

**DIRECTORATE OF EDUCATION**  
**Govt. of NCT, Delhi**

**SUPPORT MATERIAL**  
**(2021-2022)**

**Class : XI**

**BIOLOGY**

Under the Guidance of

**Sh. H. Rajesh Prasad**  
Secretary (Education)

**Mr. Udit Prakash Rai**  
Director (Education)

**Dr. Rita Sharma**  
Addl. DE (School & Exam.)

**Coordinators**

**Sh. Sanjay Subhas Kr.**  
DDE (Exam)

**Smt. Sunita Dua**  
OSD (Exam)

**Dr. Raj Kumar**  
OSD (Exam)

**Mr. Krishan Kumar**  
OSD (Exam)

Production Team

**Anil Kumar Sharma**

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**H. RAJESH PRASAD  
IAS**



प्रधान सचिव ( शिक्षा )  
राष्ट्रीय राजधानी क्षेत्र  
दिल्ली सरकार  
पुराना सचिवालय, दिल्ली-110054  
दूरभाष: 23890187 टेलीफैक्स : 23890119

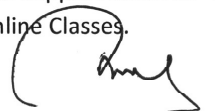
Pr. Secretary (Education)  
Government of National Capital Territory of Delhi  
Old Secretariat, Delhi-110054  
Phone : 23890187, Telefax : 23890119  
E-mail : secyedu@nic.in

**MESSAGE**

I would like to congratulate the members of Core Academic Unit and the subject experts of the Directorate of Education, who inspite of dire situation due to Corona Pandemic, have provided their valuable contributions and support in preparing the Support Material for classes IX to XII.

The Support Material of different subjects, like previous years, have been reviewed/ updated in accordance with the latest changes made by CBSE so that the students of classes IX to XII can update and equip themselves with these changes. I feel that the consistent use of the Support Material will definitely help the students and teachers to enrich their potential and capabilities.

Department of Education has taken initiative to impart education to all its students through online mode, despite the emergency of Corona Pandemic which has led the world to an unprecedented health crisis. This initiative has not only helped the students to overcome their stress and anxiety but also assisted them to continue their education in absence of formal education. The support material will ensure an uninterrupted learning while supplementing the Online Classes.

  
(H. Rajesh Prasad)

**UDIT PRAKASH RAI, IAS**  
Director, Education & Sports



सत्यमेव जयते

Directorate of Education  
Govt. of NCT of Delhi  
Room No. 12, Civil Lines  
Near Vidhan Sabha,  
Delhi-110054  
Ph.: 011-23890172  
Mob.: 8700603939  
E-mail : diredu@nic.in

### **MESSAGE**

The main objective of the Directorate of Education is to provide quality education to all its students. Focusing on this objective, the Directorate is continuously in the endeavor to make available the best education material, for enriching and elevating the educational standard of its students. The expert faculty of various subjects undertook this responsibility and after deep discussions and persistent efforts, came up with Support Material to serve the purpose.

Every year the Support Material is revised/updated to incorporate the latest changes made by CBSE in the syllabus of classes IX to XII. The contents of each lesson/chapter are explained in such a way that the students can easily comprehend the concept and get their doubts solved.

I am sure, that the continuous and conscientious use of this Support Material will lead to enhancement in the educational standard of the students, which would definitely be reflected in their performance.

I would also like to commend the entire team members for their contributions in the preparation of this incomparable material.

I wish all the students a bright future.

**(UDIT PRAKASH RAI)**

**Dr. RITA SHARMA**  
Additional Director of Education  
(School/Exam)



Govt. of NCT of Delhi  
Directorate of Education  
Old Secretariat, Delhi-110054  
Ph.: 23890185

D.O. No. PA/Addl.DE/Sch/31

Dated: 29.06.2021

## MESSAGE

It gives me immense pleasure to present the revised edition of the Support Material. This material is the outcome of the tireless efforts of the subject experts, who have prepared it following profound study and extensive deliberations. It has been prepared keeping in mind the diverse educational level of the students and is in accordance with the most recent changes made by the Central Board of Secondary Education.

Each lesson/chapter, in the support material, has been explained in such a manner that students will not only be able to comprehend it on their own but also be able to find solution to their problems. At the end of each lesson/chapter, ample practice exercises have been given. The proper and consistent use of the support material will enable the students to attempt these exercises effectively and confidently. I am sure that students will take full advantage of this support material.

