. Thallophyta, Bryophyta and Pteridophyta. On the other hand organisms with evident sex organs and seeds are included in Phanerogamae.

Thallophyta/Algae

Organisms of this group do not have well differentiated body design, i.e. their body do not show differentiation into root, stem and leaves. This type of body is called thalloid body. They are commonly known as **algae** and are predominantly aquatic. Their cell wall is made of cellulose. They follow autotrophic mode of nutrition and their reserve food is generally starch. Algae are mostly non-vascular, i.e. they do not have vascular tissue.

e.g. *Ulothrix*, *Spirogyra*, *Chara,* etc.

Algae are usually of three types depending upon types of pigment, present in them brown algae (xanthophyll), green algae (chlorophyle) and red algae (*r*-phycoerythrin).

Bryophyta

Organisms of this group are called as the amphibians of the plant kingdom because they can live in soil, but are dependent on water for sexual reproduction.

In bryophytes, true vascular system is absent, i.e. they do not have specialised tissues for the conduction of water and food materials from one part of the body to another.

The body is commonly differentiated into stem and leaf-like structures. They lack real roots, stems, leaves, etc., and do not bear flower. It includes liverworts (*Riccia, Marchantia*), mosses (*Funaria, Sphagnum*) and hornworts (*Anthoceros*).

Sphagnum is an economically important bryophyte used as a constituent of peat. It is also useful in transportation of moisture requiring products.

Pteriodophyta

These are **first land plants** having vascular tissues. The body of these plants is differentiated into roots, stems and leaves and has specialised tissue for the conduction of water and food (well-developed vascular system, xylem and phloem).

Thus, are called **vascular cryptogams.** They do not bear flowers and do not produce seeds.

These include ferns (*Marsilea*, *Azolla*, *Adiantum*, *Dryopteris*, *Pteris* and *Pteridium*), club moss (*Selaginella*), horsetails (*Equisetum*).

Gymnosperms

These plants are most primitive and they bear seeds. The seeds produced are naked and are not enclosed within fruits.

Flower formation is also absent. These plants are usually perennial, evergreen and woody. Xylem lacks vessels and phloem lacks companion cells. *Cycas*, *Pinus* (pine), *Cedrus* (deodar) and *Ginkgo* (living fossil).

Angiosperms

These plants are also called as flowering plants as they contain their sex organs inside flower.

Their seeds develop inside ovary (female reproductive part), which modifies to become a fruit. Plant embryos in seeds have structures, called **cotyledons**. which are embryonic leaves.

The angiosperms are divided into two groups on the basis of number of cotyledons present in the seed. These includes monocotyledons (1 cotyledon) or dicotyledons (2 cotyledons).

KINGDOM–ANIMALIA

This kingdom includes animals ranging from Protozoa to mammals.

- These organisms are eukaryotic and heterotrophic. Their cells do not have cell walls and chloroplast. Most of the animals show locomotion and store glycogen (animal-starch).
- Unicellular animal are Protozoa, while multicellular animals are Metazoa.
- Animals are classified depending upon the presence or absence notochord.

Invertebrata or Non-Chordata

Invertebrates account for 95% of the total animal species. In invertebrates, notochord is absent. Non-chordata divided into two sub-kingdom.

1. Sub-kingdom–Protozoa

- Protozoans are small, microscopic, unicellular organisms with varied forms.
- They may be aquatic (freshwater or marine), terrestrial, free-living or parasites, parasitic forms cause diseases in humans and animals. The mode of nutrition can be holozoic, holophytic or parasitic.
- They show intracellular labour division, i.e. different organelles are present to perform different functions.
- Locomotory organelles are pseudopodial, flagella or cilia. Exchange of gases takes place through the general body surface of the individuals.
- Excretion occurs by contractile vacuole through general body surface. Asexual reproduction occurs by binary fission (e.g. *Leishmania*), multiple fission or budding (e.g. *Plasmodium*). Sexual reproduction occurs by syngamy or conjugation.

Classification

On the basis of locomotory organs, phylum–Protozoa is divided into four groups

(i) Zooflagellata, e.g. *Trypanosoma*, *Leishmania*, *Giardia*.
(ii) Sarcodina (Rhizopoda), e.g. *Amoeba*, *Entamoeba*.
(iii) Sporozoa, e.g. *Plasmodium*.
(iv) Ciliata, e.g. *Vorticella*, *Opalina*.

2. Sub-kingdom–Metazoa

Sub-kingdom–Metazoa includes following phyla

Phylum–Porifera (Sponges)

- All sponges are aquatic, mostly marine, rarely freshwater (e.g. *Spongilla)*, solitary or colonial.
- They have cellular or tissue level organisation .They are diploblastic.
- Sponges have high generative power.
- Body is porous. The pores are of two types, i.e. ostia and osculun.
- The central body cavity of a sponge is called **spongocoel**.
- For protection they possess cells called as cnidoblasts.
- Spongocoel is lined by flagellate cells called **collar cells**. Skeleton forming cells are called **sclerocytes**.
- Skeleton is made up of either siliceous spicules or proteinaceous spongin fibres or both.
- Sponges reproduce both asexually (by budding) and sexually. Sponges have very high regeneration power.

Classification

On the basis of skeleton, phylum–Porifera is divided into three classes

(i) Calcarea, e.g. *Sycon, Leucosolenia.*
(ii) Hexactinellida or Hyalospongiae, e.g. *Euplectella, Hyalonema*.
(iii) Demospongiae, e.g. *Euspongia, Spongilla.*

- Some common sponges are

(i) *Euplectella* (venus flower basket)
(ii) *Hyalonema* (glass rope sponge)
(iii) *Euspongia* (bath sponge)
(iv) *Chalina* (mermaid's glove)
(v) *Hippospongia* (horse sponge)

Phylum–Coelenterata, Ctenophora or Cnidaria

- All are aquatic, mostly marine except a few like *Hydra.*
- Coelenterates possess cell-tissue level of organisation.
- Coelenterates are diploblastic animals, i.e. derived from ectoderm and endoderm.
- The body cavity is known as coelenteron or gastrovascular cavity.
- Presence of peculiar types of cells called **cnidoblasts** or **nematocysts** or **stinging** cells in the ectoderm, especially in tantacles used for offence and defence.
- Hypotoxin is produced by nematocysts.
- Respiration and excretion are carried out through body surface by diffusion.
- Reproduction is both sexual and asexual (budding, e.g. *Hydra*).

Classification

- On the basis of dominance of medusoid or polypoid phase in the life cycle, phylum–Coelenterata is divided into three classes

(i) **Hydrozoa**, e.g. *Hydra, Obelia, Physalia*.
(ii) **Scyphozoa**, e.g. *Aurelia, Rhizostoma, Cassoprea*.
(iii) **Anthozoa**, e.g. *Gorgonia, Metridium,* corals.

Some Important cnidarians are

Obelia	Sea fur
Physalia	Portuguese man-of-war
Aurelia	Jelly fish
Metridium	Sea anemone
Pennatula	Sea pen
Gorgonia	Sea fan

Phylum–Platyhelminthes

- Platyhelminthes (flatworms) include flatworms, which are primitive triploblastic, acoelomate animals with organ level of organisation.
- Body of these animals is soft, dorsoventrally flattened leaf-like or ribbon-like.
- No true body cavity or coelom is present.
- Excretion is brought about by special cells called **flame cells** or **solenocytes**, which open through one or more excretory pores to outside.
- Nervous system is ladder-like, consisting of brain and two main longitudinal nerve cords.
- Animals are generally hermaphrodite.
- Fertilisation is internal.
- In parasitic form suckers, hooks or both are present on the head for attachment with the host.

Classification

On the basis of type of life cycle and presence or absence of digestive system, phylum–Platyhelminthes has been divided into three groups

(i) Turbellaria — *Dugesia*
(ii) Trematoda — *Fasciola*
(iii) Cestoda — *Taenia*

- *Taenia solium* is a member of Platyhelminthes. Its important characteristics are presence of hooks for adhesion, presence of digestive system, externally segmented body,etc. It derives it's nutrition from the host by absorbing nutrients through integuments. Some important Platyhelminthes are

Lung worm	*Paragonimus ringeri*
Blood worm	*Schistosoma haemotobium*
Beef tapeworm	*Taenia saginata*
Dog tapeworm	*Echinococcus granulosus*

Phylum–Aschelminthes or Nemathelminthes or Nematodes (Roundworms)

- Roundworms differ from flatworms in possessing pseudocoelom (pseudocoel).
- Body is usually cylindrical without segmentation.
- Body wall consists of cuticle, epidermis and muscular layer.
- The epidermis is syncytial (multi-nucleated) and without cilia.
- Roundworms are triploblastic (3 germ layers) with bilateral symmetry.
- Digestive system is complete with a mouth and an anus.
- Excretion is brought about by gland cells or intracellular canals or both.
- Regeneration and asexual reproduction are absent.
- The animals are unisexual and exhibit sexual dimorphism.

Classification

Phylum–Aschelminthes has five classes

(i) Nematoda, e.g. *Ascaris.*
(ii) Nematophora, e.g. *Nectonema.*
(iii) Rotifera, e.g. *Philodina.*
(iv) Kinorhyncha, e.g. *Echinoderes.*
(v) Gastrotricha, e.g. *Chaetonotus*

- *Wuchereria bancrofti* is a digenetic parasite, i.e. it completes it's life cycle in two hosts. The first host is human while the second host is *Culex* mosquito. These parasites are found in the blood vessels and lymph of humans and cause elephantiasis disease.
- *Enterobius vermicularis* is a common worm found parasitic in children.

Some important nematodes and the diseases they cause are

Common name	*Scientific name*	*Disease*
Whip worm	*Trichiuris trichiuris*	gastrointestinal trouble
Filaria worm	*Wuchereria bancrofti*	filariasis
Eye worm	*Loa-loa*	calabar swelling
Hook worm	*Ancylostoma duodenale*	ancylostomiasis
Guinea worm	*Dracunculus medinensis*	diarrhoea
Pin worm	*Enterobius vermicularis*	Perineal itching

Phylum–Annelida

- Annelids (segmented animals) are triploblastic, bilaterally symmetrical, eucoelomate (schizocoelia), e.g. earthworms, leech, etc.
- Body of annelids is divided into segments called **metamerism**.
- Many annelids bear fleshy appendages called **parapodia**, which are locomotory in function.
- Excretory organs are called as **nephridia**.
- Annelids usually reproduce sexually.
- The animals are bisexual/hermaphrodite/monoecious, but may be unisexual or dioecious.
- They are oviparous and the eggs are laid in oothecae.

Classification

On the basis of number and presence or absence of setae, phylum–Annelida is divided into three classes

(i) Polychaeta, e.g. *Nereis* is unisexual.
(ii) Oligochaeta, e.g. *Pheretima* (earthworm) is a bisexual.
(iii) Hirudinea, e.g. *Hirudinaria* (leech) is a bisexual.

- Earthworm (*Pheretima posthuma*) is a common annelid found in soil.
- It's skin is brown due to the presence of porphyrin pigment. This pigments protect the animal from UV rays.
- In earthworm, closed circulatory system is present.
- The haemoglobin is usually dissolved in the blood.
- Earthworm is a bisexual animal.
- In earthworm, testis is present in 10th and 11th segment, while ovaries are present in 13th segment.
- Earthworm does not undergo moulting.
- They excrete urea.

Phylum–Arthropoda

- Arthropods is the largest phylum of animal kingdom. Members of this kingdom are triploblastic, haemocoelomic, segmented invertebrates. They have chitinous exoskeleton and joined legs.
- Body is segmented.
- Characteristic of insect is three pairs of legs.
- The body cavity is haemocoel *viz* cavity filled with blood.
- Respiration occurs through gills, tracheae and book lungs.
- Blood vascular system is open *viz* blood does not flow in definite vessels.
- In insects, blood is colourless (haemolymph).
- The excretory organs are either green glands or Malpighian tubules.
- Moulting, i.e. sheding of chitinous covering occurs.
- The animals are unisexual, i.e exhibit the phenomenon of sexual dimorphism.
- Fertilisation is internal.
- The animals are oviparous.

Classification

Phylum–Arthropoda is divided into five classes on the basis of body divisions and presence or absense of certain appendages

(i) Crustacea, e.g. cancer lobesters.
(ii) Chilopoda, e.g. *Scolopendra.*
(iii) Diplopoda, e.g. *Julus.*
(iv) Insecta (Hexapoda), e.g. cockroach (*Blatta*), silverfish, honeybee, mosquito, etc.
(v) Arachnida, e.g. scorpion, spider.

- Wings are vestigial in female *Blatta* (cockroach), while silverfish is wingless insect.
- In mosquito, the Johnston's organ (sensitive to sounds) is present in its antenna.
- Mosquito have 15 segments in their antenna.
- Dengue and yellow fever is caused by *Aedes* mosquito.
- Larva of cockroach and housefly is called maggot.
- Housefly transmits dysentery, typhoid, cholera, etc.
- Honeybees are economically important arthopods as they are reared for the production of honey.
- A colony of honeybees have a queen bee (fertile female), drone bees (fertile males) and worker bees (sterile females). Males are haploid and females are diploid. Honey is produced by worker bees.

Phylum–Mollusca

- Molluscs are soft-bodied, unsegmented, triploblastic, coelomate, commonly shelled animals.
- Body is differentiated into head, foot and visceral mass covered by mantle.
- They are mostly aquatic, both marine as well as freshwater. Some are terrestrial also.
- A hard calcareous shell is secreted by the mantle.
- Coelom is greatly reduced and the body cavity is called **haemocoel**.
- Exchange of gases takes place through one or more gills called **ctenidia**.
- In Mollusca, blood is blue-coloured due to copper containing haemocyanin pigment in plasma.
- Excretion occurs through paired sac-like kidneys (or metanephridia).
- The sexes are generally separate, but some are hermaphrodite.
- Asexual reproduction is absent.
- The larvae of molluscs develop through *Velliger*, *Glochidium* and *Trochophore* stages.

Classification

- Phylum–Mollusca is divided into seven classes

(i) Monoplacophora, e.g. *Neopilina.*
(ii) Aplacophora, e.g. *Chitonderma.*
(iii) Scaphopoda, e.g. *Dentalium.*
(iv) Gastropoda, e.g. *Pila.*
(v) Pelecypoda or Lamellibranchiata or Bivalvia, e.g. *Unio* (freshwater mussel).
(vi) Cephalopoda, e.g. *Octopus* (devil fish), squid and cuttle fish, etc.
(vii) Polyplacophora e.g. *Chitum*.

- Kokichi Mikimoto of Japan is known as the father of pearl industry.
- Pearl oyster–*Pinctada vulgaris* yields pearl.

Phylum–Echinodermata
(Spiny Skinned Animals)

- They are exclusively marine, carnivorous and benthonic, i.e. found at the bottom of sea.
- Body shape is cylindrical, globular, star-like or cucumber-like.
- Cephalisation or head formation is absent.

- They have true coelom, which is lined by peritoneum.
- The most feature is presence of water vascular system or ambulacral system.
- They have peculiar to be feet for locomotion.
- Internal endoskeleton is made up of a calcareous plates called **ossicles**, derived from mesoderm.
- Respiration takes place through dermal branchiae, peritonial gills and feet.
- Circulatory system is reduced and open type. It is known as haemel system.
- They are dioecious, but there is no sexual dimorphism. Fertilisation is external.
- Life-history usually includes a ciliated larva, such as *Bipinnaria, Brachiolaria, Auricularia*. Larva undergoes metamorphosis.
- Phenomena of autotomy (breaking parts to confuse enemy), evisceration (ejection of viscera) and regeneration are common.

Classification

- Phylum–Echinodermata is divided into five classes
  (i) Asteroidea, e.g. *Asterias* (starfish).
  (ii) Ophiuroidea, e.g. *Ophiothrix* (brittle-star).
  (iii) Echinoidea, e.g. *Echinus* (sea-urchin).
  (iv) Holothuroidea, e.g. *Holothuria* (sea-cucumber).
  (v) Crinoidea, e.g. *Antedon* (feather-star).
- In starfish, radial symmetry and tube feet are present.

Phylum–Hemichordata

- Hemichordata was earlier placed as a sub-phylum under the phylum–Chordata. But now, it considered as a separate phylum (under non-chordata). Hemichordates are also called **half-chordates**. They include small group of worm-like animals.
- They are exclusively marine and mostly live in burrows.
- Body cavity is true coelom.
- Digestive system is complete, circulatory system is of open type.
- Sensory cells of the epidermis acts as sense organs.
- Reproduction is mostly sexual. Sexes are separate.
- Respiration occurs through several pairs of **gill slits** or through general body surface, e.g. *Balanoglossus* (tongue worm), *Cephalodiscus*, etc.

Vertebrata or Chordata

- Chordates possess three diagnostic features–notochord, dorsal hollow nervous system and pharyngeal gill slits. In chordates, endoskeleton of bones and cartilages is present. Phylum–Chordata is divided into two groups, on the basis of presence or absence of skull. These groups are Acraniata and Cranita.
- All chordates possess axial skeletal rod of notochord.
- Post anal tail is a chordate character.

Group–Acraniata

Acraniata do not possess skull. They are divided into two sub-phyla.

(i) Sub phylum–Urochordata

- Notochord is present only in the tail of the larva (tadpole).
- Tail may or may not persist in adults. They may show retrogressive metamorphosis. e.g. *Herdmania, Doliolum, Salpa.*

(ii) Sub phylum–Cephalochordata

- Notochord extends throughout the body and persists throughout the life.
- Dorsal hollow nerve cord is present.
- Excretory organs are protonephridia with solenocytes.
- Blood is without respiratory pigment.
- Heart is absent, but circulatory system is present, e.g. *Branchiostoma.*

Group–Craniata or Sub phylum–Vertebrata

The members of Craniata possess skull. They are included in sub-phylum vertebrata.

- These are advanced chordates that have cranium (brain box) around brain.
- It is believed that all vertebrates are chordates, but all chordates are not vertebrates.
- Notochord is replaced by vertebral column around spinal cord and cranium around the brain.
- The endoskeleton is formed of cartilage and bones.
- Heart is ventrally situated. Excretory organs are kidney.
- The sub-phylum has two groups–Agnatha (without jaws) and Gnathostomata (with jaws).
- Gnathostomata is divided into two sub-groups, i.e. Pisces and Tetrapoda.

Sub-group–Pisces (The Fishes)

- Fishes are cold-blooded animals, i.e. animals whose body temperature varies according to the temperature of atmosphere typically with backbone, gills and fins.
- The body of a typical fish comprises, the head, trunk and tail. Heart is two-chambered and venous (i.e. only impure blood flows in the heart).
- Body of a fish may or may not covered by scales.
- Pisces are anamniotes (i.e. without amnion—an extra embryonic membrane), e.g. flying fish (*Exocoetus evolans*), mosquito fish (*Gambusia*), sea horse (*Hippocampus*), Shark (viviparous).

Sub-group–Tetrapoda

- Tetrapoda is again divided into amphibians, reptiles, birds and mammals.

Class–Amphibia (Vertebrates with dual-life)

- They are cold-blooded (poikilothermic) animals, often undergoes summer sleep and amphibious in nature, i.e. aquatic and terrestrial habitat simultaneously.
- The skin is smooth or rough having glands, which keep it moist.
- The gills are present in larval stage.
- The respiratory organs are lungs, buccopharyngeal cavity, skin and gills.
- The heart is three-chambered. e.g. *Rana tigrina, Bufo melanostictus, Alytes.*
- Amphibia includes anamniotes (without amnion).
- *Hyla* is a flying frog.
- *Ichthyophis* is a limbless amphibian.

Class–Reptilia (Creeping Vertebrates)

- Reptiles are creeping and burrowing cold-blooded vertebrates bearing epidermal scales.
- Respiration always takes place through lungs.
- Heart consists of two auricles and partly divided ventricle.
- The lateral line system is absent.
- Fertilisation is internal.
- They are mostly oviparous, e.g. *Hemidactylus, Draco, Calotes,* snakes (cobra, krait, viper, rattle).
- Snakes are limbless reptiles having poisonous parotid glands.
- Venom of cobra affects nervous system.
- Viper is a non-poisonous snake.
- Crocodile is a Reptilia, having a four-chambered heart that store fat in its tail.

Class–Aves (The Birds)

- Aves are animals in which forelimbs are modified into wings.
- These are warm-blooded animals, whose body temperature does not vary according to the temperature of atmosphere.
- Exoskeleton is made up of feathers.
- Flight muscles of bird are attached to keel of sternum.
- The upper and lower jaws are modified into beak.
- Syrinx is a sound producing organ in birds.
- The alimentary canal has crop and gizzard.
- The heart is four-chambered.
- Bone marrow is absent in bones of birds.
- Sexual dimorphism is found, fertilisation is internal.
- All birds are oviparous.
- The fastest fly bird is albatross.
- The flightless birds are kiwi, emu and penguin.
- *Archaeopteryx* is an extinct bird, which is considered as connecting link between reptiles and birds. It was only bird known to have teeth.
- The smallest bird is humming bird. This bird is the only bird that can fly backward.
- Emu, kiwi and penguin are flightless birds.
- Penguin bird possesses flipper-like wings.
  Other examples of this class are ostrich, kiwi, penguin, parrot, pigeon.
- Dodo bird is the recently extincted bird.

Class–Mammalia (The Mammals)

- These animals are hairy and have mammary or milk producing glands. These are warm-blooded animals whose body temperature does not vary according to the temperature of atmosphere. They are the only animals, which nourish their young ones with milk.
- Heart is four-chambered.
- Teeth are of different types (heterodont) and are embedded in the sockets of jaws (thecodont).
- The skull is dicondylic, i.e. with two occipital condyles.
- The coelom is divided into four cavities, a pericardial cavity, two pleural cavities and an abdominal cavity.
- Fertilisation is internal.
- Most mammals are viviparous (giving birth to individuals), e.g. kangaroo, rabbit (*Oryctolagus cuniculus*), squirrel (*Funambulus pennati*), human (*Homo sapiens*), dolphin, whale, seal and bats, etc.
- Blue whale gives birth to the biggest baby.
- Spiny anteater and platypus are mammals, which lays egg that is oviparous.
- **Baboon** is the largest monkey.
- Salivary glands are absent in whales and sea cow.
- Dolphins are most intelligent, second to man.
- Gorillas do not drink water.
- Cow, camel, etc., are called **ruminants** or cud chewing mammals. Their stomach is four-chambered and digestion of cellulose takes place.
- Two-horned rhino has become extinct from India.
- Fastest mammal–*Actinoryx jubatus* (cheetah) of Africa.

IMPORTANT POINTS

- ***Cyclops*** (an arthropod) possesses a single median eye.
- Honey is nectar + saliva of **honey bees.**
- The **venom** of **honeybees** is used in treatment of arthritis and snake bite.
- Electric fish *Torpedo* (electric ray), produces electric shock of 600 V.

Viruses

- The term 'virus' was given by **Pasteur.** It was discovered by **Ivanowski** in tobacco plant infected with mosaic disease. **Stanley** recovered tobacco mosaic virus in crystalline form. He later got Nobel Prize in 1946. The science dealing with the study of viruses is called as virology. They are intracellular parasites. They lack enzymes necessary for the generation of energy.
- These are considered as non-living and are dependent on the host for their survival. They exist as crystal-like forms outside the host and once get inserted, lead to dangerous and lethal infections, which lead to death of the individual. Most of the viruses are known to possess small fragment of DNA or RNA in single or double-stranded forms covered by means of protein coat called as capsid. Capsid is made up of smaller units called capsomere.
- A virus consists of approximately 94% protein and 6% nucleic acid and are capable to insert into the DNA of the host organism.
- Virus are usually 10-300 mμ in size. The smallest virus has size of 20 μ. The largest virus is pox virus having a size of 300 mμ. They can isodiametric, spherical, polygonal, anisodiametric, rod-shaped or thread-like depending upon the shape.

PRACTICE EXERCISE

1. The term Biology was coined by
(a) Linnaeus (b) Aristotle
(c) Theophrastus (d) Lamarck

2. Physical basis of life is
(a) nucleus (b) cell
(c) protoplasm (d) food

3. The most peculiar feature shown by all living organisms is
(a) excretion
(b) autotrophic nature
(c) transpiration
(d) cellular structure

4. The main difference between non-living and living is in
(a) size
(b) movement and growth
(c) presence of protoplasm
(d) None of the above

5. Nutrition occurs in
(a) living
(b) non-living
(c) Both (a) and (b)
(d) None of these

6. Body organisation may be uncontrolled in
(a) living (b) non-living
(c) Both (a) and (b) (d) None of these

7. Mechanical movement is present in
(a) living (b) non-living
(c) Both (a) and (b) (d) None of these

8. Metabolic activities are shown by
(a) living (b) non-living
(c) Both (a) and (b) (d) None of these

9. A definite shape and size is present in
(a) living (b) non-living
(c) Both (a) and (b) (d) None of these

10. Waste products are excreted by
(a) non-living (b) living
(c) Both (a) and (b) (d) None of these

11. Who is called the Father of Microbiology?
(a) Lamarck
(b) Antony van Leeuwenhoek
(c) Aristotle
(d) Linneaus

12. Irritability is shown by
(a) non-living (b) living
(c) Both (a) and (b) (d) None of these

13. Bryophytes resemble algae due to the feature
(a) no photosynthesis
(b) have photosynthetic activity but no vascular tissue
(c) have photosynthetic activity and vascular tissue both
(d) None of the above

14. Which of the following does not possess a specialised conducting tissue for transport of water and other substances in plants ?
(a) *Marchantia* (b) Angiosperms
(c) *Cycas* (d) Fern

15. The scavengers of earth are
(a) bacteria (b) viruses
(c) algae (d) fungi

16. Five kingdom, classification was given by
(a) Whittaker (b) Haeckel
(c) Linnaeus (d) Copeland

17. 'Venus flower basket' is a common name of
(a) *Sycon* (b) *Euplectella*
(c) *Euspongia* (d) *Leucosolenia*

18. Which of the following is the characteristics of sponges?
(a) Aquatic
(b) Diploblastic
(c) Body has pores
(d) Link between living and non-living

19. In which animal, collar cells are found?
(a) Sponge (b) *Hydra*
(c) Sandworm (d) Starfish

20. In Porifera, skeleton forming cells are
(a) amoebocytes (b) thesocytes
(c) sclerocytes (d) archaeocytes

21. Which is universal for sponges?
(a) Radial symmetry
(b) Calcareous spicules
(c) Marine
(d) High regenerative power

22. 'Portuguese man of war' is a common name of
(a) *Physalia* (b) *Pennatula*
(c) *Obelia* (d) coral

23. Organ pipe coral is a common name of
(a) *Astraea* (b) *Tubipora*
(c) *Heliopora* (d) *Fungia*

24. Body cavity of *Hydra* is known as
(a) coelenteron
(b) enterocoel
(c) gastrovascular cavity
(d) Both (a) and (c)

25. Jelly fishes belong to class
(a) Scyphozoa (b) Hydrozoa
(c) Anthozoa (d) None of these

26. Which is a coelenterate?
(a) Sea pen (b) Seafish
(c) Sea urchin (d) Sea cucumber

27. Tapeworms obtain their food from the host by
(a) sucking (b) scraping
(c) absorption through integument
(d) autotrophic

28. Intermediate host of liver fluke is
(a) man (b) pig
(c) snail (d) mosquito

29. Flame cells are found in
(a) Porifera (b) Coelenterata
(c) Platyhelminthes (d) Aschelminthes

30. *Taenia solium* is characterised by
(a) presence of hooks for adhesion
(b) presence of digestive tract
(c) externally divided body
(d) All of the above

31. Roundworms differ from flatworms in possessing
(a) pseudocoelom (b) flame cells
(c) segmented body
(d) production of antienzymes

32. In which animal, pseudocoel is found?
(a) *Hydra* (b) *Ascaris*
(c) Cockroach (d) Earthworm

33. Common worm found in children is
(a) *Enterobius vermicularis*
(b) *Oxyuris vermicularis*
(c) *Drancunculus medinensis*
(d) *Brugia malayi* and *B. timori*

34. Scientific name of starfish is
(a) *Echinus* (b) *Asterias*
(c) *Echidna* (d) *Limulus*

35. How many pairs of heart are present in earthworms
(a) 6 pairs (b) 4 pairs
(c) 2 pairs (d) 1 pair

36. Excretory organs of earthworm are
(a) flame cells (b) coelom
(c) nephridia (d) gizzard

37. Blood vessel in *Pheretima* having valve is
(a) dorsal (b) lateral
(c) ventral (d) integumentary

38. In Echinodermata, tube feet are related with
(a) excretory system
(b) reproductive system
(c) respiratory system
(d) locomotion

39. Which sound producing organ is found in bird?
(a) Syrinx (b) Larynx
(c) Pharynx (d) Trachea

40. Haemoglobin is dissolved in blood plasma of
(a) frog (b) rabbit
(c) cockroach (d) earthworm

41. Major nitrogenous excretory material of earthworm is
(a) uric acid (b) ammonia
(c) urea (d) amino acids

42. Housefly transmits all the diseases except
(a) dysentery (b) typhoid
(c) cholera (d) yellow fever

43. Johnston's organ is found in
(a) head of cockroach
(b) antenna of mosquito
(c) abdomen of housefly
(d) abdomen of spider

44. Which one among the following is absent in arthropods?
(a) Cilia
(b) Jointed appendages
(c) Respiratory organs
(d) Segmented body

45. Which of the following is characteristic of insect?
(a) Compound eyes
(b) Calcareous exoskeleton
(c) Pseudosegmented body
(d) Three pairs of legs

46. Maggot of housefly is its
(a) pupa (b) larva
(c) chrysalis (d) imago

47. Dengue fever spreads by
(a) *Anopheles* (b) *Aedes*
(c) *Culex* (d) *Musca*

48. In which insects wings are vestigial?
(a) Female *Anopheles*
(b) Male *Anopheles*
(c) Male *Blatta*
(d) Female *Blatta*

49. In honeybee, barbless sting occurs in
(a) workers (b) queen bee
(c) drone (d) All of these

50. Which one belongs to Mollusca?
(a) Cuttle fish and mussel
(b) Silverfish and starfish
(c) Sea urchin and *Pila*
(d) Feather star and sea cucumber

51. Octopus, squid and cuttle fish belong to
(a) Scaphopoda (b) Apoda
(c) Decapoda (d) Cephalopoda

52. Tube feet is developed for locomotion in
(a) cockroach (b) cuttle fish
(c) catfish (d) starfish

53. Which of the following shows the radial symmetry?
(a) *Anopheles* (b) Cockroach
(c) *Asterias* (d) Snail

54. In which of the following class starfish has been placed?
(a) Crinoidea (b) Asteroidea
(c) Ophiuroidea (d) Holothuroidea

55. Which is not a member of Echinodermata?
(a) Starfish (b) Sea-lily
(c) *Ascaris* (d) *Ophiuthrix*

56. Which is characteristic feature of Echinodermata?
(a) Vascular system
(b) Radial symmetry
(c) Radial canal
(d) Ambulacral system

57. Which one among the following is a chordate character?
(a) Spiracles (b) Post anal tail
(c) Gills
(d) Chitinous exoskeleton

58. Which one character of the following is possessed by all chordate?
(a) Limbs (b) Skull
(c) Axial skeletal rod of notochord
(d) Exoskeleton

59. Which is cold-blooded animal?
(a) Kangaroo (b) Pigeon
(c) Shark (d) Rabbit

60. Which one is viviparous?
(a) Shark (b) Frog
(c) Lung fish (d) Bony fish

Directions (Q. No. 61-63) *The following question consists of two statements one labelled Statement I and the other labelled Statemenet II. Select the correct answers to these questions from the codes given below*

Codes
(a) Both statements are true and Statement II is the correct explanation of Statement I
(b) Both statements are true, but Statement I is not the correct explanation of Statement II
(c) Statement I is true, but Statement II is false
(d) Statement I is false, but Statement II is true

61. **Statement I** Living beings exchange their energy with surroundings.
Statement II Living beings are examples of open system.

62. **Statement I** Fungi are widespread in distribution and they even live on or inside other plants and animals.
Statement II Fungi have chlorophyll.

63. **Statement I** Cyanobacteria are blue-green algae with prokaryotic structure.
Statement II They appear green in colour due to the presence of chloroplast.

64. *Sphagnum* is an important bryophytes. Consider the following statements about it
1. It is a chief constituents of peat.
2. Very useful in transportation of wet or moisture requiring products.
3. Also used for synthesis of antibiotics.

Codes
(a) 1 and 2 (b) Only 3
(c) 2 and 3 (d) Only 1

65. Which among the following has specialised tissue for conduction of water?
1. Thallophyta 2. Bryophyta
3. Pteridophyta
4. Gymnosperms

(a) 1 and 2 (b) 1 and 3
(c) 3 and 4 (d) 1 and 4

66. Which of the following statements is/are correct?
1. Viruses contains enzymes necessary for the generation of energy.
2. Viruses can be cultured in any synthetic medium.
3. Viruses are transmitted from one organism to another by biological vectors only.

Select the correct answer using the codes given below
(a) Only 1 (b) Only 2
(c) 1 and 3 (d) All of these

Previous Years' Questions

67. **Statement I** Bats can catch their prey in the darkness of night.
Statement II Bats can produce and detect ultrasonic waves.
Codes **2012 (I)**
(a) Both the statements are individually true and Statement II is the correct explanation of Statement I
(b) Both the statements are individually true, but Statement II is not the correct explanation of Statement I
(c) Statement I is true, but Statement II is false
(d) Statement I is false, but Statement II is true

68. What are cold-blooded animals? **2012 (I)**
(a) Animals with blood without haemoglobin
(b) Animals who are not ferocious
(c) Animals whose body temperature remains constant
(d) Animals whose body temperature varies according to the temperature of atmosphere

69. Which one among the following animals gives birth to the biggest baby? **2013 (II)**
(a) Elephant (b) Rhinoceros
(c) Blue whale (d) Hippopocamus

70. Which one among the following animals is a mammal? **2013 (II)**
(a) Great Indian Bustard
(b) Gharial
(c) Platypus
(d) Hornbill

71. Which one among the following animals does not undergo periodic moulting of their external body covering? **2013 (II)**
(a) Cockroach (b) Cobra
(c) Earthworm (d) Dragonfly

72. Which one among the following groups is the most abundant in terms of number of species identified? **2014 (I)**
(a) Fungi (b) Green plants
(c) Bacteria (d) Insects

73. Which of following plant leaves are not used for the rearing of silk worm **2014 (I)**
(a) Mulberry (b) Castor
(c) Oak (d) Sagon

74. Which one of the following animals is cold-blooded? **2014 (II)**
(a) Dolphin (b) Shark
(c) Whale (d) Tortoise

75. Living things are grouped into subgroups like plant kingdom /animal kingdom. Which one of the following is not correct for animal kingdom? **2015 (II)**
(a) Cannot make their own food
(b) Body contains cellulose
(c) Do not have chlorophyll
(d) Migrate from one place to another

76. Who discovered antibiotic producing fungus from *Penicillium* genes? **2015 (II)**
(a) Louis Pasteur
(b) Sir Alexzendar Fleming
(c) Stanley Prusiner (d) Robert Hook

77. Which of the following is not an example of eukaryotic organisms? **2015 (II)**
(a) Yeast (b) Bacteria
(c) Plants (d) Human

78. Consider the following statements. **2016 (I)**
1. All echinoderms are not marine.
2. Sponges are exclusively marine.
3. Insects are found in all kinds of habitats.
4. Many primates are arboreal.

Which of the statement(s) given above is/are correct?
(a) 1, 3 and 4 (b) 3 and 4
(c) 2 and 4 (d) Only 3

79. Which of the following statements are correct? **2016 (I)**
In hoheybees
1. Males are haploid.
2. Workers are sterile and diploid.
3. Queen develops from diploid larvae that feed on royal jelly.
4. Honey is collected/made by males.

Select the correct answer using the code given below
(a) 1, 2, 3 and 4 (b) 2 and 3
(c) 1, 2 and 3 (d) 1 and 4

ANSWERS

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

02

CELL AND CELL DIVISION

Usually 4 to 5 questions are asked from this chapter. Questions are mostly based upon general characteristics of animal cells, genetic material and osmosis in animal cells.

Cell (**Lt.** *cellula* – a small compartment) is the structural and functional unit of life. It is composed of an organised mass of protoplasm, which is surrounded by a protective and selectively permeable covering called **cell membrane**.

Robert Hooke (1665) was the first to observe a honeycomb-like pattern in a slice of cork under primitive microscope. He termed these honeycomb-like structures as 'cell'. His work was published in his book *Micrographia*.

Cytology is the study of structure and function of cell under microscope, similarly **cell biology** includes the study of cell structure, function, development, biochemistry and physiology.

Organisms may have one or more cells. Organism with a single cell is called **unicellular** (e.g. *Amoeba*, bacteria), while organism with more than one cell is called **multicellular** (e.g. higher plants and animals) an organism without cell is called **acellular** (e.g. virus).

CELL THEORY

Cell theory was proposed by **Matthias Schleiden** (German Botanist) in 1838 and **Theodor Schwann** (German Zoologist) in 1839.

Cell theory now suggests

(i) living organisms are composed of cells and their products.

(ii) cell is the functional **unit of life**.

(iii) Later cell theory was extended by **Rudolf Virchow** in 1855. He proposed *Omnis cellula-e-cellula*, i.e. cells arise only by division of previously existing cell. Viruses are considered to be the exceptions to cell theory as they are acellular.

Types of Cells

All living cells are of two basic types

(i) **Prokaryotic** Those primitive cells lacking a true nucleus and cell organelles like mitochondria, Golgi body, ER, e.g. bacterial cells, cyanobacteria (blue-green algae), mycoplasma.

(ii) **Eukaryotic** Those cells have the nucleus with membrane bound cell organelles, e.g. animals and higher plant's cells.

Differences between Prokaryotic Cell and Eukaryotic Cell

Components	*Prokaryotic Cell*	*Eukaryotic Cell*
Cell size	Generally smaller in size (1-10 μm).	Generally larger in size (5-100 μm).
Nuclear region	It is not well-defined.	It is well-defined and surrounded by a nuclear membrane.
Genetic material	DNA is circular and lies free in cytoplasm (no true nucleus).	DNA is linear and contained in a nucleus.
Organelles	Lack organelles like endoplasmic reticulum, mitochondria, Golgi apparatus, centrosome, etc.	Contains organelles like endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomes, centrosomes, etc.
Vacuoles	Sap vacuoles are lacking. Gas vacuoles may be present.	Sap vacuoles are commonly present.

Components	*Prokaryotic Cell*	*Eukaryotic Cell*
Ribosomes	Ribosomes are 70S (30S + 50S)	They are 80S (40S + 60S)
Respiration	Occurs through Mesosomes	Occurs through mitochondria
Cell cycle	Cell cycle is short of nearly about 20-60 minutes.	Cell cycle is long of about 12-24 hours.

Eukaryotic cells are further categorised into animal cells and plant cells.

Plant and Animal Cells

Plant cells and animal cells have common basic structure with cell membrane, cytoplasm, nucleus and various cytoplasmic organelles, but they differ in many features.

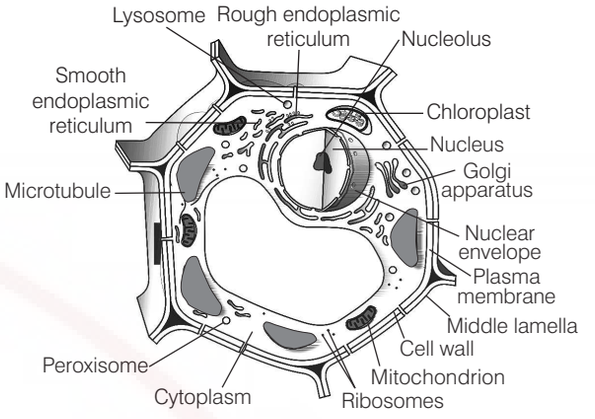
- Largest cell is **egg of ostrich.**
- Smallest cell is *Mycoplasma gallisepticum*.
- **Totipotency** Animal and plant cells have the capability of totipotency, i.e. they can transform into other types of cells.

IMPORTANT FACTS

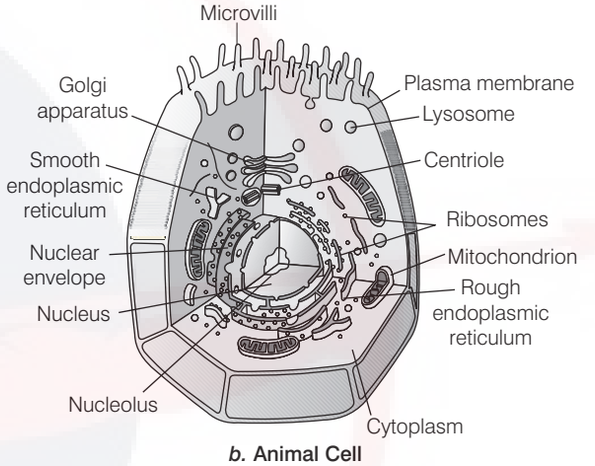
- Cell membrane and cytoplasm are the living matter of cell.
- Cell wall, granular excretory substances and lipid droplets are the non-living matter.
- Enzymes are biological catalysts.
- Microbes and ruminants use cellulose as food material.

Differences between Animal Cell and Plant Cell

Characteristics	*Animal Cell*	*Plant Cell*
Cell wall	Cell wall is absent.	Cell wall is present.
Membrane organisation	It has thin, flexible and living plasma membrane only.	It has thick, rigid, dead cell wall in addition to plasma membrane.
Nucleus	It has nucleus generally in or near the centre of the cell.	Its nucleus is pushed to one of the side in the peripheral cytoplasm.
Endoplasmic reticulum	Rough ER is abundant in animal cells.	Rough ER is sparse in plant cells.
Glyoxysomes	They lack glyoxysomes.	They have glyoxysomes.
Lysosomes	They have lysosomes.	They generally do not have lysosomes.
Vacuole	Cytoplasm contains small vacuoles.	The peripheral, central space is occupied by a large vacuole.
Plastid	Plastids are absent.	Plastids are present.
Golgi bodies	Prominent and highly complex Golgi bodies are present.	Subunits of Golgi apparatus called dictyosomes are present.
Centriole	Animal cell possess centrioles.	Plant cells lack centrosome and centrioles.
Reserve food material	glycogen	starch



a. **Plant Cell**



b. **Animal Cell**

Structure of plant and animal cells

STRUCTURE AND WORK OF CELL

Knoll and Ruska (1932) discovered electron microscope. This microscope magnifies a cell about 1-2 lakh times. Structural organisation of a cell viewed by a electron microscope includes following structures

Cell Wall

- Cells of most fungi, prokaryotes (bacteria and blue-green algae) and plants (except gametes) are surrounded by a wall. In animals, cell wall is found to be absent.
- In true bacteria and cyanobacteria, cell wall is of peptidoglycan, while in most fungi, it is of chitin, but in most of the algae and higher plants, it is of cellulose. In plants, it mainly consists of four layers, i.e.
  - (i) Middle lamella (composed of pectin compounds)
  - (ii) Primary wall
  - (iii) Secondary wall
  - (iv) Tertiary wall
- The main function of cell wall is to protect cytoplasm and plasma membrane from external shocks.
- In ripened fruits, softening occurs due to dissolution of pectin.

Plasma Membrane

(Cytoplasmic Membrane or Plasmalemma)

- Cell membrane is the selectively permeable (membrane that allow movement of some molecules, which restrict the others) thin film-like covering present around the cell.
- **Singer** and **Nicolson** (1972) proposed the most accepted **'Fluid mosaic model'** of plasma membrane structure.
- Beside plasma membrane, in eukaryotic cells intracellular membrane is also present, which surrounds the vacuole and organelles.
- Main function of cell membrane is to regulate and control the flow of materials into and outside the cell and diffusion of O_2 and CO_2. The movement of substances across a membrane occurs by following processes

(i) Diffusion

- It is the spontaneous movement of substances (such as CO_2). From a region of their high concentration to a region of their low concentration.
- It does not require a semipermeable membrane.

(ii) Osmosis

- It is the passage of water from a region of high water concentration through a semipermeable membrane to a region of low water concentration.
- Osmosis is a special case of diffusion in which water (solvent) is diffused across the membrane.
- The movement of water in animal cells may take place in different manners
  (a) If the water concentration of the solution surrounding the cell is too high, the cell bursts due to endosmosis (entry of water inside the cell). Such a solution is known as **hypotonic solution**.
  (b) If the water concentration of the solution surrounding the cell is too low, the cell shrinks due to exosmosis, i.e. outward movement of water. This solution is known as **hypertonic solution**.

Protoplasm

Protoplasm is an elastic, viscous, complex, colloidal system. It constitutes the living part of a cell.

- In 1861, **Max Schultze** proposed the 'protoplasm theory'. According to this, 'cell is an accumulation of living substance (or protoplasm), which is limited by an outer membrane and posseses a nucleus'.
- **Purkinje** (1837) coined the term protoplasm.
- The presence of protoplasm is the most important characteristic of living organism.
- All life activities take place in protoplasm.
- **Huxley** (1868) called it as **physical basis of life**.
- The parts other than protoplasm are cell wall, vacuole, granular waste material, fat droplets, etc. These constitute the non-living part of cell.

Cytoplasm

Cytoplasm is a part of protoplasm present between plasma membrane and nucleus. It is a jelly-like fluid containing many biomolecules such as lipids, made of fatty acid and glycerol. Proteins made of amino acids, carbohydrats made of monosaccharides and polysaccharides, vitamins, minerals, etc.

CELL ORGANELLES

A cell is consist of certain cell organelles. Presence of these organelles is an example of division of labour. Some of the cell organelles are as follows

Mitochondria

- **Altmann** (1890) found them as granules and named these as **bioplast**. **C Benda** (1897) coined the term **'mitochondria'** for the first time.
- Mitochondria play a significant role as the site of cellular respiration.
- Plant cells have fewer number of mitochondria as compared to animal cell.
- It is usually 1-10 μ in size.
- Mitochondria is a double-membrane bound structure.
- The outer membrane is separated from the inner membrane by means of a space called **perimitochondrial** (6-10 nm wide).
- Inner membrane is folded and projected into a number of finger-like structures called **cristae**.
- On the surface of cristae, small particles known as F_1-particles or oxysomes are found. These particles are involved in the synthesis of ATP.
- They are semiautonomous organelles. They contain circular DNA, *m*RNA, ribosomes and able to synthesise their own proteins.
- It is the **powerhouse of cell,** as oxidation of fuel occurs stepwise in it resulting in the release of ATP.
- It is absent in *Nostoc*, *Clostridium* and *Gleotricha.*

Endoplasmic Reticulum (ER)

- It is a membrane bound intercommunicating system of channels consisting of cisternae, vesicles and narrow fluid-filled tubules. It was named endoplasmic reticulum by **Porter** in 1953.
- Endoplasmic reticulum is also known as the endoskeleton of cell.

ER is of two types

(i) **Smooth Endoplasmic Reticulum** (SER) without ribosomes, takes part in lipid synthesis.
(ii) **Rough Endoplasmic Reticulum** (RER) with ribosomes, takes part in protein synthesis. Ribosomes are attached to this.

- Mitochondria also provide space for storage of synthetic product like glycogen. They also help in secretion.

Ribosomes

- Ribosomes were discovered and named by **Palade** (1955).
- Ribosomes are minute organelles that could be seen through electron microscope only. These are synthesised in the nucleus.
- Two basic types of ribosomes are 70S and 80S type.
- 70S ribosomes are found in prokaryotic cells, mitochondria and plastids of eukaryotic cell and consist of 50S (larger) and 30S (smaller) subunits. 80S ribosomes are present in cytoplasm of eukaryotic cell and consist of 60S (larger) and 40S (smaller) subunits.
- It provides space as well as enzyme for the synthesis of protein in a cell, hence called **protein factories** of cells.
- **Venkatraman Ramakrishnan** got Nobel Prize in 2009 for his work on structure and function of ribosomes.

Lysosomes

- Lysosomes were discovered by **Christian de Duve** in 1955.
- These are commonly called **suicidal bags** of the cell.
- A lysosome is a single-membraned, spherical, tiny sac-like body.
- It is most common in **eukaryotic** cells, but abundantly found in **animal cells** exhibiting **phagocytic** activity.
- These are reservoirs of **hydrolytic enzymes** (about 40). These enzymes can hydrolyse different substances such as proteins, nucleic acids, etc.
- These help in the digestion of material taken in by endocytosis (internalisation of substances).

Golgi Bodies

- Golgi bodies were discovered by **Camillo Golgi** in 1898. He got Nobel Prize for this.
- It is a complex organisation of net-like tubules or vesicles surrounded by smaller spherical vesicles.
- It is mainly present in eukaryotic cells, **except mammalian RBCs**. These are abundantly found in secretory cells.
- The Golgi apparatus plays an important role in the formation of lysosome, acrosome of sperms, formation of yolk and storage of secretion products, formation of pectin in plants, formation of melanin granules, secretion of hormones. The carbohydrates link with proteins to form glycoproteins in Golgi bodies.

Centrosome

- Centrosome is a structure found in animal's cell and some lower plants *Chlamydomonas*. It is composed of two granule-like structures called **centrioles**.
- The term 'centrosome' was coined by **T Boveri** in 1888.
- During cell division, it is divided into two pairs of centrioles, which move towards two opposite poles.
- Each centriole is made up of microtubules with a group of triplet fibres.

Vacuole

- It is surrounded by a single membrane called **tonoplast** and filled with liquid substances.
- Its size is large in plants, while in animal it is absent or very minute in size.
- It consists of anthocyanin pigment that gives red or purple colour to flowers.

Plastids

Plastids were discovered by **Haeckel**, but term plastid was given by **Schimper**. Plastids are of three types

(i) **Leucoplast** It is colourless plastid found in underground roots, stems and stores food.

(ii) **Chromoplast** It is coloured plastid and found in coloured parts of flower, leaves, petals and fruits, etc. It is found in the form of **lycopene** in tomato, **carotene** in carrot, etc.

(iii) **Chloroplast** It is green coloured plastid found in all green plants.

Chloroplast

Chloroplast was discovered by **Schimper** (1885).

- Chloroplast is a cell organelle found in green plants.
- It can be variously shaped, i.e. cup-shaped, e.g. *Chlorella, Chlamydomonas,* girdle-shaped, e.g. *Ulothrix,* ribbon-shaped, e.g. *Spirogyra,* etc.
- Chloroplast consists of pigments such as chlorophyll, carotene and xanthophyll.
- It is composed of a matrix-stroma covered by double-membranes.
- In the stroma, sac-like membranous units, i.e. thylakoids are found. These thylakoids are stacked one above the other. One such stack is called as **granum**. In cyanobacteria granaless chloroplasts, i.e. chromatophores are present.
- On the outer surface of thylakoids, quantasomes are found. Quantasome is a unit of photosynthesis consisting of 200-300 chlorophyll molecules.
- Chloroplast possesses 70S ribosomes and its own DNA. Due to this, they are also called as **semiautonomous organelles**.
- Chloroplast may also consist of pyrenoids with starch.
- Light and dark reaction of photosynthesis occur in chloroplast.

Nucleus

- Nucleus was discovered by **Robert Brown** in 1831.
- Every eukaryotic cell consists of at least one, almost spherical, dense, highly specialised structure called as **nucleus** (exceptions–sieve tube element of mature phloem in plants, RBCs of mammals).
- All the metabolic activities of a cell are under the control of nucleus.

- Chemically nucleus consists of 70% proteins, 20% DNA, 5% RNA and 3% lipids.
- Nucleus is considered to be the **vehicle of heredity** as it contains the genetic information for reproduction, development, metabolism as well as behaviour of irritability organism. Nucleus is the smallest unit that shows capacity for metabolism, irritability growth and reproduction.
- The nucleus consists of following parts
  (i) **Nuclear Membrane** It is double-layered membrane and surrounds the nucleolus of a eukaryotic cell.
  (ii) **Nucleoplasm** It is clear gel-like, ground matrix having ions, proteins, nucleotide and ribosomes. Chromatin threads and nucleolus are also embedded in it.
  (iii) **Nucleolus** Nucleolus was discovered by **Fontana** in 1781. It is a non-membranous, sphere-like structure, composed of 10% RNA, 85% protein and 5% DNA. It takes part in the production of ribosomal subunits, *r*RNA and some specific proteins.
  (iv) **Chromatin** It is present in the nucleoplasm as thin-threads.
  It is made up of DNA basic proteins (histones) and non-histone proteins. During cell division, chromatin condenses into **chromosomes**.

NUCLEIC ACIDS

- Nucleic acids are complex carbonic compounds and most important macromolecules of cell. They are polymers of smaller units called **nucleotides**, joined end to end by phosphodiester bonds to form long chains.
- **Nucleotides** = Sugar + Nitrogenous base + Phosphate
- **Nucleosides** = Sugar + Nitrogenous base

Two nucleic acids abundant in living organisms are

(i) **DNA** (Deoxyribonucleic acid) DNA is a double helical structure with two nucleotide chains that run antiparallel to each other. It consists of pentose sugar deoxyribose, phosphoric acid and nitrogenous base. Nitrogenous bases are of two types

(a) Purines — Adenine (A), Guanine (G)

(b) Pyrimidines — Cytosine (C), Thymine (T)

A pairs with T and G pairs with C.

- DNA carries the genetic information of cell and controls the structure and function of cell. It serves as hereditary material, so it functions as blueprint for building and running cellular machinery.
- The segments of DNA are genes, which are located on chromosome. Genes code for different proteins. Apart from genes, non-coding sequences are also present in DNA.
- DNA is of different types like A-DNA, B-DNA, C-DNA, D-DNA, while T-DNA is present in Ti plasmid.

(ii) **RNA** (Ribonucleic acid) It consists of ribose sugar, phosphoric acid joined with four nitrogenous bases.

(a) Purines — Adenine (A), Guanine (G)

(b) Pyrimidines — Cytosine (C), Uracil (U)

U pairs with A and G pairs with C.

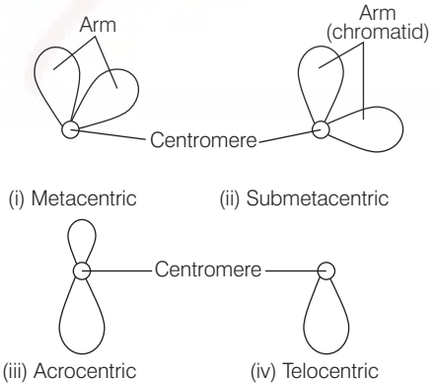
- In some viruses RNA is genetic material, e.g. retrovirus (*ds*). Non-genetic RNA is of three types, i.e. *m*RNA, *t*RNA and *r*RNA, of which, *t*RNA is the smallest RNA.
- **Transcription** is the process by which DNA gives rise to RNA.
- **Restriction Endonucleases** are special enzymes that cut the DNA at specific site, so called **molecular scissors**.

CHROMOSOME

- The term chromosome was coined by **Waldeyer** (1888).
- **Sutton** and **Boveri** (1902) proved that chromosome is the **physical basis of heredity**, in the chromosomal theory of inheritance.
- Chromatin material (made of DNA), which is found in the interphase nucleus gets condensed at the time of division into small and thick threads called **chromosome**.
- Chromosome number for a species remains always same. It is diploid ($2n$) in somatic cell and haploid (n) in **gametes**. Chromosome has one or more centromeres (centre) and arms (chromatids).
- **Genome** is the haploid entity of an organism's hereditary information. It includes both genes and non-coding sequences of DNA/RNA.

Centromere

There are four types of chromosomes based upon the position of centromere.



Some Organisms and their Chromosome Number

Organism	*Chromosome number*	*Organism*	*Chromosome number*
Roundworm	2	Mouse	40
Mosquito	6	Rat	42
Garden pea	14	Human beings	46
Onion	16	Potato	48
Maize	20		
Rice	24		
Sunflower	34		

- Largest chromosome number 1262 has been recorded in a fern plant, i.e. *Ophioglossum*.
- **Karyotype** is the number and appearance of chromosomes, in nucleus of a eukaryotic cell.
- **Idiogram** is a diagrammatic representation of the karyotype, it is useful point of reference of analysing mutations.

CELL DIVISION

- Division of cell at the time of growth is the character of life. The period from the starting of one cell division to another is known as **cell cycle**. During cell cycle, karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm) occurs.
  Cell cycle occurs in two phases

1. Interphase

During interphase, the cell synthesises all the proteins required in cell division. It also includes replication of DNA. Interphase is divided into G_1, S and G_2 phases.

2. M-phase

- M-phase is the dividing phase, it can be of two types, i.e. mitosis and meiosis.

Mitosis

- Mitosis was first described by **E Strasburger** (1875) in **plants** and by **W Flemming** (1879) in **animals**.
- Mitosis term was coined by **W Flemming** in 1882.
- It usually occurs in somatic cells, hence called **somatic division**. Mitosis mainly occurs for growth.
  Mitosis occurs into two stages:

(i) Karyokinesis

Karyokinesis includes four substages

(a) **Prophase** After interphase, prophase comes, which is first and longest stage of mitosis. Longitudinal splitting or division of each chromosome into two sister chromatids takes place. Nuclear membrane breaks down and nucleolus disappears. Spindle is also formed at late prophase.

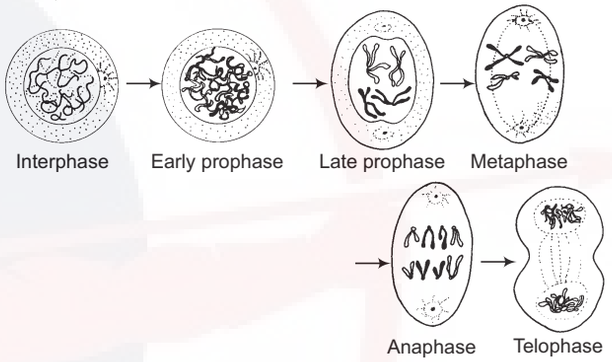
(b) **Metaphase** During this stage, spindle formation occurs. Due to attachment of spindle fibres at the centromere of chromosomes, the chromosome aligned themselves in the centre or equator due to their active movements.

(c) **Anaphase** This is the shortest stage. Chromosomes divide at the point of centromere and thus, two sister chromatids are formed. These sister chromatids move towards the opposite poles of spindle.

(d) **Telophase** Chromosomes reach opposite poles and nuclear membrane reappears around each group of chromosomes, thus forming two daughter nuclei.

(ii) Cytokinesis

Formation of two nuclei is followed by division of cytoplasm, thus forming two cells (daughter cells) by cell plate (only in plants) or cell furrow method (only in animals).



Different stages of mitosis

Meiosis

- **Farmer** and **Moore** (1905) proposed the name meiosis (reduction division).
- This type of cell division is found only in reproductive cells. The nucleus divides twice, but chromosome divides only once.
- The number of chromosomes in the daughter cells is half the number of chromosomes of mother cell.
- Four haploid (n) daughter cells are formed.
- Best material to study the meiosis is unopend flower buds of onion.

It consists of two divisions

1. Meiosis-I or First Meiotic Division

It is very important because it reduces the chromosome number to half. It comprises four substages, i.e. prophase-I, metaphase-I, anaphase-I and telophase-I.

(i) **Prophase-I** It is the longest phase and divided into five steps

(a) **Leptotene** Chromosomes appear as thin, uncoiled thread-like structures. Nuclear membrane starts disappearing and chromatin condenses to form chromosomes.

(b) **Zygotene** Pairing of homologous chromosomes (called **synapsis**) takes place. This results into the formation of **bivalents**.

(c) **Pachytene** Chromosomes split and show tetravalent stage and crossing over takes place between non-sister chromatids.

(d) **Diplotene** Separation starts from centromere (terminalisation), but it is not complete, but the homologous chromosomes remain attached at one or more points and these points are called **chiasmata**.

(e) **Diakinesis** Terminalisation is almost complete. Both nucleolus and nuclear membrane completely disappear.

(ii) **Metaphase-I** Chromosomes arranged at equator and attached to the spindle fibres.

(iii) **Anaphase-I** The chromosome with its two chromatids moves to the opposite pole.

(iv) **Telophase-I** Nuclear membrane appears around the group of chromosomes at each pole of the cell. The two daughter nuclei with half the number of chromosomes are formed. First meiotic division may or may not be followed by **cytokinesis**.

2. Meiosis-II or Second Meiotic Division

After the completion of meiosis-I, second meiotic division starts. Meiosis-II is similar to mitosis.

(i) **Prophase-II** Chromosomes become thick and short, nuclear membrane disappears.

(ii) **Metaphase-II** Chromosomes get arranged on equator and spindle apparatus is formed.

(iii) **Anaphase-II** Centromere divides into two chromatids which move to the opposite poles.

(iv) **Telophase-II** Chromosomes form a group at the opposite poles. Nuclear membrane and nucleolus reappear. Thus, two daughter nuclei are formed.

Cytokinesis

Later, karyokinesis is followed by cytokinesis. As a result of this four haploid cells are formed.

Differences between Mitosis and Meiosis

Mitosis	*Meiosis*
Takes place in somatic and reproductive cells.	Takes place in reproductive cells.
Formed two diploid cells.	Formed four haploid cells.
Every chromosome behaves independently.	Homologous chromosomes show pairing.
Chromosome number remains constant.	Chromosome number becomes half.
Mitosis ends in 1-2 hours.	Meiosis takes about 24 hours to few days.
Crossing over does not occur.	Crossing over occurs.

Amitosis

- It was first observed by **Rober Remak** (a German scientist) in the RBCs of chick embryo.
- It is direct nuclear division, without formation of spindle and recognisable appearance of chromosomes.
- It is a primitive type of division.
- It occurs in prokaryotes, protozoans, yeast, foetal membranes of mammals and in degenerative and old tissues.

PRACTICE EXERCISE

1. Cell without organised nucleus is found in
(a) bacterial cell (b) algal cell
(c) cyanophycean cell
(d) Both (a) and (c)

2. Who proposed cell theory?
(a) Robert Hooke (b) Robert Brown
(c) Schleiden and Schwann
(d) Watson and Crick

3. In which one, extranuclear DNA is found?
(a) Chloroplast (b) Mitochondria
(c) Cytoplasm (d) Both (a) and (b)

4. Through which cell organelle, cell activities are controlled?
(a) Chloroplast (b) Mitochondria
(c) Nucleolus (d) Nucleus

5. Which substance is found in middle lamella?
(a) Cutin (b) Suberin
(c) Pectin (d) Lignin

6. Which of the following is characterised by cell wall?
(a) Animals (b) Protozoans
(c) Mycoplasma (d) Plants

7. 80S ribosomes have subunits of
(a) 70S + 10S (b) 50S + 30S
(c) 60S + 40S (d) 60S + 20S

8. Mitochondria are absent in
(a) *Nostoc* (b) *Clostridium*
(c) *Gleotricha* (d) All of these

9. Smallest cell is of
(a) virus (b) bacteria
(c) *Mycoplasma gallisepticum*
(d) yeast

10. Oxysomes are found in
(a) cell (b) cytoplasm
(c) mitochondria (d) microsome

11. The colourless plastids which are found in storage food is
(a) leucoplast (b) chromoplast
(c) chloroplast (d) All of these

12. Pigment absent in chloroplast is
(a) chlorophyll
(b) carotene
(c) xanthophyll
(d) anthocyanin

13. Which of the following is related with cristae?
(a) Photosynthesis
(b) Protein synthesis
(c) ATP synthesis
(d) Fat synthesis

14. *'Omnis cellula-e-cellula'* was the statement of
(a) Robert Brown (b) Virchow
(c) Purkinje (d) Schwann

15. Chloroplast without grana are called
(a) chromoplast (b) leucoplast
(c) chloroplast (d) chromatophore

16. Which cell organelle is known as powerhouse of cell?
(a) Nucleus
(b) Endoplasmic reticulum
(c) Mitochondria
(d) Chloroplast

17. In which type of cell division synapsis occurs?
(a) Meiosis (b) Amitosis
(c) Mitosis (d) Cytokinesis

18. Pachytene occurs during
(a) meiosis (b) mitosis
(c) free cell formation
(d) budding

19. Chiasmata formation occurs during
(a) leptotene (b) zygotene
(c) pachytene (d) diplotene

20. The nuclear membrane disappears in mitosis, at
(a) metaphase (b) late prophase
(c) anaphase (d) early prophase

21. The cellular structure which always disappears during mitosis is
(a) mitochondria
(b) plastids
(c) nuclear membrane
(d) plasma membrane

22. The duplication of chromosome occurs in mitosis during
(a) early prophase (b) late prophase
(c) interphase (d) late telophase

23. Karyokinesis means division of
(a) nucleus into two
(b) cytoplasm into two
(c) protoplasm into two
(d) None of the above

24. In meiosis, bivalent condition of chromosomes occurs in
(a) leptotene (b) zygotene
(c) pachytene (d) diplotene

25. In meiosis, terminalisation almost completed in
(a) zygotene (b) pachytene
(c) diplotene (d) diakinesis

26. Which type of cell division occurs in somatic cells?
(a) Mitosis
(b) Meiosis
(c) Both (a) and (b)
(d) None of the above

27. Which type of cell division occurs in reproductive cells?
(a) Mitosis (b) Budding
(c) Amitosis (d) Meiosis

28. In yeast, which type of cell division occurs?
(a) Mitosis (b) Budding
(c) Amitosis (d) Meiosis

29. In algae, which type of cell division occurs?
(a) Meiosis (b) Mitosis
(c) Both (a) and (b) (d) Budding

30. In mitosis, spindle formation occurs in
(a) prophase (b) metaphase
(c) anaphase (d) telophase

31. In animal which type of cytokinesis occurs?
(a) By cell plate
(b) By cell furrowing
(c) Both (a) and (b)
(d) None of the above

32. Which of the following is not related to DNA?
(a) Adenine (b) Guanine
(c) Cytosine (d) Uracil

33. An adenine pairs with
(a) guanine (b) cytosine
(c) thiamine (d) adenine

34. Circular DNA is found in
(a) *E. coli* (b) mitochondria
(c) chloroplast (d) All of these

35. Double-stranded RNA is found in
(a) bacteriophage (b) TMV
(c) mycoplasma (d) retrovirus

36. Which type of RNA is the smallest?
(a) *m*RNA (b) *t*RNA
(c) *r*RNA (d) G-RNA

37. Nucleotides are composed of
(a) Sugar + Phosphate
(b) Sugar + Nitrogenous base
(c) Sugar + Nitrogenous base + phosphate
(d) Nitrogenous base + phosphate

38. Genes are segments of
(a) chromosome (b) DNA
(c) *m*RNA (d) nucleolus

39. Nitrogenous base lacks
(a) carbon (b) nitrogen
(c) phosphorus (d) hydrogen

40. 'T' form of DNA is present in
(a) Ti plasmid (b) bacteriophage
(c) coliphage (d) cyanobacteria

41. **Statement I** Cells are functional unit of life.
Statement II Cells are totipotent.
Codes
(a) Both Statements are true and Statement II is the correct explanation of Statement I
(b) Both Statements are true, but Statement I is not the correct explanation of Statement II
(c) Statement I is true, but Statement II is false
(d) Statement I is false, but Statement II is true

42. Consider the following statements regarding the living cell.
1. The Golgi apparatus links carbohydrates with proteins to form glycoproteins.
2. In plants, the Golgi complex synthesises pectin.
3. The lysosomes store the hydrolysing enzymes.

Which of these statements is/are correct?
(a) 1 and 2 (b) Only 2
(c) Only 3 (d) All of these

43. Which one among the following nutrients is a structural component of the cell wall of plants? **2012 (I)**
(a) Manganese (b) Potassium
(c) Phosphorus (d) Calcium

44. Cell membrane is selectively permeable because **2012 (I)**
(a) it is made up of selected organic molecules
(b) it does not allow transport of some substances from region of higher concentration to the region of lower concentration
(c) the movement of organic molecules occurs only at specific concentration
(d) it allows the movement of certain molecules in and out of the cell, while the movement of other molecules is prevented

45. **Statement I** Red blood cells burst when placed in water.
Statement II Due to the phenomenon of osmosis, water enters into red blood cells. **2012 (II)**
Codes
(a) Both the statements are individually true and Statement II is the correct explanation of Statement I

(b) Both the statements are individually true, but Statement II is not the correct explanation of Statement I
(c) Statement I is true, but Statement II is false
(d) Statement I is false, but Statement II is true

46. Which of the following groups is present in animal cells? **2012 (II)**
(a) Mitochondria, Cell membrane, Cell wall, Cytoplasm
(b) Chloroplasts, Cytoplasm, Vacuole, Nucleus
(c) Nucleus, Cell membrane, Mitochondria, Cytoplasm
(d) Cell membrane, Nucleus, Mitochondria

47. Consider the following statements regarding osmosis in animal cells. **2013 (I)**
1. If the water potential of the solution surrounding the cell is too high, the cell shrinks.
2. If the water potential of the solution surrounding the cell is too low, the cell swells and bursts.
3. It is important to maintain a constant water potential inside the animal body.
4. In animal cells, water potential far exceeds the solute potential.

Which of the statement(s) given above is/are correct?
(a) 1 and 2 (b) Only 3
(c) Only 4 (d) 2 and 3

48. The site of cellular respiration in animal cell is **2014 (I)**
(a) ribosome
(b) mitochondria
(c) endoplasmic reticulum
(d) lysosome

49. Within an animal cell, the most abundant inorganic constituent of protoplasm is **2014 (I)**
(a) sodium and potassium salt
(b) water
(c) iron
(d) phosphate

50. Growth and repair of damaged tissue involves **2014 (II)**
(a) mitotic cell division only
(b) Both mitotic and meiotic cell divisions
(c) meiotic cell division only
(d) amitotic cell division only

51. Which one of the following cell organelles is absent in animal cell? **2014 (II)**
(a) Cell membrane
(b) Endoplasmic reticulum
(c) Cell wall
(d) Mitochondria

52. **Statement I** *Amoeba* is a unicellular organism and the single cell performs all functions of a living organism.
Statement II Cell is the fundamental unit of living organism. **2014 (II)**

Codes
(a) Both the statements are individually true and Statement II is the correct explanation of Statement I
(b) Both the statements are individually true, but Statement II is not the correct explanation of Statement I
(c) Statement I is true, but Statement II is false
(d) Statement I is false, but Statement II is true

53. Which one of the following is the smallest unit showing the properties of life such as capacity for metabolism, response to the environment, growth and reproduction? **2015 (II)**
(a) Gene (b) Chromosome
(c) Nucleus (d) Cell

54. Which of the following statements about DNA is/are correct? **2016 (I)**
1. DNA is the hereditary material of all living organisms.
2. All segments of DNA code for synthesis of proteins.
3. Nuclear DNA is doubled helical with two nucleotide chains which run antiparallel.
4. DNA is also found in mitochondria.

Select the correct answer using the codes given below.
(a) 1, 2 and 3 (b) 3 and 4
(c) 1, 3 and 4 (d) Only 4

ANSWERS

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

03

CONSTITUENTS OF FOOD
(BIOMOLECULES)

As an average 4 to 5 questions are asked from this chapter. These questions are based on Carbohydrates, Vitamins, Proteins and Balanced diet.

FOOD

It is the material, which is required by all living organisms for the production of energy, growth, repairing of tissues and regulation of other life processes.

Balanced Diet

- Balanced diet is the diet that contains all the essential components required by the body in the optimum proportions and quantity suitable for maintaining the body in perfect state of health, activity and development.
- Various substances of balanced diet are carbohydrates (60%), proteins (15%), fats (25%), mineral, vitamins, water, roughage, etc.
- Balanced diet should have carbohydrate, proteins and fats in the ratio of 3/5 : 1/5 : 1/5, respectively.
- The components of a balanced diet are:

1. Water

It is the main component of the body. Human body contains about 65% water and about 70% of this water is protoplasm.

An average adult needs 5-6 glasses of water daily for the normal functioning of the body. The amount of water required varies with temperature and humidity of the air and the degree of physical work. Babies/infants under 6 months are not advised to take water as their kidneys are not that matured to meet the intoxication and sodium present in the water.

Functions of water are as follows

(i) To control the body temperature.
(ii) To act as an important medium in the excretional activities.
(iii) To regulate almost all biochemical reactions.

2. Carbohydrates

- They are the main energy producers or fuel substances in our body. They are stored in plants and animals in the form of starch, glucose or glycogen.
- These constitute the 1.5% part of body.
- Carbon, hydrogen and oxygen are the main components of carbohydrates.
- Carbohydrates are polymers of smaller units, i.e. glucose.
- Depending on the number of monomers present, carbohydrats are of three types

(i) **monosaccharides** (e.g. glucose, fructose),
(ii) **disaccharides** (e.g. sucrose, lactose, maltose),
(iii) **oligosaccharides** and **polysaccharides** (e.g. glycogen, starch, cellulose).

The disaccharide units bound together by glycosidic linkages
(i) Maltose (malt sugar) = Glucose + Glucose
(ii) Lactose (milk sugar) = Glucose + Galactose
(iii) Sucrose (cane sugar) = Glucose + Fructose

- Cotton and paper are pure cellulose.
- Cellulose is a polymer of glucose.
- Animals like cow, buffalo, goat can digest cellulose, but human is devoid of it.
- **Starch** is converted into maltose in saliva of human beings by an enzyme ptyalin or salivary amylase.
- Its 1.0 g gives 4 kcal energy.
- Living cells receive carbohydrate from blood mostly in the form of glucose.
- Excess of glucose is stored in liver and muscles as glycogen, by the process of **glycogenesis**.
- When level of blood glucose falls, glycogen in liver is hydrolysed to produce it, i.e. **glycogenolysis** takes place.
- Excess carbohydrate of food is changed into fat through the process of **lipogenesis**.
- Cereals (wheat, rice and maize), sugarcane, milk (lactose sugar), fruits, honey (fructose sugar), beet, etc., are the sources of carbohydrates.
- An adult requires 500 g carbohydrates per day.
- This requirement increases in sports persons and lactating mother.

Functions of Carbohydrates

- To supply energy to the body by the oxidation of food.
- To construct the external skeletons of insects and cell wall of plants.
- To form nucleic acids (ribose and deoxyribose sugars).

3. Lipids

- Lipids are made of fatty acids and glycerols.
- Lipids are generally of two types; **simple**, e.g. fat and oil and **compound**, e.g. lecithin and glycolipid.
- They provide two times more energy (9 kcal/g) than carbohydrates. Oxidation of 1 g fat yields 9.3 kcal energy.
- Fat is the major stored food kept in adipose tissue.
- At 20°C fat is called **lipid**.
- Stored food is used as fuel, when glucose is not available.
- Lipase enzyme digests fat and breaks it into fatty acids and glycerol.

There are two types of fatty acids
(i) **Saturated** These are solid at room temperature.
(ii) **Unsaturated** These are liquid at room temperature.

- Our diet should contain less saturated fats, e.g. butter, ghee, hydrogenated vegetable oils, etc.
- Excess of saturated fats in diet may lead to heart attack as they increase blood cholesterol. This disease is known as **hypercholesterolemia**.
- The unsaturated fatty acids should be more in diet as they cannot synthesised in the body itself. These fatty acids are called **essential fatty acids** (e.g. linoleic acid, linolenic acid, etc.).
- Excessive intake of fats may cause obesity. Its symptoms are fat accumulation in tissues, high blood pressure, cardiac disorder and proneness to diabetes.

Functions of Lipids

- Stored source of energy.
- Fat functions as a cushion and shock absorber for eyeballs, gonads, kidney, etc.
- It provides insulation to the animals living in colder regions.

4. Proteins

- The term 'protein' was coined by **Mulder** in 1838.
- They are made up of carbon, hydrogen, oxygen, nitrogen and sulphur. Thus, these are required for protein formation in body.
- They play a vital role in growth, development and repair of the body. All enzymes are protins except ribozymes.
- They are digested in **alimentary canal** by the action of pepsin and trypsin enzymes.
- They are the building block substances of body.
- Proteins are polymers of amino acids.

Amino acids are of two types
(i) **Essential** cannot be synthesised in the body and must be taken in diet, e.g. lysine, methionine, valine, tryptophan, phenylalanine, etc.
(ii) **Non-essential** synthesised in the body and do not need to be taken from outside, e.g. alanine, arginine, aspartic acid, glutamin, cysteine, proline, serine, hystidine, tyrosine.

- In stomach proteins are first broken down in amino acids then are digested. Hence, amino acids are the substances, which are never excreted out through urine under normal circumstances in any healthy individual.
- 1.0 g of protein may yield 5.65 kcal energy.
- Daily requirement of protein is 70-100 g.
- Excessive thinning of hair in man is due to low protein content.
- They build up various protoplasmic structures including cell membrane.
- Main sources of protein are groundnuts, soybean, meat, pulses, fish, egg, milk, etc.

Functions of Proteins

- Essential for growth and repair of body.
- Act as enzymes or biological catalyst in metabolic reactions.
- Antibodies are proteins, which work for the defence of body.
- Collagen protein is present in bone, tendons, cartilage and transports fatty acids and lipids in blood.
- Insulin protein helps to regulate glucose metabolism.
- Keratin is present in skin, nails, hairs, horns, etc.
- Haemoglobin, visual pigments, cytochromes are proteins.

5. Minerals

- Metals, non-metals and their salts are called **minerals**.
- These are essential parts of **enzyme** (known as cofactors and prosthetic group) and **vitamins**.

Sodium (Na) and Potassium (K)

- These are main cations of extracellular and intracellular fluids.
- Sodium helps in absorption of glucose and electrochemical impulse conduction in nerves and muscles.
- Potassium takes part in muscles and nerves activity, glycogen and protein synthesis.
- Deficiency of sodium and potassium causes cramps and convulsions, respectively.
- Its sources are salt, milk, vegetables, etc.

Chlorine (Cl)

- It is the main anion of extracellular fluid.
- It helps in synthesis of HCl in alimentary canal for food digestion and acid-base balance.
- Deficiency of chlorine causes loss of appetite and muscle cramps.
- Its sources are salted food and sea food.

Magnesium (Mg)

- It is enzyme activator.
- It is a component of bones and teeth.
- Its deficiency produces convulsion and irregularity of metabolism.
- Its sources are meat and green vegetables.

Sulphur (S)

- It is the main constituent of many proteins, enzymes and coenzymes.
- Its deficiency disturbs protein metabolism.
- Its sources are dairy products, meat, eggs and broccoli.

Cobalt (Co)

- It is a component of vitamin-B_{12}.
- Its deficiency causes pernicious anaemia.
- Its sources are meat, yeast and milk.

Fluorine (F)

- It maintains enamel and checks dental decay or caries.
- In excess, harmful to teeth and bones, i.e. caused fluorosis.
- It is present in milk and drinking water.
- Its sources are water supplies, tea, seafood, meat, liver and beans.

Calcium (Ca)

- It is a major component of bones and teeth.
- It is required for blood clotting and muscles contraction and heart functioning.
- It is required more in children and pregnant ladies.
- It is present in milk, green vegetables, gram, fish, etc.
- Its deficiency causes rickets, muscles spasms and tetany.

Iodine (I)

- It is essential for production of thyroxine hormone from thyroid gland.
- Its deficiency causes goitre.
- Its sources are iodised salt, fish and seafood.

Phosphorus (P)

- Along with calcium, it occurs in bones and teeth.
- It is a component of nucleic acids, phospholipids and ATP.
- Its deficiency reduces growth, metabolism and causes rickets in children.
- Its sources are milk, cheese, eggs, peanuts and most foods.

Iron (Fe)

- It is an important component of haemoglobin.
- These are required more in girls (35 mg) as compare to boys (25 mg). Because blood is loss in menstrual cyele in girls.
- Its deficiency may leads to anaemia.
- Its sources are green leafy vegetables like spinach, *Chenopodium*, methi, etc.

6. Vitamins

- These are accessory food factors, required in small quantity for controlling metabolism and body functioning. They do not provide energy.
- Vitamins were discovered by **Funk** in 1912.
- These are of two types; **fat soluble** (A, D, E and K) and **water soluble** (B-complex and C).
- Fat souble vitamins are stored in liver.
- Eating of raw fish can cause the deficiency of vitamin-B (thiamine).
- Milk is a poor source of vitamin-C.

Vitamins, their Sources and Functions

Vitamins	*Common Sources*	*Functions*	*Deficiency Symptoms*
Vitamin-A (Retinol or Antixerophthalmic vitamin or anti-infective) (β-carotene is a precursor of vitamin-A)	Milk, butter, eggs, fish oil, vegetables (carrot), fruits (papaya), liver, etc.	Forms retinal pigments (rhodopsin of rod cells) and iodopsin of cone cells of eye.	Night blindness (no vision in dim light). Xerophthalmia is caused.
Vitamin-B_1 (Thiamine)	Yeast, wheat bread, peanuts, beans, pulses, etc.	Essential for normal carbohydrate metabolism and functioning of nervous system.	Beri-beri (weakness of limb muscles).
Vitamin-B_2 (Riboflavin)	Liver, milk, cheese, leafy vegetables, eggs, kidney, seeds, yeast, etc.	Part of coenzymes, maintains healthy skin and oral mucosa. It makes cow's milk nutritious and yellow.	Chailosis (fissures in skin).
Vitamin-B_3 (Niacin or Nicotinic acid)	Wheat bread, meat, peanuts, yeast, milk, sugarcane, etc.	Carbohydrate metabolism.	Pellagra (swollen lips and pigmented skin).
Vitamin-B_5 (Pantothenic acid)	Yeast, milk, groundnut, tomatoes, liver, kidneys, egg yolk, honey, etc.	Main component of coenzyme-A, plays various metabolic roles especially in conversion of pyruvate into acetyl Co-A for Krebs cycle.	Deficiency is rare due to its abundance.
Vitamin-B_6 (Pyridoxin)	Meat, milk, egg yolk, fish, pear, soya bean, green leafy vegetables, etc.	Involved in neurotransmitter synthesis, haemoglobin synthesis, keeps blood sugar (glucose) in normal ranges.	Dermatitis.
Vitamin-B_7 (Biotin) Vitamin-H	Egg yolk, milk, liver, kidney, honey, peanuts, beans, chocolate, etc.	Helps the body metabolise proteins, fats, and carbohydrates, nausea, muscle pain, fatigue and depression.	Muscular dystrophy, anaemia, tiredness.
Vitamin-B_{10} (Folic acid)	Liver, green vegetables, banana, soya bean, etc.	Nucleic acid metabolism, formation of RBCs.	Megaloblastic anaemia.
Vitamin-B_{12} (Cyanocobalamin)	Eggs, fish, liver, *Spirulina*, milk, etc. Not available from plants.	Promotes DNA synthesis, maturation of RBCs.	Pernicious anaemia.
Vitamin-C (Ascorbic acid) Antiviral vitamin	Citrus fruits (e.g. amla, orange, etc.), guava, tomatoes, leafy vegetables, chillies, etc.	Formation of collagen, essential in making connective tissue.	Scurvy (bleeding of gums, teeth falling).
Vitamin-D (Calciferol), Synthesised by our own skin, in sunlight.	Fish liver oil, sunlight, milk, egg yolk, etc. Synthesised by human skin	Ca and P deposition in bones and teeth.	Rickets in children (bent and weak bones) Osteomalacia in adults.
Vitamin-E (Tocopherol) Antisterility vitamin or beauty vitamin	Almonds, leafy vegetables, vegetable oil, cereal grain.	Keeps skin healthy, maintains RBCs.	Destruction of RBCs, reproductive failure.
Vitamin-K (Phyloquinone) anti cancer vitamin	Leafy vegetables, soybean oil.	Normal blood clotting helps to prevent cancer.	Delayed blood clotting.

7. Roughage

Indigestable fibrous material present in the food is called **roughage**. It provides bulk to the diet for satisfying appetite. Bulk amount of roughage helps in expanding gut and also stimulates peristalsis to eliminate the faceal mater.

Thus, food rich in roughage may help to prevent constipation, e.g. cellulose present in the cell walls of plant material such as vegetables, fruits and bran all contain roughage.

Nutritional Deficiencies and Imbalances

- **Protein Energy Malnutrition** (PEM) It causes two types of diseases–kwashiorkor and marasmus.
  (i) **Kwashiorkor** commonly affects children. Its symptoms are retarded growth, oedema, slender legs and bulging eyes.
  (ii) **Marasmus** commonly affects infants under one year of age. Its symptoms are mental retardation and weak body, wrinkled skin, thin limbs, loss of weight.
- Obesity causes by excess of food fat.
- Excess of vitamin-A, D and K causes *hypervitaminosis*.
- Excess of saturated lipids causes *hypercholesterolemia*.

PRACTICE EXERCISE

1. About 80% of the body weight in most organisms is
(a) protein (b) minerals
(c) water (d) fat

2. Tocopherol is the chemical name of vitamin
(a) B (b) E (c) C (d) D

3. Calciferol is the chemical name of vitamin
(a) D (b) A (c) C (d) B

4. Water soluble vitamins are
(a) A, D (b) E, K
(c) B, C (d) None of these

5. Fluorosis is caused due to
(a) excessive intake of fluorine
(b) excessive intake of fat
(c) deficiency of fluorine
(d) deficiency of fat

6. Which substance is known as building block?
(a) Water (b) Fat
(c) Carbohydrate (d) Protein

7. Osteomalacia is caused due to the deficiency of vitamin
(a) A (b) B_{12}
(c) D (d) None of these

8. Which vitamin is responsible for the formation of bones and teeth?
(a) A (b) B_7 (c) C (d) D

9. Bleeding in gums is caused due to the deficiency of vitamin
(a) B (b) A
(c) C (d) D

10. Which of the following is depicted by ascorbic acid?
(a) Vitamin (b) Protein
(c) Fat (d) Carbohydrate

11. The main carbohydrate in plants is
(a) glycogen (b) starch
(c) Both (a) and (b) (d) None of these

12. Pernicious anaemia is caused due to vitamin
(a) B_1 (b) B_2 (c) B_4 (d) B_{12}

13. Obesity is caused due to
(a) excessive intake of fats
(b) deficiency of food
(c) Both (a) and (b)
(d) None of the above

14. Xerophthalmia is caused due to deficiency of vitamin
(a) D (b) A (c) C (d) K

15. Fat soluble vitamins are
(a) A, B and C (b) B and C
(c) A, D, E and K (d) None of these

16. Deficiency of iodine causes
(a) pellagra (b) rickets
(c) goitre (d) None of these

17. Night blindness is due to the deficiency of vitamin
(a) D (b) B (c) A (d) K

18. Which is the best source of vitamin-E?
(a) Almonds (b) Oranges
(c) Meat (d) Carrots

19. Deficiency of vitamin-D in children causes
(a) ricket (b) beri-beri
(c) anaemia (d) scurvy

20. Sucrose is abundant in
(a) milk (b) orange juice
(c) sugarcane (d) grapes

21. The essential fatty acid in the diet is
(a) linoleic (b) stearic
(c) oleic (d) palmitic

22. A good source of vitamin-B is
(a) carrot
(b) fish oil
(c) germinated seeds
(d) egg yolk

23. Anaemia is caused in man due to the deficiency of
(a) folic acid (b) vitamin-B_{12}
(c) iron (d) All of these

24. The best source of vitamin thiamine is
(a) cod liver oil (b) curd
(c) egg (d) wheat bread

25. Eating of raw fish can cause deficiency of vitamin
(a) D (b) B_1 (c) B_4 (d) B_{12}

26. Cow's milk is more nutritious and slightly yellow due to the presence of
(a) vitamin-D (b) ascorbic acid
(c) riboflavin (d) tryptophan

27. One of the vitamin is antiviral
(a) A (b) D (c) C (d) K

28. Pantothenic acid is vitamin
(a) B_1 (b) B_5 (c) B_{12} (d) K

29. Liver does not store one of the following
(a) vitamin-A (b) vitamin-B
(c) fats (d) None of these

30. Which is not shown by vitamins?
(a) Digestion
(b) Metabolism
(c) Growth
(d) Release of energy

31. Which of the following is Vitamin-E?
(a) Retinol (b) Tocopherol
(c) Calciferol (d) Thiamine

32. Which vitamin is essential for RBC formation?
(a) Thiamine (b) Riboflavin
(c) Folic acid (d) Calciferol

33. Which vitamin is also known as vitamin-B_2?
(a) Riboflavin (b) Thiamine
(c) Niacin (d) None of these

34. Excessive thinning of hair in man will be due to
(a) less blood supply
(b) low proteins
(c) less fats
(d) None of the above

35. Antixerophthalmic vitamin is
(a) vitamin-A (b) vitamin-D
(c) vitamin-E (d) vitamin-K

36. The vitamins, which we must daily consume should be
(a) fat soluble (b) water soluble
(c) ether soluble (d) alcohol soluble

37. The essential mineral for synthesis of proteins in body is
(a) sodium (b) iron
(c) sulphur (d) potassuim

38. Prolonged deficiency of nicotinic acid causes
(a) pellagra (b) anaemia
(c) osteomalacia (d) xerophthalmia

39. Who coined the term vitamin?
(a) Calvin (b) AG Tansley
(c) Funk (d) None of these

40. Which is not an adequate protein?
(a) Milk (b) Meat (c) Eggs (d) Corn

41. With reference to human nutrition, consider the following statements.
1. Glycogen is stored in liver.
2. Coconut oil has the essential fatty acids.
3. Sprouted pulses are a source of folic acid.
4. Vitamin-K is synthesised in the human body.