Before concluding my words, I would like to appreciate all the team members for their valuable contributions in preparing this unmatched material and also wish all the students a bright future.

  
(Rita Sharma)

**भारत का संविधान**  
**भाग 4क**  
**नागरिकों के मूल कर्तव्य**

**अनुच्छेद 51क**

**मूल कर्तव्य** - भारत के प्रत्येक नागरिक का यह कर्तव्य होगा कि वह -

- (क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;
- (ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;
- (ग) भारत की संप्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण बनाए रखे;
- (घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;
- (ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभावों से परे हो, ऐसी प्रथाओं का त्याग करे जो महिलाओं के सम्मान के विरुद्ध हों;
- (च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परिरक्षण करे;
- (छ) प्राकृतिक पर्यावरण की, जिसके अंतर्गत वन, झील, नदी और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;
- (ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;
- (झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;
- (ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे, जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई ऊँचाइयों को छू सके; और
- (ट) यदि माता-पिता या संरक्षक हैं, छह वर्ष से चौदह वर्ष तक की आयु वाले अपने, यथास्थिति, बालक या प्रतिपाल्य को शिक्षा के अवसर प्रदान करे।

# CONSTITUTION OF INDIA

## Part IV A (Article 51 A)

### Fundamental Duties

**Fundamental Duties :** It shall be the duty of every citizen of India —

1. to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
2. to cherish and follow the noble ideals which inspired our national struggle for freedom;
3. to uphold and protect the sovereignty, unity and integrity of India;
4. to defend the country and render national service when called upon to do so;
5. to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
6. to value and preserve the rich heritage of our composite culture;
7. to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures.
8. to develop the scientific temper, humanism and the spirit of inquiry and reform;
9. to safeguard public property and to adjure violence;
10. to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.
11. who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

## भारत का संविधान उद्देशिका

हम, भारत के लोग, भारत को एक <sup>1</sup>[संपूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को :

सामाजिक, आर्थिक और राजनैतिक न्याय,  
विचार, अभिव्यक्ति, विश्वास, धर्म  
और उपासना की स्वतंत्रता,  
प्रतिष्ठा और अवसर की समता  
प्राप्त कराने के लिए,  
तथा उन सब में

व्यक्ति की गरिमा और <sup>2</sup>[राष्ट्र की एकता  
और अखंडता] सुनिश्चित करने वाली बंधुता  
बढ़ाने के लिए

दृढसंकल्प होकर अपनी इस संविधान सभा में आज तारीख  
26 नवंबर, 1949 ई. को एतद्वारा इस संविधान को  
अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से) “प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य” के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से) “राष्ट्र की एकता” के स्थान पर प्रतिस्थापित।

# **THE CONSTITUTION OF INDIA**

## **PREAMBLE**

**WE, THE PEOPLE OF INDIA**, having solemnly resolved to constitute India into a <sup>1</sup>**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

**JUSTICE**, social, economic and political;

**LIBERTY** of thought, expression, belief, faith and worship;

**EQUALITY** of status and of opportunity; and to promote among them all

**FRATERNITY** assuring the dignity of the individual and the <sup>2</sup>[unity and integrity of the Nation];

**IN OUR CONSTITUENT ASSEMBLY** this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)





**DIRECTORATE OF EDUCATION**  
**Govt. of NCT, Delhi**

**SUPPORT MATERIAL**  
**(2021-2022)**

**BIOLOGY**  
**Class : XI**

**NOT FOR SALE**

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**PUBLISHED BY : DELHI BUREAU OF TEXTBOOKS**



# BIOLOGY

## CLASS-XI

### Members of Review Committee

S.No.	Name	Designation	School
1.	Ms. Sarita Singh	Vice Principal	RPVV, Lajpat Nagar, New Delhi
2.	Dr. Anita Singh	Lecturer	RPVV, Sector-10, Dwarka, New Delhi
3.	Ms. Iqbal Kaur	Lecturer	RPVV, Shalimar Bagh, New Delhi
4.	Ms. Pooja Verma	Lecturer	School of Excellence, Dwarka, New Delhi
5.	Ms. Leena Saxena	Lecturer	SKV, H-Block, Ashok Vihar, Phase-E, New Delhi



## 9. BIOLOGY (Code No. 044)

The present syllabus reinforces the ideas introduced till the secondary classes. It provides the students with new concepts along with an extended exposure to contemporary areas of the subject. The syllabus also aims at emphasizing on the underlying principles that are common to both animals and plants as well as highlighting the relationship of biology with other areas of knowledge. The format of the syllabus allows a simple, clear, sequential flow of concepts without any jarring jumps. The syllabus also stresses on making better connections among biological concepts. It relates the study of biology to real life through the use of technology. It links the discoveries and innovations in biology to everyday life such as environment, industry, health and agriculture. The updated syllabus also focuses on reducing the curriculum load while ensuring that ample opportunities and scope for learning and appreciating basic concepts of the subject continue to be available within its framework. The prescribed syllabus is expected to :

- Promote understanding of basic principles of Biology
- Encourage learning of emerging knowledge and its relevance to individual and society
- Promote rational/scientific attitude towards issues related to population, environment and development
- Enhance awareness about environment issues, problems and their appropriate solutions.
- Create awareness amongst the learners about diversity in the living organisms and developing respect for other living beings
- Appreciate that the most complex biological phenomena are built on essentially simple processes

It is expected that the students would get an exposure to various branches of Biology in the syllabus in a more contextual and friendly manner as they study its various units.

**BIOLOGY (Code No. 044)**  
**Course Structure**  
**Class XI (2021-22)**  
**(Theory)**

Time : 3 Hours

Max. Marks : 70

Unit	Title	No. of Periods	Marks
I	Diversity of Living Organisms	27	12
II	Structural Organisation in Plants and Animals	27	12
III	Cell : Structure and Function	26	12
IV	Plant Physiology	40	17
V	Human Physiology	40	17
Total		160	70

**Unit-I Diversity of Living Organisms**

**27 Periods**

**Chapter-1 : The Living World**

What is living ? Biodiversity; Need for classification; three domains of life : taxonomy and systematics; concept of species and taxonomical hierarchy; binomial nomenclature; tools for study of taxonomy-museum, zoological parks, herbaria, botanical gardens.

**Chapter-2 : Biological Classification**

Two kingdom classification, Five kingdom classification; Salient features and classification of Monera, Protista and Fungi into major groups; Lichens, Viruses and Viroids.

**Chapter-3 : Plant Kingdom**

Salient features and classification of plants into major groups – Algae, Bryophyta, Pteridophyta, Gymnospermae and Angiospermae (three to five salient and distinguishing features and at least two examples of each category); Angiosperms –classification upto class, characteristic features and examples.



## Chapter-4 : Animal Kingdom

Salient features and classification of animals non-chordates up to phyla level and chordates up to class level (three to five salient features and at least two examples of each category).

**\*\***(No live animals or specimen should be displayed.)

## Unit-II Structural Organisation in Animals and Plants

27 Periods

### Chapter-5 : Morphology of Flowering Plants

Morphology and modifications : Internal morphology of different plants : root, stem, leaf, Inflorescence, flower, fruit and seed. (to be dealt with relevant experiments of the Practical Syllabus).

### Chapter-6 : Anatomy of Flowering Plants

Anatomy and functions of different tissues.

### Chapter-7 : Structural Organisation in Animals

Animal tissues (epithelial, connective, muscular and nervous tissue), Brief account of morphology, anatomy and functions of different systems (digestive, circulatory, respiratory, nervous and reproductive) of an insect (cockroach).

## Unit-III Cell : Structure and Function

26 Periods

### Chapter-8 : Cell-The Unit of Life

Cell theory and cell as the basic unit of life : Structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; cell envelope; cell membrane, cell wall; cell organelles—structure and function; endomembrane system, endoplasmic reticulum, Golgi bodies, lysosomes, vacuoles ; mitochondria, ribosomes, plastids, microbodies; cytoskeleton, cilia, flagella, centrioles (ultrastructure and function); nucleus.

### Chapter-9 : Biomolecules

Chemical constituents of living cells : Biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids, enzymes— types, properties, enzymes action.

## Chapter–10 : Cell Cycle and Cell Division

Cell cycle, mitosis, meiosis and their significance.

## Unit–IV Plant Physiology

40 Periods

### Chapter–11 : Transport in Plants

Movement of water, gases and nutrients; cell to cell transport, Diffusion, facilitated diffusion, active transport; plant-water relations, imbibition, water potential, osmosis, plasmolysis; long distance transport of water–absorption, apoplast, symplast, transpiration pull, root pressure and guttation; opening and closing of stomata and transpiration; Uptake and translocation of mineral nutrients–transport of food, phloem transport, mass-flow hypothesis.