Which of these statements are correct?
(a) 1, 2 and 3 (b) 2 and 4
(c) 1, 3 and 4 (d) All of these

42. Consider the following items.
1. Proteins, carbohydrates and fats
2. Vitamins 3. Minerals
4. Water

Which of the above are considered as the constituents of food?
(a) 1, 2 and 4 (b) 1 and 3
(c) 2 and 3 (d) 1, 2, 3 and 4

43. Consider the following statements
1. Lysine, valive are essential amino acids
2. Alanine, arginine are non-essential amino acids.
3. Term 'protein' was coined by Funk.
4. Vitamin-E is also called beauty vitamin.

Which of these statements are correct?
(a) 1, 2 and 4 (b) 1, 2 and 3
(c) 1 and 2 (d) 2, and 4

44. Match Column I with Column II and select the correct answer using the codes given below.

Column I (Nutrient)	Column II (Food stuff)
A. Protein	1. Cheese
B. Fats	2. Butter
C. Minerals	3. Green vegetables
D. Starch	4. Maize

Codes

	A	B	C	D		A	B	C	D
(a)	2	1	3	4	(b)	1	2	3	4
(c)	1	2	4	3	(d)	2	1	4	3

45. Carbohydrates are stored in animals and plants in the form of **2012 (I)**
(a) cellulose and glucose, respectively
(b) starch and glycogen, respectively
(c) starch and glucose, respectively
(d) cellulose and glycogen, respectively

46. Balanced diet should have approximately **2012 (I)**
(a) 1/5 protein, 3/5 fat and 1/5 carbohydrate
(b) 3/5 protein, 1/5 fat and 1/5 carbohydrate
(c) 1/5 protein, 1/5 fat and 3/5 carbohydrate
(d) 1/2 protein, 1/4 fat and 1/4 carbohydrate

47. Which one among the following statements about a healthy diet is correct? **2013 (I)**
(a) Regular eating of high energy snacks between meals is healthy, since it provides energy and vitamins in plenty
(b) Fruits and vegetables make a good choice because their energy content is high
(c) A balanced diet must contain plenty of fats and proteins with little carbohydrates and fibre
(d) An optimal quantity of fat, protein, carbohydrate with adequate amount of water and fibre makes a healthy diet

48. After diagnosis of disease in a person, the doctor advises the patient iron and folic acid tablets. The person is suffering from
(a) osteoporosis **2014 (I)**
(b) anaemia
(c) goitre
(d) protein-energy malnutrition

49. In honey, which one among the following sugars predominates? **2014 (I)**
(a) Sucrose (b) Fructose
(c) Galactose (d) Maltose

50. Which of the following statements about vitamins are correct? **2014 (I)**
1. Vitamin-C is essential to make connective tissue in body.
2. Vitamin-D is needed for synthesis of eye pigment.
3. Vitamin-B_{12} helps in maturation of RBCs.
4. Vitamin-C is required to make use of calcium absorbed from the intestine.

Select the correct answer using the codes given below.
(a) 1 and 2 (b) 1 and 3
(c) 2 and 4 (d) 1 and 4

51. Consider the following statements. **2014 (II)**
1. Carbohydrates are the only source of energy to humans.
2. Fats give maximum energy on oxidation as compared to other foods.

Which of the statement(s) given above is/are correct?
(a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) Neither 1 nor 2

52. Precursor of which one of the following vitamins comes from β-carotene? **2015 (I)**
(a) Vitamin-A (b) Vitamin-C
(c) Vitamin-D (d) Vitamin-K

53. Which one of the following vitamins is synthesised in our own skin? **2015 (II)**
(a) Vitamin-A (b) Vitamin-B
(c) Vitamin-C (d) Vitamin-D

54. Match the Column I with Column II and select the correct answer using the codes given below. **2016 (I)**

Column I (Molecule)	Column II (Product of Digestion)
A. Proteins	1. Nitrogenous bases and pentose sugars
B. Carbohydrates	2. Fatty acids and glycerol
C. Nucleic acids	3. Monosaccharides
D. Lipids	4. Amino acids

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	1	4	(b)	2	1	3	4
(c)	4	1	3	2	(d)	4	3	1	2

ANSWERS

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

04

STRUCTURAL ORGANISATION OF PLANTS AND ANIMALS

Usually 3 to 4 questions are asked from this chapter. These questions are based on Blood, plant and animal tissues.

Plants and animals (except Protista) are complex multicellular organisms. Their external and internal features are respectively studied in morphology and anatomy.

PLANT MORPHOLOGY

- Morphology is the branch of biology dealing with the study of form and structure of organisms and their specific structural features. It includes the study of external structure such as root, stem, leaves, etc.
- *On the basis of external appearance, plants can be of following types*
  (i) **Herbs**, e.g. carrot, turmeric, pea, etc.
  (ii) **Shrubs**, e.g. rose, sunflower, etc.
  (iii) **Trees**, e.g. neem, mango, bamboo, etc.

Root

In plants, root is the non-green (due to the absence of chlorophyll), cylindrical and descending part that normally grows downwards into the soil.

It develops from the radicle of embryo. It does not bear leaves, buds and not distinguished into nodes and internodes. In some roots, buds are found for vegetative propagation, e.g. sweet potato.

There are two types of roots

(i) **Tap Roots** Tap root is the primary root that develops directly through radicle. It bears secondary and tertiary roots, root caps and root hairs. The primary root with secondary, tertiary roots constitutes tap root system, e.g. most dicots.

(ii) **Adventitious Roots** Roots that develop from any part of the plant other than the radicle are called as adventitious roots, e.g. grass, *Monstera*, banyan tree, etc.

Modifications of Tap Root

(i) **Napiform** These become very thick at the base and tapers towards the apex, e.g. turnip, sugarbeet, etc.

(ii) **Fusiform** These roots become thicker in middle and tapers at both the ends, e.g. radish (*Raphanus sativus*).

(iii) **Conical** Swollen at base and narrow at apex, e.g. carrot.

Modifications of Adventitious Roots

For the Stroage of Food

- **Tuberous roots** From the nodes of the stem, swollen without any definite shape, e.g. sweet potato.
- **Fasciculated roots** Arise in bunches, e.g. *Asparagus, Dahlia.*
- **Nodulose roots** Apical portion swells up, e.g. *Curcuma*, etc.
- **Annular roots** Ring structure formed, e.g. *Psychotria.*

For Support

- **Prop** or **pillar roots** Hang from branches and penetrate into soil, e.g. banyan, screwpine.
- **Stilt** or **brace roots** Develop from lower nodes of stem to give additional support, e.g. maize, sugarcane, etc.
- **Climbing roots** Arise from nodes and help in climbing, e.g. *Pothos*, *Piper betle*.
- **Buttress roots** Arise from basal part of main stem, e.g. *Ficus.*
- **Contractile roots** Underground and fleshy, help the plant in fixation, e.g. onion, corm of *Crocus*, etc.

For Vital Functions

- **Floating roots** Arise from nodes, help in floating, e.g. *Jussiaea.*
- **Photosynthetic** or **assimilatory roots** Have chlorophyll, e.g. *Trapa, Tinospora.*
- **Reproductive roots** Develop vegetative buds, e.g. *Trichosanthes dioica.*
- **Mycorrhizal roots** With fungal hyphae, e.g. *Pinus.*
- **Thorn roots** Serves as protective organ, e.g. *Pothos.*

Functions of Roots

The functions of roots are given below

(i) Roots anchor the plant from the substratum and perform very important function of absorption of water and minerals from the soil.

(ii) Roots hold the soil particles firmly to prevent soil erosion.

(iii) Roots also perform some secondary functions with the help of its modification like food storage, additional mechanical support, act as haustoria, reproduction and nitrogen-fixation.

Stem

It is ascending part of plant and formed by the prolongation of the plumule of embryo. It is positively phototropic and negatively geotropic and hydrotropic. It bears nodes and internodes. In flowering plants, stem bears leaves, branches (arise from the cortex), flowers and fruits. Leaf bearing part of stem is called **shoot**.

Modifications of Stems

Stems usually modify to perform following functions

(i) Survival in the adverse conditions (perennation).

(ii) For helping in vegetative propagation.

(iii) For storage of food.

Modification of Underground Stem

- **Rhizome** occurs underground, gives rise to annual aerial branches or leaves, e.g. *Collocasia, Amorphophallus*, ginger, turmeric.
- **Bulb** is underground condensed shoot having a reduced, discoid stem with fleshy scales, e.g. garlic, onion, tulips, lilies, etc.
- **Tuber** is swollen tips of underground branches, e.g. potato (*Solanum tuberosum*).
- Corms are swollen underground vertical stems bearing buds and membranous leaves on upper surface and adventitious roots below, e.g. *Colocasia*, *Gladiolus*, *Amorphophallus*, *Colchicum*, etc.

Modifications of Subaerial Stem

- **Runners** are special, narrow, green, horizontal branches, which develop at the base of crown, e.g. grasses.
- **Stolons** are underground, e.g. *Colocasia* or above ground, e.g. strawberry horizontal branches, which develop at the base of a crown.
- **Offsets** are one internode long runners formed in rosette plants at ground or water level, e.g. water lettuce (*Pistia*).
- **Suckers** are non-green narrow stem, develops at the underground base of a crown grows horizontally, e.g. *Mentha* (mint), roses, etc.

Modifications of Aerial Stem

- **Phylloclades** are green, photosynthetic, often succulent stems, e.g. *Opuntia.*
- **Cladodes** are green stems with leaves reduced to scales or modified into spines and limited growth, e.g. *Ruscus, Asparagus.*
- **Bulbil** A multicellular structure, functions as organ of vegetative reproduction, e.g. *Oxalis, Dioscorea,* etc.
- **Stem thorn** Axil of the leaf or apex of the branch is modified into pointed structure called **thorn**, e.g. *Citrus, Bougainvillea,* etc.
- **Stem tendril** In plants with weak stem, the apical bud is modified into tendril for climbing, e.g. *Passiflora,* cucumber, etc.

Functions of Stem

Functions of stem are given below

(i) The stem supports the leaves, branches, flowers, fruits and conducts water and minerals from the roots to the leaves and synthesised food from the leaves to other plant parts.

(ii) It also bears flowers and fruits.

(iii) It performs various secondary functions like storage, vegetative propagation and support.

Leaf

The leaf is green (due to the presence of photosynthetic pigment chlorophyll), flat, thin and expanded. It is a lateral appendage of stem, which is borne at a node and bears a bud in its axil.

On the basis of incision of lamina, leaves are of two types

(i) **Simple leaves** In this, there is a single lamina, which is entire, i.e. no incisions are present, *e.g.* mango, guava, *Cucurbita*, etc.

(ii) **Compound leaves** In these leaves lamina is divided completely into distinct and separate segments called **leaflets**. Rachis is the main axis on which leaflets are arranged.

These are mainly of two types

(a) Palmate compound leaf is one, in which the petiole bears leaflets at the tip, like the fingers of the palm, e.g. *Bombax*.

(b) In pinnately compound leaf, leaflets are borne laterally on an elongated axis. It is of various kinds.

Venation in Leaves

The arrangement of veins and veinlets in leaf lamina is known as venation. It is of following types

(i) **Reticulate venation** The veinlets are irregularly distributed to form a network, e.g. dicot plants. *Callophyllum* is the dicot plant with parallel venation.

(ii) **Parallel venation** The veins are arranged parallel to each other, e.g. monocots. *Smilax* and *Dioscorea* are monocots having reticulate venation.

Phyllotaxy

Phyllotaxy is the arrangement of leaves on the stem or its branches. Function of phyllotaxy is to arrange leaves in such a way that all of them get proper exposure to sunlight.

(i) **In alternate** type of phyllotaxy a single leaf arises at each node in alternate manner, e.g. *Mangifera indica* (mango), *Hibiscus rosa sinensis* (China rose), *Brassica campestris* (mustard), *Nicotiana tabacum* (tobacco).

(ii) **In opposite** type of phyllotaxy, each node gives rise to two leaves lying opposite to each other, e.g. *Calotropis,* guava. Opposite phyllotaxy may be either opposite superimposed (i.e. position of two leaves of each node resembles with the leaves of upper node), e.g. *Eugenia*, *Quisqualis*, *Ixora*, etc., or opposite decussate, (i.e. leaves of a node are at right angle to the leaves of next node), e.g. *Calotropis procera*, *Ocimum*, etc. It should be noted that in guava (*Psidium guavava*) both types of arrangements are found.

(iii) **In whorled** phyllotaxy, more than two leaves arise at a node and form a whorl, e.g. *Alstonia*, *Nerium*, *Vangueria*, etc.

Modifications of Leaves

- **Leaf tendrils** Leaf or leaf parts are modified into thread-like sensitive structure called tendrils, e.g. *Lathyrus odoratus.*
- **Leaf spines** Leaf parts are changed into spines in order to protect the plant form grazing animals and excessive transpiration, e.g. *Aloe*.
- **Phyllodes** Flattened green, photosynthetic, petioles and rachis, e.g. *Utricularia*, *Acacia*.
- **Leaf pitchers** Lamina or whole leaf is modified into pitcher, e.g. *Nepenthes*.
- **Succulent leaves** are fleshy or swollen, e.g. *Aloe, Agave*.
- **Stroage leaves** are swollen, e.g. *Allium* (onion).
- Xerophytic leaves usually have hard, waxy tiny leaves that are usually modified into thorns to reduce water loss.

Functions of Leaves

Leaves in plants perform several functions as given below

(i) Leaves carry out photosynthesis and possess stomata for the gaseous exchange and transpiration.

(ii) The leaves protect terminal and axillary buds.

(iii) Vascular bundles present in veins and petiole carry out the function of conduction.

(iv) Modified leaf structures perform various functions like storage, support and vegetative reproduction (*Bryophyllum*).

Inflorescence

The arrangement and distribution of flowers on the floral axis is called inflorescence. It is mainly of two types

(i) **Racemose** In racemose inflorescence, the main axis is capable of continuous growth and it does not end in flower. The flowers show acropetal succession on the main axis, e.g. fennel, coriander, maize.

(ii) **Cymose** In cymose inflorescence, the main axis ends in a flower, since the peduncle stops growing. The flower shows basipetal succession, e.g. dichasial chyme–jasmine.

Flower

- It is a modified shoot that is the reproductive part of plant. It consists of accessory whorls (calyx and corolla) and essential whorls (androecium and gynoecium).
- The flower consists of four whorls, i.e. calyx, corolla, androecium and gynoecium.
- These four whorls are borne on thalamus.
- Calyx is outermost whorl consisting of units called **sepals**. These are typically green and enclose the rest of the flower in the bud stage.
- The next whorl towards the apex, composed is corolla and it consists of units called **petals**, which are typically thin, soft and coloured to attract animals that help the process of pollination.
- Androecium is the male reproductive part consists of stamens made of anther and filament.
- Gynoecium is the female reproductive part made of stigma, style and ovary.

- The flower, in which both male and female reproductive parts are present are called as **bisexual flowers**, whereas those having either of them are known as **unisexual flowers.**
- The plant, which bears both male and female flowers is called **monoecious**, while separate plants with one type of flower are called **dioecious**.
- When asexual, unisexual and bisexual, all kinds of flowers are present in plants the condition is known as polygamous.
- A zygomorphic flower is divisible into two equal halves by a single vertical plane, e.g. *Ocimum,* pea, etc.
- An actinomorphic flower is divisible into two or more equal halves by any radial plane, e.g. mustard, onion, brinjal.

Aestivation

The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as aestivation. The aestivation pattern is important in classification of plants. It is of following types

(i) **Valvate** Petals come to each other, but do not overlap, e.g. mustard (*Brassica*).

(ii) **Twisted** Regular overlapping of petals occurs, in which margin of one petal overlaps with the next one petal, e.g. China rose (*Hibiscus rosa sinensis*).

(iii) **Imbricate** There are five petals, arranged in such a way that one petal is completely external and another petal is completely internal, while three petals are partially external and partially internal, e.g. *Cassia, Cullistemon, Caesalpinia*.

(iv) **Vexillary** When the largest petal overlaps the two lateral petals, which in turn overlap the two smallest anterior petals (keel), the aestivation is called as vexillary or papilionaceous.

Placentation

The arrangement of placentae on the ovary wall is called **placentation**. The placentation may be

Marginal	Ovules are borne on the ventral surface, where the margins fuse, e.g. Leguminosae.
Parietal	The ovary has two or more longitudinal placentae, e.g. *Argemone*, *Cucurbita*.
Basal	Ovules directly arise on thalamus from base of ovary, e.g. Compositae, Gramineae.
Axile	Ovules arise from central axis, e.g. Malvaceae, Solanaceae, Liliaceae.
Free central	The placentae are borne on a central column, e.g. *Stellaria* and *Dianthus*.
Superficial	Placentae develop all around the inner surface of partition wall, e.g. *Nymphaea*.

Fruits

After fertilisation of ovary, ovule is changed into seed and ovary into fruit. The fruit is a characteristic feature of the flowering plants. A true fruit is a ripended ovary. Fruits that develop from parts other than ovary are false fruits, e.g. strawberry, apple. The study of fruits is called as **pomology**.

Classification of Fruits

Fruits can be broadly classified into following three types

(i) **Simple Fruits** A simple fruit develops from the single simple (monocarpellary) or compound (polycarpellary) syncarpous ovary of a flower. In this type, only one fruit is formed from one gynoecium. These fruits can be of following two main types. Dry fruits and fleshy fruits.

(ii) **Aggregate** (Etaerio) **Fruits** An aggregate fruit is a group of fruitlets, which develops from a flower having polycarpellary apocarpous (free) gynoecium. The aggregate fruit is also called etaerio, e.g. sadabahar, custard apple, lotus.

(iii) **Composite Fruits** A composite of multiple fruits develops from the complete inflorescence. These are of two types

(a) **Sorosis** A multiple fruit derived from just the pistils of many unisexual flowers of an inflorescence, e.g. mulberry, jackfruit, pineapple, etc.

(b) **Syconus** A multiple fruit derived from numerous ovaries borne on the inside of the fleshy receptacle of an inflorescence, e.g. peepal, gular.

Seeds

Seed is a ripened ovule, which contains the embryo. In some seeds, the endosperm (nutritive tissue) is completely consumed by the developing embryo. Thus, the seeds are called **non-endospermic** or **exalbuminous seeds**, e.g. most dicots (gram and pea).

In most monocots (maize and rice) and some dicots (castor bean, papaya and cotton) embryo does not consume all endosperm. So, it persists in the mature seed. Such seeds are called **endospermic** or **albuminous** seeds.

PLANTS ANATOMY

'Anatomy' (Gk. *Ana*–up; *tome*–cutting) is the study of internal structure of an organisms. Plant anatomy deals with the study of gross internal structure of plant organs after section cutting of plant parts.

Plant Tissues

Tissues are the cluster of structurally and functionally similar cells arranged and designed, so as to give the highest possible efficiency of the function they perform. All cells of a tissue have a common origin. A tissue may be simple or complex type. Blood, phloem and muscles are all examples of tissues.

There are following types of plant tissue

1. Meristematic Tissue

Meristem is a group of cells that have the power of continuous division resulting in the formation of new cells. These are immature cells. They are present on roots and stems that help them to grow. Meristematic tissues are of three types based on their position

(i) **Apical meristem** Found at the apices of stem and root and function to increase their length. During the formation of primary plant body, specific regions of this meristem produce dermal tissues, ground tissues and vascular tissues.

(ii) **Intercalary meristem** These tissues are intercalated between permanent tissues. It is responsible for increase in the stem length. Commonly located at the base of the leaves, above the nodes, e.g. grasses or below the nodes, e.g. mints.

(iii) **Lateral meristem** Present along the lateral side of stems and roots. Divide in tangential plane, giving rise to the secondary permanent tissues to inside and outside and lead to the increase in thickness or girth of the plant body.

2. Permanent Tissue

These are formed as a result of division and differentiation in meristematic tissues. They lost the power of division. Permanent tissues are of two types, i.e. simple tissue and complex tissue.

(i) Simple Permanent Tissue

A group of similar, permanent cells that performs a common function is called **simple permanent tissue**. These are of three types, i.e. parenchyma, collenchyma and sclerenchyma.

(a) Parenchyma

They are present in softer parts of plants. This tissue is consist of simple living cells with little specialisation. The cells are isodiametric (all sides equal) with thin cell walls (made up of cellulose). Cells are usually loosely packed with large intercellular spaces. It stores and assimilates food and storage tissue. This tissue provides supports to plants.

- When the parenchyma cell contains chlorophyll in some situations, it performs photosynthesis. Such type of parenchyma tissue is called **chlorenchyma**. It is composed of spongy and mesophyll tissues.
- In aquatic plants, large air cavities are present in parenchyma cells in order to give buoyancy to plants, which help them to float. Such type of parenchyma tissue is called **aerenchyma**.

(b) Collenchyma

This is a modified form of parenchyma. These are the tissues, which are generally found in leaf stalks below the epidermis, leaf midribs and herbaceous dicot stems.

- Cells are living, elongated and irregularly thickened at the corners. Cell wall has extra deposition of cellulose and pectin and possesses simple pits. They have very little intercellular spaces. The ability to dedifferentiate is nearly absent in collenchyma cells.
- They often contain chloroplasts. It provides mechanical support and elasticity (flexibility) to plants.
- It also allows easy bending in various parts of a plant (leaf and stem) without breaking.
- They manufacture sugar and starch when possess chloroplasts.

(c) Sclerenchyma

- This type of tissue is present in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts.
- The cells of sclerenchymatous tissue are dead and do not contain protoplasm.
- The cells are long and narrow in appearance.
- Cell walls are thickened due to lignin (a chemical substance) deposition, which acts as cement and hardens them. A prominent middle lamella exists between cells.
- Due to the presence of thick walls, there is no internal space inside the cell.
- It is known to be the chief mechanical tissue, which makes plant hards and stiff, e.g. husk of coconut is made up of sclerenchymatous tissue.
- It provides strength and enables the plant to bear various stresses.
- It forms protective covering around seeds and nuts. It gives rigidity, flexibility and elasticity to the plant body.

(ii) Complex Permanent Tissue

- It is made of more than one type of cells having a common origin. Hence, the cells look different from each other unlike simple permanent tissue, in which cells are similar in appearance.
- Regardless of different appearances, all the cells coordinate to perform a common function.
- Types of complex permanent tissue are
  (a) Xylem (b) Phloem
  Both of them are conducting tissues and constitute the vascular bundle. This is a distinctive feature of the complex plants, which provided them the possibility of surviving in the terrestrial environment.

(a) Xylem

- It is a vascular and mechanical conducting tissue, also known as wood. The cells of xylem have thick walls and many of them are dead.
- Xylem consists of four types of elements, i.e. tracheids vessels, wood fibre and wood parenchyma.
- It is responsible for the transport of water and minerals from roots to other parts of the plant.
- It also provides mechanical strength to the plant.

(b) **Phloem**

- It is another kind of living conducting tissue, also known as bast.
- All phloem cells are living except phloem fibres. Phloem is composed of four types of elements, i.e. sieve tubes, companion cell, phloem parenchyma and phloem fibres.
- Sieve tubes are tubular cells with walls perforated by pores no nucleus. Companion cells are small elongated cell having thin walls.
- It transports food from leaves to other parts of the plant. Materials can move in both directions in it.

Characteristic features of dicot and monocot root

Characters	*Dicot root*	*Monocot root*
Pericycle	Gives rise to secondary roots and lateral meristem.	Gives rise to lateral roots only.
Vascular bundles	Diarch to hexarch.	Hexarch to polyarch (more than 6 in number).
Cambium	Develops at the time of secondary growth.	Cambium absent.
Pith	Absent or poorly developed.	Abundant and fully developed.
Secondary growth	Takes place.	Does not take place.
Cortex and endodermis	Narrow cortex. Endodermis is less thickened and casparian strips are more prominent.	Cortex wide. Casparian strips are visible only in young root. Later on endodermal cells become highly thickened.

Characteristic features of dicot and monocot stem

Characters	*Dicot stem*	*Monocot stem*
Epidermis	Cells are larger and with multicelled hair.	Cells are comparatively smaller and without hair.
Hypodermis	Collenchymatous (green).	Sclerenchymatous (non-green).
Cortex	Made up of several layers of parenchymatous tissue.	Absent, but parenchymatous ground tissue is present from hypodermis to the centre of stem.
Endodermis	Single layered, starchy sheath, which is usually not well-differentiated.	Absent
Pericycle	Made up of one or more layers of parenchymatous and sclerenchymatous cells.	Absent
Medullary rays	Found in between vascular bundles.	Absent
Pith (medulla)	Abundant, made up of parenchymatous cells situated in the centre of stem. Found between the vascular bundles.	Absent
Vascular bundles	Vascular bundles in a ring. Angular in outline conjoint, collateral and open. All of same size. wedge-shaped. Bundle sheath absent. Phloem parenchyma present. Xylem vessels more radial. Schizolysigenous cavity absent.	Scattered circular in outline conjoint, collateral and closed. Larger towards centre. Oval bundle sheath present. Phloem parenchyma absent. Xylem vessels either Y or V-shaped.

Characteristic features of dicot and monocot leaves

Characters	*Dicot leaf*	*Monocot leaf*
Epidermis	The upper epidermis has larger and thick-walled cells as compared to those of lower epidermis.	The epidermal cells are similar on both the surfaces (upper and lower) of the leaf.
Epidermal cells	The epidermal cells possess sinuous walls and the silica does not occur on the outer wall of epidermal cells.	The epidermal cells have straight walls and silica deposition is common on the outer wall of epidermal cells.
Number of stomata	More stomata occur on the lower surface as compared to the upper surface.	An equal number of stomata occurs on both the surfaces.
Guard cells	Guard cells are bean-shaped.	Guard cells are dump-bell shaped.
Mesophyll cells	The mesophyll is differentiated into palisade and spongy tissues.	There is no such differentiation.
Veins	The veins run in different directions.	The veins are parallel.
Bundle sheath	Bundle sheath is formed of colourless cells and the extensions of bundle sheaths are parenchymatous.	Bundle sheath cells usually possess chloroplasts and the extensions of bundle sheaths are sclerenchymatous.
Protoxylem	The protoxylem does not differentiate.	Protoxylem is differentiable into larger vascular bundles.

Secondary Growth

Secondary growth is the growth in the girth of stems and roots in dicots produced by divisions of secondary meristem, resulting in woody tissue. The cambium is involved in secondary growth. The increase in the diameter or thickness is due to the formation of secondary tissues (secondary xylem and phloem) as a result of the activities of primary and secondary lateral meristems, namely vascular cambium (fascicular cambium) and cork cambium (phellogen), respectively. Secondary growth is seen in only dicot plants. Monocots do not show secondary growth because cambium is absent in them.

IMPORTANT POINTS

- N Grave (1682) gave the term parenchyma. He is known as father of plant anatomy.
- Hydathodes are the specialised structures present on the leaf apex for guttation.
- *Wolffia* has smallest and *Rafflesia* has biggest flower.

Wood

Wood represents the secondary xylem. It is composed mostly of hollow, elongated, spindle-shaped cells that are arranged parallel to each other along the tree trunk. Wood clearly show distinctions, i.e. sapwood (inner wood, composed of living cells that conduct sap upward in tree) and heartwood (the outer, less porous dark wood having dead cells).

Based on activity in a growth year, wood is of two types

(i) **Latewood or Autumn wood** It is produced in autumn and have few small xylem elements that are having small lumen.

(ii) **Earlywood or Spring wood** It is produced in spring, when cambium is more active and produces large number of large sized xylem element.

- Thus, each year two zones of secondary xylem are formed, which constitute an annual or growth ring that determines the age of a plant.

ANIMAL TISSUE

All animals are structurally organised into cells, tissues, organs or organ systems. The body of all complex animals consists of four basic types of tissues.

A tissue may be defined as a group of similar cells having a similar origin and specialised for a specific function along with the intercellular substance. The study of tissues is called **Histology**. **Bichat** (Father of Histology) introduced the term 'tissue'. The term 'Histology' was coined by **Mayer.** The tissue arises from the undifferentiated cells of the primary germ layers (ectoderm, mesoderm and endoderm).

On the basis of their structure and function, animal tissues can be broadly classified into four basic types, i.e. epithelial, connective, muscular and neural tissues. These are as follows

1. Epithelial Tissue

The term 'epithelium' (Pl. epithelia) was introduced by **Frederik Ruysch** in 1703. An epithelium is a tissue made up of one or more layers of cells, compactly arranged with little intercellular matrix. It covers the external body surface and lines internal body cavities. Thus, it is also called as covering tissue. Epithelial tissue also takes part in healing the wounds.

On the basis of cell layers and shape of cells, epithelial tissues are classified into

(i) **Simple Squamous Epithelium** It is single layered and closely fitted. It is further catagorised as

(a) **Squamous Epithelium** It also covers oesophagus and lining of mouth.

(b) **Cuboidal Epithelium** It forms lining of kidney tubules and ducts of salivary glands, where it provides mechanical support. It also forms germinal epithelium of gonads. It also helps in absorption, excretion and secretion.

(c) **Columnar Epithelium** It is found in the inner lining of intestine, where absorption and secretion occur. It facilitates movement across epithelial barrier.

(ii) **Stratified Squamous Epithelium** Cells are arranged in many layers and are not similar. It is found in the outer side of skin as it is highly resistant to mechanical injury and is water-proof. They are present on body cavity, cornea of eyes, anus, buccal cavity, etc.

(iii) **Pseudostratified Epithelium** The epithelium is one-cell thick, but appears two-layered because all the cells do not reach the free surface. The cells are attached to the basement membrance, hence they are called pseudostratified. The mucus secreting goblet cells also occur in this epithelium. It is present in respiratory tract.

GLANDULAR EPITHELIUM

- Sometimes, portion of epithelial tissue folds inward. This results in the formation of a multicellular gland. It's tissue is called **glandular epithelium**.
- In this type of epithelium, cells acquire additional specialisation functions such as secretion of substances at the epithelial surface. They are known as gland cells.
- On the basis of secreting substances glands can be serous glands, e.g. sweat glands, mucous glands and mixed glands (salivary glands).

Glands are mainly of three types-

(i) **Exocrine glands** These are duct glands, which secrete enzymes, e.g. salivary, tear, intestinal glands.

(ii) **Endocrine glands** These are ductless glands, which secrete, hormones, e.g. pituitary gland, etc.

(iii) **Mixed glands** secrete both enzymes and hormones, e.g. pancreas.

2. Connective Tissue

Connective tissue is most abundant, widely distributed body tissue, mesodermal in origin (with intercellular spaces). Major functions include binding, support, protection, transport, insulation, fat storage and body defence. They make approximately 30% part of body. They are broadly categorised into three main types

(i) Proper Connective Tissue

It has a viscous, gel-like matrix composed of proteoglycans. It is of following types

(a) **Loose connective tissue** Cells and fibres are loosely arranged in a semifluid matrix. They are of the following types

- **Areolar tissue** It occurs beneath the epithelia of many hollow visceral organs, skin and in blood vessels (arteries and veins).
- **Adipose tissue** Located mainly beneath the skin, heart, blood vessels, kidney and bone. It is specialised to store fats and reduces heat loss through the skin. Thus, it keeps the body warm.

  There are two types of adipose tissue, **white/yellow fat** (single layered fat droplets present in cell surrounded by small amount of cytoplasm) and **brown fat** (has multiple small fat droplets surrounded by larger amount of cytoplasm).

The former is found in blubber of whales while latter occurs in newborn babies and some hibernating animals.

(b) **Dense connective tisssue** It is mainly made up of compactely packed bundles of collagen fibres with very little matrix. It is further classified as

- **Dense regular connective tissue**, where collagen fibres are present in rows between many parallel bundles of fibres. White fibrous, e.g. tendon (connect muscle and bone) and yellow elastic, e.g. ligament (connect bone and bone) are two of its types.
- **Dense irregular connective tissue** having fibroblasts with many fibres oriented differently, e.g. in skin.

(ii) Supportive Connective Tissue

It is of following two types, i.e. cartilage and bone.

(a) **Cartilage** It is solid, semi-rigid with matrix and is composed of a firm, but flexible material called **chondrin** (protein) that is secreted by cells, called **chondrocytes**. It also contains fibres, mostly of collagen.

- The cartilage is of three types as following.
- **Hyaline cartilage** It occurs in the larynx, nasal septum, tracheal rings and costal cartilage and found at the ends of bones to form articular cartilage.
- **Fibrous cartilage** It contains prominent fibres in matrix of two types.
- White fibrocartilage connects bones like pubis symphysis in pelvis and form interverterbral discs and yellow.
- **Elastic fibrocartilage** It provides strength and maintains shape of ear pinna, tip of the nose, epiglottis, Eustachian tube and larynx.
- **Calcified cartilage** Cartilage matrix contains granules of calcium carbonate. Found in suprascapula of pectoral girdle of frog and vertebrae of shark.

(b) **Bone** It is a solid, rigid connective tissue consisting of four parts, i.e. periosteum, matrix, endosteum and bone marrow. Completely covered with dense, white fibrous sheath called **periosteum**.

- Spaces called **lacunae** occur in the matrix. Each lacuna is occupied by flat bone cell or osteocyte (they are metabolically inactive cells).

(iii) Vascular Connective Tissue

Also called fluid connective tissue. These are specialised connective tissue that circulate through the cardiovascular system. It is broadly classified as two main types, i.e. blood and lymph.

Blood

- Blood is a mobile and softest connective tissue. The study of blood is known as haematology. In human beings, volume of blood is around 5-6 litres. It makes up 6-10% of total body weight.
- Blood makes up the chief transport system in body.
- Blood is salty in taste and it is heavier than water.
- Viscosity of blood is 4.7.
- pH of blood is 7.3 to 7.4, i.e. it is slightly alkaline.
- pH of blood is maintained by balancing the ratio of sodium bicarbonate and carbonic acid in blood.
- Buffer of the blood is sodium bicarbonate.
- Oxygenated blood is shining red in colour, whereas deoxygenated blood is pink-purple in colour.
- Acidity of blood results haemoglobin to carry less oxygen.
- pH of blood in arteries is more than in veins.
- People living at higher altitudes, usually have more blood compared to those living at lower altitudes.
- Blood is made up of two main components
  (i) Plasma (ii) Blood cells (blood corpuscles)

Plasma

Plasma represents the matrix of blood, in which blood cells remain embedded.

- Plasma = blood – corpuscles (RBCs + WBCs).
- Plasma is a transparent, slightly alkaline part of blood.
- It forms 55-60% volume of blood. It contains water (91-92%), solid (8-9%) and inorganic salts (0.9%).
- Solid part of it contains 7% protein (albumin, globulin, fibrinogen, immunoglobulin and prothrombin).
- Albumin protein in plasma maintains normal blood pressure.
- Similarly, immunoglobulins of blood plasma act as antibodies and help in body defence.

Functions of Blood Plasma

- Retention of fluid in blood.
- Removal of excretory substances.
- Disposal of CO_2, transport of O_2, distribution of hormones and distribution of vitamins.
- Regulation of water balance.
- It contains antibodies to help resist of infection.

Blood Corpuscles

Blood corpuscles formed in a process called **haemopoiesis**. They form upto 40-45% of blood by volume. These are mainly of four types, i.e. RBCs, WBCs, platelets and spindle cells.

RBCs (Red Blood Corpuscles)

- RBCs are also known as erythrocytes.
- RBCs of vertebrates are nucleated, whereas those of mammals are non-nucleated except camel.
- RBCs of mammals lose nucleus, due to degeneration during development process.

- In the foetus, RBCs are mainly formed in liver and spleen, but after birth they are formed in bone marrow. Bone marrow is the main site for formation of RBCs.
- Salamander (*Amphiuma means*) has largest RBCs (about 80 µm in diametre). Musk deer (*Tragulus javanicus*) has the smallest RBCs (1.5 µm).
- RBCs are biconcave and round in shape.
- Number of RBCs changes due to physiological state.
- Lifespan of RBCs in man is 120 days and number is 5000000/cu mm.
- In frog and rabbit their lifespan is 100 and 50-70 days, respectively.
- Number of RBCs is counted by Haemocytometer.
- Excess of RBCs is known as polycythemia.
- Alone RBC is yellow in color, but it appears red in cluster.
- Excess RBCs are stored in spleen, thus it is also known as blood bank.
- Liver is called as the graveyard of RBCs.
- When blood is mixed with distilled water or hypotonic solution, the RBCs increase in volume and burst. This is known as haemolysis.
- RBCs possess haemoglobin, due to which they appear red in colour. Haemoglobin also acts as vasculatory respiratory pigment.
- In male (15-16 gm), female (13-14 gm) and in child (16.5 gm) haemoglobin is present in 100 mL of blood.
- Presence of haemoglobin in blood is measured by Sahli's haemometer.
- Due to the deficiency of Hb, anaemia occurs. It may be of following types
  (i) **Pernicious anaemia** It is a non-genetic disorder due to the deficiency of vitamin-B_{12}. In which number of RBCs decreases and size of RBCs increases, but Hb content is less in RBCs.
  (ii) **Sickle-cell anaemia** It is genetic disorder, in which RBCs become sickle-shaped.
  (iii) **Thalassemia** It is a genetic disorder, in which body does not prepare Hb or RBCs.
  (iv) **Specticemia** It is a sort of blood poisoning.
  (v) **Nutritional anaemia** It is a caused due to the deficiency of iron.

Erythropoiesis

- It is a process of formation of RBCs.
- Stem cells (myeloblast cells or haemocytoblast) are responsible for RBCs formation.
- In man, RBCs formation takes place within 72 hrs.

Functions of RBCs

- Haemoglobin of RBC readily combines with oxygen to form oxyhaemoglobin.
- In the tissues oxyhaemoglobin readily gives up its oxygen. Thus, blood transports oxygen to tissues by means of RBCs.
- Maintain pH of blood.
- RBCs also transport CO_2.

WBCs (White Blood Corpuscles)

- These are also called as **leucocytes**.
- These are larger than RBCs and devoid of Hb, so they are colourless.
- Nucleus is present in all WBCs.
- In human blood 8000-9000/cu mm WBCs are present.
- The ratio of RBC/WBC is 600 : 1.
- WBCs play an important role in defence system, hence called soldier's of body.
- The increase in number of WBCs is called as **leukemia**.
- Abnormally low level of WBCs is called as **leucopenia**.
- The movement of WBCs to the site of injury is called as **diapedesis**.
- The lifespan of WBCs in human is approximate 10–13 days.

WBCs are of two types

(i) **Granulocytes** (eosinophils, basophils and neutrophils).
(ii) **Agranulocytes** (monocytes and lymphocytes).

Eosinophils (2-8%)

- These cells are also known as acidophils.
- They are non-phagocytic.
- Their lifespan is about 10-14 hours.
- They can be stained with eosin dye.
- Their nucleus is usually bilobed.
- The number of eosinophils increases in allergy condition (i.e. asthma and hay fever) and worm infection (e.g. *Ascaris*).
- They play important role in hypersensitivity.
- These are also important in wounds.

Basophils (2%)

- These are also known as cyanophils.
- Minimum number in total WBCs.
- These are phagocytic in nature.
- Their nucleus is usually trilobed.
- Their lifespan is 12-15 days.
- Their number increases in chickenpox.
- They represents mast cells of connective tissue.
- These help in blood coagulation by secreting heparin and histamine.

Neutrophils/Heterophils (65%)

- These are found in maximum number among WBCs in blood.
- They are phagocytic in nature.
- Their nucleus is multilobed.
- Their number increases in bacterial infection. They are most active type of WBCs.
- Their lifespan in blood is 10-12 hours and in tissue is 4-5 days.

Monocytes (6%)
- These are the largest WBCs that are phagocytic in nature.
- Their nucleus is horseshoe-shaped.
- Their lifespan is 28 days.
- They are known as macropoliceman of blood.
- Their number increases in TB (tuberculosis).
- They are produced in lymph glands and spleen.
- They are extremely motile.
- Their lifespan varies from some hours to 1 day.

Lymphocytes (26%)
- These are smallest WBCs.
- Their nucleus is rounded and central.
- Their lifespan is of three days.
- They produce antibodies.
- Their number increases in viral infection.
- These are produced in thymus, spleen and tonsils.

Platelets
- These are found in mammals only.
- They are also known as thrombocytes.
- These are non-nucleated.
- Their size is irregular, oval or spherical.
- Their number is 2-5 lakhs/cu mm.
- These have a lifespan of only one week.
- These are the source of thromboplastin, necessary for blood clotting.
- The blood platelets are absent from the blood of lower vertebrates, but possess thrombocytes.

Spindle Cells
- These occur in all vertebrates other than mammals.
- These are like RBCs, but devoid of haemoglobin.
- These are spindle-shaped.
- Their nucleus is spherical or oval and cytoplasm is granular.
- Their main function is similar to that of mammalian blood platelets.

IMPORTANT POINTS
- 750 mL/min blood transports to brain.
- Prothrombin, produced by liver, helps in blood clotting.

Blood Pressure
- It is the pressure exerted by the flow of blood on the walls of arteries and measured as millimeter of mercury by the instrument called **sphygmomanometer**.
- It can be felt at certain places in our body *viz* wrist of the hands, etc.
- It is recorded as systolic/diastolic.
- It has a high systolic value (normal 120 mm Hg) and low diastolic value (normal 80 mm Hg).
- It is lower in the capillaries than in arteries.
- It is usually lower in women than in men.
- **Hypertension/High blood pressure** Systolic pressure is more than 140 mm Hg and diastolic pressure is more than 90 mm Hg.
- **Hypotension/Low blood pressure** Systolic pressure is below 110 mm Hg and diastolic pressure is below 70 mm Hg.
- The larva of genus *Chironomus* is called **bloodworm**. It has haemoglobin, providing red colour to it.
- Uraemia is the presence of more urea in blood.

Blood Glucose
- Usually blood glucose level is about 80-100 mg per 100 mL of blood 12 hours after a normal meal, but its concentration rises soon after a carbohydrate rich diet.
- If blood glucose level exceeds 180 mg per 100 mL, it starts appearing in urine, i.e. glycosuria.
- Fasting blood glucose is 70-110 mg/dL, glucose after breakfast (pp) is 110-140.

Blood Cholesterol
- Blood cholesterol in limited amount is important for us, but when it exceeds it's normal amount, it can be harmful for us. Blood cholesterol increases due to consumption of excess fats.
- The fats are used in the synthesis of biomembrane, vitamin-D, bile salts and steroid hormones.
- Normal blood cholesterol is 80-180 mg in 100 mL of blood plasma. Increased blood cholesterol may lead to its deposition in the internal wall of blood vessels like arteries and veins, which causes high blood pressure and heart problems.
- To prevent heart problems, the level of high density lipoproteins (HDL) should be high and low density lipoproteins (LDL) should be low.

Blood Groups
- **Karl Landsteiner** (Australian pathologist) is known as the father of blood groups. There are four types of blood groups, A, B, AB and O.
- A, B and O groups were discovered by **Landsteiner** in 1900, while AB was discovered by **Decastello** and **Sturle** in 1902.
- **Blundell** discovered the technique of blood transfusion in 1825.
- It is based upon the presence or absence of specific antigens.
- AB blood group is universal recipient (can receive blood from all blood groups).
- O blood group is universal donor (can donate blood to individuals of any blood group).

Antigens (Agglutinogens)
- An antigen is stimulus for antibody formation.
- These are present on the surface of RBCs.
- Antigens are proteinaceous in nature.
- A and B are two main antigens.

Antibodies (Agglutins)
These are also known as agglutins.
- Antibodies are proteins, produced by body in response to the presence of an antigen.
- These are present in blood plasma. These are produced in lymph nodes and lymph glands.
- These are formed by globulin protein.
- Antibodies are a and b.

Antigens and antibodies for blood groups

Blood groups	Antigen present	Antibody present	Donate to	Receive from
A	A	b	A and AB	O, A
B	B	a	B and AB	O, B
AB	A and B	—	AB	O, A, B, AB
O	—	a and b	O, A, B, AB	O

Rh factor

- Rh factor is associated with Rh antigen.
- Rh factor was discovered by **Landsteiner** and **Veiner** in 1940 in Rhesus monkey.
- Genes, which control Rh factor are present on autosomes.
- Marriage of Rh^+ man and Rh^- woman is prohibited because due to this, first birth is safe, while second is fatal. The disease responsible is known as erythroblastosis foetalis.
- It is because if Rh^+ blood is mixed with Rh^- blood then antibodies formation starts, i.e. antibodies against Rh antigen, are produced in Rh^- blood.
- Now-a-days IgG (Immunoglobulin preparation) is given to each Rh^- woman after first birth for prevention of this disease. During blood transfusion Rh factor also plays an important role.

Blood Clotting (Coagulation)

- It is a process of formation of blood clot after injury.
- 3-8 minutes is normal time of blood clot.
- Blood clotting is checked in blood vessels by the presence of anticoagulant (e.g. heparin).
- Anticoagulant removes the cation to check the coagulation.
- Important components of blood clotting are fibrinogen, prothrombin, thromboplastin, calcium ions and vitamin-K.
- Prothrombin protein of blood clotting is released by liver, while fibrinogen is synthesised in liver.
- Haemophilia is a genetic disease, in which blood clotting does not occur.

Functions of blood

(i) Transport of digested food materials (glucose, amino acids, etc.) and excretory products (CO_2).
(ii) It maintains internal homeostasis.
(iii) Platelets help in blood clotting.

(b) Lymph

It is a colourless fluid connective tissue made up of plasma and WBCs mostly lymphocytes. It is an Extra Cellular Fluid (ECF), which is intermediate between blood and tissue fluid. It lacks RBCs, platelets and blood proteins. It carries materials from tissues to blood stream and also in reverse direction. Lymph capillaries present in the intestinal villi are called **lacteals**. These are associated with the absorption of digested food.

3. Muscular Tissue

Muscular tissue is contractile tissue in general, develops from the mesoderm of the embryo.

It consists of long, cylindrical fibres, composed of numerous fine fibrils called **myofibrils**, which are made of two proteins called **actin** and **myosin**. The presence of these proteins gives striated appearance to the muscle fibres. The cytoplasm of a muscle fibre is called as sarcoplasm and its endoplasmic reticulum as Sarcoplasmic Reticulum (SR).

Sarcosomes are abundant mitochondria present between the myofibrils. Sarcolemma is the plasma membrane of a muscle fibre, surrounded by basal lamina. These are responsible for movement of body parts (tongue), locomotion, supporting the bones and other structures. Contractibility, excitability and conductivity are the special features of muscular tissue.

They are categorised into three types

(i) Striated or Striped or Skeletal Muscle

- It is found in body wall, limbs and also occurs in the tongue, pharynx and oesophagus. These are voluntary muscles that gets fatigued easily.
- It is cylindrical with unbranched fibres. The cells are multinucleate and bounded by sarcolemma with dark, anisotropic or A-bands and light, isotropic or I-bands.
- Each A-band has a light zone Henson's line or H-zone at its middle, so it is the gap between the actin filaments extending through myosin filaments.
- Each I-band has a dark membrane, at its centre, the membrane of krause or Z-line or Z-band.
- Sarcomere is the part of myofibril between two successive Z-lines (attached on both sides by actin filaments).
- Sarcomere has thick primary myofilaments, composed of protein, myosin and secondary myofilaments composed of actin, tropomyosin and troponin.
- All bands are made of either actin/myosin filaments like A-band (both actin and myosin filaments), I-band (actin filaments) and H-band (myosin filaments).

(ii) Non-striated or Smooth Muscle

- These are found in walls of internal organs, such as blood vessels, alimentary canal (also called as visceral muscle). These are involuntary muscles that do not get fatigued.
- These are spindle-shaped with unbranched fibres that contain a single oval nucleus bounded by plasmalemma and are composed of actin and myosin. The length of its fibres is 100-200 µm and diameter is 10 µm. There are no cross-striations, hence are smooth. They have less extensive SR and less numerous mitochondria.

(iii) Cardiac Muscle

- These are largely confined to the wall of heart. Also, present in the pulmonary veins and superior vena cava. These are striated involuntary muscles and never get fatigued.

- These are cylindrical with branched fibres. These are uninucleate, have a rich blood supply and contain actin and myosin filaments.
- They show cross-striations and contain numerous large mitochondria and glycogen granules.

Functions of Muscles

(i) **Heat production** Muscles contract and maintain the body temperature in extreme cold.

(ii) **Locomotion** Muscles help in locomotion by contraction.

(iii) **Posture** Muscles help in maintaining posture at time of sitting and standing by contraction.

4. Neural/Nervous Tissue

Neurons are the cells making nervous tissues. Their main function is to receive stimuli and conduct impulses to control and coordinate body functions. These tissues are devoid of power of division and regeneration. Human body consists of approximately 10^{11} neurons out of which maximum are present in brain. Neurons are longest cells of the body. They are functional and structural unit of nervous system.

Structure of Neuron

Structure of neuron consists of following things

- **Cell body** also called **cyton**, containing nucleus. Cell body consists of cytoplasm, cell organelles and Nissl's granules.
- **Dendrites** Nissl bodies, neurofibrils and mitochondria are present in dendrites. They conduct nerve impulse towards the cell body and are called **afferent processes**.
- **Axon** They conduct nerve impulse away from the cell body.
- It is long, thick, cylindrical structure made of Schwann cells. If axon is covered by myelin sheath then it is termed as myelinated otherwise non-myelinated. Nodes of Ranvier are places on axon, where myelin sheath is absent.

Functions of Neuron

- Neurons accept stimuli from the atmosphere and respond accordingly.
- They regulate various other biological activities happen in body.

PRACTICE EXERCISE

1. Roots develop from
(a) radicle (b) plumule
(c) stem (d) leaf

2. Prop root is
(a) fibrous roots (b) branched roots
(c) tap roots
(d) modified adventitious roots

3. Fusiform roots are found in
(a) *Solanum tuberosum*
(b) *Dacus carota* (c) *Raphanus sativus*
(d) *Colocasia*

4. Stilt roots are reported from
(a) sugarcane (b) *Bryophyllum*
(c) radish (d) ginger

5. Pneumatophores are present in
(a) xerophytes (b) hydrophytes
(c) mesophytes (d) mangrove plants

6. Sweet potato is modification of
(a) leaf (b) root
(c) stem (d) flowering axis

7. Which one is involved in the reproduction of plants?
(a) Flower
(b) Root
(c) Stem
(d) Underground stem

8. In *Opuntia,* the function of photosynthesis is carried out by
(a) cladode (b) phylloclade
(c) phyllode (d) bulb

9. Which of the following represents example of corm?
(a) Underground bud
(b) Underground root
(c) Horizontal stem
(d) Underground vertical stem

10. Bulb is underground condensed
(a) leaf (b) stem (c) root
(d) flower

11. The arrangement of leaves on stems or its branches is
(a) reticulate venation
(b) phyllotaxy
(c) parallel venation
(d) placentation

12. Main function of leaf is
(a) manufacture of food
(b) exchange of gases
(c) nerve impulse conduction
(d) None of the above

13. Which of the following is an example of storage leaves?
(a) *Triticum* (b) *Allium*
(c) *Zizyphus* (d) *Trapa*

14. Study of fruits is called
(a) Embryology (b) Palynology
(c) Pomology (d) Morphology

15. The placentae are borne on a central column in
(a) basal placentation
(b) marginal placentation
(c) axile placentation
(d) free central placentation

16. The innermost whorls of a flower, consisting of one or more units are called
(a) calyx (b) carpels
(c) corolla (d) Both (b) and (c)

17. Which among the following is a true fruit?
(a) Apple (b) Strawberry
(c) Grape (d) All of these

18. Which of the following is true about underground modification of stem?
(a) It is found above the ground level
(b) Potato is an example of underground modification
(c) Runner and stolon are underground modifications stem
(d) They are not important for human being

19. Which of the following statements is true about gynoecium (female sex organ of flower)?
(a) It is the outermost part of flower
(b) It is brightly coloured and attract insects
(c) It contains ovary, which gets converted into fruit
(d) It has no role in fertilisation

20. Which of the following is true about fruits?
(a) It is the ripened androecium of flower
(b) Simple fruits are made from many ovaries
(c) Aggregate fruits are made from one ovary
(d) Composite fruits are made from many ovaries of many flowers

21. Xylem and phloem are type of complex permanent tissue. Which of the following statements is true about it?
(a) Xylem meant for food conduction, while phloem for water conduction
(b) Xylem is made up of sieve tube and companion cells
(c) Phloem is made up of tracheids and vessels
(d) Xylem is major part of wood

22. Which of the following statements is incorrect?
(a) Stem tendrils are found in grapes
(b) Stipules are the reproductive structures
(c) Tendrils are modified stem in cucumber
(d) Jack fruit is an aggregate fruit

23. Which one among the following animal tissues transports hormones, heat and maintains water balance?
(a) Connective tissue
(b) Blood
(c) Muscular tissue
(d) Nervous tissue

24. Respiratory tract has
(a) compound epithelia
(b) pseudostratified epithelium
(c) stratified columnar epithelium
(d) stratified ciliated columnar epithelium

25. Which of the following is incorrect?
(a) Ginger—Modified stem
(b) Turmeric—Rhizome
(c) Onion—Modified root
(d) Clove—Flower bud

26. In aquatic plants, which permanent tissue provides buoyancy to the plant?
(a) Parenchyma (b) Collenchyma
(c) Aerenchyma (d) None of these

27. Which of the following structures of a plant is responsible for transpiration?
(a) Xylem (b) Root
(c) Stomata (d) Phloem

28. Which of the following is not a stem modification?
(a) Bulb of onion
(b) Corm of arvi
(c) Tuber of sweet-potato
(d) Tuber of potato

29. The nutritive tissue in the seeds of higher plants is known as
(a) embryo (b) endosperm
(c) nucellus (d) hypocotyl

30. Which of the following have endospermic seeds?
(a) Gram (b) Pea
(c) *Cicer* (d) Castor

31. The main function of the bast of a woody plant is to
(a) transport minerals and water from the roots to the leaves
(b) act as a membrane impermeable to water and gas
(c) transport food from the leaves to the other parts of the plant
(d) protect the plant from herbivorous animals

32. Which one of the following categories does adipose tissue belong to?
(a) Epithelial (b) Connective
(c) Muscular (d) Neural

33. Protein present in a cartilage is
(a) ossein (b) chondrin
(c) thrombin (d) collagen

34. The tissue whose cells are thin-walled and living, more or less isodiametric and have intercellular spaces is known as
(a) sclerenchyma (b) collenchyma
(c) parenchyma (d) sclereids

35. The food in plants is stored in
(a) chlorenchyma (b) parenchyma
(c) collenchyma (d) sclerenchyma

36. The term 'tissue' was coined by
(a) Mayer (b) Bichat
(c) Malpighi (d) William Bowman

37. The softest tissue present in body is
(a) bone (b) nervous tissue
(c) blood (d) tendon

38. Rh factor was discovered by
(a) Landsteiner and Veiner
(b) Deeastello
(c) Sturle
(d) William Harvey

39. The lymph differs from blood in having
(a) more RBCs, less WBCs
(b) more WBCs, less RBCs
(c) more WBCs, no RBCs
(d) no RBCs, no WBCs

40. In human, pH of blood is
(a) 2.2-3.4 (b) 7.3-7.4
(c) 6.0-6.5 (d) 10.0-10.2

41. Nucleated RBCs are present in
(a) camel (b) man
(c) rabbit (d) elephant

42. Presence of haemoglobin in blood is measured by
(a) Ganong's potometer
(b) Lactometer
(c) Sahli's haemometer
(d) Barometer

43. Functions of RBCs are
(a) carry the O_2
(b) maintain pH of blood
(c) transportation of CO_2
(d) All of the above

44. Blood groups were discovered by
(a) Landsteiner (b) Robert Koch
(c) William Harvey (d) None of these

45. Normal blood glucose level is
(a) 50-80 mg/100 mL
(b) 50-100 mg/100 mL
(c) 80-100 mg/100 mL
(d) 80-300 mg/100 mL

46. Universal recipient blood group is
(a) O (b) AB
(c) A (d) None of these

47. Universal donor blood group is
(a) AB (b) A (c) B (d) O

48. A person of blood group AB can give blood to
(a) A and B (b) Only AB
(c) A, B and O (d) All of these

49. RBCs in mammals have no nucleus because
(a) it has degenerated during development
(b) it does not have nucleus since early time
(c) haemoglobin is absent in RBCs
(d) None of the above

50. RBCs can burst if they are kept in
(a) super saturated salt solution
(b) isotonic salt solution
(c) hypertonic salt solution
(d) hypotonic salt solution

51. Anaemia due to the deficiency of iron is
(a) pernicious anaemia
(b) nutritional anaemia
(c) sickle-cell anaemia
(d) thalassemia

52. Blood bank of body is
(a) liver (b) kidney
(c) spleen (d) heart

53. A person beside with blood group O receives blood transfusion, study of blood groups is also helpful in
(a) personality estimation
(b) health status
(c) forensic science
(d) None of the above

54. Clotting of blood of a wound involves
(a) evaporation of the plasma
(b) blood albumins dissolution
(c) conversion of fibrinogen to fibrin by thrombin
(d) haemolysis of the red corpuscles

55. In blood, largest corpuscles are
(a) monocytes (b) RBCs
(c) lymphocytes (d) neutrophils

56. Which of the following is a genetic blood disease?
(a) Cancer (b) TB
(c) Haemophilia (d) Syphilis

57. The characteristic feature of pernicious anaemia is
(a) increase in size of RBCs
(b) deficiency of haemoglobin in RBCs
(c) delay in maturation of erythrocytes
(d) All of the above

58. Blood group that contains antigen 'A' and antigen 'B', is
(a) A (b) AB
(c) B (d) O

59. Antibodies are absent in blood group
(a) A (b) B
(c) AB (d) A, B and O

60. Which of the following is required in coagulation?
(a) Ca^{2+} (b) CO
(c) Na^{+} (d) None of these

61. In leukaemia, the number of
(a) WBCs increases excessively
(b) RBCs increases excessively
(c) WBCs decreases excessively
(d) RBCs decreases excessively

62. Which of the following is related with prothrombin?
(a) agglutination of blood
(b) clotting of blood
(c) blood pressure
(d) transport of gases through blood

63. Which of the following is correct definition for an antigen?
(a) Opposite of an antibody
(b) Part of antibody
(c) Stimulus for antibody formation
(d) All of the above

64. Life of RBCs in human blood is of
(a) 30 days (b) 60 days
(c) 120 days (d) 15 days

65. Formation of blood corpuscles is known as
(a) haemolysis (b) rouleaux
(c) haemopoiesis (d) phagocytosis

66. The volume of blood present in adult human is
(a) 10 L (b) 5 L
(c) 2 L (d) 1 L

67. Which of the following is termed as 'graveyard' of RBCs?
(a) Liver (b) Spleen
(c) Kidney (d) Bone marrow

68. Blood does not contain
(a) calcium (b) prothrombin
(c) fibrinogen (d) elastin

69. Lymph differs from blood in the absence of
(a) WBCs (b) RBCs
(c) Plasma (d) All of these

70. Study the following statements.
1. Tap root commonly occurs in dicotyledons.
2. Onion is a modified form of stem.
3. Ginger is a modified leaves.
4. Eyes of potato are axillary buds.

Which of the statements given above are correct?
(a) 1, 2, 3 and 4 (b) 1, 2 and 4
(c) 1, 2 and 3 (d) None of these

71. Which of the following characteristics are associated with mangrove plants.
1. Presence of pneumatophores.
2. Leaves and stem have hairy and waxy covering.
3. Modified roots.

Select the correct answer from the codes given below
(a) 1, 2 and 3 (b) 1 and 2
(c) Only 2 (d) 1 and 3

72. Consider the following statements.
1. Annual rings are distinct in plant, which grown in temperate region.
2. One growing ring of plant consists of spring wood and autumn wood.

Which of the statements given above is/are correct about annual ring?
(a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) None of these

73. Which of the following leaf modifications occurs/occur in desert areas to inhibit water loss?
1. Hard and waxy leaves.
2. Tiny leaves or no leaves.
3. Thorns instead of leaves.

Select the correct answer using the codes given below
(a) 1 and 2 (b) Only 2
(c) 1 and 2 (d) All of these

74. Study the following statements.
1. True fruits are developed from ovary.
2. Apple is an example of false fruit.
3. Coconut and mango grouped under the kind of fruit drupe.

Which of the statement(s) given above is/are correct?
(a) Only 1 (b) Only 2
(c) 1 and 3 (d) 1, 2 and 3

75. Consider the following statements.
1. Epithelium tissue forms protective layer of body.
2. Transmission of stimuli from one part of body to other part takes place through nervous tissue.
3. Blood is an example of connective tissue.

Which of the statements given above are correct about tissue?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 2 (d) 1, 2 and 3

76. Study the following statements.
1. Neurons are considered as the longest cell of the body.
2. Neurons form the structural and functional unit of nervous system.
3. Nervous tissues are found in brain, spinal cord and nerves.

Which of the statements given above are correct?
(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

77. Consider the following statements
1. Areolar connective tissue is found between the skin and muscles, around blood vessels and nerves and in the bone marrow.
2. Fat storing adipose tissue is found below the skin and between internal organs.

Which of the statement(s) given above is/are correct?
(a) Only 1 (b) Only 2
(c) 1 and 2 (d) None of these

78. Consider the following functions of xylem.
1. Conduction of water.
2. Conduction of minerals.
3. Translocation of food.

Which of the function(s) of xylem given above is/are correct?
(a) Only 1 (b) 1 and 2
(c) 2 and 3 (d) Only 3

79. Which of the following pairs is/are correctly matched?
1. Cartilage—Supportive connective tissue
2. Adipose tissue—Dense connective tissue
3. Tendon—Specialised connective tissue
4. Areolar tissue—Loose connective tissue

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

80. Match the Column I (tissue) and Column II (origin).

Column I	Column II
A. Epithelial tissue	1. Tongue
B. Connective tissue	2. Retina of eye
C. Muscular tissue	3. Bone
D. Nervous tissue	4. External and internal exposed surface of the body

Codes

	A	B	C	D		A	B	C	D
(a)	2	1	4	3	(b)	4	3	2	1
(c)	1	2	3	4	(d)	4	3	1	2

81. Sickle-cell anaemia is a disease caused due to the abnormality in
(a) white blood cells **2012 (I)**
(b) red blood cells
(c) thrombocytes
(d) blood plasma composition

82. Certain parts of a plant can be bent easily without breaking. This flexibility in certain parts, like leaf and stem, can be attributed to the abundance of **2012 (I)**
(a) parenchyma
(b) collenchyma
(c) sclerenchyma
(d) xylem and phloem

83. Which of the following statements is/are correct? **2012 (I)**
1. Ligaments are highly flexible.
2. Ligaments connect muscles and bones.
3. Ligaments contain very little matrix.

Select the correct answer using the codes given below.
(a) 1, 2 and 3 (b) 1 and 3
(c) 2 and 3 (d) Only 1

84. Which one among the following parts of blood carries out the function of body defence?
(a) Platelets **2012 (II)**
(b) White blood cells
(c) Haemoglobin
(d) Red blood cells

85. Consider the following statements in relation to plant tissue 'chlorenchyma'. **2013 (I)**
1. It is formed by the palisade and spongy mesophyll.
2. It is a form of parenchyma, which contains chloroplasts.
3. It serves to transport organic solutes made by photosynthesis.
4. It is a thin transparent layer, which has chiefly a protective function.

Which of the statement(s) given above is/are correct?
(a) 1 and 2 (b) 1, 2 and 3
(c) 2 and 4 (d) Only 1

86. In blood, platelets are required for
(a) transporting oxygen **2015 (II)**
(b) transporting carbon dioxide
(c) initiating blood clotting
(d) initiating degradation of urea

87. To prevent heart problems, blood of a normal healthy person should have **2016 (I)**
1. low cholesterol level
2. high HDL level
3. high VLDL level
4. high LDL level

Select the correct answer using the codes given below
(a) 1 and 2
(b) 1, 2 and 4
(c) 3 and 4
(d) 1, 2 and 3

ANSWERS

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

05

PLANTS PHYSIOLOGY AND REPRODUCTION

In 2015, 5 questions are asked from this chapter. So, this is very important chapter. These questions are based upon fertilisers, reproduction, photosynthesis and plant harmones.

Plants carry out several physio-chemical activities. The study of functioning of these activities is known as plant physiology. It includes processes like transportation, mineral nutrition, photosynthesis, respiration, etc., which ultimately leads to growth, development and reproduction of plants.

TRANSPORTATION IN PLANTS

- The materials produced in plants or absorbed through roots are transported to each and every part of the plant.
- Xylem conducts water and minerals from root to leaves, while phloem distributes food upto roots. Thus, xylem and phloem constitute the transport system of plants.

Translocation

- The process of transport of soluble products, i.e. sugar produced in photosynthesis from leaves to other parts of plant *via* phloem tissue is termed as translocation.
- Translocation is mainly achieved by use of energy.

Transpiration

- Loss of water in the form of vapours from aerial parts of the plant is called **transpiration**.
- Transpiration can occur in stems and leaves.
- **Curtis** (1926) called it a necessary evil.
- Potometer is used to measure transpiration.
- Transpiration is of three types, i.e. cuticular transpiration, lenticular transpiration and stomatal transpiration.
- Stomatal transpiration occurs through stomata. These are pores guarded by guard cells (possess chloroplast), which are in turn surrounded by subsidiary cells. In dicot, the guard cells are kidney-shaped, while in monocot they are dumb-bell-shaped.
- Stomata open when the guard cells take up K^+ ions from the surrounding cells, which leads to osmotic entry of water in the guard cells and they close when K^+ ions exit the guard cells.
- The rate of transpiration increases due to increase in the temperature, while it decreases in high humidity.
- Transpiration is called a **necessary evil** as it aids in water movement.
- Stomata are usually open during day and close at night.
- Rate of transpiration can be reduced by antitranspirants such as Abscissic Acid (ABA) and Phenyl Mercuric Acetate (PMA).
- Process of transportation of water absorbed by roots against the gravity is known as ascent of sap.
- **Imbibition** is water absorption by solid particles without forming a liquid, e.g. dry piece of wooden absorbs water.
- Plasmolysis is the shrinkage of plant cytoplasm due to exosmosis, e.g. if excess fertiliser applied to plant without water, plant dies due to plasmolysis.
- Guttation is loss of water from the small pores called **hydathodes**, e.g. in rose, strawberry, tomato, etc.

MINERAL NUTRITION

- **De Saussure** (1804) first of all demonstrated that plants obtain mineral from soil through root system.
- Analysis of plant ash shows that about 92 mineral elements are present in different plants.
- Out of these 16 elements are necessary for plants and are called **essential elements**.
- Essential elements are of three types.
  (i) **Macroelements** required in large amounts, e.g. C, H, O, N, S, P, K, Ca, Mg.
  (ii) **Microelements** required in very small amounts, e.g. Fe, Cu, B, Zn, Mn, Mo, Cl.
  (iii) **Trace elements** used to detect various metabolic pathways in plants, e.g. C^{14}, N^{15}, P^{32}.

Specific Role and Effect of Deficiency of Minerals for Plants

Elements	*Absorbed in form of*	*Role*	*Deficiency effect*
C, H, O	Organic compounds	Framework	Growth reduced
N	Nitrates	Component of protein, nucleic acid and chlorophyll	Chlorosis of old leaves, stunted growth
S	Sulphate	Constituent of amino acids, important nutrient for pulses crops	Chlorosis of young leaves
P	Phosphate	Constituent of nucleic acid	Leaf fall and weakness
Ca	Nitrates and sulphates	Part of middle lamella	Chlorosis along meristem, wither tip
K	Nitrate and chloride	Activator of enzymes	Chlorosis of leaves, rosette growth
Mg	Magnesium	Constituent of chlorophyll	Growth reduced
Fe	Ferrous and ferric	Photosynthesis and respiration	Growth reduced
B	Borate	Translocation of sugar	Root growth stunted
Mn	Oxide of Mn	Component of plant cell well, activator of some enzymes	Physiological diseases, gray spot disease
Zn	Zinc	Synthesis of tryptophan	Chlorosis of older leaves, little leaf
Cu	Copper	Oxidising of enzymes	Necrosis of leaves
Mo	Molybdenum	Nodulation in legumes	Inhibition of fruit formation, whiptail disease
Cl	Chlorine	Photosynthesis	Growth reduced

- A complete fertiliser should have N, P and K in adequate amounts.

PHOTOSYNTHESIS

- Green plants prepare their food using CO_2 and H_2O as raw materials in the presence of sunlight and chlorophyll by a process called **photosynthesis**. About 90% of total photosynthesis in world is done by algae occurring in oceans and in freshwater. Chloroplast is the site of photosynthesis, which is present in green leaves.
- Photosynthesis is an anabolic process that requires energy (endothermic).
- All green plants carry out the process of photosynthesis because of the presence of green pigment in leaf. These are chlorophyll-*a* and *b* mainly along with some other accessory pigments. These pigments have the ability to use light energy and convert it into the chemical energy in the form of organic compounds (carbohydrates). Starch is the visible product of photosynthesis.
- The equation of photosynthesis is

$$6CO_2 + 12H_2O \xrightarrow[\text{Green plant}]{\text{Light}} \underset{\text{Glucose}}{C_6H_{12}O_6} + 6H_2O + 6O_2 + 686 \text{ kcal}$$

(Hexose sugar, i.e. carbohydrates)

- Factors influencing the rate of photosynthesis are CO_2, light, water and temperature.
- Photosynthesis mainly includes two types of reactions, i.e. light reaction and dark reaction.

1. Light Reaction or Hill Reaction

- Light reaction of photosynthesis occurs in grana part of chloroplast. It involves photolysis of water and production of NADPH and ATP in photophosphorylation (production of ATP in the presence of light).
- Rate of photosynthesis is measured in quantum.
- Quantum requirement in photosynthesis is 8.
- There are two photosystems involve in the process of light reaction.
  (i) P_{700} is the reaction centre of PS-I.
  (ii) $P_{680\text{-}690}$ is the reaction centre of PS-II.

2. Dark Reaction or Blackman's Reaction

- Dark reaction of photosynthesis occurs in stroma (matrix) part of chloroplast.
- It is also known as Calvin cycle or C_3 cycle.
- In this cycle, one mole of hexose sugar (glucose) is formed by 18 ATP + 12 $NADPH_2$. This process of CO_2-fixation occurs in the presence of RuBisCO enzyme (most abundant enzyme).
- In some plants instead of C_3 cycle, C_4 cycle is observed. In this cycle, first stable product of CO_2-fixation is a four carbon compound unlike C_3 plants in which it is a 3 carbon compound.

- This 4C compound produced in C_4 cycle is Oxaloacetic Acid (OAA). Which is the first product of Hatch and Slack pathway.
- In C_4 plants a special type of leaf anatomy, i.e. Kranz anatomy is seen.
- Examples of C_4 plants that are monocots are sugarcane, maize, *Cyprus*, etc., and dicots are *Amaranthus*. *Artiplex* can show both C_3 and C_4 cycle.
- In plants such as *Opuntia*, *Bryophyllum*, *Agave*, etc. CO_2-fixation occurs at night. These plants are known as CAM plants and this process is known as Crassulaceae Acid Metabolism (CAM).

Bacterial Photosynthesis

- Like green plants, some purple and green sulphur bacteria are capable of synthesising their organic food in the presence of **light** and in the absence of O_2, which is known as bacterial photosynthesis, e.g. Green sulphur bacteria (*Chlorobium*), purple sulphur bacteria (*Chromatium*) and non-sulphur bacteria (*Rhodospirillium*).

Chemosynthesis

- Chemosynthesis is the formation of organic food, utilising chemical energy by some aerobic bacteria. These bacteria are
  (i) **Nitrifying bacteria**, e.g. *Nitrosomonas, Nitrosococcus, Nitrobacter*.
  (ii) **Sulphur bacteria**, e.g. *Beggiatoa, Thiothrix, Thiobacillus*.
  (iii) **Iron bacteria**, e.g. *Ferrobacillus, Leptothrix, Cladothrix*.
  (iv) **Hydrogen bacteria**, e.g. *Bacillus pentotrophus*.
  (v) **Carbon bacteria**, e.g. *Bacillus oligocarbophilus.*

RESPIRATION

- Respiration is a **catabolic**, i.e. breaking up and exergonic, i.e. energy releasing process of cell that involves oxidation of complex carbonic substances such as carbohydrates, proteins, fats, etc., into CO_2, water and energy without utilising O_2. This process occurs in every living cell, so called **cellular respiration**.
- The equation of respiration is shown by following equation

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + E \text{ (686 kcal)}$$

- The process of respiration involves glycolysis, Krebs' cycle, electron transport chain and oxidative phosphorylation of ATP.
- In glycolysis, 1 molecule of glucose is converted into 2 molecules of pyruvic acid, 2 ATP and 2 NADH molecules.
- Krebs' cycle occurs in mitochondria and it involves complete oxidation of pyruvic acid.
- One molecule of glucose may yield 38 ATP molecules.
- In yeasts and bacteria, anaerobic respiration occurs outside the protoplasm. This is known as fermentation.
- In our muscles, during vigorous physical exercise, glucose is metabolised to form lactic acid. Due to the lactic acid, muscle cramps and fatigue occurs after heavy exercises.
- Respiratory Quotient (RQ) is the ratio of CO_2 and O_2 released in respiration.
- RQ is less than one for proteins and fats, more than one for carbonic acids and one for carbohydrates.

PLANT MOVEMENTS

Plants have the capacity of changing their position in response to external or internal stimuli. These are known as plant movements.

- This specific site that receives the stimuli is known as perception site.
- The minimum time, required for a response to occur against a stimuli is known as presentation time.

Movements are basically of four types

1. Movements of Locomotion

These are further of two types

(i) Autonomic

Due to internal stimuli, these are of following types
(a) **Ciliary movement** Move from one place to another with the help of cilia, e.g. *Chlamydomonas*.
(b) **Amoeboid movement** Locomotion with the help of pseudopodia, e.g. slime moulds.
(c) **Cyclosis movement** Autonomic movement of protoplasm, e.g. *Hydrilla*.

(ii) Induced

Due to external stimuli, these are of following types
(a) **Chemotactic** Movements of bacteria towards chemicals.
(b) **Phototactic** Many algae move from weak and high light to medium light intensity.
(c) **Thermotactic** Some algae move from cold water to warmer water.

2. Movements of Curvature

These are of two types

(i) Mechanical Movement

These are shown by dead organs.
(a) **Xerochasy** by loss of H_2O, e.g. capsules.
(b) **Hydrochasy** by absorption of H_2O, e.g. peristomial teeth of moss capsule.

(ii) Vital Movement

These are shown by living organs. They are of two types

(a) **Autonomic** Response to internal stimulus, e.g. leaf opening by hyponasty.

(b) **Induce** This is also called tropic or **nastic movement**.

3. Tropic Movement

Response to unidirectional external stimulus. These are of following types

(a) **Phototropism** Response to light stimulus, e.g. root is negatively phototropic.

(b) **Geotropism** Response to gravity stimulus, e.g. stem is negatively geotropism.

(c) **Hydrotropism** Response to water stimulus, e.g. young roots are positive hydrotropic.

(d) **Thigmotropism** Movements shown by tendrils due to contact stimulus.

4. Nastic movement

Response to diffused external stimulus.

(a) **Sleeping movement** Leaves of some legume plants show horizontal position during daytime and become vertical (sleep) during night, e.g. leaves of *Oxalis*.

(b) **Seismonastic movement** These are due to shock or touch stimulus, e.g. *Mimosa pudica* (touch-me-not).

(c) **Thigmonastic movement** Shown by some insectivorous plants, e.g. *Dionaea* and *Drosera*.

PLANT GROWTH AND DEVELOPMENT

Plant growth is a complex, stable and irreversible process. For complete regulation of plant growth and development, certain growth regulatory substances are utilised.

Growth

- All living organisms show various positive changes in their weight, shape, size and volume during their entire life cycle (birth to death). All these changes are collectively known as growth.
- Growth means an increase in size (usually an increase in length and volume) and an increase in the dry weight of the growing parts of the organism.
- In plants, growth is confined only to meristems and associated with both anabolic and catabolic means.
- The growth of cells of plants is divided into three phases, i.e. formative phase, cell enlargement and cell maturation.
- If the growth rate is plotted against time, a sigmoid or S-shaped curve is obtained, which is called growth curve.
- The growth curve can be differentiated into three phases, i.e. lag phase, log phase (exponential phase), steady phase (stationary phase).
- The rate of growth is called **efficiency index**.
- Growth can be measured by auxanometer horizontal microscope and crescograph. Growth is affected by many external and internal factors.
- Some external factors are light, temperature, water, oxygen, CO_2, pollutants, etc.
- The optimum temperature for growth is 20-30°C.
- The internal factors include genetic factors and growth regulators.

Plant Growth Hormones

Plant growth hormones also called **phytohormones**. These are the chemical substances that are naturally produced in plants and are capable of regulating the important processes of plants. Different plant hormones help to coordinate growth, development and response to the environment.

- Term 'phytohormone' was first utilised by **Thimann**.
- Plant harmones are of five types. Auxin, gibberellin and cytokinin (growth promotory), abscisic acid and ethylene (growth inhibitory) hormones.

Auxins

- Auxins were first collected by **Went** in 1928 from coleoptile of *Avena*. Auxins were first isolated from urine.
- The auxins in apical bud inhibit the development of lateral buds and the phenomenon is called **apical dominance**.
- Auxin is produced from tryptophan.
- IAA (Indole-3-acetic acid) is natural, while NAA (Naphthaleneacetic acid) and 2, 4-D (2,4 Dichloro phenoxyacetic acid) are synthetic auxins.
- Indole-3-Acetic Acid (IAA) is the best known and universal natural auxin found in all plants and fungi.
- Auxin test is known as auxin bioassay, which is the quantitative test and is famous by the name of Avena curvature test.
- 2, 4-D and 2, 4, 5-T are used as herbicides.
- Auxin causes parthenocarpic fruit development.
- It controls phototropism and geotropism.
- Auxin helps a plant in bending towards light in phototropism.
- Auxins promote cell division and cell elongation.
- Femaleness in plants is caused by auxins.
- It induces rooting in stem cuttings.

Gibberellins

- It is isolated by **Kurosawa** from a fungus *Gibbrella fujikuroi* (a causative agent of bakanae or foolish seedling disease in rice plants).

- Gibberellins cause cell elongation and increase in internodal length (bolting).
- Gibberellins are produced in embryos, roots and young leaves near the shoot tip.
- It is a hormone, which stimulates the plant cells to grow in a manner such that the plant appear to be bent towards light.
- It is helpful in flowering, enzyme synthesis and fruit growth.
- Gibberellin induces parthenocarpy in some cases, e.g. pome fruits, so gibberellins are more potent parthenocarpic agents than auxins.
- Antigibberellins are those compounds, which supress and reduce the effect of gibberellins, e.g. phosphon-D, malaic hydrazide, Chlorocholine Chloride (CCC).

Cytokinins

- Cytokinins are known to promote cytokinesis (cell division).
- Kinetin was first isolated from degraded sample of DNA.
- Zeatin is the first natural cytokinin isolated from maize endosperm.
- Cytokinins are synthesised in roots as well as stems.
- It is responsible for cell division, cell enlargement, prevention of senescence (Richmond Lang effect) and enzyme synthesis.
- Auxin-cytokinin ratio causes root-shoot initiation.
- Cytokinins also promote flowering in short day plant.

Ethylene

- Only gaseous hormone, which promotes transverse growth. It is a ripening hormone that mainly acts as a natural growth inhibitor.
- Ethylene hastens ripening of fruits and promotes aging of plant organs.

Abscisic Acid (ABA)

- It acts as a growth inhibitor by counteracting other hormones.
- It is responsible for dormancy in buds and seeds, aging in leaves, inhibition of mitosis, abscission of leaves, flowers and fruits.
- It supresses the growth of dormant lateral buds.
- Florigens, caline and traumatin are some other plant hormones.

REPRODUCTION

The process of producing new organisms from the existing organisms of the same species is known as **reproduction**. There are two modes of reproduction, i.e. asexual and sexual.

Asexual Reproduction

Asexual reproduction is a rapid mode of multiplication in which single parent is involved. The cells divide either mitotically or amitotically. The new individuals produced in asexual reproduction are exactly similar to their parent (i.e. clone).

Asexual reproduction is of following types

(i) **Fission** Found in unicellular organisms. Fission leads to equal division of the cell, e.g. *Amoeba*.

(ii) **Fragmentation** By simple breaking of body part and generation of whole body by fragmented part, e.g. *Spirogyra*, bryophytes, etc.

(iii) **Regeneration** Any part of body has the ability to form the new part, e.g. *Hydra*.

(iv) **Budding** Any bud comes out the body and capable to grow into full length body of main organism, e.g. *Hydra*, yeast, etc.

(v) **Vegetative propagation** Any part of plant body develops into new plant.

Vegetative propagation is of following types

(a) **Cuttings** It is of three types
- **Stem cuttings**, e.g. sugarcane, rose, *Bougainvillea*.
- **Root cuttings**, e.g. apple, lemon.
- **Leaf cuttings**, e.g. *Begonia*, etc.

(b) **Grafting,** e.g. mango, guava, rubber, etc.

(c) **Layering**, e.g. jasmine.

(d) **Leaves** When the leaves fall down in soil, from their edges, new plants are formed. e.g. *Bryophyllum* and *Begonia,* etc.

(vi) **Spore formation** In many multicellular organisms, spore is the reproductive cell, which has the ability to germinate and give rise to a new colony. Algae, ferns, mosses and fungi reproduce through spore formation.

Different types of spores produced in different organisms are as follows

(a) **Zoospores** (motile), e.g. Algae–*Ulothrix*, *Oedogonium*, Fungi–*Pythium* and *Achlya*.

(b) **Sporangiospores** (non-motile), e.g. *Mucor* and *Rhizopus*.

(c) **Conidia** (non-motile), e.g. *Penicillium, Aspergillus, Fusarium.*

(d) **Cysts** (thick coverings), e.g. *Vaucheria* and *Botrydium*.

Sexual Reproduction

Sexual reproduction is an adaptation for adverse conditions. **R Camararius** was the first one to describe sexual reproduction in plants. It is the process of producing new individuals by two parents. It involves production of gametes by meiosis and fusion of gametes. In plants, all the events related to sexual reproduction, takes place in flower.

- Flower is the reproductive organ of plants. When flower contains both male and female reproductive organs, it is called **bisexual flower** and when it contains only one either male or female reproductive part it is called **unisexual flower**.

- Stamens and carpels are the male and female reproductive parts of plants respectively present in flower.
- Stamen comprises of two parts, i.e. anther and filament.
- Anther is the microsporangium in which microspores (pollen grains) are formed. Within pollen grains male gametes are formed.
- Anthers are usually bithecous and tetrasporangiate. Carpel consists of three parts, i.e. stigma, style and ovary.
- Stigma is the receptive surface where pollen grains are received. Style connects stigma to ovary.
- Ovary consists of ovules. Ovules act as the megaspores, i.e. female gamete bearing structures. They remain connected to the ovary by means of placenta.

Types of Ovules

An ovule consists of micropyle (opening), chalaza (part opposite to micropyle) and funicle (stalk). It is always 7-celled and 8-nucleated. One of the cell is female gamete.

There are following types of ovules

(i) **Orthotropous** The micropyle, chalaza, and funicle are in straight line. This is the most primitive type of ovule, e.g. piper, polygonum and *Cycas*.

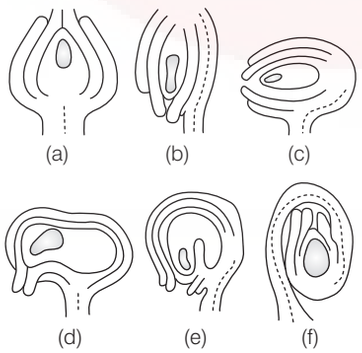
(ii) **Anatropous** The ovule turns at 180° angle. Thus, it is inverted ovule. It is found in 82% angiosperm families.

(iii) **Hemianatropous** The ovule turns at 90° angle upon the funicle or the body of ovule and is at right angle to the funicle, e.g. *Ranunculus.*

(iv) **Campylotropous** The ovule is curved more or less at right angle to the funicle, e.g. in the members of Leguminosae and Cruciferae.

(v) **Amphitropous** The ovule as well as embryo sac is curved like horseshoe, e.g. *Lemna*, poppy and *Alisma*.

(vi) **Circinotropous** The ovule turns at more than 360° angle, e.g. *Opuntia* (Cactacea).



Shapes of ovule (a) Orthotropous, (b) anatropous, (c) hemianatropous, (d) campylotropous, (e) amphitropous, (f) circinotropous

Pollination

The process of transfer of pollen grains from the anther to the stigma is called **pollination**.

Pollination is of two types, i.e. self-pollination and cross-pollination.

- Self-pollination involves the transfer of pollen grains from the anthers to the stigma of the same flower or of another flower borne by the same plant.
- Self-pollination occurs only in bisexual or hermaphrodite flower/plant.
- Cross-pollination involves the transfer of pollen grains from the flower of one plant to the stigma of the flower of another genetically different plant.
- Pollination may occur by means of abiotic or biotic agents.
- Abiotic agents are wind and water.
- Biotic agents are living organisms.
- Based on type of agent, pollination can be

Pollination by wind	—	Anemophily
Pollination by insect	—	Entomophily
Pollination by bats	—	Chiropterophily
Pollination by ants	—	Myrmecophily
Pollination by water	—	Hydrophily
Pollination by birds	—	Ornithophily
Pollination by snails	—	Malacophily

- Since cross-pollination ensures more variable seeds self-pollination is generally prevented by means of some mechanisms. This mechanism is known as self-sterility or self-incompatibility.
- Dichogamy is one of the mechanism of self-incompatibility in which either anthers (protandry) or carpels (protogyny) mature earlier than the other.

Fertilisation

- Process of male and female gamete fusion is known as fertilisation. It involves the following steps.
- The pollen grains after pollination absorb water and swell on stigma.
- These germinate and form a pollen tube.
- By means of pollen tube the male gametes are transferred from pollen grains to ovary and finally ovule.
- Now, fertilisation occurs in following manner

Stamen → Anther → Pollen grain → Male gamete (n)
Pollen grain → Male gamete (n)

Carpel → Ovary → Ovule → Egg cell (n)
Ovule → Polar nuclei ($2n$)

Male gamete (n) × Polar nuclei ($2n$) $\xrightarrow{\text{Triple fusion}}$ Endosperm ($3n$)

Endosperm ($3n$) $\xrightarrow{\text{Disintegrate to provide nutrition}}$ Embryo ($2n$)

Male gamete (n) × Egg cell (n) $\xrightarrow{\text{Syngamy}}$ Zygote ($2n$)

- Since, process of fertilisation in plants includes two fusions, i.e. syngamy and triple fusion, it is known as **double fertilisation**. The changes taking place in flower after fertilisation.
- Ovary changes to fruit and ovule changes to seed after fertilisation.
- Endosperm in angiosperms is triploid ($3n$), but in gymnosperms, it is haploid (n).
- Polyembryony is the phenomenon of production of multiple embryos, e.g. *Citrus*.
- Fruits develop from ovary after fertilisation, but when a fruit is formed without fertilisation, process is called **parthenocarpy**.
- Parthenogensis is the development of embryo/seed from an egg without fertilisation.
- Sometimes, dormant seeds are exposed to low temperature to induce germination in them. This process is known as **vernalisation**.
- **Vivipary** is germination of seed within the fruit, while still attached to mother plant.