### Chapter–12 : Mineral Nutrition

Essential minerals, macro-and micronutrients and their role; deficiency symptoms; mineral toxicity; elementary idea of hydroponics as a method to study mineral nutrition; nitrogen metabolism, nitrogen cycle, biological nitrogen fixation.

### Chapter–13 : Photosynthesis in Higher Plants

Photosynthesis as a mean of autotrophic nutrition; site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical and biosynthetic phases of photosynthesis, cyclic and non-cyclic photophosphorylation; chemiosmotic hypothesis; photorespiration; C3 and C4 pathways; factors affecting photosynthesis.

### Chapter–14 : Respiration in Plants

Exchange of gases; cellular respiration–glycolysis, fermentation (anaerobic), TCA cycle and electron transport system (aerobic); energy relations–number of ATP molecules generated; amphibolic pathways; respiratory quotient.

### Chapter–15 : Plant–Growth and Development

Seed germination; phases of plant growth and plant growth rate; conditions of growth; differentiation, dedifferentiation and redifferentiation; sequence of



developmental processes in a plant cell; growth regulators—auxin, gibberellin, cytokinin, ethylene, ABA; seed dormancy; vernalisation; photoperiodism.

## Unit–V Human Physiology

40 Periods

### Chapter–16 : Digestion and Absorption

Alimentary canal and digestive glands, role of digestive enzymes and gastrointestinal hormones; Peristalsis, digestion, absorption and assimilation of proteins, carbohydrates and fats; calorific values of proteins, carbohydrates and fats; egestion; nutritional and digestive disorders—PEM, indigestion, constipation, vomiting, jaundice, diarrhoea.

### Chapter–17 : Breathing and Exchange of Gases

Respiratory organs in animals (recall only); Respiratory system in human; mechanism of breathing and its regulation in humans—exchange of gases, transport of gases and regulation of respiration, respiratory volume; disorders related to respiration—asthma, emphysema, occupational respiratory disorders.

### Chapter–18 : Body Fluids and Circulation

Composition of blood, blood groups, coagulation of blood; composition of lymph and its function; human circulatory system—structure of human heart and blood vessels; cardiac cycle, cardiac output, ECG; double circulation; regulation of cardiac activity; disorders of circulatory system—hypertension, coronary artery disease, angina pectoris, heart failure.

### Chapter–19 : Excretory Products and Their Elimination

Modes of excretion—ammonotelism, ureotelism, uricotelism; human excretory system—structure and function; urine formation, osmoregulation of kidney function—renin–angiotensin, atrial natriuretic factor (ANF), ADH and diabetes insipidus; role of other organs in excretion; disorders—uraemia, renal failure, calculi, nephritis; dialysis, artificial kidney and kidney transplant.



## Chapter–20 : Locomotion and Movement

Types of movement–Ciliary, flagellar, muscular; skeletal muscle–contractile proteins and muscle contraction; skeletal system and its functions; joints; disorders of muscular and skeletal system–myasthenia gravis, tetany, muscular dystrophy, arthritis, osteoporosis, gout.

## Chapter–21 : Neural Control and Coordination

Neuron and nerves; Nervous system in humans–central nervous system; peripheral nervous system and visceral nervous system; generation and conduction of nerve impulse; reflex action; sensory perception sense organs; elementary structure and functions of eye, ear, nose and tongue.

## Chapter–22 : Chemical Coordination and Integration

Endocrine glands and hormones; human endocrine system–hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal, pancreas, gonads; mechanism of hormone action (elementary idea); role of hormones as messengers and regulators, hypo–and hyperactivity and related disorders; dwarfism, acromegaly, cretinism, goiter, exophthalmic goitre, diabetes, Addison’s disease.