PRACTICE EXERCISE

1. Which element is the constituent of chlorophyll molecule?
(a) Mg (b) K (c) Ca (d) S

2. Which of the following is not a purpose of transpiration?
(a) Supplies water for photosynthesis
(b) Helps in transportation of water
(c) Cools leaf surface
(d) Maintains shape and structure of plant

3. The rate of transpiration accelerates due to
(a) increase in temperature
(b) decrease in temperature
(c) no change in temperature
(d) low humidity

4. Which element causes whiptail disease in plants?
(a) N (b) Mo (c) Ca (d) Mg

5. Chlorophyll-*a* is present in all photosynthetic organisms except
(a) green algae
(b) photosynthetic bacteria
(c) green sulphur bacteria
(d) higher plants

6. Which equation represents respiration?
(a) $C_6H_{12}O_6 \longrightarrow 6CO_2 + 6H_2O + E$
(b) $C_6H_{12}O_6 + 6CO_2 \longrightarrow 6CO_2 + 12H_2O + E$
(c) $C_6H_{12}O_6 + 6CO_2 \longrightarrow 6CO_2 + 6H_2O + E$ (686 kcal)
(d) $6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O + E$

7. In eukaryotic cells, the complete breakdown of respiratory substances to CO_2 and H_2O in the presence of O_2 is called
(a) anaerobic respiration
(b) fermentation
(c) Both (a) and (b)
(d) aerobic respiration

8. Sulphur is an important nutrient for optimum growth and productivity in
(a) cereals (b) fibre crops
(c) pulse crops (d) oil seed crops

9. Premature leaf fall and weakness in plants is due to the deficiency of
(a) nitrogen (b) phosphorus
(c) sulphur (d) calcium

10. Name the elements, which occur in nucleic acids?
(a) C, O, N and S
(b) C, H, O, N and S
(c) C, H, O, N and P
(d) H, O and P

11. Which element is required for the germination of pollen grains?
(a) Calcium (b) Boron
(c) Potassium (d) Chlorine

12. In which part of plants transpiration takes place?
(a) Stem
(b) Roots
(c) Leaves
(d) Both (a) and (c)

13. Which type of movement is shown by the leaves of *Oxalis*?
(a) Seismonastic (b) Sleeping
(c) Chemotropism (d) Thigmonastic

14. Which one of the following is a micronutrient?
(a) Ca (b) Mg
(c) N (d) Mn

15. First visible product of photosynthesis is
(a) glucose (b) sucrose
(c) cellulose (d) starch

16. Which type of movement is shown by *Mimosa pudica*?
(a) Rheotropism (b) Geotropism
(c) Seismonastic (d) Chemotropism

17. Which of the following equations represents photosynthesis?
(a) $C_6H_{12}O_6 \longrightarrow 6H_2CO_3$
(b) $6CO_2 + 12H_2O \longrightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$
(c) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 686$ kcal
(d) $C_6H_{10}O_5 + 6O_2 \longrightarrow 6CO_2 + 5H_2 + 674$ kcal

18. Which of the following organelles is site of photosynthesis?
(a) Chloroplast (b) Mitochondria
(c) Endoplasmic reticulum
(d) Golgi bodies

19. Which of the following is a growth inhibitor?
(a) Auxins (b) Ethylene
(c) GA (d) Cytokinins

20. Auxins were first isolated from
(a) corn germ oil (b) *Rhizopus*
(c) urine (d) *Avena* tip

21. Which is the precursor of IAA?
(a) Acetic acid
(b) Tryptophan amino acid
(c) Glycine amino acid
(d) Alanine amino acid

22. The chemical which perceives the photoperiodic stimulus in leaves is
(a) cytochrome (b) phytochrome
(c) auxins (d) vernalin

23. Which one is antigibberellin?
(a) Maleic hydrazide
(b) Phosphon-D
(c) Chlorocholine chloride
(d) All of the above

24. Phenomenon of bolting is caused by which plant hormone?
(a) Auxins (b) Gibberellin
(c) Cytokinins (d) Ethylene

25. Femaleness in plants is caused by
(a) auxins (b) cytokinins
(c) ethylene (d) All of these

26. Fluorene ring is feature of
(a) GA (b) ethylene
(c) morphactines (d) None of these

27. A natural growth inhibitor is
(a) ethylene (b) NAA
(c) 2, 4-D (d) benzaldehyde

28. Hormone involved in phototropism is
(a) IAA (b) GA_3
(c) kinetin (d) 2,4-D

29. Low temperature required for vernalisation is
(a) 20 - 30°C (b) 10 - 20°C
(c) 50 - 100°C (d) 0 - 5°C

30. Flowering in a short day plant is promoted by
(a) auxin (b) gibberellin
(c) ethylene (d) cytokinins

31. Optimum temperature for growth generally is
(a) 0 -10°C (b) 10 - 20°C
(c) 20 - 25°C (d) 20 - 30°C

32. The development of fruit without fertilisation is
(a) parthenogenesis
(b) parthenocarpy
(c) apomixis
(d) apogamy

33. Mango and guava plants are propagated through
(a) stem cuttings (b) layering
(c) grafting (d) tissue culture

34. Presence of many embryos is a characteristic feature of
(a) *Citrus* (b) mango
(c) banana (d) None of these

35. Stem cuttings are commonly used for the propagation of
(a) banana (b) rose
(c) mango (d) cotton

36. The development of embryo/seed from an egg without fertilisation
(a) parthenocarpy (b) parthenogenesis
(c) parthenogamy (d) apogamy

37. Vegetative reproduction by layering is found in
(a) jasmine (b) mango
(c) rose (d) All of these

38. Haploid plants can be obtained by culturing
(a) young leaves (b) endosperm
(c) pollen grains (d) root tips

39. The stem are used for the asexual reproduction of
(a) sugarcane (b) cotton
(c) banana (d) mango

40. Vegetative propagation in *Agave* is by
(a) sucker (b) stolon
(c) rhizome (d) bulbils

41. Tubers are used for vegetative reproduction in
(a) tomato (b) sweet potato
(c) onion (d) garlic

42. Which of the following develops into seed after fertilisation?
(a) Anther (b) Stigma
(c) Ovule (d) Stamen

43. The apical bud inhibits the growth of lateral buds, this process is called as
(a) bolting (b) apical dominance
(c) parthenocarpy (d) parthenogenesis

44. The sexual reproduction in plants was first reported by
(a) Nawaschin (b) Camerarius
(c) Hanstein (d) Amici

45. Double fertilisation is characteristic of
(a) algae (b) angiosperms
(c) gymnosperms (d) pteridophytes

46. The endosperm in gymnoperms is
(a) haploid (b) diploid
(c) triploid (d) tetraploid

47. The transfer of pollen grains from anther to stigma of the same flower is called
(a) geitonogamy (b) xenogamy
(c) autogamy (d) Both (b) and (c)

48. Growth can be measured by
(a) auxanometer (b) hydrometer
(c) barometer (d) spirometer

49. Endospermic nucleus is usually
(a) haploid (b) diploid
(c) triploid (d) tetraploid

50. Double fertilisation was discovered by
(a) Nawaschin (b) Strasburger
(c) Hofmeister (d) None of these

51. Which of the following is not true about asexual reproduction?
(a) It is most common form of reproduction.
(b) It is found in unicellular to multicellular organisms
(c) It involves formation of gametes
(d) It is the main mode of reproduction in lower organisms

52. Which of the following is not true about sexual reproduction?
(a) It is an adaptation for adverse conditions
(b) It involves formation and fusion of gametes
(c) It involves the development of sex organs
(d) It is a major mode of reproduction in lower organism

53. Which of the following is true about male reproductive part of flower?
(a) It is called megasporangium
(b) It produces egg cell
(c) It bears anther that produces pollen grains
(d) It has no role in reproduction

Directions (Q. Nos. 54-55) *The following questions consist of two statements one labelled Statement I and other labelled Statement II. Select the correct answers to these questions from the codes given below.*

Codes
(a) Both the statements are individually true and Statement II is the correct explanation of Statement I.
(b) Both the statements are individually true, but Statement II is not the correct explanation of Statement I.
(c) Statement I is true, but Statement II is false.
(d) Statement I is false, but Statement II is true.

54. **Statement I** Factors influencing the rate of photosynthesis are CO_2, light, water and temperature.

Statement II The rate of photosynthesis decreases with increase in temperature in the range from 5°C to 35°C.

55. **Statement I** Ascent of sap is transportation of soluble products from leaves to other plant part by phloem.

Statement II Ascent of sap occurs against the gravitational force.

56. Consider the following statements.

1. Sexual reproduction involves fusion of gametes.
2. Sexual reproduction is main mode of reproduction in angiosperm.

Which of the above statements is/are true?

(a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) Neither 1 nor 2

57. Consider the following kinds of organisms.

1. Bat 2. Bee
3. Bird

Which of the above is/are pollinating agent/agents.

(a) 1 and 2 (b) Only 2
(c) 1 and 3 (d) All of these

58. Consider the following statement.

1. Fission is a major mode of reproduction in *Amoeba*.
2. Fragmentation is found in bryophytes.

Which of the above statements is/are true?

(a) Only 1 (b) Both 1 and 2
(c) Only 2 (d) Neither 1 nor 2

59. Consider the following statements. Apical dominance in plants

1. allows plant growth.
2. retards the growth of lateral buds.
3. enhances the growth of lateral buds.

Which of these statement is/are correct?

(a) Only 1 (b) Only 2
(c) Only 3 (d) 1 and 2

60. Match the Column I with Column II and select the correct answer using the codes given below the column.

Column I (Types of pollination)	Column II (Pollinator)
A. Anemophily	1. Birds
B. Ornithophily	2. Insects
C. Entomophily	3. Wind
D. Chiropterophily	4 Water
	5. Bats

Codes

	A	B	C	D		A	B	C	D
(a)	1	3	4	5	(b)	3	1	2	5
(c)	3	1	4	2	(d)	1	3	4	2

61. Match the following columns.

Column I (Mode of reproduction)	Column II (Plants)
A. Vegetative propagation by leaves	1. Rubber, mango and guava
B. Stem cutting	2. *Bryophyllum and Begonia*
C. Grafting	3. Potato and Tapioca
D. Tissue culture	4. Sugarcane, rose and *Bougainvillea*

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	1	3	(b)	1	4	3	2
(c)	3	2	4	1	(d)	4	2	1	3

62. Which of the following is not a micronutrient for a plant? **2012 (I)**

(a) Iron (b) Magnesium
(c) Molybdenum (d) Manganese

63. Which one among the following hormones stimulates the plant cells to grow in a manner such that the plant appears to be bent towards light? **2013 (I)**

(a) Cytokinin (b) Auxin
(c) Gibberellin (d) Abscisic acid

64. Which of the following statements about sexual reproduction in flowering plants are correct? **2013 (I)**

1. Stamen is present in the centre of a flower.
2. Stamen produces pollen grains.
3. The swollen bottom part of carpel is the ovary.
4. The fusion of germ cells gives rise to zygote.

Select the correct answer using the codes given below

(a) 2, 3 and 4 (b) 2 and 4
(c) 1 and 3 (d) All of these

65. Which one among the following is a plant hormone? **2014 (II)**

(a) Insulin (b) Thyroxin
(c) Gibberellin (d) Oestrogen

66. Gametophytes of sexually reproducing flowering plants are **2015 (I)**

(a) haploid (b) diploid
(c) tetraploid (d) polyploid

67. The seeds of flowering plants are made up of **2015 (I)**

(a) ovary and ovary wall
(b) embryo, food reserves and seed coat
(c) cotyledons only
(d) zygotes only

68. In plants, which one of the following gases is released during photosynthesis? **2015 (I)**

(a) Carbon dioxide (b) Oxygen
(c) Hydrogen (d) Methane

69. Carbon and energy requirements of autotrophic organisms are fulfilled by **2015 (II)**

(a) photosynthesis (b) gluconeogenesis
(c) glycogenesis (d) external sources

70. **Statement I** Growth of plants is smooth with a complete fertiliser.

Statement II A complete fertiliser always contains N, P and K. **2015 (II)**

(a) Both the statements are individually true and Statement II is the correct explanation of Statement I
(b) Both the statements are individually true, but Statement II is not the correct explanation of Statement I
(c) Statement I is true, but Statement II is false
(d) Statement I is false, but Statement II is true

ANSWERS

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

06

HUMAN SYSTEM-I

Generally 5-6 questions are asked from this chapter. These questions are based upon muscles, blood circulatory system, digestive system and reproduction.

Human body is consists of different organs and organ systems. These organ systems include skeletal system, respiratory system, digestive system, etc. In this chapter we will study about all these systems and how they coordinate with each other, for various functions.

LOCOMOTORY SYSTEM

Locomotory system includes skeletal system and muscular system.

1. Skeletal System

Osteology is the study of bones. A human body consists of total 206 bones, while newly born baby have 300 bones.

Human skeleton is divided into two parts.

(i) **Axial Skeleton** It includes the bones of skull, vertebrae, ribs and sternum. It consists of total 80 bones.

Bones in Axial Skeleton

Bone	*Number*
Axial Skeleton	**Total bones are 80**
(a) Skull	29 (Cranium-8, Face-14, Hyoid- 01 and Ear ossicles-06)
(b) Vertebrae	26 (Sacrum-1, Coccyx–1 or Coccygeal-bone, Cervical-7, Thoracic-12 and Lumbar-5)
(c) Ribs	24 (12 on each side)
(d) Sternum	01

(ii) **Appendicular Skeleton** It consists of total 126 bones. It includes bones of girdles and arms and legs. Appendicular system is divided into upper extremity (64 bones) and lower extremity (62 bones).

Bone	*Number*
Appendicular Skeleton	**Total bones are 126**
I. Upper extremity	**Total bones are 64**
(a) Pectoral girdles	04 (two in each pectoral girdle)
(b) Upper arms	02
(c) Lower arms	04
(d) Wrists (carpals)	16
(e) Palm	10
(f) Fingers	28
II. Lower extremity	**Total bones are 62**
(a) Pelvic girdles	02 (one bone in each pelvic girdle)
(b) Thighs	02
(c) Knee caps	02
(d) Lower legs	04
(e) Ankles	14
(f) Soles	10
(g) Toes	28

- Bone is the hardest tissue.
- Osteoblasts are bone forming cells.
- Os Penis is a bone found in the penis of rodents.
- Femur is the longest bone, while stapes (a bone in ear ossicles) is the smallest bone.
- Fibula is the thinnest bone. Tibia is thin and shining bone.

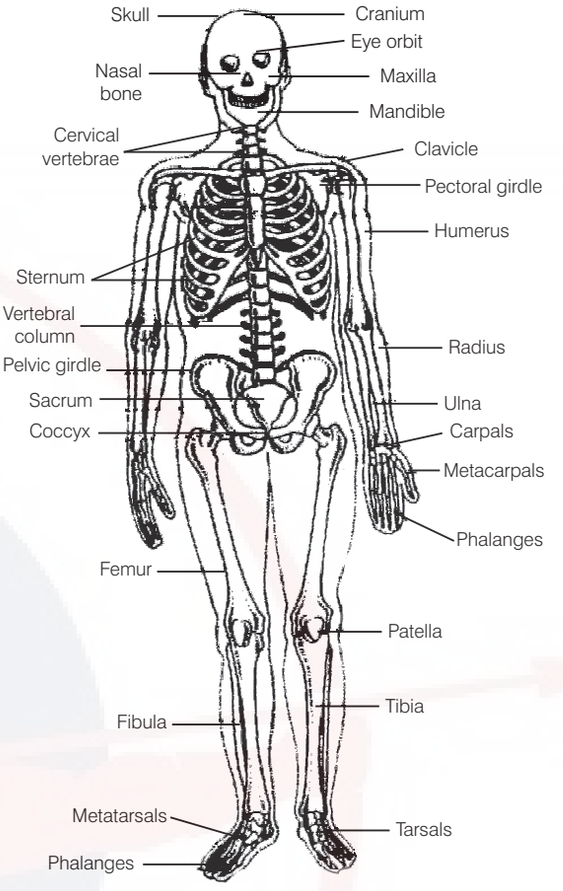
- Sternum is absent in fishes.
- Tibia fibula is the longest bone of frog.
- Funny bone (ulna) is a bone found in bend of the elbow.
- Spondylitis is the inflammation of vertebrae.
- Arteries of ancient mummies remain intact due to well-preserved fibroblast fibres.
- Synovitis is an inflammation leading to swelling at joint.
- Chondrology is the study of cartilages.
- Fibro cartilage is the strongest cartilage.
- Skeleton have 12 pairs of ribs in human.
- True ribs are first seven pairs of ribs, while 8th, 9th and 10th pairs are false ribs and last two pairs (11th and 12th) are known as floating ribs.
- Cartilage of ear lobes have less blood supply. Tendons and ligaments are dense connective tissues. They are made up of collagen and elastic yellow fibre, respectively.
- Tendon connects skeletal muscles to bones.
- Ligament attaches one bone to another bone, it is highly flexible and contains very little matrix.
- Bone marrow is absent in birds, but in human, it is the site of production of blood cells in some bones.

2. Muscular System

Muscles contribute most of the total weight of the body (about 40%).

- Muscles are helpful in locomotion and movement.
- The study of muscles is called as **Myology**.
- Muscles have glycogen (polysaccharide), which are used to obtain energy.
- Muscle tissues are of three types, i.e. striated, non-striated and cardiac. We have studied about muscles in chapter-4.
- Muscles have proteins, which are myoglobin, actin, myosin, etc.
- Muscles of face contract slowly, but can remain contracted for a longer time.
- Lactic acid is a chemical, which is responsible for fatigue after muscular activity in human beings.
- Lactic acid accumulates in muscles due to anaerobic respiration.
- Myograph instrument is used to record single muscle twitch.
- Cori's cycle is relationship between muscles glycogen and liver glycogen through lactic acid.
- Motor unit acts as an independent unit of muscle.
- Ca^{+2} and Mg^{+2} are required for muscle contraction.
- Myostasis is inflammation of a muscle.

The structure of human skeletal system is as follows



Structure of human skeleton

Joints

A joint is the meeting place of two bones. Arthrology is the study of joints.

Joints can be classified into following three types

(i) Immovable Joints (Fibrous or Synarthrose Joints)

- In these, the adjoining bones are joined by strong bundles of collagen fibres, so that the bones cannot move freely.
- The bones of the skull articulate with one another in a type of immovable joint called **suture**, e.g.
  (a) Articulation of teeth with mandible and maxillae. Here, peg-shaped roots fit into cone-shaped sockets in the jawbones.
  (b) Articulation between the first pair of ribs and the breast bone.

(ii) **Slightly Movable** (Cartilaginous Joints)

In these joints, there is a pad of fibro-cartilage between two adjoining bones, which allows for very slight movements. These are also called **symphysis**, e.g. joints between pubic bones of pelvic girdles and the joints between the vertebrae (intervertebral disc).

(iii) **Freely Movable** (Synovial Joints)

In these joints, the movement is possible in one or other directions. These are of following types

(a) Ball and socket between humerus and glenoid cavity of pectoral girdle, femur and pelvic girdle.
(b) Hinge joint between knee, ankle, elbow, phalanges of digits.
(c) Pivot joint between atlas and axis of mammals.
(d) Saddle joint between metacarpal and carpal of thumb.
(e) Gliding joint between radio-ulna and carpals.
(f) Ellipsoidal joint between skull and first vertebra.

RESPIRATORY SYSTEM

Structurally and functionally the conducting part of human respiratory system is highly complicated. The respiratory system is derived from embryonic endoderm.

The respiratory system includes respiratory organs and conducting organs. The main respiratory organs of humans are lungs. The lungs and related structures together constitute the respiratory system of humans.

Respiratory Organs

- Lungs acts as the major respiratory organs.
- Each lung is covered by double membrane called **pleurae**.
- In human, the right lung has three lobes and left lung has two lobes.
- The alveoli are the ultimate structural and physiological units of lung.
- Alveoli provide great surface area (like villi of intestine in mammals) for gaseous exchange by diffusion.
- Gaseous exchange occurs across the respiratory membrane of the alveoli.
- Residual air of lungs can be traced in alveoli.
- The diaphragm is a dome-shaped muscular structure separating the thoracic and abdominal cavities.
- The diaphragm is characteristic of mammals.

Conducting Organs

Conducting organs conduct air to lungs. These are as follows

(i) **Nostrils** Holes of the nose are called **nostrils**, these are paired openings that open up into the nasal chambers.

There are two nasal chambers separated by the nasal septum. Each nasal chamber consists of three regions, i.e. vestibular, respiratory and olfactory regions.

It consists of many goblet cells.

(ii) **Pharynx** It provides passage to both air and food.

(iii) **Larynx** It is the uppermost portion of trachea made up of cartilages in humans. It is also called as **voice box**.

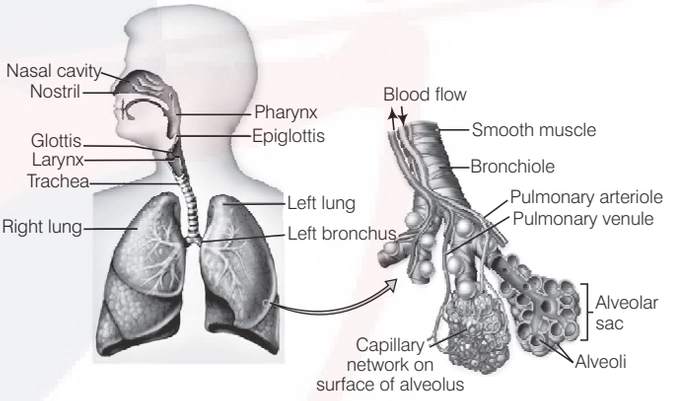
Human larynx consists of glottis, cartilages, hyoid bone, thyrohyoid membrane, vocal cords, laryngeal ligaments and muscles. **Glottis** is an opening in the floor of pharynx leading to larynx. There are nine pieces of cartilages (3 are single and 3 are paired).

There is a little difference in the size of the larynx in man and woman. It grows larger and becomes prominent in man, therefore it is called **adam's apple** in man.

(iv) **Trachea** The trachea or windpipe is a continuation of the larynx. Trachea is supported by incomplete (C-shaped) rings of hyaline cartilages.

(v) **Bronchus** These are one pair of small, thin-walled tubular structures formed by the division of trachea at the level of 5th thoracic vertebra.

(vi) **Bronchiole** The tertiary bronchi is subdivided into smaller branches called **bronchioles**. Bronchioles can enter into group of alveoli by means of their edges. Each group consists of air sacs.



Human respiratory system

Respiration

It is the process by which gases are exchanged between the blood and the air. It is a physical process. It is simply the intake of oxygen and giving out of carbon dioxide. It includes inspiration and expiration.

Inspiration

- It is a process, by which fresh air enters in the lungs.
- In this, diaphragm becomes flat and gets lowered by the contraction of its muscle fibres and increases the volume of thoracic cavity.
- The external intercostal muscles contract and pull the ribs and sternum upwards and outwards direction and thus, the volume of thoracic cavity is increased.

Expiration

- It is a process, by which CO_2 is expelled out from the lungs.
- Muscle fibres of the diaphragm relax make it convex, decreasing the volume of the thoracic cavity.
- External intercostal muscles relax and pull the ribs downwards and inwards direction, thus decreasing the size of the thoracic cavity.
- 12-15 times in a minute.
- Newborns breath 40 times per minute.
- Respiration rate is minimum while sleeping.
- The air passage in humans occurs in following manner

  Nasal chamber → Pharynx → Voice box → Trachea
  Blood ← Cells ← Air sac ← Bronchiole ← Bronchus

Respiratory Volume and Capacity for Males and Females

Measurement	Adult Male Average Value	Adult Female Average Value	Description
		Respiratory Volumes	
Tidal Volume (TV)	500 mL	500 mL	Amount of air inhaled or exhaled with each breath under resting conditions.
Expiratory Reserve Volume (ERV)	1200 mL	700 mL	Amount of air that can be forcefully exhaled after a normal tidal volume exhalation.
Inspiratory Reserve Volume (IRV)	3100 mL	1900 mL	Amount of air that can be forcefully inhaled after a normal tidal volume inhalation.
Residual Volume (RV)	1200 mL	1100 mL	Amount of air remaining in the lungs after a forced exhalation.
		Respiratory Capacities	
Inspiratory Capacity (IC)	3600 mL	2400 mL	Maximum amount of air that can be inspired after a normal expiration, IC = TV + IRV
Functional Residual Capacity (FRC)	2400 mL	1800 mL	Volume of air remaining in the lungs after a normal tidal volume expiration, FRC = ERV + RV
Total Lung Capacity (TLC)	6000 mL	4200 mL	Maximum amount of air contained in lungs after a maximum inspiratory effort, TLC = TV + IRV + ERV + RV
Vital Capacity (VC)	4800 mL	3100 mL	Maximum amount of air that can be expired after a maximum inspiratory effort, VC = TV + IRV + ERV (should be 80% TLC)

DIGESTIVE SYSTEM

Digestion is the process, in which complex, non-diffusible food gets converted into simple diffusible food particles with the help of digestive enzymes, e.g. proteins are broken down into amino acids. It consists of following parts

Alimentary Canal

It is also called **gut** and starts from mouth to anus. Parts of gut are as follows

(i) Mouth or Buccal Cavity

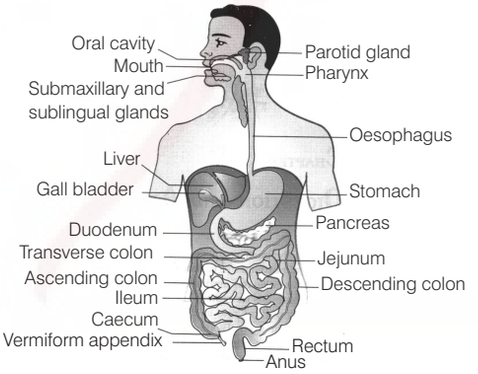
It has following parts

(a) Palate forms the roof of mouth and separates mouth from nasal chamber.

(b) Tongue is muscular and also bears taste buds to perceive the taste of food.
- It's anterior part is sensitive to sweet taste.
- Saliva secreted from buccal cavity contains enzymes salivary amylase (ptyalin) and lysozyme (which kills the bacteria).

(c) Teeth are set in tooth sockets on jaws and are of four types, i.e. incisors (cutting teeth), canines (tearing teeth), premolars and molars (grinding teeth).
- An adult has 16 teeth on each jaw.
- In each half of jaws starting from middle to backward there are incisors-2, canine-1, premolar-2, molars-3, (2 + 1 + 2 + 3).
- Dental formula in human is 2123/2123.
- A tooth is made up of bone-like material called **dentine**.
- A tooth is covered by a white shining material called **enamel**.

- Enamel is the hardest part of our body.



Digestive system of human

- Last molars are called **wisdom teeth**.
- Canines are absent in rabbit and squirrel.
- Milk teeth start erupting after 6 months of birth and appear between 6-24 months.
- Dental formula of milk teeth is 2102/2102.

(ii) Pharynx

- It is small sized (12-14 cm), conical part, where food and air passages cross each other.
- It is divided into three parts, i.e. nasopharynx (lies behind the nasal chambers), oropharynx (lies behind the buccal cavity) and laryngopharynx (lowest part of pharynx).

(iii) Oesophagus

- It is a long (22-25 cm) narrow, muscular and tubular structure.
- It has longitudinal folds, the oesophageal rugae, which prevent the entry of air in it.
- It conducts the food to stomach by peristalsis.

(iv) Stomach

- It acts as a temporary reservoir, which churns the food material. Food after getting churned in stomach is called **chyme**.
- Stomach secretes gastric juice containing HCl and pepsin (enzyme).
- HCl helps in digestion of food.
- Digestion of protein takes place in stomach and small intestine.
- Stomach mixes food with gastric juice.
- It secretes lipase and amylase in gastric juice.
- Lipase and amylase act on fats and starch (or other sugars), respectively.
- The stomach of ruminant animals is consist of four chambers, i.e. rumen, reticulum, omasum and abomasum.

(v) Small Intestine

- It is the longest part (about 2 ft or 6 metre) of alimentary canal.
- It is divided into three parts, i.e. duodenum (situated nearest to stomach), jejunum and ileum.
- Duodenum receives the bile-pancreatic duct.
- Inner mucosa of small intestine have finger-like projections called **villi**.
- Villi and microvilli increase the surface area of digestion and absorption of food.
- Pancreatic duct have few enzymes, which act on carbohydrates, fats and proteins.
- Ileum absorbs the fatty acids. Maximum food absorption takes place in ileum only.
- Complete digestion of proteins, fats and carbohydrates occurs in small intestine.

(vi) Large Intestine

- It consists of three parts, i.e. caecum, colon and rectum.
- In some herbivores (like horse and ass), caecum is large and is a site of microbial digestion of cellulose.
- In man, caecum is very small vestigial organ and is called **appendix**. In colon, water is reabsorbed.
- Large intestine does not secrete enzyme.
- Absorption of food and excess water from undigested food is carried out in large intestine.

Digestive Glands

These secrete digestive juices for the digestion of food. These are of four types

1. Salivary Gland

It produces saliva. Salivary glands secrete salivary amylase (ptyalin), which converts the starch into maltose. These are of four types

(i) **Parotid glands** Largest glands present just below the external ear. In these glands, virus causes mumps disease.

(ii) **Submaxillary glands** These lie beneath the jaw-angles.

(iii) **Sublingual glands** Smallest glands, which lie beneath the tongue and open at the floor of buccal cavity.

(iv) **Zygomatic glands** These lie beneath eyes.

2. Gastric Gland

It is present in the mucosa of the stomach.

These are of three types

(i) **Cardiac glands** secrete an alkaline mucus.

(ii) **Pyloric glands** secrete an alkaline mucus.

(iii) **Fundic glands** each gland has four types of cells.

(a) **Peptic/zymogen cells** secrete pepsinogen for dry digestion of proteins.

(b) **Oxyntic cells** secrete HCl.

(c) **Goblet cells** secrete mucus.

(d) **Argentaffin cells** secrete gastrin hormone.

3. Liver

- It is the largest gland and consists of a large right lobe, a small left lobe and two small lobes called **quadrate lobe** and caudate lobe behind the main lobes.
- On the right lobe lies gall bladder, which stores bile juice secreted by the liver.
- Bile juice contains no enzyme, but possesses bile salts and bile pigments (bilirubin-yellow and biliverdin-green).
- Bile juice (acids) are steroid.
- Liver also has some phagocytic cells in between hepatic cells called **Kupffer's cells** to engulf bacteria and foreign substances.
- Liver is helpful in blood clotting, formation of glycogen, regulation of blood sugar as reserved food, synthesis of vitamin-A and storage of some minerals and vitamins.
- Glycogen reserves are utilised in human body for obtaining energy.
- Liver breaks fat to produce cholesterol. It helps in the deamination of amino acids and ammonia into urea.

4. Pancreas

It functions both as an exocrine and endocrine gland.
It secretes amylase, trypsin and chymotrypsin, carboxypeptidase, lipase and nucleases in the digestive system.

It secretes pancreatic juice, which is helpful in digestion of both starch and proteins.

CIRCULATORY SYSTEM

- Circulatory system was discovered by **William Harvey** (1628).
- Circulatory system can be either of open type or closed type.
- In open circulatory system, blood does not flow in vessels.
- The circulatory system consists of heart and blood vessels.

Heart

The heart is a hollow, fibromuscular organ of somewhat conical or pyramidal form with upper broad part, the base and the lower narrow apex, which is slightly directed to the left.

Structure of Heart

- Human heart is situated in the pericardial cavity.
- The heart wall is made of three layers, i.e. pericardium, myocardium and endothelium.
- Pericardial fluid is the fluid present between layers of heart wall. It allows frictionless movements of heart and protects it from mechanical shocks.
- In males, weight of heart is about 280-340 g. While in females it is 230-280 g.
- Weight of heart of a newborn baby is 20 g.
- Human heart is consist of two atrium and two ventricles.

(i) Right Auricle or Atrium

- It receives deoxygenated blood from superior vena cava and inferior vena cava.
- Right auricle opens in right ventricle through a wide circular right auriculoventricular aperture guarded by tricuspid valve.
- Tricuspid valve regulates unidirectional flow of blood from right auricle to right ventricle.

(ii) Right Ventricle

It gives off a large blood vessel called **pulmonary artery** leading to the lungs, which carries deoxygenated blood to the lungs. Semilunar valve stops blood to return back to ventricle.

(iii) Left Auricle or Atrium

- It receives oxygenated blood from lungs through pulmonary veins.
- They have no valve.
- Left auricle opens in left ventricle by an aperture called **left auriculoventricular aperture**.
- This aperture is guarded by bicuspid valve (mitral valve).
- Bicuspid valve prevents backflow of blood from left auricle to left ventricle.

(iv) Left Ventricle

- It gives off a large blood vessels called the **aorta**.
- Aorta carries oxygenated blood to various body parts.
- The thickest part of the human heart is the wall of the left ventricle.

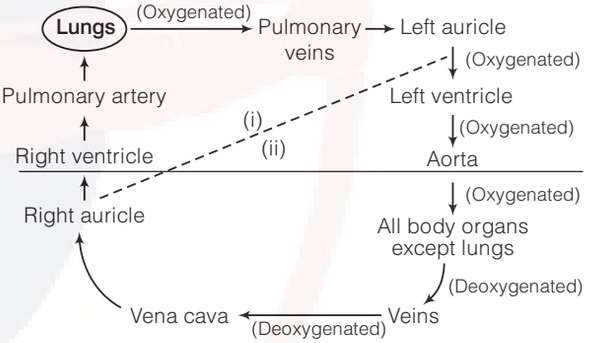
Circulation of Blood

Blood circulation in humans is an example of double circulation. It includes pulmonary circulation and systemic circulation.

(i) **Pulmonary Circulation** In this type of circulation, the deoxygenated blood is pushed by the right ventricle to the lungs for oxygenation through pulmonary artery. The oxygenated blood is brought back to left atrium of heart through pulmonary vein.

(ii) **Systemic Circulation** In this type of circulation, the oxygenated blood brought to left atrium goes to left ventricle and then passed on to different body parts through aorta.

Following diagram shows both pulmonary and systemic circulation



Double circulation

Cardiac Cycle

- The study of structure and functioning of heart is called as **cardiology**.
- Heart constantly contracts or relaxes, due to which transportation of blood occurs in the whole body.
- Cardiac cycle is the event, during which one heartbeat or one cycle of systole and diastole of cardiac muscle occurs.
- Cardiac cycle consists of systole and diastole of atria and ventricles.
- The cardiac impulse starts from SA node, than *via* a conducting system, this impulse is conducted to all parts of heart.
- SA node is called as the **pacemaker of heart**.
- Rate of heartbeat in humans is 72-75 per minute.
- One cardiac cycle takes 0.8 seconds.

Heart Sounds

The beating of heart produces sounds, heard by stethoscope.

First sound (lubb) is a long and louder sound created by the closure of atrioventricular valves (tricuspid and bicuspid) at the beginning of ventricular systole.

Second sound (dupp) is a short and sharper sound created by the closure of semilunar valves towards the end of ventricular systole (beginning of ventricular diastole).

Cardiac Output

It is the amount of blood pumped by the heart per minute. Cardiac output = Normal heart rate of an adult per min × Amount of blood pumped by heart per min

$= 72 \times 70 = 5040$ mL per min (5 L/min).

Blood Vessels

In circulatory system, oxygenated and deoxygenated blood is transported to different body parts through different vessels namely arteries, veins and capillaries.

Differences between Arteries and Veins

Arteries	*Veins*
Arteries distribute blood from the heart to the different parts of the body.	Veins collect blood from different parts of the body and pour it into the heart.
Tunica media is thick, having more muscle fibres.	Tunica media is thin, having fewer muscle fibres.
Tunica interna has strong elastic membrane and more elongated endothelial cells.	Tunica interna has simple, elastic membrane and elongated endothelial cells.
The walls of the arteries are thick and muscular and hence, are non- collapsable.	The walls of the veins are thin and non-muscular and hence, are collapsable.
Arteries have no valves.	Veins have valves, which prevent backward flow of blood.

EXCRETORY SYSTEM

The process of elimination of metabolic wastes from the body is called **excretion**.

Removal of excess of water from the body or keep water content constant is called **osmoregulation**.

Depending on the type of waste, nitrogen elimination is of three types

(i) **Ammonotelism** is the elimination of nitrogen mainly in the form of ammonia, e.g. aquatic invertebrates, bony fishes and amphibians.

(ii) **Ureotelism** is the removal of nitrogen mainly as urea. Ammonia combines with CO_2 in liver to form urea, e.g. mammals, man, frogs, toads.

(iii) **Uricotelism** is the elimination of nitrogen mainly as uric acid, e.g. birds, reptiles, many insects.

Uric acid is commercially extracted from bird dropping.

Excretory Organs of Invertebrates

- Flame cells are the organs of excretion in tapeworm.
- Sponges remove their wastes through their water canal system.
- In *Hydra*, cells release waste into coelenteron.
- In annelids, excretion takes place by nephridia.
- In insects, excretion takes place by Malpighian tubules.
- In some arthropods (prawns), green glands also help in excretion.
- Waste material in *Amoeba* is taken out by plasmalemma.
- Spiders have coxal glands.

Excretory System of Human

Excretory system of human consists of following organs

1. Kidney

- Kidney is a paired bean-shaped organ, that is present in abdomen just below the diaphragm.
- The left kidney is placed a little higher than the right kidney (reverse in rabbit).
- Concavity of kideny called **hilus** is always inwardly directed.
- They form urine and drain it ultimately into pelvis of the kidney from where the ureter arises.
- Water reabsorption in kidney is controlled by a hormone called **ADH**.
- In anuria, kidneys become unable to form urine.

Nephron

- It is the functional unit of kidney.
- In one kidney around 1 million nephrons are found.

It has two parts

(i) Bowman's Capsule

(a) It has a network of blood capillaries called **glomerulus**, which together form Malpighian body.

(b) Blood enters glomerular capillaries through afferent arteriole and leaves through efferent arteriole.

(ii) Renal Tubule

It consists of three parts

(a) Proximal Convoluted Tubule (PCT).

(b) Loop of Henle with thin descending and thick ascending limb.

(c) Distal Convoluted Tubule (DCT), which opens into collecting duct.

- Skin excretes mainly water and NaCl in sweat. Evaporation of sweat requires latent heat from the body due to which body feels cool. This is known as perspiration.
- Lungs excrete CO_2 and some water vapour. Liver excretes bile pigments and cholesterol in the bile.

2. Ureters

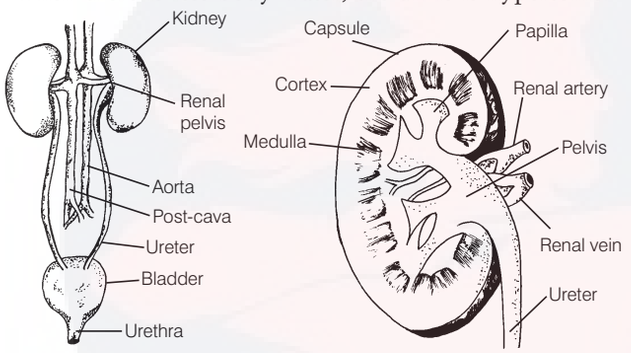
This muscular tube emerges out from the hilum of kidneys. Urine enters the ureter from the renal pelvis.

3. Urinary bladder

Sac-like structure, which stores urine temporarily. It is absent in birds.

4. Urethra

- Membranous tube, which conducts urine to the exterior. Urethral sphincters keep the urethra closed except during voiding of urine.
- The act of voiding urine is called **micturition**.
- An adult man secretes 1-1.8 L of urine in 24 hours.
- The yellow colour of urine is due to the presence of the pigment urochrome. pH of urine should be 5.8.
- When water intake is high, the urine is hypotonic.
- When there is less body water, the urine is hypertonic.



Structure of kidney

REPRODUCTIVE SYSTEM

A process by which living organisms produce young ones of their own types is called **reproduction**.

It includes asexual and sexual reproduction.

- **Asexual reproduction** occurs without the formation and union of sex cells, e.g. budding (*Hydra*), binary fission (*Amoeba*) and multiple fission (malaria parasite).
- **Sexual reproduction** includes fusion of male and female gametes.

Male Reproductive System

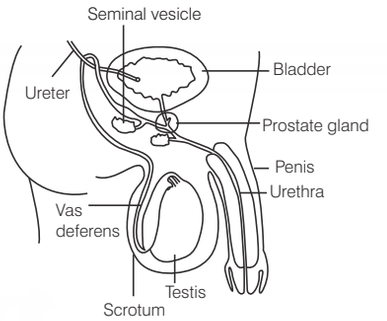
Parts of male reproductive system are as follows

Testes

- A pair of glandular, oval-shaped organs present in scrotum.
- Temperature of scrotum is 2°C below the body temperature.
- Endocrine tissues of testes produce testosterone.
- Seminiferous tubules are the structural and functional unit of testes.
- In seminiferous tubules, spermatogenic cells are present, which produce sperm cells. Sertoli cells provide nutrition to sperm cells. Leydig's cells in testes secrete testosterone.

Vas Deferens

- Vas deferens is a term used for ducts extending from the epididymis to the ejaculatory ducts.
- These store spermatozoa temporarily and transport them during ejaculation.
- Removal of vas deferens is called vasectomy.



Male reproductive system

Urethra

It is a thick-walled muscular duct and it is a common passage for both urine and semen. It is also called **urinogenital duct**. It traverses and opens at the tip of the penis.

Penis

It is erectile copulatory organ. It helps in deposition of sperms into female genital tract.

Accessory Sex Glands

Different types of accessory sex glands are as follows

(i) Seminal Vesicle

- Seminal vesicles (uterus masculinus) are situated behind the urinary bladder.
- About 70% of the semen in seminal fluid is produced by seminal vesicles. Seminal fluid contains fructose, (energy source for sperm) citrate, inositol, prostaglandins and several proteins.
- The product of the testes (spermatozoa) and prostate gland along with the fluid from the seminal vesicle are collectively known as semen. Seminal fluid has a pH of about 7.4.

(ii) Prostate Gland

- Prostate is situated around the first part of the urethra.
- Prostate gland secretes a thin, milky fluid that contains calcium, citrate ion, phosphate ion, a clotting enzyme and a profibrinolysin called as **semen**.
- Enlargement of prostate results in prostatitis, in which urination is difficult or impossible.

(iii) Cowper's Gland

It is also known as bulbourethral glands are found in male mammal. The secretion of Cowper's glands act as lubricant for the glans penis. It also neutralises any urine in urethra.

Path of Sperms in Mammals

Seminiferous tubules → Rete testis → Vas efferentia → Epididymis → Vas deferens → Urethra → Vagina

Female Reproductive System

Parts of female reproductive system are as follows

Ovaries

Ovaries are primary sex organs present in upper pelvic cavity on both lateral sides of uterus. It produces ova and sex hormone progesterone and oesterogen.

Fallopian Tube (Oviducts)

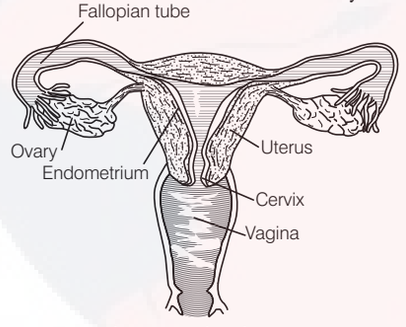
- It extends from ovary to the uterus.
- It conducts egg and provides site for fertilisation.
- Tubectomy is the removal of Fallopian tube.

Uterus

- It is situated above and behind the urinary bladder and remains attached to the body wall by ligaments.
- The wall of uterus is composed of smooth muscle fibres called **myometrium**. Lumen of the uterus is lined by a mucous membrane called **endometrium**.
- It receives ova or egg.
- In uterus, foetus gets attached by placenta.

Vagina

- It opens to the exterior between the urethra and the anus.
- It receives semen from penis during mating.
- It serves as birth canal at the time of baby birth.



Female reproductive system

Accessory Sex Glands

Different types of accessory sex glands are as follows

(i) Bartholin's Gland (Vestibular Gland)

Occurs in female mammals and helps in vestibular lubrication. Bartholin's gland of female corresponds to bulbourethral gland (Cowper's gland) of the male.

(ii) Mammary Glands

The mammary glands are modified sweat glands. Production of milk in mammary glands is stimulated by the hormone prolactin, which is secreted by anterior part of pituitary gland, while the ejection of milk into the ducts of mammary glands is stimulated by the hormone oxytocin, which is secreted by posterior part of pituitary gland.

Gametogenesis

- It is the process of formation of gametes in gonads.
- It includes spermatogenesis and oogenesis.
- Spermatogenesis is the formation of sperms. Oogenesis is the formation of eggs (ovum).
- Gametogenesis is controlled by gonadotropic hormones (FSH, LH, ICSH, etc.) secreted by pituitary gland.

Menstrual Cycle

- These are cyclic changes occur in the uterus, extending approximately a month period (mesum).
- Menstrual cycle has three phases, i.e. proliferative, secretory and menstrual phase.

(i) Proliferative Phase

- FSH stimulates follicle to secrete oestrogen.
- This phase has duration of 10-12 days.
- It is also called **follicular phase**.

(ii) Secretory Phase

- Corpus luteum secretes progesterone.
- This phase has duration of 12-14 days.
- Discharge of ovum from Graafian follicle is known as ovulation. It takes place at 14th day of menstrual cycle under the control of LH.

(iii) Menstrual Phase

- If ovum is not fertilised, the corpus luteum degenerates causing sudden fall in the progesterone level.
- Breakdown of endometrium takes place, which results in discharge of blood.
- It is controlled by FSH, LH, oestrogen and progesterone.
- The menstrual cycle and menstruation normally remains suspended during pregnancy and lactation.

Menopause

- Ovulation and menstrual cycle are stopped permanently.
- It occurs around 45-50 years of age.
- In this stage, women lose the ability to reproduce.

- The sex of a newborn baby is determined by the chromosome inherited from father's sperm as it can contain either from the two chromosomes XY, while mother has only XX-chromosomes.
- **Amniocentesis** A technique to detect the chromosomal abnormalities, if any, in the developing foetus by analysing the cells present in the amniotic fluid.
- **Population explosion** Enormous increase in population in a short span of time.
- **Test tube baby** A baby born from the ovum fertilised *in vitro* and then implanted in the woman's uterus.

PRACTICE EXERCISE

1. In which part of our body osteoblasts are found?
(a) Blood (b) Muscle
(c) Bone (d) Cartilage

2. Which of the following is depicted by bile juice?
(a) Bile salts (b) No enzymes
(c) Bile pigments (d) All of these

3. Gastrin hormone is secreted by
(a) goblet cells (b) oxyntic
(c) argentaffin cells (d) zymogen cells

4. Which one among the following is the nature of bile acids?
(a) Carbohydrates (b) Steroides
(c) Proteins (d) Vitamins

5. In which part of alimentary canal fatty acids are absorbed?
(a) Duodenum (b) Oesophagous
(c) Ileum (d) Stomach

6. The largest gland in the human body is
(a) gall bladder (b) liver
(c) pancreas (d) brain

7. In ruminants, cellulose is digested by
(a) worms (b) symbiotic bacteria
(c) enzyme (d) protozoans

8. Food after getting churned in stomach is called
(a) bolus (b) chyle
(c) chyme (d) None of these

9. The contraction of gall bladder is due to
(a) gastrin (b) secretin
(c) cholecystokinin (d) enterogasterone

10. Which one is secreted by oxyntic cell?
(a) HCl (b) NaOH
(c) Pepsin (d) Trypsin

11. Maximum food absorption takes place in
(a) ileum (b) colon
(c) rectum (d) stomach

12. Which type of vitamin is stored by liver?
(a) D (b) A
(c) K (d) All of these

13. Digestion of both starch and protein is done by
(a) gastric lipase (b) gastric juice
(c) pancreatic juice (d) ptyalin enzyme

14. Which of the salivary glands are smallest?
(a) Parotid (b) Sublingual
(c) Submaxillary (d) Both (a) and (c)

15. Which enzymes are present in saliva?
(a) Pepsin (b) Ptyalin
(c) Trypsin (d) Rennin

16. Major part of digestion is completed in
(a) mouth (b) stomach
(c) small intestine (d) large intestine

17. Stage when lung collapsed, specially the alveoli is
(a) atelactasis (b) poliomyelitis
(c) asthma (d) epistasis

18. In which animals pouched gills are found?
(a) Fishes (b) Cyclostomes
(c) Amphibians (d) Aquatic mammals

19. Which of the following is represented by true ribs?
(a) First seven pairs of ribs
(b) False ribs
(c) Last two pairs of ribs
(d) Floating ribs

20. Which of the following part of intestine is situated near to the stomach?
(a) Ileum (b) Duodenum
(c) Caecum (d) Rectum

21. In which, residual air can be traced?
(a) Alveoli (b) Bronchi
(c) Nasal chambers (d) Trachea

22. Which of the following is the ultimate structural and physiological units of lungs?
(a) Trachea (b) Bronchi
(c) Alveoli (d) Bronchioles

23. Which of the following is called as voice box?
(a) Glottis (b) Epiglottis
(c) Larynx (d) Vocal cord

24. Which of the following is called as windpipe?
(a) Trachea (b) Epiglottis
(c) Food pipe (d) Glottis

25. Diaphragm is supplied by
(a) optic nerves (b) phrenic nerves
(c) trigeminal nerves
(d) vagus nerves

26. The thickest part of the human heart is the wall of
(a) left auricle (b) right auricle
(c) left ventricle (d) right ventricle

27. Heartbeat is initiated in man by
(a) SA node (b) Purkinje fibres
(c) AV node (d) bundle of His

28. The number of bones in ribs of human beings
(a) 13 on each side (b) 24
(c) 50 (d) 35

29. Which one is a characteristic of human heart?
(a) two-chambered
(b) three-chambered
(c) four-chambered
(d) None of the above

30. The anterior part of the tongue is most sensitive to
(a) salty (b) sweet (c) bitter (d) sour

31. Which one is the functional unit of kidney?
(a) Nephron (b) Nephritis
(c) Neuron (d) Loop of Henle

32. The yellow colour of urine is due to
(a) urochrome (b) bilirubin
(c) biliverdin (d) xanthophyll

33. Water reabsorption in kidney is controlled by
(a) GH (b) ADH
(c) oxytocin (d) aldosterone

34. Green glands, present in some arthropods help in
(a) respiration (b) excretion
(c) digestion (d) reproduction

35. A condition of failure of kidney to form urine is called
(a) deamination (b) entropy
(c) anuria (d) None of these

36. The joint between skull and first vertebra is
(a) pivot joint (b) hinge joint
(c) ball and socket joint
(d) ellipsoidal joint

37. Waste material in *Amoeba* is taken out by
(a) plasmalemma (b) Malpighian tubule
(c) nephron (d) vacuole

38. The excretory product of birds and reptiles is
(a) urea (b) ammonia
(c) uric acid (d) TMV

39. Ammonia is converted into urea in
(a) liver (b) stomach
(c) pancreas (d) intestine

40. Sweating from body is related to
(a) thermal regulation
(b) water regulation (c) excretion of salts
(d) All of the above

41. The acid in gastric juice is
(a) acetic acid (b) nitric acid
(c) hydrochloric acid
(d) sulphuric acid

42. Which one among the following organs breaks fat to produce cholesterol?
(a) Intestine (b) Liver
(c) Kidney (d) Lungs

43. Which one among the following statements are correct? **2012 (I)**
I. Ligaments are very flexible.
II. Ligaments connect muscles and bones.
III. Ligaments contain very little matrix.
Choose correct answer from given codes.
(a) Only I (b) I and III
(c) II and III (d) All of these

44. Which one of the following statements is correct? **2012 (II)**
(a) All arteries carry oxygenated blood
(b) All veins carry oxygenated blood
(c) Except pulmonary artery, all arteries carry oxygenated blood
(d) Except pulmonary vein, all veins carry oxygenated blood

45. Which one among the following statements is correct? In digestive system of living organisms, **2012 (II)**
(a) glucose is broken down into glycerol
(b) glucose is converted into glycogen
(c) glucose is broken down into carbon dioxide and water
(d) proteins are broken down into amino acids

46. Which one among the following is the hardest part of our body?
(a) Skull bones of head **2012 (II)**
(b) Thumb nails (c) Enamel of teeth
(d) Spinal vertebra

47. The process of conventional earlobe piercing does not lead to bleeding. This is because the **2012 (II)**
(a) heart does not supply blood to earlobes
(b) cartilage found in earlobe has lesser blood supply unlike other body parts
(c) earlobes consist of dead nondividing tissues
(d) needle used for ear piercing is sterilised

48. Which acid is present in pancreatic juice? **2013 (I)**
(a) Acetic acid (b) Nitric acid
(c) HCl (d) Sulfuric acid

49. The sex of a newborn baby is determined by the chromosome inherited from the **2013 (I)**
(a) mother (b) father
(c) mother's mother (d) father's father

50. The complete digestion of carbohydrates, proteins and fats occurs in **2013 (I)**
(a) stomach (b) liver
(c) small intestine (d) large intestine

51. Which one among the following substances is never excreted out through urine under normal circumstances in any healthy individual? **2013 (II)**
(a) Urea (b) Sodium
(c) Amino acid (d) Potassium

52. Muscles of which one among the following body parts contract slowly, but can remain contracted for a longer time? **2013 (II)**
(a) Face (b) Arms
(c) Intestine (d) Legs

53. Which one of the following is not a function of liver? **2014 (II)**
(a) Conversion of glucose into glycogen
(b) Production of urea
(c) Destruction of dead and worn out red blood cells
(d) Absorption of food and excess water from the undigested food

54. Which one of the following is not a part of female reproductive system? **2014 (II)**
(a) Fallopian tube (b) Cervix
(c) Urethra (d) Vagina

55. Energy is essential for the continuity of life. Energy is obtained by which one of the following events? **2015 (I)**
(a) Metabolism
(b) Phagocytosis
(c) Photorespiration
(d) Decomposition

56. Perspiration cools the body because **2015 (I)**
(a) the presence of water on the skin is cooling
(b) evaporation requires latent heat
(c) water has a high specific heat
(d) water is a poor conductor of heat

57. 'Lubb-dupp' sound is produced due to the action of **2015 (I)**
(a) large intestine (b) lungs
(c) heart (d) oesophagus

58. Muscle fatigue is due to the accumulation of **2015 (II)**
(a) cholesterol (b) lactic acid
(c) lipoic acid (d) triglycerides

59. In Egypt, ancient mummies can be found to have their arteries intact due to well-preserved **2015 (II)**
(a) mineralised blood
(b) fibroblast fibres
(c) elastic fibres
(d) brown fat

ANSWERS

1	*c*	2	*d*	3	*c*	4	*b*	5	*c*	6	*b*	7	*b*	8	*c*	9	*c*	10	*a*
11	*a*	12	*d*	13	*c*	14	*b*	15	*b*	16	*c*	17	*a*	18	*b*	19	*a*	20	*b*
21	*a*	22	*c*	23	*c*	24	*a*	25	*b*	26	*c*	27	*a*	28	*b*	29	*c*	30	*b*
31	*a*	32	*a*	33	*b*	34	*b*	35	*c*	36	*d*	37	*a*	38	*c*	39	*a*	40	*d*
41	*c*	42	*b*	43	*b*	44	*c*	45	*d*	46	*c*	47	*b*	48	*c*	49	*b*	50	*c*
51	*c*	52	*a*	53	*d*	54	*c*	55	*a*	56	*b*	57	*c*	58	*b*	59	*b*		

07

HUMAN SYSTEM-II

Usually 1 to 2 questions are asked from this chapter. These questions are based upon sensory organs and functions of various harmones.

NERVOUS SYSTEM

- The neural system is a control system, which coordinates with endocrine system to coordinate various body parts, thus maintaining physiology.
- It gives ability to think and understand.
- Nervous system receives and conducts stimuli to show a specific response against that stimuli. It mainly occurs with the help of neurons.
- Neurons are structural and functional units of nervous system.
- On the basis of function, neurons can be
  - (i) Sensory (receptor/afferent), which connect sense organs with CNS,
  - (ii) Motor (effector/efferent), which connects CNS to effectors like muscles and glands,
  - (iii) Interneurons/connector/relaying/adjuster, which occurs in between sensory and motor neurons for distant transmission of impulses.
- On the basis of number of nerve processes, there are four types of neurons namely unipolar neuron (only axon with no dendron, e.g. early embryo) bipolar neuron (1 dendrite and 1 axon, e.g. olfactory epithelium and retina), multipolar neuron (1 axon and multiple dendrites, e.g. brain and spinal cord) and pseudounipolar neuron (bipolar but appear as unipolar, e.g. dorsal root ganglion of spinal cord).
- A synapse is a gap between two neurons.
- Synapse helps in the transmission of nerve impulse from one neuron to another. The membranes of pre and postsynaptic neurons are separated by a synaptic cleft.
- Human nervous system is divided into three parts, i.e. central nervous system, peripheral nervous system and autonomic nervous system.

1. Central Nervous System (CNS)

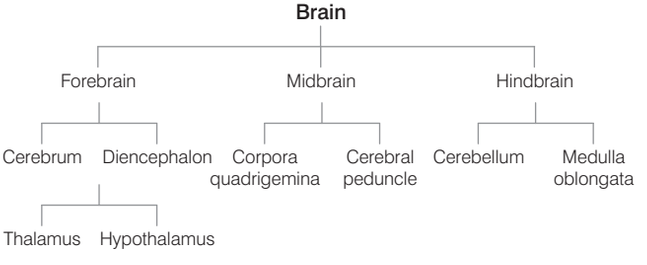
CNS is the part of nervous system that controls whole body and itself. The central nervous system is consists of brain and spinal cord.

(i) Brain

It is the anterior portion of the CNS, which is lodged in the cranial cavity, i.e. cranium of the skull. It weighs from 1220 to 1400 grams. Structurally, it consists of three membranes (meninges)

- **Piamater membrane** innermost thin, very delicate, vascular and inverts the brain closely.
- **Arachnoid membrane** outer to piamater thin, spider webby structure.
- **Duramater membrane** outermost, tough fibrous membrane, adhering closely to the inside of the skull.

Brain have following parts



(a) Forebrain

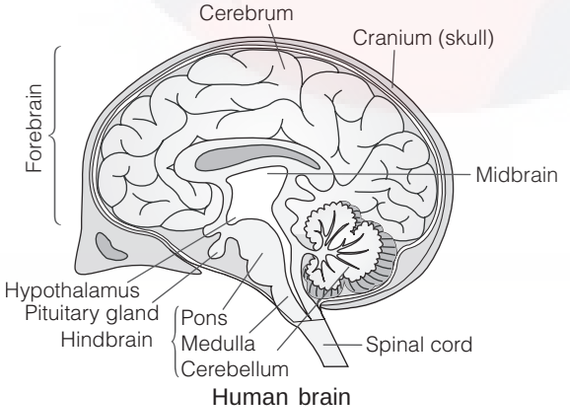
- It is the largest part of brain.
- It occupies 2/3 portion of brain.
- It is the main thinking part of brain.
- It consists of two parts, i.e. cerebrum and diencephalon.
- Cerebrum is the most developed part in human. It is divided into right and left cerebral hemispheres connected by corpus callosum.
- Cerebrum consists of many fold having small grooves (sulci), large grooves (fissures) and bulges between two (gyri).
- Diencephalon is consists of three parts, i.e. thalamus, hypothalamus and epithalamus.
- Thalamus controls emotions and memory.
- Hypothalamus control visceral activities. It helps to maintain homeostasis, control thirst, hunger, temperature, respiration, heartbeat.

(b) Midbrain

- It is made of two parts, i.e. cerebral peduncle and corpora quadrigema. It lies between the **hindbrain** and **forebrain**.
- If consists of group of fibres that arouses the forebrain when something unusual happens.
- Midbrain is responsible for vision and heary.

(c) Hindbrain

- It consists of the medulla, cerebellum and pons. The medulla is the swelling at the tip of the brain that serves as the passage way for nerves extending to and from the brain.
- The pons is the swelling between the medulla and midbrain. The pons acts as a bridge between various portions of the brain.
- Hind brain is responsible for muscular activities breathing, coughing, etc.



Human brain

(ii) Spinal Cord

- It extends from the base of the brain and is continuous to second lumbar vertebra. In adult, the spinal cord ranges from 42 to 45 cm in length.
- It mainly lies in the neural canal of the vertebral column.
- It is basically the posterior part of CNS, which runs mid-dorsally within the vertebral column. The three meninges, i.e. duramater, arachnoid and piamater, which covers the brain, also continue over the spinal cord.
- The two indentations, i.e. posterior median sulcus and the anterior median tissues separates the spinal cord into left and right halves.
- The inner area is the **grey matter**, while outside to it are white columns called the **white matter.**

Functions of Spinal Cord

(i) The stimuli passes from and to the brain through the spinal cord.

(ii) It also act as the centre of spinal reflex action.

2. Peripheral Nervous System (PNS)

- The nerves that originate from central nervous system connect either with receptor or effector organs from peripheral neural system.
- Nerves, which arises from brain are called cranial nerves while the nerves originating from the spinal cord are termed as spinal nerves.
- It relays impulse from the CNS to skeletal muscles. In human body there are 12 pairs of cranial nerves and 31 pairs of spinal nerves.

3. Autonomic Nervous System (ANS)

It transmit impulse from the CNS to the involuntary organs and smooth muscles of the body. This system was discovered by **Langly** in 1921.

It is further divided into two types

(i) **Sympathetic Nervous System** Accelerates heartbeat, enlarge pupils, supply blood to muscles, contract nerves of urinary bladder, lowers the intestinal digestion activities, helps in blood clotting, increased secretion of sweat glands, make breathing easier and promote liver to release sugar and decrease bile production are some activities controlled by this nervous system.

(ii) **Parasympathetic Nervous System** Works just analogus to the sympathetic nervous system, i.e. slows down heartbeat, dilates arteries and lower blood pressure, speeds up peristalsis, stimulate salivary gland secretion, contracts gall bladder, promotes pancreas for secretion, decreases the secrection of sweat glands, etc.

Reflex Action

- A reflex action is an automatic response to a stimulus.
- The pathway taken by nerve impulses in a reflex action is called the reflex arc.
- Reflex actions are under the control of spinal cord (CNS).
- Reflex actions were discovered by **Marshell Hall**.

- Some examples of reflex action are moving our foot away when we step on something sharp, moving our hand away on touching a hot plate, a knee-jerk, movement of diaphragm during respiration, coughing, yawning, etc.

Reflex actions are of two types

(i) **Uncondition reflex action** These are rapid actions that are not controlled by brain, e.g. tears, knee-jerk reflex, etc.

(ii) **Conditioned Reflex Action** These actions or activities are learnt by an individual by continuous practice and experience, e.g. dancing, cycling, swimming. These are under the control of cerebral.

SENSE ORGANS

Following four sense organs are found in humans

Eyes

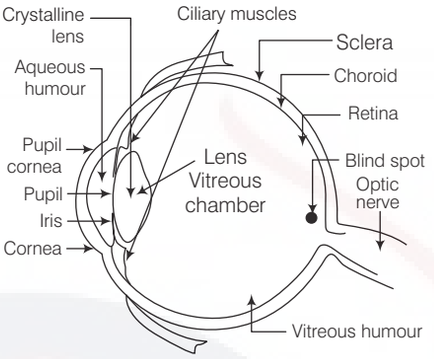
- Eyes are sense organs for vision. These have photoreceptors, which convert the energy of specific wavelength of light into action potentials of nerve fibres.
- Eyes are located in the bony cavity called orbit.
- Each eye is a hollow spherical organ often called eyeball.
- The wall of eyeball have three concentric layers, i.e. sclera, choroid and retina.

Sclera

- It is the outer layer made up of white fibrous tissue and having transparent cornea.
- Cornea remain covered by thin and transparent membrane called conjuctiva.

Choroid

- Choroid is the middle layer that contains many blood vessels.
- It forms the cilliary body, which inturn form iris.
- Attached to cilliary body a lens is present, which is held in place by ligaments.
- In front of lens pupil is found.
- A transparent watery fluid called aqueous humour fills the space between the lens and cornea.



Internal structure of eye

Retina

- It is the innermost light sensitive layer.
- It is made up of two types of cells, i.e. photoreceptor rod and cone cells.
- Rods contain a purple coloured photosensitive pigment rhodopsin (formed from vitamin-A) and are sensitive even in dim light and dark. Their function is UV light vision.
- Cones have a violet coloured photosensitive pigment iodopsin and are sensitive to bright light and colour perception. The day light vision and colour vision are functions of light.
- The space between lens and retina is filled with vitreous humour.
- Colour blindness (or Daltonism) is caused due to the deficiency of cones.
- Presbyopia is a visual defect common in older people. In this disease ciliary muscles are weakened causing hardning of lens.
- **Myopia** (short-sightedness) Image is formed in front of retina. Corrected by using concave lens.
- **Hypermetropia** (long-sightedness) Image is formed behind the retina. The person cannot see the nearby object clearly. The near point of eye gets shifted away from the normal position. It can be corrected by convex lens.
- Many domestic animals and sharks do not possess colour vision.
- Many nocturnal animals like owls have mainly rods in retina and are able to see in darkness. Human eyes are sensitive only to visible range of the spectrum (380-760 nm).
- Honeybees can see ultraviolet light.

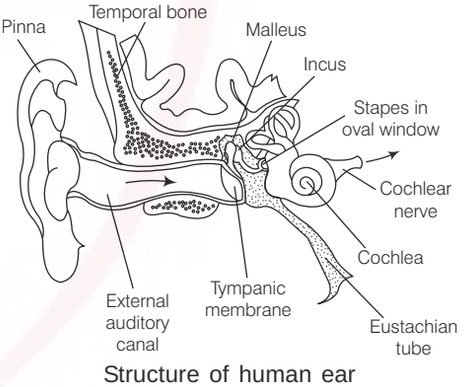
Human Ear

Human ear can hear sound of 60-80 decible. Ear consists of three parts–external, middle and internal ear.

(i) **External Ear** It consists of an earlobe or pinna and an external auditory canal. It collects and directs soundwaves into the external auditory canal.

(ii) **Middle Ear** Middle ear have three small bones, called ear or auditory ossicles. These are hammer-shaped malleus, anvil-shaped incus and stirrup-like stapes.

(iii) **Internal Ear** It consists of a bony labyrinth and a membranous labyrinth. The bony labyrinth has three bony semicircular canals, a bony cavity called vestibule and a coiled bony tube called cochlea. It is filled with perilymph.



Structure of human ear

Tongue

- Taste buds are the organs for taste sensation.
- A taste bud has taste recepor cells, which act as chemoreceptors. Human tongue possess 10,000 taste buds.
- The anterior part of the tongue is most sensitive to sweet taste, back to the bitter and sides to salty and sour.
- The taste of chillies is a sensation of burning, pain on the pain receptors of the tongue.

Nose

- Receptors for smell occur in a modified form of pseudostratified epithelium covering a part of the nasal mucosa. It is called olfactory epithelium.
- The olfactory receptors cells function as chemoreceptors. They are stimulated by specific chemical substances and produce impulse of smell.

ENDOCRINE SYSTEM

- Endocrine system works in coordination with nervous system.
- It is a system of glands, which pour their secretions, i.e. hormones directly into venous blood or lymph and passage to different body organ in order to control their functioning, metabolism, growth and stress conditions.
- **Endocrinology** is the branch of Biology, that deals with the study of endocrine glands, hormones and their effects.
- **Thomas Addison** (1793-1863) Father of Endocrinology.

HORMONES

- These are active messenger (organic) compounds, which are secreted by endocrine cells (glands) of some parts of body and circulates in blood.
- The term hormone was first used by **Hippocrates**.
- In 1903, **Baylis** and **Starling** extracted first hormone from the secretory cells of duodenal mucosa and named it as **secretin**.
- Hormones are not found in food. These are synthesised in the body itself by **endocrine cells**.

These are mainly three types

(i) **Protein hormones**, e.g. hormones of parathyroid, pituitary, hypothalamus and pancreas.

(ii) **Steroid hormones**, e.g. hormones of adrenal cortex and gonads.

(iii) **Amino acid derivatives**, e.g. hormones of adrenal medulla and thyroid glands like tyrosine derived hormones.

Hormones *Vs* Enzymes

- Biological catalysts in living organisms are known as enzymes.
- Besides hormones, enzymes are also compounds of high biological activities, influencing cell metabolism.

Similarities between Hormones and Enzymes

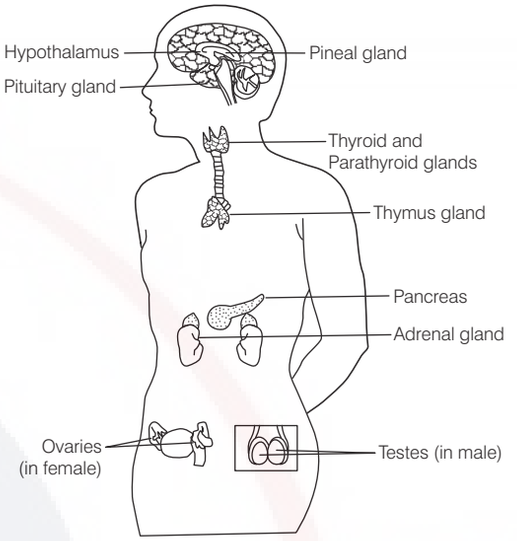
- Both are absent in food and are synthesised in cells.
- Both are required in small amounts.
- Role of both in cellular metabolism is specific.

Dissimilarities between Hormones and Enzymes

- Hormones are synthesised only in endocrine cell, while enzymes are synthesised in all cells.
- Hormones do not function outside cells but enzymes can catalyse reactions even outside cells.

Endocrine Glands

Several types of endocrine glands are found in vertebrate body. The location of different glands is given in the figure



Location of different endocrine glands

Pineal Gland

- It is also known as biological clock.
- It is located on the roof of diencephalon in brain.
- It start degenerating in children at the age of 7 years, in adult it is largely fibrous tissue.
- It secretes three hormones namely melatonin, serotonin and adrenoglomerulotropin.
- Melationin affects melanophores.

Pituitary Gland

Pea-shaped endocrine gland present at base of the brain. It is also called master endocrine gland/chief executive gland. It has two parts/lobes

(i) **Adenohypophysis** (anterior and intermediate lobes)

(ii) **Neurohypophysis** (posterior lobe)

Part	*Hormone*	*Function*
Adenohypo -physis (interior lobe)	Adrenocorticotropic Hormone (ACTH)	Promotes release of glucocorticoid and androgens from adrenal cortex.
	Follicle-stimulating hormone	Stimulates follicle maturation and production of estrogen.
	Luteinising hormone	Triggers ovulation and production of estrogen and progesterone in female and secretion of androgens in males.
	Growth hormone (somatotropic hormone)	Stimulates body growth, protein, fat and carbohydrate metabolism.
		Over secretion–Gigantism (in childhood). Acromegaly (in Adults) and under secretion (cause dwarfism).
	Prolactin	Regulates growth of mammary glands and formation of milk in them.

Part	*Hormone*	*Function*
	Thyroid Stimulating Hormone (TSH)	Stimulate the synthesis and secretion of thyroid hormones.
Intermediate lobe	Melanocyte stimulating hormone	Acts on melanocytes and regulates pigmentation of the skin.
	Oxytocin	Initiates labour and milk ejection.
Neurohypo-physis (posterior lobe)	Vasopressin or Antidiuretic Hormone (ADH)	Stimulates water reabsorption by kidneys. Deficiency causes diabetes insipidus.

Hypothalamus

- Hypothalamus secretes both releasing and inhibitory hormones controlling the secretion of some anterior pituitary hormones.
- Appetite, thirst and satiety-centres are located in hypothalamus.

Thyroid

- It is largest endocrine gland located in the larynx region of neck. It is bilobed in mammals and birds.
- It secretes thyroxine (T_4), tri ido thyronine (T_3) and calcitonin hormone.
- T_3 and T_4 increases metabolism, blood pressure and regulate tissue growth.
- Calcitonin regulate calcium levels during childhood.
- Thyroid disorders are more frequent in female than males.
- Hyposecretion in children leads to cretinism and in adults myxoedema (slueggish appearance, feeble mindedness, low body temperature).
- In insufficient quantity of iodine in diet (which is required for the synthesis of thyroxine) is the cause of simple goitre (swelling in the neck).
- Table salt is often iodised for certain area to prevent goitre.
- Excess of thyroxine (hyperthyroidism) leads to increased metabolic activity (highly nervous, overactive and irritated person). Sometimes it leads to exophthalmic goitre or Grave's disease (bulging eyeballs, irregular heartbeat and loss of weight).
- The deficiency of calcitonin results in osteoporosis or loss of bone density.
- Due to age factor or autoimmune disease in thyroid gland, secretion of thyroid reduces, which results in Hashimoto disease.

Parathyroid

- Parathyroid hormone maintains Ca^{2+} level in blood.
- It lowers the serum phosphate.
- It decreases the excretion of calcium.
- On hyposecretion Ca^{2+} become less in blood plasma and so muscle contraction decreases and sometimes may stop and may result tetany (parathormone deficiency disease).
- Hypersecretion leads to ostioporosis and weakend bones.

Thymus

- It is an endocrine gland nearest to the heart.
- It is partially endocrine and partially lymphoid gland.
- It produces thymine hormone.
- It helps in the formation of antibodies in embryo and infants.
- Absence of thymus in embryo brings about lack of lymphocytes, lymph nodes and antibodies.
- T-cells or T-lymphocytes are produced in thymus.
- It is responsible for immunity.

Adrenal (Supra Renal) or Emergency Gland

- It is situated at the top of the kidney.
- It is also known as **3F** gland, i.e. 3F
  - F — Fear
  - F — Fight
  - F — Flight
- It is also called **4S** gland, i.e. 4S
  - Source of energy
  - Sex hormone
  - Salt retaining
  - Sugar metabolism

It has two parts

(i) Cortex (ii) Medulla

Gland	*Hormone*	*Function*
Adrenal gland (suprarenals)		
Adrenal cortex	Glucocorticoids (cortisol)	Long-term stress response. Increased blood glucose levels, blood volume maintenance, immune suppression Oversecretion–Cushing's syndrome.
	Mineralocorticoids (aldosterone)	Long-term stress response; blood volume and pressure maintenance, sodium and water retention by kidneys. Excess secretion–**aldosteronism**, less secretion–**Addison's disease**.
	Sexocorticoids (androgen)	Acts as a precursor of both testosterone and estrogens (sex hormones). Excess section in female–Adrenal virilism. (male like character in females).
Adrenal medulla (emergency hormones)	Adrenaline (epinephirne) Nor-adrenaline (nor-epinephrine)	Short-term stress response; Increased blood sugar levels, vasoconstriction, increased heart rate and blood diversion.
		Short-term stress response: increased blood glucose levels, blood volume maintenance and immune suppression.

Pancreas

- Exocrine as well as endocrine gland.
- Endocrine part constitutes 2-3% and represented by 'islets of Langerhans'. The islets have five types of endocrine cells secreting different hormones are
  - (i) α-cells → Glucagon (a hyperglycaemic hormone)
  - (ii) β-cells → Insulin (a hypoglycaemic hormone)
  - (iii) γ-cells → Gastrin
  - (iv) δ-cells → Somatostatin
  - (v) F-cells → Pancreatic polypeptide

- Insulin is an anabolic hormone.
- Insulin controls the amount of sugar in blood. Its hyposecretion leads to diabetes mellitus.
- Glucagon increases blood sugar level.
- Somatostatin controls the functioning of α and β-cells.

Kidney

- It produces erythropoietin hormone, which regulates erythropoiesis or haemopoiesis in bone marrow.
- It also influences ultrafiltration in nephron of kidney.
- It also produces renin hormone, which controls aldosterone secretion through renin-angiotensin pathway.

Liver

- It is the largest gland in human.
- It produces angiotensinogen hormone, which changes into angiotensin in the presence of renin of kidney.
- It controls blood pressure.

Gonads

- These are reproductive organs in which ova (eggs) and sperms are formed.
- These may also function as endocrine glands, secreting sex hormones. Gonads are of the following types

Testes

- It produces male hormone, i.e. androgens.
- Important androgen of testis is testosterone.
- Testosterone is responsible for deep voice, enlargement of genital organs and appearance of beard in male.
- Testosterone is secreted by Leydig cells.
- Surgical removal of testis is castration or orchidectomy.
- At puberty by the influence of FSH and ICSH of pituitary, a large amount of testosterone is produced.

Ovary

- It produces female hormone, i.e. oestrogen.
- Oestrogen is responsible for thin voice, well-developed ovary, oviduct, mammary gland, uterus and vagina in female.
- It helps in controlling of menstrual cycle.
- Corpus luteum is a temporary endocrine gland that produces progesterone hormone.
- It maintains pregnancy.
- It helps in implantation of the embryo or foetus.

IMPORTANT POINTS

- Contraceptive pill have oestrogens and progesterone.
- Corpus luteum secretes relaxin hormone at the time of parturition.
- Placenta releases HCG (Human Chorionic Gonadotropin) hormone at the time of pregnancy. Its presence in urine indicates pregnancy.

PRACTICE EXERCISE

1. The responsible for vision and hearing is
(a) midbrain (b) forebrain
(c) hindbrain (d) spinal cord

2. Reflex actions are under the control of
(a) CNS (b) PNS
(c) ANS (d) Endocrine system

3. The part responsible for coughing is
(a) hindbrain (b) midbrain
(c) spinal cord (d) medulla oblongata

4. Sympathetic nervous system increases
(a) heartbeat (b) saliva secretion
(c) secretion of digestive juices
(d) All of the above

5. Hemispheres are connected by
(a) sulcus
(b) corpora callosum
(c) corpus callosum
(d) gyrus

6. The neurons that connect
(a) motor neurons (b) sensory neurons
(c) inter neurons (d) All of these

7. Forebrain is consists of
(a) cerebrum
(b) medulla oblongata
(c) diencephalon (d) Both (a) and (c)

8. The larger grooves present in the convolusion of cerebrum are known as
(a) sulci (b) gyri
(c) fissures (d) None of the above

9. Human ear can hear sound of
(a) 60-80 dB (b) 60-80 million dB
(c) 60-80 billion dB (d) 60-80 trillion dB

10. Who is known as Father of Endocrinology?
(a) Thomas Addison
(b) Robert Hooke
(c) Antony van Leeuwenhoek
(d) Pasteur

11. Through which type of glands, hormones are produced?
(a) Exocrine glands
(b) Endocrine glands
(c) Holocrine glands
(d) Apocrine glands

12. Which of the following is correct for endocrine glands?
(a) Ductless glands
(b) Non-ductless glands
(c) Pour their secretion into blood
(d) Both (a) and (c)

13. Which of the following is not an endocrine gland?
(a) Pituitary (b) Thyroid
(c) Parathyroid (d) Salivary gland

14. Which gland acts as exocrinally as well as endocrinally?
(a) Pancreas (b) Sebaceous gland
(c) Thyroid (d) None of theSe

15. Which gland is called as 'Master endocrine gland'?
(a) Pituitary (b) Pancreas
(c) Thyroid (d) Kidney

16. Which of the following is concerned with diabetes insipidus?
(a) ADH deficiency
(b) Pituitary neurohypophysis
(c) Both (a) and (b) (d) Pancreas

17. Diabetes mellitus is concerned with
(a) thyroxine hormone
(b) pituitary (c) pancreas
(d) Both (a) and (c)

18. The hormone insulin is secreted by
(a) hypothalamus (b) thymus
(c) β-cells of Langerhans
(d) pituitary

19. Hyposecretion of which gland in children leads to cretinism?
(a) Pineal (b) Parathyroid
(c) Thymus (d) Thyroid

20. The male sex hormone is called
(a) vasopressin
(b) gonadotropic hormone
(c) FSH (d) testosterone

21. Deficiency of iodine in food or water leads to
(a) colour blindness (b) simple goitre
(c) opthalmic goitre (d) cancer

22. Diabetes mellitus is the result of undersecretrion of
(a) insulin (b) thyroxine
(c) oestrogen (d) None of these

23. Which cells of testis secrete testosterone hormone?
(a) Leydig's cells (b) Sertoli cells
(c) Both (a) and (b) (d) Spermatogonia

24. Deficiency of adrenal cortex activity leads to
(a) diabetes (b) Conn's disease
(c) Addison's disease
(d) Simmond's disease

25. STH (Somatotrophic Hormone) is also known as
(a) TSH (b) LTH
(c) ADH (d) GH

26. Hormone that stimulates milk secretion is
(a) prolactin (b) luteinising hormone
(c) oestrogen (d) testosterone

27. Which is not secreted by anterior pituitary?
(a) ADH (b) GH (c) Prolactin (d) FSH

28. Secretion of ductless glands are known as
(a) hormones (b) pheromones
(c) enzymes (d) vitamins

29. Intermediate lobe of pituitary secretes a hormone
(a) oxytocin (b) MSH
(c) corticotropin releasing hormone
(d) thyrotropin releasing hormone

30. A woman may develop beard and moustaches due to
(a) hypersecretion of adrenal cortex
(b) hypersecretion of thyroxine
(c) hyposecretion of adrenaline
(d) hyposecretion of thyroxine

31. Hormone controlling contraction of uterus during parturition is
(a) luteinising hormone
(b) oestrogen (c) progesterone
(d) oxytocin

32. Which hormone is hypoglycaemic in nature?
(a) Insulin (b) Glucagon
(c) Thyroxine (d) ACTH

33. Emergency gland is a common name of
(a) adrenal (b) pancreas
(c) liver (d) kidney

34. Cretinism is due to less secretion of
(a) thyroid (b) pituitary
(c) parathyroid (d) adrenal

35. Which of the following is controlled by hormone oxytocin?
(a) Growth (b) Lactation
(c) Child birth (d) Both (b) and (c)

36. Endocrine gland responsible for immunity is
(a) pineal (b) thymus
(c) pituitary (d) adrenal

37. Parathormone deficiency disease is
(a) cretinism (b) hypercalcemia
(c) tetany (d) myxoedema

38. 3F (Fear-Fight-Flight) gland is
(a) pituitary (b) thyroid
(c) parathyroid (d) adrenal

39. Biological catalysts in living organisms are known as
(a) hormones (b) vitamins
(c) steroids (d) enzymes

40. Which part of brain controls fine movement, maintains balance and equilibrium of the body and muscle tone in a human beings?
(a) Cerebrum (b) Thalamus
(c) Cerebellum (d) Hypothalamus

41. The following layers are found in the structure of the eye.
1. Conjuctiva 2. Choroid
3. Retina 4. Sclerotic
(a) 4, 1, 3, 2 (b) 4, 1, 2, 3
(c) 1, 4, 2, 3 (d) 1, 4, 3, 2

42. Consider the following statements. Hypermetropia is a defect of vision in which **2012 (I)**
1. a person cannot see the distant objects clearly.
2. a person cannot see the nearby objects clearly.
3. the near point of the eye gets shifted away from the normal position.
4. the far point of the eye gets shifted towards the eye.

Which of the statements given above are correct?
(a) 1 and 3 (b) 2 and 4
(c) 1 and 4 (d) 2 and 3

43. The main thinking part of the brain is **2013 (I)**
(a) midbrain (b) hypothalamus
(c) forebrain (d) hindbrain

44. Presbyopia is a visual defect caused by **2013 (II)**
(a) elongation of the eyeball
(b) shortened curvature of the eye lens
(c) weakening of the ciliary muscles
(d) gradually increasing flexibility of the eye lens

45. Which one of the following is not a part of nerves? **2015 (I)**
(a) Axons (b) Connective tissues
(c) Schwann cells (d) Smooth muscles

46. Which endocrine gland requires iodine to synthesise a particular hormone, whose deficiency may cause goitre disease? **2015 (I)**
(a) Hypothalamus (b) Pancreas
(c) Thymus (d) Thyroid gland

ANSWERS

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

08

HEALTH AND DISEASES

As an average 4 to 5 questions are asked from this chapter. These questions are based upon bacterial diseases, viral diseases and STDs.

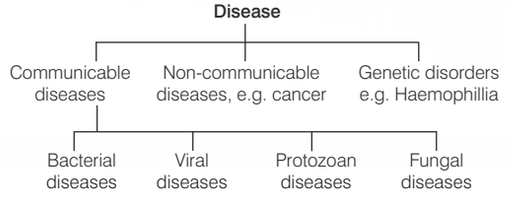
HEALTH

Health is a state of complete physical, mental and social well-being. It is the functional or metabolic efficiency of a living being. Some basic factors such as balanced diet, personal hygiene and regular exercise contributes to good health. Apart from these, awareness about diseases and immunisation, etc., also affects health.

DISEASES

Disease is a condition of disturbed or damaged functioning of the body due to infection, defective diet, heredity and environment. The causes of disease in humans can be pathogens, genetical, etc.

Different types of diseases are categorised as follows



Communicable Diseases

There are various kinds of communicable diseases, which affect the health of human beings. These diseases are infectious, i.e. they spread from affected individual to normal individual. These are caused by pathogens such as bacteria, virus, Protozoa and fungi. These pathogens can spread the disease by means of air, water, vectors or sexual contact.

Some of them are as follows

Bacterial Diseases

Following diseases are caused by bacteria

1. Tuberculosis (TB)

- It is caused by *Mycobacterium tuberculosis* (gram positive).
- It spreads through coughing, sneezing, talking and splitting droplets. Symptoms of this disease are fever, cough, sputum with blood, chest pain, loss of appetite, weight loss.
- It can be prevented by immunisation that includes BCG (Bacillus Calmette Guerin) vaccine, isolation of patient, sanitation, etc.
- Antibiotics such as rifampicin, isoniazid, etc.

2. Diphtheria

- It is caused by *Corynebacterium diphtheriae* (gram positive).
- Infection occurs through droplets.
- It is characterised by slight fever, oozing of semisolid material in throat (sore throat).
- Immunisation is done with DPT vaccine.

3. Pertussis/Whooping Cough

- It is caused by *Bacillus pertussis* or *Bordetella pertussis* (gram negative).
- Infection occurs through direct contact and droplets, characterised by inflamation of respiratory passage, cold, cough and mild fever in beginning leading to accumulation of mucus and **inspiratory whoop**.

- Vaccination is done with DPT (Diphtheria, Pertussis and Tetanus), use of antibiotic drugs like erythromycin, chloramphenicol and ampicillin.

4. Tetanus / Lock Jaw Disease (Dhanustamba)

- It is caused by *Clostridium tetani* (rod-shaped, gram positive).
- Its infection occurs through spores of bacteria entering into body *via* wounds, accidents and unsterilised surgical instruments as this bacterium secretes tetanospasmin toxin.
- It is characterised by muscular rigidity (lock jaw) and painful muscular spasm.
- Injection of ATS (Anti Tetanus Serum) within 24 hours of injury leads to protection against this disease.

5. Cholera

- It is caused by *Vibrio cholerae.*
- It spreads through contaminated food and water or by direct contact.
- It is characterised by effortless watery stool, vomiting, rapid dehydration, muscular cramps.
- It is treated by use of ORS (Oral Rehydration Solution) and sanitation.
- ORS contains (1L) 1.5 g glucose, 3.5 g NaCl, 2.9 g KCl and 12.9 g trisodium citrate.

6. Diarrhoea

- It is caused by *Salmonella typhimurium* (salmonellosis) and *Shigella shigae* (shigellosis).
- It spreads through contaminated meat and other proteinaceous food articles and transmitted through fingers, beds, clothes and utensils and most importantly by faeces.
- Vomiting, nausea, headache, paratyphoid fever and frequent passage of stool with mucus, blood and abdominal cramps are symptoms.
- Oral and intravenous rehydration is required for treatment.

7. Pneumonia

- It is caused by *Diplococcus pneumoniae* or *Streptococcus pneumoniae* (gram positive).
- It transmits through droplets (sputum).
- Symptoms are sudden chill, chest pain, cough with rusty mucoid sputum and rise in temperature.
- It is treated by uses of drugs like erythromycin, tetracycline and penicillin.