**\*\***(Diseases related to all the human physiological systems to be taught in brief).

## Practicals

**Time Allowed : Three hours**

**Max. Marks : 30**

Evaluation Scheme	
One Major Experiment Part A (One from Experiment No. 1,3,7,8)	5 Marks
One Minor Experiment Part A (One from Experiment No. 6, 9, 10, 11, 12, 13)	4 Marks
Slide Preparation Part A (One from Experiment No. 2, 4, 5)	5 Marks
Spotting Part B	7 Marks
Practical Record + Viva Voce	4 Marks
Project Record + Viva Voce	5 Marks
<b>Total</b>	<b>30 Marks</b>

### A. List of Experiments

**60 Periods**

1. Study and description of three locally available common flowering plants, one from each of the families Solanaceae, Fabaceae and Liliaceae including dissection and display of floral whorls, anther and ovary to show number of chambers (floral formulae and floral diagrams). Types of root (Tap and adventitious); stem (herbaceous and woody); leaf (arrangement, shape, venation, simple and compound).
2. Preparation and study of T.S. of dicot and monocot roots and stems (primary).
3. Study of osmosis by potato osmometer.
4. Study of plasmolysis in epidermal peels (e.g. Rhoeo leaves).
5. Study of distribution of stomata in the upper and lower surface of leaves.
6. Comparative study of the rates of transpiration in the upper and lower surface of leaves.
7. Test for the presence of sugar, starch, proteins and fats. Detection in suitable plant and animal materials.
8. Separation of plant pigments through paper chromatography.
9. Study of the rate of respiration in flower buds/leaf tissue and germinating seeds.

10. Test for presence of urea in urine.
11. Test for presence of sugar in urine.
12. Test for presence of albumin in urine.
13. Test for presence of bile salts in urine.

**B. Study/observation of the following (spotting)**

1. Study of the parts of a compound microscope.
2. Study of the specimens/slides/models and identification with reasons—Bacteria, Oscillatoria, Spirogyra, Rhizopus, mushroom, yeast, liverwort, moss, fern, pine, one monocotyledonous plant, one dicotyledonous plant and one lichen.
3. Study of virtual specimens/slides/models and identification with reasons—Amoeba, Hydra, liver-fluke, Ascaris, leech, earthworm, prawn, silk-worm, honeybee, snail, starfish, shark, rohu, frog, lizard, pigeon and rabbit.
4. Study of tissues and diversity in shapes and sizes of plant and animal cells (palisade cells, guard cells, parenchyma, collenchyma, sclerenchyma, xylem, phloem, squamous epithelium, muscle fibers and mammalian blood smear) through temporary/permanent slides.
5. Study of mitosis in onion root tip cells and animal cells (grasshopper) from permanent slides.
6. Study of different modifications in roots, stems and leaves.
7. Study and identification of different types of inflorescence (cymose and racemose).
8. Study of imbibition in seeds/raisins.
9. Observation and a comments on the experimental set up for showing :
  - (a) Anaerobic respiration
  - (b) Phototropism
  - (c) Effect of apical bud removal
  - (d) Suction due to transpiration

10. Study of human skeleton and different types of joints with the help of virtual images/models only.
11. Study of external morphology of cockroach through virtual images/models.

### **Practical Examination for Visually Impaired Students**

**Note :** Same Evaluation scheme and general guidelines for visually impaired students as given for Class XII may be followed.

#### **Items for Identification/Familiarity with the apparatus/equipments/ animal and plant material/chemicals etc. for assessment in practicals (All experiments)**

1. Plants of—
  - Solanaceae—Brinjal, Petunia, any other
  - Fabaceae—Rice, Wheat, any other
  - Liliaceae—Any of the Lilies
2. A compound microscope, seeds of monocot and dicot—maize and gram or any other Model of Human skeleton to show—
  - Ball and socket joints of girdles and limbs
  - Rib cage
3. Test tube, honey comb, Mollusc shell, Models of Pigeon and Star fish, mushroom, petridish, succulents such as *Aloe vera*/kalenchoe, raisins, beaker, potatoes, scalpel, chromatography paper, chromatography chamber, alcohol, specimen/model of cockroach.

#### **List of Practicals**

1. Study three locally available common flowering plants of the families—Solanaceae, fabaceae, Liliaceae
2. Identify the types of :
  - roots as Tap and Adventitious
  - stems as Herbaceous or Woody
  - leaves as Compound or Simple



3. Study the parts of a compound microscope—eye piece and objective lense, mirror, stage, coarse and fine adjustment knobs.
4. Differentiate between monocot and dicot plants on the basis of venation patterns.
5. Study the following parts of human skeleton (Model):
  - Ball and socket joints of thigh and shoulder
  - Rib cage
6. Study honey bee or butterfly, snail, starfish and pigeon using models.
7. Identify the given specimen of a fungus (Mushroom), a gymnosperm (pine cone).
8. Identify and relate the experimental set up with the aim of experiment :For Potato Osmometer/endosmosis in raisins.