8. Syphilis

- It is caused by *Treponema pallidum* (a spirochaete).
- It transmits through sexual contact and from mother to children.
- Common symptoms are painless ulcer on the genitals and swelling of local lymph glands, rashes, hair loss, swollen joints and flu-like illness.
- Disease is curable through appropriate antibiotics, e.g. penicillin and tetracycline.

9. Gonorrhoea

- It is caused by *Neisseria gonorrhoeae* or *Diplococcus gonorrhoeae.*
- It spreads through sexual contact, common toilets and under clothes.
- Bacterium lives in genital tubes, produces pus containing discharge, pain around genitalia and burning sensation during urination.
- Use of antibiotics, e.g. penicillin, ampicillin and maintain high moral characters.
- It is Venereal Disease (VD) or Sexually Transmitted Disease (STD).

10. Plague/Bubonic Plague (Black Death)

- This disease is caused by *Yersinia pestis* or *Pasturella pestis*.
- It spreads through rat flea (*Xenopsylla cheopis)* to man.
- Symptoms are armpit and groin swell up into painful buboes, high-fever, chill, exhaustion and haemorrhages, which turns black.
- Treatment with antiplague vaccine, spraying of pesticides for killing of rats.
- Wayson stain test is performed for diagnosis of this disease.

11. Typhoid

- It is caused by *Salmonella typhi.*
- It spreads through food, milk and water contaminated with intestinal discharge either directly or through houseflies.
- High fever in steps, lesions and ulceration in the intestinal wall are common symptoms.
- Use of antibiotics (ampicillin and chloramphenicol), prolonged treatment is required for this disease.
- **Widal test** is performed for diagnosis of this disease.

12. Leprosy (Hansen's Disease)

- It is caused by *Mycobacterium leprae.*
- It does not spread by initial contact, but prolonged closer contact through skin lesions, nasal and throat discharges also spreads this disease.
- Sanitation and use of suitable drugs like dapsone, rifampicin, ofloxacin and chaulmoogra oil along with surgery may protect from the disease.
- Bacterium can enter into the body and damage nerves, skin, lymph nodes, eyes, nose, mouth, larynx, muscles, spleen, etc.
- Appearance of skin patches, numbness in some body parts, fever, finally ulcer, nodules, lesions, scaly scabs, deformities in finger, toes and wasting of body parts are symptoms.

13. Botulism

- It is caused by *Clostridium botulinum.*
- Symptoms are double vision, blurred vision, drooping eyelids, slurred speech, difficulty in swallowing, dry mouth and muscle weakness.
- It spreads through contaminated food and water or food stuffs product.
- To remove the source of toxin producing bacteria, the administration of proper antibiotics are used.

Viral Diseases

Following diseases are caused by viruses

1. **Measles** (Khasra)

- It is caused by *Rubeola* virus/*Polynosa morbillorum.*
- It is transmitted by contact, fomite or droplet methods.
- The virus enters through respiratory tract and conjuctiva.
- It is characterised by itching, skin rash, small raised red spot in crescent-shaped groups starting from back of ears and reaching to forehead, face and then on whole body.
- Antibiotics and vitamin-A are given to prevent complications. Vaccination MMR (Mumps, Measles, Rubella) is given at the age of one.

2. **Mumps**

- It is caused by Paramyxo or Mumps virus.
- It is transmitted by direct contact, droplet.
- In this disease, patient feels difficulty in swallowing and opening of mouth.
- Its symptoms are high fever, chills, headache, general bodyaches and loss of appetite.
- Treated by vaccination with MMR.

3. **Smallpox** (Chechuk)

- It caused by *Variola* virus.
- Common but less severe in children of upto 10 years and severe, but rare in adults.
- Infection spreads from oral, nasal, vesicular discharges, pustules and scabs.
- Symptoms are reddish spots, which change into papules, pustules and finally scab.
- Spots appear first on the hair line, then face followed by over rest of the body, but fewer on the trunk. On falling, these spots **left permanent marks**.
- Vaccination for small pox was developed by **Edward Jenner** in 1796.

4. **Chickenpox**

- It is caused by *Varicella zoster* with incubation period of 14-16 days.
- It is a contagious disease that occurs in winter and springs.
- Presence of prodermal rashes with crops of pinkish centripetal spots first on trunk, forehead and face.
- Uneasiness, aches and high fever accompany each new crop. Spots turn into fluid-filled vesicles and then scabs.
- Scabs fall off without leaving any mark.
- No drugs and no vaccines, only use of boric acid and calamine reduces itching problem.

5. **Polio / Infantile Paralysis**

- It is caused by *Polio* virus or *Entero* virus.
- Highly infectious disease of infant and children.
- Transmitted through faeces, urine and nasal secretions contaminating food, water, drinks, either directly or through flies with an incubation period of 5-17 days.
- It produces inflammation of the nervous system causing inability to bend the head forward.
- Paralysis starts following the weakness of particular skeletal muscles.
- Polio is preventive.
- Salk's vaccine (now Sabin's oral) is available for taking at the age of 6 weeks, 10 weeks, 14 weeks and booster dose at 18-24 months.
- The Hoffkine Institute of Mumbai is known for the production of polio vaccine.

6. **Influenza / Flu**

- It is caused by *Haemophilus influenzae* or *Myxovirus influenzae.*
- It spreads by the entering of contaminated air into respiratory tract.
- It starts with fever, headache, sore throat, cold with sneezing and pain all over the body with restlessness.
- No vaccine, hygiene and sanitation.

7. **Rabies / Hydrophobia**

- It is caused by *Rhabdo* virus.
- It is transmitted to human beings by bitting saliva of rabid (mad) dog or cat.
- Jackals, wolves, foxes, mongoose and bats also have rabies virus.
- Initial symptoms of rabies are excessive saliva from mouth, severe headache, high fever, depression and inability to swallow even fluids due to choked throat.
- Fear of water, i.e. hydrophobia is most important characteristic.
- The virus destroys the brain and spinal cord.
- Bitten person should be immediately administered vaccine (earlier 14 inoculations but now 6 doses of vaccines) are recommended.
- Dog should be watched for 10 days for the development of rabies symptoms (running amuck, change of voice and excessive salivation).

8. **Dengue Fever**

- It is caused by DEN-1-4 virus and transmitted by female Tiger mosquito (*Aedes aegypti).*
- Its symptoms are headache, fever chill, pain in joints and skin rashes. More severe in adults.
- In this disease, blood platelets number falls below 70000/mm^3.
- Paracetamol with replenishment of blood platelets may be helpful.

9. **Hepatitis**

- It is commonly called **jaundice**.
- Jaundice is the result of incomplete metabolism of bilirubin pigment of wornout RBCs.
- Its infection spreads through faecal-oral route and polluted water.

- Initially liver is enlarged and congested.
- Symptoms are fever, nausea, vomiting, pain in muscles and joints. Urine is dark and stool is pale.
- Six varieties of hepatitis virus are HAV, HBV, HCV, HDV, HEV and HGV.
- Personal cleanliness, use of boiled water, properly cooked/cleaned food articles and control of flies are required.

10. AIDS

- Acquired Immuno Deficiency Syndrome (AIDS) is a disease of human immune system.
- It is caused by Human Immunodeficiency Virus (HIV).
- HIV is a lentivirus of the retrovirus family.
- HIV can spread by the following methods
  (i) Through sexual contact, e.g. oral, vaginal and anal sex.
  (ii) Through blood transfusions, e.g. accidental needle sticks or needle sharing.
  (iii) From mother to child, e.g. a pregnant woman can transmit virus to her foetus through their shared blood circulation or a nursing mother can pass it to her baby through breast's milk.
- Major clinical symptoms of AIDS in humans are loss of weight, prolonged fever, chronic diarrhoea, red or brown blotches on or under the skin of nose, mouth. swallon gland, fatigue, etc.
- In children less then 12 years of age, persistent cough is not a clinical symptom of AIDS.
- ELISA, PCR and RIP/IFA are the confirmatory tests for AIDS.
- Anti-retroviral drugs, e.g. AZT (Azidothymidine), zidovudine and norvir are used to supress AIDS.
- AIDS day is observed on 1st December.

11. Yellow Fever

- It is caused by *Flavi virus*.
- The mosquito *Aedes aegypti* transmits the virus to humans.
- Its symptoms are aching muscles particularly the back and knee muscles, dizziness, loss of appetite, nausea, shivers (chills) and vomiting. Skin and whites of eyes take a yellow tinge.
- No effective antiviral medication, but making sure the patient's blood pressure is adequate, replacing lost blood and treating any secondary infections.
- This disease is not prevalent in India.

12. Chikungunya

- It is caused by *Alphavirus* and spreads by *Aedes* mosquito.
- The symptoms are fever, joint pain, swelling and rashes.
- It can be prevented by checking mosquito populations.
- No such treatment apart from paracetamol and anti inflammatory drugs.

13. Swine Flu

- It is caused by H1N1 virus.
- It is also called hog flu or pig influenza.
- The risk of this disease is higher in those, who consume pork.
- Symptoms are fever, lethargy, sneezing, coughing, difficulty in breathing and decreased appetite.
- Tamiflu and relenza vaccine are used to prevent this disease.
- There is absence of an effective treatment or vaccine for swine flu.

Helminthic Diseases

These diseases are caused by helminthic worms. Some helminthic diseases are

1. Ascariasis

- It is caused by *Ascaris lumbricoides.*
- It spreads through raw vegetables, dirty hands and ingestion of contaminated soil.
- Its symptoms are nausea, cough and severe abdominal pain. Intestinal destruction may also occur.
- Preventive measures includes sanitation and uses of antihelminthic drugs.

2. Taeniasis

- It is caused by *Taenia solium*.
- It spreads through improperly cooked food and also through raw vegetables, which are not properly washed.
- The symptoms are chronic indigestion, anorexia, similar symptoms of epilepsy.
- Treated by sanitation, use of properly cooked food and helminthic drugs.

3. Filariasis

- It is caused by *Wuchereria bancrofti.*
- Transmitted by *Culex* sp. of mosquito.
- Fever, legs may become swollen and resemble with those of elephant. So, this disease is also called **elephantiasis**.
- The preventive measures includes destruction of mosquitoes and use of mosquito repellent creams and mats and antihelminthic drugs.

Protozoan Diseases

These diseases are caused by protozoans. Some protozoan diseases are

1. Malaria

- It is caused by *Plasmodium* species. It affects several body parts like liver (initial multiplication), RBCs, spleen and brain. But it does not affect kidney. It shows multiplication in liver.

Plasmodium has two hosts

(i) Female *Anopheles* mosquito (definitive or primary host) present in the saliva of mosquito.

(ii) Human beings (intermediate or secondary host).

- ***Plasmodium vivax***

(i) It causes benign tertian malaria.

(ii) Most common in India.

- ***Plasmodium falciparum***

(i) It causes cerebral malaria.

(ii) Common in certain parts of India.

- ***Plasmodium ovale***

(i) Rarest species, which infects man.

- ***Plasmodium malariae***

(i) Common in tropical Africa, Burma, Sri Lanka and parts of India.

(ii) Use of mosquito nets, repellent creams and mats, use of chloroquine, primaquine tablets may prevent malaria.

(iii) Most effective medicine for malaria is quinine (obtained from cinchona tree).

2. Amoebiasis / Amoebic Dysentry

- It is caused by *Entamoeba histolytica* (an endoparasite).
- Parasite lives in the large intestine of humans.
- Infection occurs by ingesting cysts with food and water.
- The symptoms are mild diarrhoea, presence of mucus and blood in stool and abdominal pain.
- Proper sanitation and personal hygiene is useful for protection. Antiamoebic drugs are used for protection.

3. Leishmaniasis

- It is commonly called as kala-azar.
- It is caused by *Leishmania donovani*. It multiplies by multiple fission.
- Spreads by sandfly (*Phlebotomus*) bite.
- The symptoms often resemble malaria with irregular recurrent fever and leukopenia with enlargement of spleen and liver.

4. African Sleeping Sickness (Trypanosomiasis)

- It is caused by *Trypanosoma gambiense.*
- The parasite is transmitted by blood sucking tse-tse fly (*Glossina palpalis*).
- Parasite lives in blood plasma.
- Fever with glandular swelling.
- In acute condition, parasite enters into cerebrospinal fluid and damage the brain. It makes the patient lethargic and unconscious.
- Prevention is done by eradicating from flies and shrubs.

Fungal Diseases

Fungal diseases are also called mycoses. Mycoses are common in human as well as in animals. One of them is

Ringworm

- It is caused by *Microsporum.*
- It spreads by unbathed cats, dogs or infected persons.
- In this disease, sores are formed, which become reddish and contain blisters.
- Treated by proper sanitation and hygiene.
- Some other fungal diseases with their causative agents are aspergillosis (*Aspergillus fumigatus*), meningitis (*Cryptococcus neoformans*), dermatitis of beard and hair (*Trichophyton verrucosum*) and athlete's foot (*Tinea pedis*).

NON-COMMUNICABLE DISEASES

There are various kinds of non-communicable diseases, which affect the health of human beings.

Some of the common non-communicable diseases are

1. Diabetes

- Diabetes is a long-term condition caused by too much glucose (sugar) in the blood.
- There are two main types of diabetes

(i) Type 1 diabetes occurs when the body does not produce enough insulin to function properly or the body's cells do not react to insulin. This is known as insulin resistance.

(ii) Type 2 diabetes is far more common than type 1 diabetes, which occurs when the body does not produce any insulin at all. Type 2 diabetes usually affects people over the age of 40.

- Symptoms are feeling very thirsty, urination frequently particularly at night, feeling very tired, weight loss and loss of muscle bulk.

2. Cancer

- It is the uncontrolled growth of abnormal cells in the body.
- Cancer occurs when normal cells due to uncontrolled mitotic division are converted into tumour cells.
- The resulting uncontrolled growth forms masses of cells called tumour.
- Cancerous cells are also called malignant cells.
- Symptoms of cancer depend on the type and location of the cancer.
- These are induced by physical, chemical and biological factors or agents. The agents causing cancer are called carcinogens or cancer causing agents.
- Tobacco smoke contains chemical carcinogens that cause lung cancer.
- Viruses also cause cancer. These are called oncogenic viruses as they have genes called viral oncogenes.
- Leukaemia or blood cancer can be detected based on biopsy and histopathological studies of the tissue and blood and bone marrow tests for increased cell counts.

Cancer therapies are

(i) Cryo surgery (ii) Proton therapy
(iii) Radiation therapy
(iv) Stem cell transplantation (also involved in spinal injury cure)
(v) Peripheral Blood Stem Cell Transplantation (PBSCT)

GENETIC DISORDERS

A genetic disorder is an illness caused by one or more abnormalities in the genome. These may be of three types

1. Autosomal Recessive Disorders

These are as follow

(i) **Albinism** This disesase is caused due to inability to produce melanin pigment. It is characterised by absence of normal colouration of the skin.
(ii) **Galactosaemia** This is due to defect in galactose metabolism. They may causes mental retardation.
(iii) **Phenylketonuria** It occurs due to the deficiency of an enzyme phenylalanine hydroxylase, which converts phenylalanine into tyrosine. Symptoms are mental retardation, typical colour of skin and urine.
(iv) **Alkaptonuria** In this metabolic disorder, there is absence of homogentisic acid oxidase, which oxidises homogentisic acid. The urine of such patients darkens on exposure.
(v) **Sickle-cell Anaemia** It is a genetic disorder. It is characterised by RBCs of patient(individuals) become elongated and curved to become sickle-shaped in O_2 deficiency. In defective haemoglobin, the glutamin amio acid at 6th place of β-chain of Hb is replaced by valine.

2. X-Linked Recessive Disorders

Genes are located in the differential segments of X-chromosome. These are as follow

(i) **Haemophilia** Haemophilia appeared in several interrelated Royal families of Europe, apparently arising from a mutation in one parent of Queen Victoria of England (1819-1901), hence is called 'Royal disease'. In this disorder, blood coagulation does not take place. It is due to deficiency of Factor VIII (antihaemophilic factor).
(ii) **Colour Blindness** This disease is also known as Daltonism. Affected person cannot distinguish between green and red colour. Colourblind persons cannot service in Railway department.

3. Y-Linked Recessive Disorders

- **Hypertrichosis**, i.e. excessive hairs on ear pinna is a Y-linked recessive disorder.

VACCINATION AND IMMUNISATION

- The principle of vaccination and immunisation is based upon the 'memory' of immune system.
- In vaccination a preparation of inactivated or weakened pathogen (vaccine) are introduced into the body. The antibodies are produced against these antigen would neutralise the pathogenic agents during actual infection. The vaccine also generate memory B and T-cells that recognise the pathogens quickly on subsequent exposure and act against them with a massive production of antibodies.
- **Edward Jenner** discovered the first vaccine.
- **Pasteur** invented the vaccine for rabies.
- **Robert Koch** discovered anthrax bacteria.
- Penicillin was discovered by **Sir Alexander Flemming** from *Penicillium* fungus.

Age	*Vaccinations*
3-12 months	**DTP**—Diphtheria, Tetanus and Pertussis (whooping cough) **Polio** (oral)— 3 doses at intervals of 4-6 weeks **BCG** (Bacillus of Calmette and Guerin) Tuberculosis.
9-15 months	**Measles vaccine**— one doses
18-24 months	**DTP**—booster dose **Polio** (oral) booster doses

IMMUNITY

The ability of a host to defend itself from most of the foreign agents is called as immunity. The parts of body that act together to achieve immunity together constitute the immune system. Immunology is the branch of science that studies the immunity. Emil von Behring considered to be the father of immunology.

Types of Immunity

Immunity is of two types

(i) **Innate Immunity** It is non-specific and present at the time of birth.

(ii) **Acquired Immunity** It is pathogen specific and characterised by memory. There are two types of immune systems found in our body. One is humoral and other is cell mediated. B-lymphocytes produce antibodies and T-cells help them in this process. The response provided by antibodies IgA, IgM, IgE, IgG and IgD present in blood is called **humoral** immune response (antibody-mediated).

The second type is called cell mediated immune response or cell mediated immunity (CMI). The T-cells mediate CMI.

Health Organisations

Some health organisations are as follows

(i) **World Health Organisation** It was established in 1948.

(ii) **Red-Cross** It was founded in 1864. The emblem of red-cross is a red-coloured 'plus'.

(iii) United Nations International Emergency Funds (UNICEF). Its an organisation of UNO.

PRACTICE EXERCISE

1. Extreme swelling on legs and feet is the main symptom of the disease
(a) food poisoning (b) AIDS
(c) elephantiasis (d) malaria

2. Which one is a bacterial disease?
(a) Ringworm (b) AIDS
(c) Malaria (d) Leprosy

3. Which of the following is related with diphtheria disease?
(a) Liver (b) Blood
(c) Throat (d) Spleen

4. In which disease, DPT vaccine is used?
(a) Tuberculosis (b) Diphtheria
(c) Polio (d) All of these

5. Which of the following is a cause of AIDS disease?
(a) Protozoa (b) Virus
(c) Bacteria (d) Helminthic worm

6. In our body, the immune system is suppressed by this disease
(a) AIDS (b) TB
(c) cancer (d) arthritis

7. Cancer is a disease caused by
(a) bacteria (b) virus
(c) fungus (d) carcinogens

8. Most effective medicine for malaria is
(a) streptomycin (b) quinine
(c) penicillin (d) None of these

9. Which one is a viral disease?
(a) Cholera (b) Tetanus
(c) Rabies (d) None of these

10. Which disease is called as Royal disease?
(a) Haemophilia (b) Cancer
(c) Diabetes (d) Anaemia

11. Black death is the name given to
(a) malaria (b) cholera
(c) cancer (d) plague

12. *Ascaris* is transmitted through
(a) housefly
(b) contaminated food
(c) mosquito (d) tse-tse fly

13. Rats are known to transmit the germs for
(a) malaria (b) typhoid
(c) plague (d) rabies

14. Infection of taeniasis usually occurs by
(a) mosquito
(b) roughly cooked food
(c) contaminated food and water
(d) None of the above

15. Polio vaccine was first prepared by
(a) J Salk (b) L Pasteur
(c) G J Mendel (d) Watson

16. The disease haemophilia, in human beings, is due to
(a) sex-linked recessive gene
(b) sex-linked dominant gene
(c) autosomal recessive gene
(d) autosomal dominant gene

17. Which one of the following is a genetic disorder?
(a) Bronchitis
(b) Night blindness
(c) Osteoporosis
(d) Sickle-cell anaemia

18. Which one is the causative agent of cerebral malaria?
(a) *Plasmodium falciparum*
(b) *Plasmodium malariae*
(c) *Plasmodium ovale*
(d) *Plasmodium vivax*

19. Which one of the following is not a bacterium?
(a) *Escherichia coli*
(b) *Neisseria gonorhoeae*
(c) *Treponema pallidum*
(d) *Wuchereria bancrofti*

20. Which one of the following diseases is not prevalent in India?
(a) Hepatitis (b) Fluorosis
(c) Yellow fever (d) Meningitis

21. AIDS is caused by Human Immunodeficiency Virus (HIV) which is
(a) retrovirus (b) DNA virus
(c) Both a and b (d) immune virus

22. Cure to spinal injury is likely to emerge from
(a) gene therapy
(b) stem cell therapy
(c) xenograft
(d) transfusion

23. *Leishmania*, the causative agent of kala-azar, multiplies asexually by
(a) budding (b) binary fission
(c) multiple fisson (d) sporogony

24. Consider the following statements regarding the recent global outbreak of 'Swine Flu'.
(a) The agent of infection is not well-identified
(b) The risk is higher in those who consume pork
(c) It has a propensity to spread from contact with an infected person
(d) Absence of an effective treatment or vaccine makes it risk for global pandemic

25. Which of the following pairs is correctly matched?

Disease		Causative agent
(a) Scabies	–	*Entamoeba histolytica*
(b) Pneumonia	–	*Sarcoptes Rom*
(c) Filaria	–	*Wuchereria bancrofti*
(d) Tetanus	–	*Haemophilus pertussis*

Directions (Q. Nos. 26-29) *The following questions consist of two statements one labelleled Statement I and the other labelleled Statement II. Select the correct answers to these questions from the codes given below.*

Codes

(a) Both Statements are true and Statements II is the correct explanation of Statement I

(b) Both Statements are true, but Statement II is not the correct explanation of Statement I

(c) Statement I is true, but Statement II is false

(d) Statement I is false, but Statement II is true

26. **Statement I** Haemophilia is a genetic disorder.

Statement II Its genes are located in the differential segment of X-chromosome.

27. **Statement I** Malaria is caused by *Plasmodium* sp.

Statement II *Plasmodium* is present in the saliva of female *Anopheles* mosquito.

28. **Statement I** Rabies is a viral disease.

Statement II Filariasis is transmitted by *Aedes* mosquito.

29. **Statement I** Gonorrhoea is a bacterial disease.

Statement II It spreads through sexual contact, common toilets and under clothes.

30. Consider the following pairs.

1. Syphilis – Sexually transmitted disease
2. Tuberculosis – BCG vaccine
3. Typhoid – Widal test
4. Gonorrhoea – Viral disease

Which of these pairs is/are correctly matched?

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

31. Consider the following pairs.

1. Robert Koch — Anthrax bacterium
2. Edward Jenner — Vaccine
3. Pasteur — Rabies

Which of these pairs is/are correctly matched?

(a) Only 1 (b) Only 2
(c) 1 and 3 (d) All of these

32. Which of the following are correctly matched?

1. Tse-tse fly — Sleeping sickness
2. Female *Anopheles* — Malaria mosquito
3. Sand fly — Kala-azar

Codes

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) All of these

33. Consider the following diseases.

1. Typhoid 2. Tuberculosis
3. Diphtheria 4. Filaria

Which of the above diseases is not caused by becteria?

(a) 1 and 4 (b) 2 and 4
(c) Only 4 (d) Only 2

34. Which of the following diseases are preventable by vaccine?

1. Tetanus 2. Polio
3. Leprosy 4. Pertussis

Select the correct answer using the codes given below.

(a) 1 and 3 (b) 2 and 4
(c) 1, 2 and 4 (d) All of these

35. Which of the following diseases are water-borne?

1. Typhoid 2. Cholera
3. Hepatitis-A 4. Tuberculosis

Select the correct answer using the codes given below.

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

36. Match Column I with Column II and select the correct answer using the codes given below.

Column I	Column II
A. Common cold	1. *Haemophilus pertussis*
B. Food poisoning	2. *Rhino Rom*
C. Whooping cough	3. *Streptococcus*
D. Septic sore throats	4. *Clostridium botulinum*

Codes

	A	B	C	D
(a)	2	4	1	3
(b)	2	4	3	1
(c)	4	2	1	3
(d)	4	2	3	1

37. Match the following columns.

Column I (Diseases)	Column II (Pathogen/prevention /treatment)
A. Amoebiasis	1. *Treponema pallidum*
B. Diphtheria	2. Use only sterilised food and water
C. Cholera	3. DPT vaccine
D. Syphilis	4. Use of oral rehydration therapy

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	2	4	1	3
(c)	2	1	3	4
(d)	2	3	4	1

38. Match the following columns and choose the correct option.

	Column I	Column II
A.	*Leishmania donovani*	1. Filariasis
B.	*Trypanosoma gambiense*	2. Kala-azar
C.	*Entamoeba histolytica*	3. Sleeping-sickness
D.	*Wuchereria bancrofti*	4. Amoebiasis

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	4	1	(b)	2	3	1	4
(c)	3	1	2	4	(d)	3	1	4	2

39. Match the Column I with Column II and choose the correct answer.

Column I	Column II
A. Colour blindness	1. RBCs of patient become sickle-shaped
B. Hypertrichosis	2. Inability to produce melanine pigment
C. Albinism	3. Also known as Daltonism
D. Sickle-cell anaemia	4. Excessive hairs on ear pinna

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	2	3	1	4
(c)	3	4	2	1	(d)	3	2	1	4

Previous Years' Questions

40. Which one among the following is not included in the major clinical sign as a cause definition of AIDS in children less then 12 years of age? **2012(II)**

(a) Persistent cough for more than 1 month
(b) Loss of weight
(c) Chronic diarrhoea
(d) Prolonged fever

41. Polio disease is caused by **2012(II)**

(a) bacteria (b) fungi
(c) virus (d) worm

42. After entering the human body through mosquito bite, the malarial parasite (*Plasmodium*) shows initial multiplication in **2012 (II)**

(a) Spinal cord (b) Blood
(c) Liver (d) Spleen

43. Which one among the following water-borne diseases is not caused by a bacteria? **2012 (II)**

(a) Cholera
(b) Bacillary dysentery
(c) Typhoid
(d) Hepatitis-A

44. Consider the following diseases. **2013 (I)**

1. Cholera 2. Tuberculosis
3. Filaria 4. Typhoid

Which of the above diseases are caused by bacteria?

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

45. Which one among the following diseases is not caused by polluted water? **2013 (II)**

(a) Dysentery (b) Jaundice
(c) Typhoid (d) Tuberculosis

46. Which of the following human organs is not associated with immune response? **2013 (II)**

(a) Thymus (b) Brain
(c) Spleen (d) Lymph node

47. Adulteration of which of the following causes dropsy? **2014 (I)**

(a) Ghee (b) Arhar pulse
(c) Mustard oil (d) Turmeric powder

48. Which one among the following is not a sexually transmitted disease? **2014 (I)**

(a) Syphilis (b) Gonorrhoea
(c) Scurvy (d) Hepatitis-B

49. What is 'breakbone fever' most commonly known as? **2014 (I)**

(a) Typhoid (b) Rhinitis
(c) Yellow fever (d) Dengue

50. Leprosy is caused by **2015 (I)**

(a) virus (b) bacteria
(c) protozoan (d) retrovirus

51. Who among the following discovered antibiotic producing fungus from *Penicillium* genus? **2015 (II)**

(a) Louis Pasteur
(b) Sir Alexander Flemming
(c) Stanley Prusiner
(d) Robert Hooke

52. Which one of the following is not a place of action in human body for the malarial parasite *Plasmodium*? **2015 (II)**

(a) Liver
(b) Kidney
(c) Red blood cell
(d) Brain

53. Which of the following pairs of vector and disease is/are correctly matched? **2016 (I)**

Vector		Disease
1. *Anopheles*	—	Malaria
2. *Aedes aegypti*	—	Chikungunya
3. Tse-tse fly	—	Filariasis
4. Bed bugs	—	Sleeping sickness

Select the correct answer using the codes given below

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

ANSWERS

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

09

ECONOMIC IMPORTANCE OF BIOLOGY

Usually 2 to 3 questions are asked from this chapter. These questions are based upon economic importance of plants.

PLANT BREEDING

Plant breeding is the purposeful manipulation of plant species in order to create desired plant types of early maturing, high yielding and disease resistant varieties.

Plant breeding programmes are carried out in systematic way worldwide. In 1960, green revolution was came successfully by plant breedings. Dr. N E Borlaug is known as Father of Green Revolution in world.

Objectives of Plant Breeding

Plant breeding have following objectives

- To increase the yield and quality of crops.
- To develop disease resistant crops.
- To develop crops that are resistant to drought and salt.
- To develop high yielding varieties from less yielding varieties.
- To develop pest resistant crop.

Principles of Plant Breeding

There are following principles of plant breeding

(i) Plant Introduction

- Plant introduction involves introducing plants from their natural habitat to a new habitat .
- This can be done by import or export of sexual or asexual reproductive structures.

(ii) Selection

- Individual plant or group of plants are sorted out from mixed population, thus eliminating undesirable ones.
- The selection methods include mass selection, pure line selection and clonal selection.

(iii) Hybridisation

It is the method of producing new crop varieties, in which two or more plants of unlike genotype (genetically dissimilar) are crossed.

Hybridisation can be

(i) intravarietal, (ii) intervarietal,
(iii) interspecific or intrageneric (iv) intergeneric hybridisation

Hybrid It is an offspring of a cross between two genetically unlike individuals.

(iv) Polyploid Breeding

Polyploid breeding is done to produce plants with extra set of chromosomes.

(v) Induced Mutation

- Mutations are the sudden permanent changes in the genome of organisms. These can be artificially induced with the use of X-ray, β-rays, γ-rays, UV-rays, etc. It can also be induced by chemicals such as mustard gas, etc.
- **H J Muller** (1927) first of induced mutation in *Drosophila melanogaster* using X-rays. Base analogue of thymine is 5-bromo uracil.

(vi) Tissue Culture

- Tissue culture technique is based on the totipotency (i.e. ability of a cell to give rise to whole plant) of plant cell.
- The concept of totipotency was given by **Haberlandt** (1902) and detailed practical applications of totipotency was shown by **Steward** (1932), who developed a complete carrot plant from a root cell.
- The part of plant used to generate whole plant is explant.
- Callus is a mass of cell developed due to redifferentiation in explant.
- Auxin and cytokinin are important in tissue culture.

IMPORTANT POINTS

- **Dr. M S Swaminathan** (Father of Green Revolution in India) developed a high yielding wheat variety Sharbati Sonora by induced mutation in Sonora-64.
- Jaya and Ratna are two rice varieties developed for Green Revolution in India.
- In golden rice, a transgene has been introduced for Vitamin-A production.
- Holstein-Friesin is the highest milk yielding variety of cattle in world.
- Ascariasis is a common disease of cattles.

ECONOMIC ZOOLOGY

The science of rearing, caring, feeding, breeding, improvement and utilisation of domesticated animals is called animal husbandry.

The domesticated animals kept for use or profit are collectively called live stock. Dog was the first domestic animal. The live stock of India can be categorised.

(i) **Milk yielding animals**, e.g. cow, goat, buffalo, etc.
(ii) **Egg yielding animals**, e.g. hen, ducks, etc.
(iii) **Drought animals**, e.g. mule, donkey, etc.
(iv) **General utility animals**, e.g. dog, cat, buffalo, etc.

Fisheries

- Aquaculture involves the production of useful aquatic plants and animals, such as fishes, prawns, crabs, molluscs (edible and pearl oysters).
- Pisciculture is the practice of fish rearing involving proper utilisation of freshwater, brackish water and coastal areas.
- Edible fishes in India are classified as major carps, e.g. Rohu, catla (both freshwater) and eel (marine) and minor carps, e.g. *Calbasu* (freshwater) and *Hilsa* (marine).
- In fish production, India is the second largest nation.
- Fishes are used for oil with vitamin-A and D.
- Clarification of wine and beer can be done by isinglass produced by gall bladder of fish.

Poultry

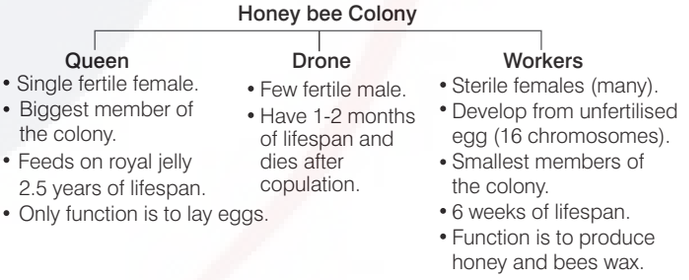
- The term 'poultry' means rearing of fowls, ducks, geese, turkey and some varieties of pigeons, but most often for fowls. Broilers are the poultry birds reared for meat and layers are the females birds raised for egg production.
- India ranks sixth nation in world for egg production.

Poultry Diseases

- Ranikhet disease (new castle disease) is the most common disease affecting the fowls of all ages. In this mortality rate is about 98-100%.
- Infectious coryza disease in poultry birds causes nasal and eye discharges with foul smell, acute respiratory problem and inflammed and swollen eyes.
- Bird flu is an avian influenza, caused by H5N1 virus.

Apiculture

Apiculture (bee-keeping) includes the maintenance of hives of honey bees for the production of honey and bees wax. Honey bees are colonial, socialy polymorphic insects, which shows division of labour.



- In India, the commonly domesticated species are *Apis mellifera* (common European bee) and *Apis indica* (the small Indian bee).
- Honey is acidic in nature. It is composed of sugarcane (sucrose), which then converts into levulose (38.9%), dextrose (21.28%), maltose and other sugars (8.81%).
- Bees wax is a secretory product of hypodermal glands of worker bee's abdomen. It is yellowish to greyish brown coloured insoluble in water and soluble in organic solvents.
- Honey bees are ecologically very important because they act as pollinator for many of our crop plants.

Sericulture

- Sericulture is the phenomenon of rearing of silkworm for commercial production of silk. India ranks second after China among the major silk producing countries of the world. There are five major types of silk produced in India, i.e. mulberry silk, tasar silk, muga silk, eri silk and oak silk.
- The catterpillars (larva) of the silkworm feed on their host tree and their salivary glands secrete liquid (pasty secretion), i.e. silk. Silk contains protein fibroin and sericin in 80:20 ratio.
- This silk when comes in contact with air takes the form of long thread of silk and is wrapped around catterpillar in form of covering called cocoon.
- Silk is obtained from six species of silk worm, i.e. mulberry silkworm (*Bombyx mori*), tasar silk worm (*Antheraea paphia*), muga silk worm (*Antheraea assama*), eri silk worm (*Attacus ricinni*), oak silk worm (*Antherae pernyi*) and giant silk worm (*Attacus altas*).
- *Bombyx mori* (mulberry silkworm) is a well known silkworm used commercially, which feeds on mulberry leaves. Diseases of silkworm are pebrine (protozoan), flacherie (viral or bacterial), muscaridine (fungal) and grasserie (viral).
- Castor, oak and teak leaves are commonly used for rearing silk worms.

Lac Culture

Lac is obtained from Indian lac insect *Tachardia lacca* or *Kerria lacca*. It lives on trees like banyan, sal, palash, beri, etc., and feed on the sap of host trees. The females are without wings, legs and eye. During unfavourable season lac is secreted as a protective covering by females.

In lac 68-90% resin, 2-10% dye, 6% wax, 5-10% albuminous substance and 3-7% mineral are found.

Lac is scrapped from twigs and processed to form shell lac. The shell lac is used in preparation of varnishes, paints, polishes, gramophone records, printing ink, buttons and pots, fillings of ornaments such as bangles and bracelets and as an insulating material.

Pearl Culture

Pearl is secreted by pearl oyster (*Pinctada velgaris*), a member of Mollusca phylum. Pearl is made of $CaCO_3$ and cholkitin. Kokichi Mikimoto is the Father of Pearl Industry. Japan ranks first in the production of pearl.

MICROBES IN HUMAN WELFARE

The main uses of microbes for human welfare are given in the tables.

1. Microbes in Antibiotic Production

Antibiotic	*Sources*
Penicillin	*Penicillium notatum* and *P. chrysogenum*
Streptomycin	*Streptomyces griseus*
Erythromycin	*S. erythreus*
Viomycin	*S. floridae*
Chlorotetracyclin	*S. aureofaciens*
Terramycin	*S. rimosus*

2. Microbes in Enzyme Production

Enzymes	*Organisms*	*Uses*
α-amylase	*Aspergillus* sp.	Laundry detergent
β-amylase	*Bacillus subtilis*	Brewing
Cellulase	*Trichoderma viride*	Fruit juice, coffee and paper
Invertase	*Saccharomyces cerevisiae*	Sweet manufacture
Lactase	*Saccharomyces fragilis*	Digestive aid and sweet manufacture
Oxidases	*Aspergillus niger*	Paper and fabric bleaching
Lipase	*Aspergillus niger* and *Candida lipolytica*	Used in detergent formulations, leather tanning and cheese production
Pectinase	*Aspergillus niger* and *Byssochlamys fulva*	Clarifying bottled fruit juice
Proteases	*Aspergillus oryzae*	Meat tenderiser, leather tanning and clarifying-bottled fruit juice
Rennin (chymosin)	*Mucor* and *E. coli*	Cheese production

3. Microbes in Nutrition

Vitamins	*Organisms*	*Uses*
Vitamin- B_{12}	*Pseudomonas* sp.	Health supplement
Vitamin-B_2 (riboflavin)	*Ashbya gossypii*	Health supplement
Vitamin-C	*Acetobacter* sp.	Health supplement
Proteins	*Chlorella* and *Spirulina*	Food additive

4. Microbes in Dairy Products

Product	*Microbes*
Swiss cheese	*Propionibacterium shermanii*
Roquefort cheese	*Penicillium roquefortii*
Curd	*Lactobacillus*
Yoghurt	*Streptococcus*
Bread	*Saccharomyces cerevisae* (Yeast)

5. **Microbes in Medicines**

- Cyclosporin-A is derived from fungus *Trichoderma polysporum*, it is used as an immuno suppressant.
- Statins that lowers Bad cholesterol are produced from yeast.
- Also insulin, growth hormones, antibodies are produced by microbes.
- Microbes also play important role in genetic engineering.

ECONOMIC BOTANY

Economic botany includes the study of the utilisation of economically important crops such as cereal crops, vegetable, pulses, etc.

Crop

On the basis of season, crops are of the following types

(i) **Kharif Crop** These crops are grown in the rainy season, i.e. from June to September, e.g. maize, bajra, red gram, paddy, soyabean, groundnut, cotton, millets, sarghum, moong bean, sugarcane as well tea, coffee, etc. These are called summer or monsoon crops.

(ii) **Rabi Crop** These are grown in the winter season, i.e. from October to March, e.g. wheat, barley, mustard, pea, seasame, green gram, linseed, etc.

Some Economically Important Crops

Following are economically important crops

Cereals

- The cereals are the most important source of food for human beings.
- Cereals are rich in carbohydrates, but also contain considerable amount of proteins, fats, vitamins and minerals.
- Paddy, wheat, maize, barley, oat and rye are cereals or true cereals. All of these belong to family–Poaceae.
- Fruit of cereals is caryopsis.

There are some true cereals namely

(i) **Rice** (*Oryza sativa*) Rice contains 90% carbohydrates and 8-10 % proteins. Its varieties are basmati, Krishna Kaveri, Sona, IR-36, etc.

(ii) **Wheat** (*Triticum aestivum*) Its varieties are Lerma Roja, Sonora-64, Sonalika, etc.

(iii) **Maize** (*Zea mays*) Its varieties are Amber, Deccan, etc.

(iv) **Oat** (*Avena sativa*) Its varieties are Bonda, Cocker, etc.

- ***Triticale*** is the first man-made cereal made by crossing wheat and *Secale*.

Sugars

- Presently, world gets major supply of sugar from the culms of sugarcane (*Saccharum officinarum,* family–Poaceae).
- A small portion of sugar is obtained from sugarbeet root (*Beta vulgaris,* family–Chenopodiaceae).
- Sugar obtained from sugarcane and sugarbeet is sucrose.

Paper

- Paper is a cellulosic product. Fibrous plants are used to make paper, cloth, rope, etc.
- About 97% of world's paper is made from pulp of wood. Of it, 85% is derived from conifers (non-flowering plants) especially spruces (*Picea* sp.), fir (*Abies* sp.) and pines (*Pinus* sp.).
- In India, chief sources of raw material for paper is bambusa (*Bambusa arundinacea* and *Dendrocalamus strictus*).

Legumes and Pulses

- These are all members of family–Leguminosae (Fabaceae).

Some of the important pulses are

(i) Gram or chick pea (*Cicer arietinum*)
(ii) Pigeon pea or Arhar (*Cajanus cajan*)
(iii) Soyabean (*Glycine max*)
(iv) Pea (*Pisum sativum*)
(v) Groundnut (*Arachis hypogea*)

- Pulses contain 17-30% protein on a dry weight basis. Soyabean (42% protein) occupies top position among the protein rich legumes.
- Folic acid can be obtained from sprouted pulses.
- Pulses also contain carbohydrates upto 60% in the form of starch. Fat content is very low (1-2%) except soyabean, where it is high (up to 20%).
- Legumes are usually preferred for mixed cropping to enhance the bioavailability of nitrogen, e.g. gram.
- Folic acid can be obtained from sprouted pulses.
- Riboflavin, niacin and thiamine, vitamins are also present in pulses and legumes.

Vegetables

- India is a major producer of vegetables as well as fruits due to different varieties and variation in its agroclimatic conditions.
- Vegetables are rich in vitamins and mineral salts.
- Carotene (a precursor of vitamin-A) is abundant in cabbage, carrot, green peppers, raw tomatoes, spinach, pumpkin and sweet potato.
- Among vegetables vitamin-C is found in tomatoes, peppers, potatoes, cabbage, bitter gourd, onion, etc.
- Green vegetables like spinach are rich in vitamin-E.
- Brinjal is good source of iron.
- Vegetables of wild cabbage are kale, broccoli, kohlrabi.
- Turmeric is rich in natural pigment curcumin.

Fruits

- Fruit is ripend ovary enclosing seeds.
- All fruits developing from a part other than ovary of inferior ovary are false fruit.
- Fruits are juicy (water content upto 96%). Fruits are inferior in food value, but banana and dates are rich sources of energy, i.e. carbohydrate.
- Usually, the fruits are good sources of mineral and vitamins.
- Banana, mango, citrus are indigenous to India.
- Majority of cultivated fruits belongs to two families– Rosaceae followed by Rutaceae.
- Amla is the richest source of vitamin-C.
- Saffron is obtained from dried stigmas.

Edible Parts and Kinds of Some Common Fruits

Fruit	*Type of fruit*	*Edible part*
Apple, pear, loquat	Pome	Fleshy thalamus
Banana	Berry	Mesocarp and endocarp
Custard apple	Etaerio of berries	Fleshy pericarp of individual berry
Cashew nut	Nut	Stalk and cotyledons
Coconut	Drupe	Endosperm
Cucumber	Pepo	Mesocarp, endocarp and placenta
Date palm	Berry	Fleshy pericarp
Guava	Berry	Thalamus and pericarp
Grapes	Berry	Pericarp and placenta
Lady's finger	Capsule	Pericarp and seed
Lemon/Orange	Hesperidium	Juicy placental hair
Maize, wheat, rice, barley	Caryopsis	Entire fruit
Mango	Drupe	Mesocarp
Papaya	Berry	Mesocarp
Pea, bean	Legume	Cotyledons and embryo
Pineapple	Sorosis	Bracts, perianth and receptacle
Tomato	Berry	Mesocarp and placenta

Oils and Fats

Oils obtained from plants, are of two types

(i) **Essential oils** Essential oils are aromatic and volatile. These contain terpenes, sulphuretted oil, oxygenated oils. These are useful in attracting insects and repel enemies.