**\*\*Note :** The above practicals may be carried out in an experimental manner rather than recording observations.

### Prescribed Books :

Biology Class-XI, Published by NCERT

Other related books and manuals brought out by NCERT (consider multimedia also)

Biology Supplementary material (Revised). Available on CBSE website.

# **BIOLOGY (Code No. 044)**

## **Question Paper Design**

**Class-XI (2021–22)**

**Time : 3 Hours**

**Max. Marks : 70**

### **Competencies**

Demonstrate Knowledge and Understanding (State, name, list, identify, define, suggest, describe, outline, summarize, etc.)	50%
Application of Knowledge/Concepts (Calculate, illustrate, show, adapt, explain, distinguish, etc.)	30%
Analyse, Evaluate and Create (Interpret, analyse, compare, contrast, examine, evaluate, discuss, construct etc.)	20%

### **Typology of Questions**

Types of Questions	Marks per question(s)	Total number of questions	Total marks
<b>SECTION-A</b>			
VSA (including Assertion–Reasoning type questions)	1	14	14
Source-based/Case-base/Passage-based/Integrated assessment questions	4	2	8
<b>SECTION-B</b>			
SA-I	2	9	18
SA-II	3	5	15
LA	5	3	15
TOTAL			70

**\*\*There is no overall choice. However, internal choice have been provided in some questions. A student has to attempt only one of the alternatives in such questions. Internal choice of approximately 33% would be provided.**

**\*The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different forms of questions and typology of questions same.**

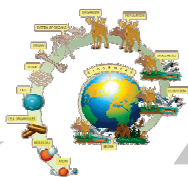
# BIOLOGY – XI

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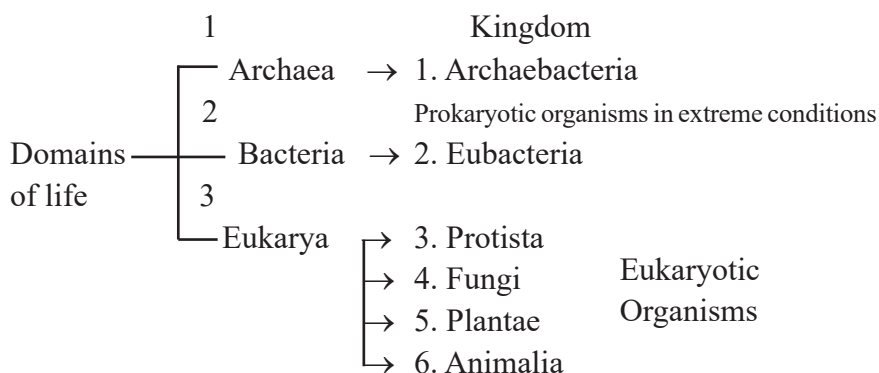


## Chapter - 1

# The Living World

### Points to Remember

1. Organism (Microorganism, plant and animals) who possesses life is living.
2. Life is a complex organisation expressing itself through chemical reactions and exhibit characteristics of living organisms.
3. **Characteristics of Living Organisms** : Growth, reproduction, metabolism, cellular organisation, consciousness, self-replicating and self regulation.
  - Reproduction and growth are NOT defining properties.
  - Metabolism (Catabolic + Anabolic), cellular organisation and consciousness are defining properties.
  - Living organisms are self-replicating, evolving, self-regulating and interactive systems capable of responding to external stimuli.
4. **Biodiversity** : The term used to refer to the variety of microorganisms, plant and animals on earth.
5. **Need for classification** : To organise the vast number of microorganisms, plants and animals into categories that could be named, remembered, studied and understood.
6. **Three Domains of Life** : Proposed by Carl Woese in 1990, who also proposed the six kingdom classification for living organisms. The three Domains of life are Archaea, Bacteria and Eukarya.