(ii) **Fatty oils** Fatty oils present in plants are of three types
  (a) Non-drying oil
  (b) Drying oil
  (c) Semi-drying oil

- Fats are solid/semisolid at room temperature. These are edible and are used in manufacturing soap and candles.

Oil	*Uses*
Olive oil	Cooking, cosmetics pharmaceuticals also used as a fuel
Mustard oil	Cooking
Soyabean oil	Cooking
Coconut oil	Cooking, medicine, industry
Groundnut oil	Making soaps, as massage oil

Woods

- It is mainly secondary xylem formed by vascular cambium during secondary growth. The main function of the inner bark of a woody plant is to transport.
- Cricket bats are manufactured from the wood of *Salix alba* (Willow).
- Matchsticks and matchboxes are made of *Salmalia malabarica, Boswellia serrate*.
- Hocky sticks, tennis and badminton rackets, cricket stumps are made of *Morus alba* (shatoot), while pencils from the wood of *Adina cordifolia, Juniperus* sp., etc.
- The wood produced by gymnosperm plants is commercially known as soft wood.

Spices and Condiments

- They are generally hard parts of plants used in pulverised state for flavour.
- They can be obtained from different parts of plants, e.g.
  (i) Turmeric, ginger from underground dried rhizomes.
  (ii) Clove (laung), saffron (kesar) from dry stigma of flower.
  (iii) Black pepper, coriander, fennel (saunf) from fruits.
  (iv) Mint (pudina), peppermint from leaves.
  (v) Cardamom (elaichi) and fenugreek (methi) from seeds.

MEDICINAL PLANTS

- **Hippocrates** is called the Father of Medicine.
- Depending upon the plant organ from, which the drug is obtained, the drug plants are divided into following categories

Drugs Obtained from Roots

- Belladona from *Atropa belladona.*
- Atropine alkaloid is obtained and used for dilating pupil of eye.
- Serpentine from *Rauwolfia serpentina.*
- About 30 alkaloids are obtained and out of which reserpine alkaloid is most important one having sedative influence.
- Ashwagandha from *Withania somnifera*.
- It is used in treatment of rheumatic pain, inflammation of joints, ulcers and to promote healing processes.

Drugs Obtained from Leaves

- Tulsi from *Ocimum sanctum.*
- Its leaf juice is given in cold, cough and chronic fever.

Drugs Obtained from Fruits and Flowers

- Opium from *Papaver somniferum*. It has great medicinal value.
- Saffron (kesar) from *Crocus sativus*. The dried stigmas and apps of the style are medicinally used. Lingeng is obtained from true ginseng. Acts as etinvlent and treat stomachache.

IMPORTANT POINTS

- Dropsy is a disease caused when adulterated ghee is consumed.
- Apple, almond, banana, tea, mango, wheat, onion, cotton, etc., are **old world** crops.
- Maize, potato, sweet potato, tobacco, tomato, groundnut, pumpkin, etc., are **new world** crops.
- Lentil, cowpea and sunnhemp are used as green manure.
- Based on calorific content
  rice → sugar → potato → banana.

PRACTICE EXERCISE

1. Which of the following enzyme is produced by *Aspergillus*?
(a) d-amylase (b) Lipase
(c) Cellulase (d) Both (a) and (b)

2. The enzyme produced by *Aspergillus oryzae* and used for leather tanning is
(a) pectinase (b) protease
(c) lactase (d) invertase

3. Vitamin-B_{12} is produced by
(a) *Pseudomonas* (b) *Ashbya gossypii*
(c) *Acetobacter* (d) *Chlorella*

4. An immuno suppressant is
(a) cyclosporin-A (b) statin
(c) penicillin (d) Both (a) and (c)

5. Statins that lower bad cholesterol are produced by
(a) a fungi (b) a bacteria
(c) algae (d) mycoplasma

6. A microbe used as protein supplements is
(a) *Chlorella* *(b) Ashbya*
(c) *Spirulina* (d) Both (a) and (c)

7. β-amylase used in brewing industry is obtained from
(a) *Bacillus subtilis* *(b) S. cerevisiae*
(c) *E. coli* *(d) A. niger*

8. The female birds raised for egg production are called as
(a) layers (b) broilers
(c) Both (a) and (b) (d) None of these

9. Bird flu is caused by
(a) H1N1 virus (b) H3N1 virus
(c) H1N3 virus (d) H5N1 virus

10. Carotene is abundantly found in
(a) carrot (b) tomato
(c) bitter gourd (d) radish

11. Bees wax, which is yellowish to greyish brown coloured byproduct of bee-keeping is
(a) soluble in water and partially soluble in organic solvent
(b) Insoluble in water and partially soluble in organic solvent
(c) insoluble in water and completely soluble in organic solvent
(d) completely soluble in water as well as organic solvent

12. The queen honey bee after mating lays down two types of eggs, i.e. fertilised diploid (with 32 chromosomes) and the other one is
(a) unfertilised diploid (with 32 chromosomes)
(b) ferilised haploid (with 32 chromosomes)
(c) unfertilised haploid (with 16 chromosomes)
(d) larvae

13. Chemically silk fibres are predominantly
(a) protein (b) carbohydrate
(c) complex lipid
(d) mixture of polysacchride and fat

14. Clarification of wine and beer can be done by the help of isinglass, which is mainly produced by
(a) liver of fish
(b) pancreas of fish
(c) larva of silkworm
(d) gall bladder of fish

15. *Bombyx mori* is a
(a) fish (b) silkworm
(c) ringworm (d) moth

16. Which one of the following plants is used for green manuring in India?
(a) Wheat (b) Sunnhemp
(c) Cotton (d) Rice

17. Highest milk yielding variety of cattle in world is
(a) brown jersey (b) ongole
(c) holstein-friesin (d) hallikar

18. Which of the following disease is not found in cattle?
(a) Athlete's foot
(b) Ranikhet
(c) Both (a) and (b)
(d) Ascariasis

19. Which of the statement is correct?
(a) Pulses contains 80% carbohydrates
(b) Rice contains 90% carbohydrates and 8-10% proteins
(c) Rice contains 60% carbohydrates and 35-40% proteins
(d) Rice contains 70% carbohydrates and 25-30% proteins

20. Which one of the following is a marine fish?
(a) Rohu (b) Hilsa
(c) Catla (d) Common Carp

21. Plant breeding methods by which new and better varieties of plant can be formed
(a) hybridisation (b) selection
(c) introduction (d) All of these

22. Name the sugars present in honey.
(a) Levulose (b) Maltose
(c) Dextrose (d) All of these

23. *Bombyx mori* is a
(a) eri silkworm (b) mulberry silkworm
(c) tasar silkworm (d) muga silkworm

24. What is/are the characteristics of honey bees?
(a) Colonial
(b) Socially polymorphic
(c) Show division of labour
(d) All of the above

25. The man-made cereal made by crossing *Triticum* with *Secale* is
(a) *Triticale* (b) *Triticum aestivum*
(c) Jaya (d) Ratna

26. The genetically engineered 'Golden rice' is rich in which of the following?
(a) Vitamin-A
(b) β-carotene and folic acid
(c) β-carotene
(d) Vitamin-A and niacin

27. Which one of the following is an example of legume?
(a) Amla (b) Groundnut
(c) Wheat (d) Brinjal

28. Which of the following pairs is the source of vitamin-C?
(a) Milk, papaya (b) Tomato, cabbage
(c) Milk, carrot (d) Both (b) and (c)

29. What is the reason for India being a major producer of different varieties of fruits and vegetables?
(a) Its large population size
(b) Its large land area
(c) Variation in its agro-climatic conditions
(d) Diversity in socio-cultural phenomenon

30. Which part of saffron plant is used to obtain the spice 'saffron'?
(a) Dry stigma (b) Leaves
(c) Fruits (d) Petals

31. Consider the following crops
1. Cotton 2. Groundnut
3. Rice 4. Wheat
Which of these are cereal yielding crops?
(a) 1 and 4 (b) 3 and 4
(c) 1, 2 and 3 (d) 2, 3 and 4

32. Consider the following plants.
1. Lentil 2. Cowpea
3. Sunnhemp 4. Wheat
Which of the plnats given above is/are used as 'green manure in India'?
(a) Only 3 (b) 1, 2 and 3
(c) 2 and 3 (d) 1, 2, 3 and 4

33. With references to human nutrition, consider the following statements.
1. Milk is a source of phosphorus.
2. Groundnuts provide iron.
3. Folic acid can be obtained from sprouted pulses.
4. Vitamin-E is available in green leafy vegetables.
Which of these statements are corrects?
(a) 1 and 2 (b) 2, 3 and 4
(c) 1, 3 and 4 (d) 1, 2, 3 and 4

34. Arrange the following in ascending order of calorific content per 100 g and choose the correct answer.
1. Banana 2. Sugar
3. Rice 4. Potato
(a) 2, 3, 1, 4 (b) 3, 2, 4, 1
(c) 2, 4, 3, 1 (d) 3, 4, 2, 1

35. Match the following columns.

Column I	Column II
A. Swiss cheese	1. *Penicillium roquefortii*
B. Roquefort cheese	2. *Propioni bacterium*
C. Curd	3. Yeast
D. Bread	4. *Lactobacillus*

Codes

	A	B	C	D		A	B	C	D
(a)	3	1	4	2	(b)	2	4	1	3
(c)	2	1	4	3	(d)	1	4	3	2

36. Match the following columns.

Column I	Column II
A. Totipotency	1. Part of a plant grown *in vitro*.
B. Callus	2. Undifferentiated tissue.
C. Explant	3. Capacity of a cell to produce whole plant.

Codes

	A	B	C		A	B	C
(a)	2	1	3	(b)	1	2	3
(c)	3	2	1	(d)	3	1	2

37. Match the following columns.

Column I	Column II
A. Chick pea	1. *Cajanus cajan*
B. Pea	2. *Pisum sativum*
C. Soyabean	3. *Glycine max*
D. Pigeon peas	4. *Cicer arietinum*

Codes

	A	B	C	D		A	B	C	D
(a)	1	4	3	2	(b)	1	2	3	4
(c)	4	2	3	1	(d)	4	3	1	2

38. Match the following columns.

Column I	Column II
A. Mango	1. Thalamus
B. Apple	2. Mesocarp
C. Litchi	3. Endosperm
D. Coconut	4. Fleshy aril

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	4	3	(b)	2	1	3	4
(c)	2	1	4	3	(d)	4	3	1	2

39. From which part of turmeric, is the turmeric powder obtained? **2013 (II)**
(a) Dried rhizome (b) Dried root
(c) Dried fruit (d) Seed

40. Leaves of which of the following plants are not used for the rearing of silkworms? **2014 (I)**
(a) Mulberry (b) Castor
(c) Oak (d) Teak

41. Which one of the following is useful in paper manufacturing industry? **2015 (II)**
(a) Fibrous plants (b) Orchids
(c) Non-flowering plants
(d) Plants growing in high altitude

ANSWERS

1	***d***	2	***b***	3	***a***	4	***a***	5	***a***	6	***d***	7	***a***	8	***a***	9	***d***	10	***a***
11	***c***	12	***c***	13	***a***	14	***d***	15	***b***	16	***a***	17	***c***	18	***c***	19	***b***	20	***b***
21	***d***	22	***d***	23	***b***	24	***d***	25	***a***	26	***a***	27	***b***	28	***b***	29	***c***	30	***a***
31	***b***	32	***b***	33	***c***	34	***b***	35	***c***	36	***c***	37	***c***	38	***c***	39	***a***	40	***a***
41	***a***																		

10

ECOLOGY, BIODIVERSITY AND ENVIRONMENT

Generally 1 to 2 questions are asked from this chapter. These questions are based upon pollution of atmosphere.

ECOLOGY

Ecology (*Oikas* = living place and *logos* = study). It is the science dealing with the study of organisms and their relations to the environment. **Haeckel** defined ecology as the branch of biology, which deals with the organisms (living beings) and their mutual relationship with surroundings (atmosphere). **Reiter** first used the term 'ecology' in 1868. **Prof R Misra** is known as Father of Ecology in India.

Ecology can be studied under the following two groups

(i) **Autecology** It is the ecology of a single species, i.e. the relations between that species and its environment.

(ii) **Synecology** It is the ecological study of interrelationships among communities of organism of any specific region. It includes population ecology, community ecology, ecosystem ecology.

ECOSYSTEM

- Term ecosystem was first given by **AG Tansley** (1935).
- The system arising out of interactions between living and non-living components of environment is called **ecosystem**.

Components of Ecosystem

An ecosystem consists of two components as described below

1. **Abiotic Components** Abiotic components mean non-living factors and some of these are mentioned below
   (i) **Physical components**, e.g. temperature, water, air, etc.
   (ii) **Inorganic matter**, e.g. nitrogen, carbon, potassium, etc.
   (iii) **Organic matter**, e.g. proteins, carbohydrates, lipids, etc.
2. **Biotic Components** Biotic components include all the living organisms present in ecosystem. These components are broadly divided into following three categories
   (i) **Producers** (Autotrophs) These are organisms, which can prepare their own food (from simple inorganic substances like carbon dioxide and water) by using sunlight in the presence of chlorophyll, e.g. green plants and certain blue-green algae. Thus, solar energy is the driving force of an ecosystem.
   (ii) **Consumers** (Heterotrophs) These are organisms, which feed on other organisms or their parts.

- They can be of three types, i.e. **primary consumers** consume mainly producers, **secondary consumers** consume mainly primary consumers, **tertiary consumers** consume secondary consumers.
- **Omnivores** Those organisms that consume both producers and other consumers.
- **Detritivores** Those organisms that consume detritus (the tissues of dead organisms, either producers or consumers and organic wastes).

(iii) **Decomposers** (Reducers) These are organisms, which feed on dead bodies of organisms and organic wastes of living organisms, e.g. termites, beetles, becteria, saprophytic bacteria, fungi (mushrooms), etc.

Types of Ecosystem

These are of two types

(i) **Natural Ecosystem** The natural ecosystems are forests, deserts, grassland (terrestrial) and ponds, lakes, wetland (aquatic), etc. The aquatic ecosystems can be of three types
  (a) **Lentic**, e.g. lake
  (b) **Lotic**, e.g. river, streams
  (c) **Marine,** e.g. oceans, sea

(ii) **Artificial** (Man-made) **Ecosystem** The man-made ecosystems are gardens, aquariums, crop fields, etc.

Energy Flow in Ecosystem

- In an ecosystem, energy is transferred in the form of food and it leads to degradation and loss of a major part of food energy as heat during metabolic activities and very small fraction becomes stored as biomass. The flow of energy from the sun to producers and then to consumers is unidirectional.
- **Lindeman** (1942) proposed that energy flow in ecosystem follows 10% law. According to this law 10% energy is transferred from one level to another. It is because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step.
- Energy flow is also dependent upon laws of thermodynamics.

Food Chain

Process of transfer of energy from producers through a series of organisms to consumers. It includes a chain of organisms that feed upon each other.

Grass (Producer) —Eaten by→ Rabbit (Primary consumer or herbivore) —Eaten by→ Hawk (Secondary consumer or carnivore)

In nature, three major types of food chains are

(i) **Grazing food chain** starts with green plants, which are eaten by herbivores, which in turn are eaten by carnivores.

(ii) **Detritus food chain** starts with dead organic matter acted upon by decomposers.

(iii) **Parasitic food chain** starts with big organisms, which in turn are eaten by small ones.

Food Web

- Various food chains are interconnected with each other forming an interlocked system, which is known as food web.
- Food webs are very important in maintaining equilibrium of ecosystem.

Trophic Level

It is a specific position of an organism in the food chain, according to their feeding relationships with other organisms. Generally, green plants form the first trophic level, (the producers). Herbivores form the second trophic level, while carnivores and omnivores form the third and even the fourth trophic levels.

TEN PER CENT LAW

The Ten Per Cent Law for the transfer of energy from one trophic level to the next was introduced by Lindeman and also known as 'Lindeman's rule'. According to this law, during the transfer of energy as organic food from one trophic level to the next, only about 10% of the energy is transferred to each trophic level. The remaining is lost during transfer, respiration or incomplete digestion, etc.

Ecological Pyramids

- Trophic structure of ecosystem is a type of producer-consumer arrangement and the graphical representation of trophic structures of ecosystem constitute ecological pyramids.
- The concept of ecological pyramid was given by **Elton** in 1927.
- Each food level is also called **trophic level**.

Ecological pyramids are of three types

(i) **Pyramid of Number** Number of individuals at each trophic level is shown in pyramid. Its pyramid may be upright in grassland and pond ecosystem, intermediate in forest ecosystem and inverted in parasitic food chain.

(ii) **Pyramid of Biomass** Where biomass of each trophic level is shown in pyramid. This pyramid may be upright in grassland and forest ecosystem, whereas inverted in pond ecosystem.

(iii) **Pyramid of Energy** Where energy content or productivity of different trophic levels is shown in pyramid. This pyramid is always upright in all ecosystems.

Ecological Succession

It is a phenomenon or process by which an ecological community undergoes more or less orderly and predictable changes following disturbance or initial colonisation of new habitat. Succession was first studied by **King** (1685) and **George-Buffon** (1742). After the establishment of an ecological community at any specific place, the process of evolution continues in it.

Types of Succession

There are mainly two types of ecological succession

(i) **Primary Succession** In this type, an ecological community is developed in the areas where no living organisms ever existed, e.g. sandy land, rocks of stone, etc.

(ii) **Secondary Succession** In this, an ecological community is developed in the regions where ecological community was earlier present, but whose existence has been destroyed, e.g. to destroy a forest through fire, but again reappearance and development of a new forest community.

Productivity in an Ecosystem

- The rate of biomass production by producers is called **gross primary productivity**.
- The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis is called as **primary productivity** and it is expressed in terms of weight (g^{-2}) or energy (kcal m^{-2}).
- The rate of formation of new organic matter by consumers is called as **secondary productivity**.
- Net primary productivity = Gross primary productivity – Energy released in respiration.
- The annual net primary productivity of the whole biosphere is approximately 170 billion tons of organic matter.

Ecological Interactions

The relationship between organisms in an ecosystem is known as ecological interactions. The negative type of interactions are predation and competition, and positive interactions are mutualism, commensalism, amensalism and parasitism, etc.

Some Ecological Relationships and their Occurrence

Relationships	*Occurring between*
Commensalism	One organism benefits without affecting the other, e.g. orchids, runners.
Mutualism	Two organisms of different species, in which each individual derives a fitness benefit, e.g. lichens, coralloid roots in *Cycas*.
Parasitism	Non-functional relationship between organisms of different species where one organism (parasite) benefits from another (host), e.g. *Cuscuta*.
Predation	Predator prey (organism that hunts)— Prey (organism that is hunted).
Competition	Living things for resources such as food, space, shelter, mate, ecological status, etc.
Amensalism	Product of one organism has a negative effect on other organism.

Commensalism and mutualism are positive interactions, while others are negative interactions.

BIOGEOCHEMICAL CYCLES

The term nutrient cycle or biogeochemical cycle is used for the exchange/circulation of biogenetic nutrients between the living and non-living components of the biosphere. Biogenetic nutrients or biogeochemicals are essential elements required by the organisms for their body building and metabolism.

1. Nitrogen Cycle

It includes following steps

(i) **Nitrogen-Fixation** It is the process of converting atmospheric nitrogen into water soluble nitrates and nitrites. This is done by nitrogen-fixing bactria (e.g. *Azotobacter*, *Clostridium* and *Rhizobium).*

(ii) **Nitrogen Assimilation** It is carried out by plants. Plants absorb nitrate and nitrites and form amino acids, that are used to make proteins.

(iii) **Ammonification** It is the process of production of ammonia either by the decomposition or breakdown of dead and complex organic matter or by degradation of animal excreta.

(iv) **Nitrification** It is the process of conversion of ammonia into nitrites and then into nitrates, by nitrifying bacteria (e.g. *Nitrosomonas* and *Nitrobacter*).

(v) **Denitrification** It is the process of reducing nitrates or ammonia, present in the soil to molecular nitrogen (N_2).

2. Carbon Cycle

The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere and atmosphere of the earth. The carbon cycle was initially discovered by **Joseph Priestley** and **Antoine Lavoisier**.

3. Oxygen Cycle

It is the biogeochemical cycle that describes the movement of oxygen within its three main reservoirs, the atmosphere, the total content of biological matter within the biosphere and the lithosphere.

4. Phosphorus Cycle

It is the biogeochemical cycle that describes the movement of phosphorus through the lithosphere, hydrosphere and biosphere. Unlike other biogeochemical cycles, atmosphere does not play a significant role in the movement of phosphorus.

5. Sulphur Cycle

The sulphur cycle is the collection of processors by which sulphur moves to and from minerals and living systems. Steps of sulphur cycle include mineralisation of organic sulphur into organic forms such as hydrogen sulphide, oxidation of hydrogen sulphide to sulphate, reduction of sulphate to sulphide and lastly incorporation of sulphide into organic compounds.

6. Water Cycle

- The water cycle is also known as the hydrological cycle or water cycle. The water constantly circulates through evaporation, condensation and precipitation and the nutrients dissolved in water also circulate within it. It describes the continuous movement of water on, above and below the surface of the earth.
- The water cycle influences climate, which leads to temperature changes. Human activites that alter the water cycle includes agriculture, industry, dams, urbanisation, use of ground water, etc.

BIODIVERSITY

Biodiversity refers to the variety and variability of living organisms on the planet earth. It can also be defined as the variety of life forms, gene pools and habitats found in an area. The term 'Biodiversity' was popularised by socio-biologist **Edward Wilson** to describe the combined diversity at all the levels of biological organisations. In 1992, UNO organised a summit in Rio De Janeiro, Brazil to concern about biodiversity. 172 countries took part in that summit. It is also known as Earth summit.

Levels of Biodiversity

Following are the levels of biodiversity

(i) Genetic diversity
(ii) Species diversity
(iii) Ecosystem diversity

Importance of Biodiversity

Biodiversity is important as it is a major resource for various services such as food, medicines, habitat, soil, preservation of soil, recycling of wastes, pollination of crops, ecological balance, etc.

Mapping Species Biodiversity

The first attempt of mapping biodiversity was made by **Brits, Paul Williams, Decair Right** and **Chris Humpreger**.

Mainly three types of diversity were taken into consideration while mapping, such as

(i) **Alpha diversity** helps in analytical study of biodiversity in various regions.
(ii) **Beta diversity** is associated with the comparison of biodiversity between ecosystem
(iii) **Gamma diversity** is the rate of change of species with the expanding geographical region.

Loss of Biodiversity

- IUCN (International Union for Conservation of Nature and Natural Resources), Red List (2004) documented the extinction of 784 species (338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years.
- Dodo (Mauritius), and three subspecies (Bali, Javan and Caspian) of tiger are the examples of recent extinction.
- About 27 species have been extincted during last 20 years. Some groups like amphibians appear to be more vulnerable to extinction.

Causes of Biodiversity Loss

The major causes of biodiversity loss (The Evil Quartet) are

(i) Habitat loss and fragmentation
(ii) Overexploitation
(iii) Alien species invasions
(iv) Coextinctions

Biodiversity Conservation

Conservation of biodiversity is protection and scientific management of biodiversity to maintain it at its optimum level and derive sustainable benefits for the present as well as future strategies. There are two ways of conserving the biodiversity.

1. *In Situ* Conservation

It is the conservation of living resources through their maintenance within the natural ecosystems, in which they occur. It includes following systems

(i) National Parks

- A national park is an area strictly reserved for the protection and welfare of wildlife. In India, there are 120 national parks. The first national park in the world, the 'Yellowstone National Park' was founded in 1872 in USA.
- In 1935, the first national park of India was established in the foothills of the Himalayas (Hailey National Park) presently known as **Corbett National Park**. A total of 166 national parks have been authorised. Plans are underway to establish the remaining scheduled parks.

(ii) Sanctuaries

These are notified for the protection of wild animal and fauna. In India, there are over 500 sanctuaries in different states. Among these, the 28 tiger reserves are governed by Project Tiger, one of special significance in the conservation of the tiger. Some wildlife sanctuaries are specifically named bird sanctuary.

(iii) Biosphere Reserves

- The concept of biosphere reserves was launched under MAB programme of UNESCO (started in 1975). Biosphere reserve programme was started in India in 1986. Total biosphere reserves in India are 14.
- The first biosphere reserve established in 1986 was 'Nilgiri Biosphere Reserve'. A biosphere reserve is made of core, buffer and manipulation zone.
- **MAB** stands for Man and Biosphere programme.

2. *Ex Situ* Conservation

It means, conservation outside the habitats by perpetuating sample population in genetic resource centres. It usually includes zoos, botanical garden, etc., e.g. 'Royal Botanical' Garden Kew, England is the largest botanical garden. Now, some newer techniques are also used.

These are as follows

(i) **Seed and Pollen Banks** The seeds and pollens have germplasm stored in them. Thus, they act as genetic resources. These can be stored by keeping them in –196°C in liquid nitrogen. This method is known as cryopreservaion.

(ii) **Tissue Culture** It can be extended to endangered species as well as those, which may orherwise require very rapid climatic condition and can be maintained at one place in aseptic culture.

(iii) **Gene Bank** Genes of plants are stored in gene banks from which whole plant can be generated. In India, NBPGR, Delhi is the main centre for gene conservation.

Hotspots

These are areas that are extremely rich in species diversity, have high endemism and are under constant threat.

The biodiversity hotspots were first proposed by **Norman Myers** in 1988. There are currently 25 hotspots in the world. India has two hotspots, i.e. one in Eastern Himalayas and other in Western Ghats.

Forests

- A forest is an area with many trees. They are very important and grow all over the world.
- Temperate or dry deciduous forests, i.e. having 70-150 cm annual rainfall. Teak, neam, peepal, sal are main varieties.
- Temperate coniferous forests, i.e. cold climate with high rainfall. Spruce, cedar, pine trees are most common varieties.
- Temperate evergreen woodland (Chaparrals), i.e. Mediterranean type climate with warmth.

Red Data Book

- A Red Data Book or Red List is a catalogue of taxa facing risk of extinction. International Union of Conservation of Nature and Natural Resources (IUCN) maintains it.
- Red Data Book or Red List was initiated in 1963 and first published on 1st January 1972.
- According to recent IUCN red list great Indian bustard, Siberian crane, Baer's pochard and Nilgiri mystees are critical endangered.

Some International and National Organisations

MNHS	Mumbai Natural History Society
CITES	Convention on International Trade in Endangered Species of wild Fauna and Flora
IBWL	Indian Board for Wildlife
NWAP	National Wildlife Action Plan
UNCED	United Nations Conference on Environment and Development
WPSI	Wildlife Preservation Society of India
WWF	World Wildlife Fund
NEERI	National Environment Engineering Research Institute

Environment

Environment means the surrounding and everything around us. It includes physical conditions like air (atmosphere), water (hydrosphere) and land (lithosphere) and the biological conditions like plants, animals, human beings, microorganisms (like bacteria, fungi, etc.) and their interrelationships.

Atmosphere of Earth

- Atmosphere of earth is in the form of gaseous layer that surrounds the planet.
- It is retained by earth's gravity.
- The atmosphere protects the life forms from ultraviolet solar radiation, greenhouse gases, etc.
- The atmospheric gases, in common term are collectively known as air.
- Components of air are nitrogen (78.09%), oxygen (20.95%), carbon dioxide (0.039%) and small amount of other gases.
- Air also contains a variable amount of water vapours, on an average of about 1%. Air content and pressure vary at different layers of atmosphere. It has different density at different height from sea level, which result in the formation of several layers. The atmosphere around earth is warm. It may be because of radiations from earth.

These layers are as follows

(i) **Troposphere** It is the lowest layer of atmosphere, extending up to a height of 18 km. It is a turbulent and dusty zone, which contains air (N_2, O_2, CO_2) much water vapour and clouds. The temperature in this region ranges from 15°C to 50°C. It is suitable for living systems like terrestrial plants and animals.

(ii) **Stratosphere** It lies between 18-60 km above the sea level. In this region, temperature starts to rise from –50°C to about 10°C, therefore tropopause is the point, at which temperature inversion occurs.

In stratosphere, ozone layer is present, which absorbs most of the ultraviolet radiation emitted by the sun and thus, protects the humans and other living things from it.

(iii) **Mesosphere** This region extends from 60-85 km. In this region, temperature decreases with height and reaches to –90 to –100°C. That's why, when any meteors enter in mesosphere, it burns up.

(iv) **Ionosphere** The ionosphere is a region of the upper atmosphere, from about (85-600 km) altitude.

POLLUTION

- **Odum** defined the term 'pollution', as undesirable change in physical, chemical and biological properties of air, water and soil, which directly or indirectly affect human beings.
- Pollution causing agents or substances are called **pollutants**. Pollutants can be primary or secondary, PAN is a secondary pollutant.

Pollutants are of two types

(i) **Biodegradable**, e.g. dung, plant debris, human dead bodies, etc.

(ii) **Non-biodegradable**, e.g. DDT, BHC, plastics, glass, etc.

Types of Pollution

Pollution can be classified into the following four groups; air pollution, water pollution, soil or land pollution, and sound or noise pollution.

Air Pollution

- Air pollution is undesirable change in physical, chemical and biological property of air.
- It occurs due to excess of different gases, smoke, particulate matters, chemicals, allergens, etc.
- Important primary air pollutants are CO, lead, benzene, SO_2, NO_2, HF, etc.
- Secondary air pollutants are Ozone (O_3), Peroxy-Acetyl Nitrate (PAN), etc.
- Secondary air pollutants are main components of photochemical smog.
- SO_2 is produced due to combustion of fossil fuels.
- Lichens are indicators of air pollution as they can only grow in purified environment. Specifically SO_2 pollution is indicated by lichens (the symbiosis plant between algae and fungi).
- Excess of sulphites is the cause of SO_2 injury in plants.
- SO_2 above 1 ppm affects human beings in terms of irritation of eyes, respiratory tract, bronchitis, asthma, etc.
- Maximum SO_2 pollution in India occurs in Kolkata.
- Yellowing and blackening of Taj Mahal in Agra is due to SO_2 released by Mathura refinery. This type of pollution is called '**stone cancer**'.
- The mixing of SO_2 and NO_2 with rain water may cause acid rain.
- The term acid rain was coined by **R August** (1872).
- Acid rain have a pH of less than 5.
- It is caused by large scale emission of nitrogen oxides (NO_2), SO_2 and HCl from thermal power plants, industries and automobiles.
- **Bhopal gas tragedy** It took place in Bhopal on 2nd December, 1984. It was a cause of case serious air pollution that occurred due to release of MIC (Methyl Isocyanate) from insecticide factory of union carbide. It took the life of nearly 8200 people.
- Diseases caused by air pollution are bronchitis, asthma, COPD (Chronic Obstructive Pulmonary Disorder) lung cancer, allergy, etc.

Water Pollution

- It is mainly caused by industrial waste, sewage and other wastes.
- Degree of water pollution is measured in terms of BOD (Biochemical Oxygen Demand).
- If BOD is less than 1500 mg/L it indicates less pollution.
- If BOD is 1500-4000 mg/L it indicates medium pollution.
- If BOD is more than 4000 mg/L it indicates high pollution.
- Mercury (Hg) is very persistant effluent and causes minamata disease.
- Cadmium (Cd) accumulation in liver, kidney and thyroid causes itai-itai (ouch-ouch) disease.
- Eutrophication is the phenomenon of aging of lake due to nutrient enrichment of a waterbody that initially supports a dense growth of plants and animal life.

Soil Pollution

- Toxicity of soil increases as a result of chemical wastes, which has adverse effect on human beings.
- Excessive use of nitrogen fertilisers has increased levels of nitrates in soil, which may cause 'blue baby syndrome'.

- Alteration in soil brought about by different types of wastes, which constitute soil pollution.
- Biological pathogens play important role in soil pollution.

Noise Pollution

- Unwanted sound is called **noise** and it is measured in terms of decibels (dB).
- Generally, sound above 80 dB is termed as noise.
- Kanpur is the most noise polluted city in UP.
- Large green plants, which are planted in high noise pollution zones are known as 'green mufflers,' as they have capacity to absorb sound waves.

Radioactive Pollution

- The chief source of radioactive pollution is nuclear-explosions.
- The radioactive substances (Sr^{90}, Cs^{137}, C^{14}, Co^{60}, Ru^{106}) are initially in gaseous form 10-15 km above earth surfaces.
- These radioactive fallouts cause air, water and soil pollution.
- Sr^{90} accumulates in bone marrow and causes cancer (leukaemia).
- Cs^{137} accumulates in muscles and causes muscular pain.
- Radioactive disasters occurred first in 1945 in Hiroshima and Nagasaki cities of Japan, when USA dropped nuclear bombs during the World War II.
- Recently in 1986, nuclear accident occurred at chernobyl (USSR).

Thermal Pollution

Due to nuclear and other conventional sources, temperature of waterbodies and atmosphere increases, which has adverse effect on different organisms.

Greenhouse Effect

Greenhouse effect is a process by which thermal radiation from a plantary surface is absorbed by atmospheric greenhouse gases and is re-radiated in all directions. Thus, these gases let incoming sunlight pass through, but stop outgoing infrared radiation. It mainly results in the elevation of the average surface temperature, i.e. global warming. It is caused by the greenhouse gases.

The four major greenhouse gases are as follows

(i) Carbon dioxide (CO_2) (ii) Methane (CH_4)
(iii) Chlorofluorocarbons (CFCs)
(iv) Nitrous oxide (N_2O)

Ozone Layer Depletion

- In the region of upper stratosphere, 17-26 km above the earth's surface, exists a thin veil of renewable ozone (O_3). This O_3 absorbs about 99 % of the harmful incoming non-ionising UV rays from the sun and prevents it from reaching the earth's surface, so it acts as a blanket for our earth.
- The primary cause of ozone depletion appears to be the increased use of chemicals, such as chlorofluorocarbons (CFCs), Carbon tetrachloride, halons.
- Researchers discovered that ozone in the upper stratosphere over Antarctica is being destorted during the Antarctic, spring and early summer (September-December). So called it as ozone hole, i.e. it is more thinning.

PRACTICE EXERCISE

1. The primary cause of ozone depletion is
(a) CFCs (b) CO_2 (c) O_3 (d) PAN

2. In a food chain, energy transfer occurs
(a) from river to earth
(b) lower lattitude to higher lattitude
(c) from one organism to other organism
(d) None of the above

3. The driving force of an ecosystem is
(a) biomass (b) producer
(c) carbohydrate in producers
(d) solar energy

4. Biodiversity is richer in
(a) tropical regions (b) polar regions
(c) temperate regions
(d) oceans

5. The concept of ecological pyramid was given by
(a) Elton (b) R August
(c) Reiter (d) Hatch and Slacks

6. Which of the following is always upright in all ecosystems?
(a) Pyramid of number
(b) Pyramid of energy
(c) Pyramid of biomass
(d) Both (b) and (c)

7. In which ecosystem grassland is included?
(a) Marine (b) Freshwater
(c) Terrestrial (d) Artificial

8. Ecosystem is
(a) any functional unit that includes the whole community in a given area interacting with the abiotic factors
(b) a group of green plants
(c) a group of animals interacting with environment
(d) a group of different plants and animals only

9. Primary productivity is the rate of
(a) formation of new organic matter by consumers
(b) conversion of light into chemical energy in an ecosystem
(c) biomass production per unit area over a time period during photosynthesis
(d) None of the above

10. Energy storage at consumer level is called
(a) gross primary productivity
(b) secondary productivity

(c) net primary productivity
(d) primary productivity

11. Which of the following ecosystem types has the highest biodiversity?
(a) Tropical rainforest
(b) Tropical deciduous forest
(c) Moist deciduous rainforest
(d) Temperate deciduous forest

12. Food chain refers to
(a) group of organisms, which eat the same type of food
(b) animals eating the plants
(c) series of plants or animals, which are interrelated in the form of organism being eaten as food by the other
(d) None of the above

13. Food chain is a series of population, which starts with producers. It is concerned with
(a) biotic components only
(b) energy flow and transfer of nutrients
(c) Both (a) and (b)
(d) physical conditions

14. Which one of the following is not a site for *in situ* method of conservation of flora?
(a) Biosphere reserve
(b) Botanical garden
(c) National park
(d) Wildlife sanctuary

15. The atmosphere around earth is warmed because
(a) warm air cannot escape, as in greenhouse
(b) molecules in the atmosphere are warmed by radiation from earth and retain that heat
(c) fossil fuels release heat
(d) plants absorb carbon dioxide (CO_2)

16. Which of the following is not a primary gas causing greenhouse effect?
(a) Carbon dioxide
(b) Carbon monoxide
(c) Argon
(d) Methane gas

17. Acid rain is formed due to contribution from the following pair of gases
(a) Methane and Ozone
(b) Oxygen and Nitrous oxide
(c) Methane and Sulphur dioxide
(d) Nitrogen oxides and Sulphur dioxide

18. Lichens indicate pollution by
(a) O_3 (b) SO_2 (c) NO_3 (d) CO

19. Disease aggravated by air pollution is
(a) Cholera (b) Rheumatism
(c) Bronchitis (d) None of the above

20. Which of the following is the most destructive enemy of ozone?
(a) Liquid NH_3 (b) SO_2
(c) CFCs (d) CO

21. Which pollution is caused by lead?
(a) Soil pollution (b) Air pollution
(c) Radioactive pollution
(d) Thermal pollution

22. Noise is measured in
(a) decibel (b) pikogram
(c) microgram (d) hertz

23. Which of the following is secondary pollutant?
(a) PAN (b) NO
(c) NO_2 (d) SO_2

24. Term ecosystem was first given by
(a) AG Tansley (b) Reiter
(c) R Misra (d) Haeckel

25. Which of the following flow is correct about ascending level of organisms in environment?
(a) Organism → Community → Species → Population
(b) Community → Population → Species → Organism
(c) Organism → Species → Population → Community
(d) Population → Species → Organism → Community

26. Which of the following statements is true about population interaction?
(a) Predation is beneficial to both interacting organisms
(b) Amensalism affects both interacting organisms
(c) Competition gives harmful effect to both participating organisms
(d) Commensalism gives benefit to both interacting organisms

27. Carbon monoxide, emitted by automobiles, prevents transport of oxygen in the body due to
(a) combining with oxygen to form carbon dioxide
(b) destruction of haemoglobin
(c) preventing reaction between oxygen and haemoglobin
(d) forming stable compound with haemoglobin

28. The increasing amount of carbon dioxide in the air is slowly raising the temperature of the atmosphere, because it absorbs
(a) the water vapour of the air and retains its heat
(b) the ultraviolet part of the solar radiation
(c) all the solar radiations
(d) the infrared part of the solar radiation

29. What is the major role of a green house gas that contributes to temperature rise of the earth's surface?
(a) Transparents to both incoming sunlight and outgoing infrared radiation
(b) Stops both incoming sunlight and outgoing infrared radiation
(c) Lets outgoing infrared radiation pass through, but stops incoming sunlight
(d) Lets incoming sunlight pass through, but stops outgoing infrared radiation

30. Which of the following are green house gases?
(a) CO_2, O_2, NO_2, NH_3
(b) CFC, CO_2, NH_3, N_2
(c) CH_4, N_2, CO_2, NH_3
(d) CFC, CO_2, CH_4, NO_2

31. Rainwater collected after 30 to 40 minutes of raining is not suitable for drinking because it
(a) contains bacteria and dirt
(b) contains dissolve toxic chemicals
(c) is deficient in minerals
(d) is acidic

32. CFCs released from refrigerator discharge may affect
(a) troposphere (b) stratosphere
(c) lithosphere (d) hydrosphere

33. Nitric oxide pollution can lead to all of the following, except
(a) leaf spotting in plants
(b) bronchitic related respiratory problems in human
(c) production of corrosive gases through photochemical reaction
(d) silicosis in human

34. Photochemical smog is a result of the reaction among
(a) NO_2, O_3 and peroxyacetyl nitrate in the presence of sunlight
(b) CO, O_2 and peroxyacetyl nitrate in the presence of sunlight
(c) CO, CO_2 and NO_2 at low temperature
(d) high concentration of NO_2, O_3 and CO in the evening

35. Acid rain is caused by the pollution of environment by
(a) carbon dioxide and nitrogen
(b) carbon monoxide and carbon dioxide
(c) ozone and carbon dioxide
(d) nitrous oxide and sulphur dioxide

36. The rapidly growing mass of phytoplankton covering the surface water of a lake or pond is known as
(a) water pollution (b) water hyacinth
(c) eutrophication (d) water bloom

37. Chloroflurocarbons are widely used in
(a) micro-ovens (b) solar heaters
(c) washing machines
(d) refrigerators

38. Greenhouse effect is the heating up of the earth's atmosphere, which is due to
(a) the ultraviolet rays
(b) γ-rays (c) the infra-red rays
(d) *X*-rays

39. 'Bhopal gas tragedy' 1984 is related to
(a) aluminium phosphide
(b) methyl bromide (c) methyl isocyanate
(d) carbon dioxide

40. Which of the following pairs of an animal and a plant represents endangered organisms in India?
(a) Banyan and black duck
(b) *Bentinckia nicobarica* and red panda
(c) Tamarind rhesus monkey
(d) *Cinchona* and leopard

41. Consider the following statements
1. Any undesirable change in physical, chemical or biological characteristics of air, land or soil and water is called pollution.
2. Term biodiversity is given by Edward Wilson.

Which of the above statements is/are incorrect?
(a) Only 1 (b) Only 2
(c) 1 and 2 (d) Neither 1 nor 2

42. The red data books published by the International Union for Conservation of Nature and Natural Resources contains list of
1. Endemic plant and animal species present in the biodiversity hotspots.
2. Threatened plant and animal species.
3. Protected sites for conservation of nature and natural resources in various countries.

Select the correct answer using the codes given below.
(a) 1 and 3 (b) Only 2
(c) 2 and 3 (d) Only 3

43. Biodiversity forms the basis for human existence in the following ways
1. Soil formation
2. Preservation of soil erosion
3. Recycling of waste
4. Pollination of crops

Select the correct answer using the codes given below.
(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1 and 4 (d) All of these

44. Consider the following statements.
1. Biodiversity hotspots are located only in tropical regions.
2. India has four biodiversity hotspots, i.e. Eastern Himalayas, Western Himalayas, Western Ghats and Andaman and Nicobar Islands.

Which of the statements given above is correct?
(a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) Neither 1 nor 2

45. Consider the following statements regarding ecological pyramids.
1. Pyramid of energy is always upright, can never be inverted.
2. When energy flows from a particular tropic level to the next tropic level, some energy is always lost as heat at each step.

Choose the correct option.
(a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) Neither 1 nor 2

Previous Years' Questions

46. Consider the following layers of the atmosphere. **2013 (II)**
1. Troposphere 2. Stratosphere
3. Mesosphere 4. Thermosphere

Which one among the following is the correct sequence of the layers with increasing altitude from the earth's surface?
(a) 1, 2, 3, 4 (b) 2, 1, 3, 4
(c) 3, 2, 1, 4 (d) 4, 2, 3, 1

47. Which of the following groups of plants can be used as indicators of SO_2 pollution of air? **2014 (II)**
(a) Ferns (b) Mentha
(c) Lichens (d) Hornworts

48. Which one of the following is not a greenhouse gas? **2015 (II)**
(a) Water vapour (b) Methane
(c) Ozone (d) Carbon monoxide

49. 'Sal' tree is a **2016 (I)**
(a) tropical evergreen tree
(b) tropical semi-evergreen tree
(c) dry deciduous tree
(d) moist deciduous tree

50. Spruce and cedar are tree varieties of **2016 (I)**
(a) equatorial forest
(b) temperate coniferous forest
(c) monsoon forest
(d) temperate deciduous forest

51. One of the main causes of air pollution in cities is emissions from vehicles like cars and trucks. Cars emit various pollutants, which are bad for human health when inhaled, like **2016 (I)**
1. nitrogen oxides (NO_x)
2. carbon monoxide (CO)
3. carbon dioxide (CO_2)
4. benzene

Which of the above pollutants are not tolerated by human being even at very low level?
(a) 1 and 4 (b) 1 and 2
(c) 1, 2 and 3 (d) 1, 2 and 4

ANSWERS

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