7. **Taxonomy** : Study of principles and procedures of identification, nomenclature and classification.
8. **Systematics** : It deals with classification of organisms based on their diversities and relationships among them. The term was proposed by Carolus Linnaeus who wrote '*Systema Naturae*'.
9. **Concept of Species** : All the members that can interbreed among themselves and can produce fertile offsprings are the members of same species. This is the biological concept of species proposed by Mayr.
10. **Taxa** : Each category (*i.e.*, unit) of classification is called as a taxon.
11. **Taxonomic Hierarchy** : Classification of organisms in a definite sequence of taxon or category or rank in a descending order.  
Kingdom → Phylum /Division → Class → Order → Family → Genus → Species.
12. **Binomial Nomenclature** : Given by Carolus Linnaeus. Each scientific name has two components- Generic name + Specific epithet.
13. **ICBN** : International Code for Botanical Nomenclature (for giving scientific name to plants.)
14. **ICZN** : International Code of Zoological Nomenclature (for giving scientific name to animals.)
15. **Rule for Nomenclature** :
  - Latinised names are used.
  - First word is genus, second word is species name.
  - Printed in italics; if handwritten then underlined separately.
  - First word starts with capital letter while species name written in small letter.
16. ● **Scientific names of some organisms** :
 

Man	—	<i>Homo sapiens</i>
Housefly	—	<i>Musca domestica</i>
Mango	—	<i>Mangifera indica</i>
Wheat	—	<i>Triticum aestivum</i>
17. Taxonomical Aids are the tools for study of taxonomy.
18. Museums in educational institutes (school and colleges) have collection of skeletons of animals, stuffed and preserved specimens of organisms for study and reference.
19. Zoological Parks (Places where wild animals are kept in protected environment under human care) Example : National Zoological Park, Delhi.
20. **Herbarium** : Store house of dried, pressed and preserved plant specimen on sheets, kept systematically according to a widely accepted system of classification, for future use.

- 21. Botanical Garden :** Collection of living plants for reference.
- Example :** Royal Botanical garden Kew (England), National Botanical Research Institute (Lucknow), Indian Botanical Garden (Howrah, Kolkata).
- 22. Keys :** (Used for identification of plants and animals on the basis of similarities and dissimilarities.) two types < Indented key, Bracketed key.
- 23. Couplet :** are the two alternate characteristic statement used in key to identify organisation.
- 24.** Each Statement of the key is called a *lead*.
- 25. ●** Flora (Index to plant species found in a particular area.
- 26. ●** Manuals (Provide information for identification of name of species in an area.) It is a handy book.
- 27. ●** Monographs (Contain information on any one taxon.)

### Question

#### Very Short Answer Question

(1 mark each)

1. Define species.
2. What is systematics ?
3. Give the names of two famous botanical gardens.
4. Define Life
5. Name two genus belonging to family Felidae?
6. Assertion: In planaria larva, a fragmented organism regenerates the lost body part of its body and becomes, a new organism.

**Reason:** Reproduction is defining feature of life forms.

- (a) Both assertion and reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both assertion and reason are false.

### Short Answer Question-I

(2 marks each)

7. What are the basis of modern taxonomical studies ?
8. Why growth and reproduction cannot be taken as defining property of all living organisms ?
9. How is a taxon (pl. taxa) defined ?
10. How are museum different from zoological parks?
11. Discuss the advantages of assigning a scientific name to living organism.
12. How systematics is different from taxonomy?
13. Write two significances of taxonomical aids.
14. Explain the concept species given by Ernst Mayr.

### Short Answer Question-II

(3 marks each)

15. What is the difference between Botanical Garden and Herbarium ?
16. Keys are analytical in nature and are helpful in identification and classification of organisms. How ?
17. Define : (a) Genus (b) Family (c) Order
18. Write the taxonomic categories showing hierarchal arrangement in ascending order.
19. What are botanical gardens? Mention names of three famous botanical gardens.
20. Write a short note on flora, manual, monograph and catalogue.

### Long Answer Questions

(5 marks each)

21. What are the universal rules of nomenclature ? What does 'Linn.' Refers to in *Mangifera indica* Linn ?
22. Illustrate taxonomical hierarchy with suitable examples from plant and animal species.
23. Define classification. What is the significance of classification ? What is the six kingdom classification ?
24. What is herbarium? How is it prepared? Mention the information that a label of herbarium sheet carry. What is the advantage of herbarium sheets?
25. Who proposed three domain classifications? Explain this concept.

## Answers

### Very Short Answers

(1 marks each)

1. Members that can interbreed to produce fertile offspring.
2. Systematic arrangement which also takes into account evolutionary relationships between organisms.
3. Kew (England) and National Botanical Research Institute (Lucknow), Indian Botanical Garden (Howrah).
4. Life is unique, complete functioning of metabolic activities
5. *Felis* and *Panthera*.
6. (c)

### Short Answers-I

(2 marks each)

7. External and internal structure, structure of cell, development process and ecological information.
8.
  - Non-living things can also increase in mass by accumulation of material on surface (accretion.)
  - Many organisms do not reproduce (*e.g.*, mules, sterile worker bees.)
9. Each category in a taxonomical hierarchy represents a rank and is called taxon.
10. Refer point to remember on page no. 2.
11. The scientific name ensures that each organism has only one name. Description of any organism should enable the people to arrive at the same name. They also ensure that such a name has not been used for any other known organism.
12. Refer to point to remember on page no. 2.
13. They help in correct classification and identification of organisms. These are fundamental to studies and essential for training in systematics.
14. Refer to point to remember on page 2.

## Short Answers-II

(3 marks each)

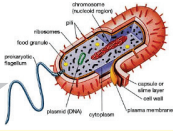
15. Botanical Garden : Collection of living plants.  
Herbarium : Collection of dried, pressed and preserved plant specimens on sheets.
16. Key is a list of alternate characters arranged in such a manner that by acceptance and rejection one can easily identify an organisms as to its name and position. Keys are generally analytical in nature.
17. (a) Genus : Group of related species;  
(b) Family : Group of related genera;  
(c) Order : Group of related families.
18. Species, genus, family, order, class, phylum/division, kingdom.
19. Refer to points on page 3.
20. Refer to points on page 3.

## Long Answers

(5 marks each)

21. Refer page no. 7, NCERT, Text Book of Biology for Class XI.  
'Linn.' indicates that the species was first described by Linnaeus.
22. Refer table 1.1, page no. 11, NCERT, Text Book of Biology for Class XI.
23. Grouping organisms on the basis of their similarities and differences.  
Significance : – Aids in study, better understanding, predicting the features of the group known.  
  
Refer 'Points to Remember' for six kingdom classification in three domains of life.
24. Refer page no. 11, NCERT, Text book of Biology class XI.
25. Refer to point to remember on page 1.





## Chapter - 2

Biological

# Classification

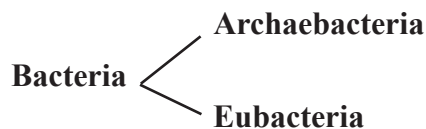
### Points to Remember

#### Systems of Classification :

- Earliest classification was given by Aristotle. Divided plants into herbs, shrubs and trees.  
Animals into those with red blood and those who do not have it.
- **Two kingdom classification** : Given by Carolus Linnaeus—Kingdom—plantae and kingdom—Animalia.
- **Five kingdom classification** : By R.H. Whittaker, Monera, Protista, Fungi, Plantae and Animalia are the five kingdoms.
- The main criteria for classification of organisms into five kingdoms include cell structure, thallus organisation, mode of nutrition, reproduction and phylogenetic relationships.

#### Kingdom Monera :

- Has bacteria as sole members.
- Cell wall made up of peptidoglycan.
- Bacteria can have shapes like : Coccus (spherical), Bacillus (rod-shaped), Vibrium (comma shaped) and spirillum (spiral shaped).
- Bacteria found almost everywhere and can be Photosynthetic autotrophs, Chemosynthetic autotrophs or Heterotrophs.



- Archaeobacteria
- Halophiles (salt-loving)
- Thermoacidophiles (in hot springs)
- Methanogens (in marsh and in gut of ruminant animals. Produce methane gas.)
- Eubacteria
- Photosynthetic autotrophs like Cyanobacteria (Blue-green algae BGA). Some like *Anabaena* and *Nostoc* have specialized cells called heterocysts for nitrogen fixation.
- *Algae bloom* is rich growth of blue green algae over the surface of polluted water bodies.
- Algae bloom releases neurotoxins, deplete oxygen and makes water unfit for use.
- **Chemosynthetic autotrophs** : Oxidise various inorganic substances like nitrates/nitrites, ammonia and use released energy for their ATP production. They help in nutrients recycling of N, P, Fe and S.
- **Heterotrophic bacteria** : Decomposers help in making curd, production of antibiotic,  $N_2$  fixation, cause diseases like cholera, typhoid, tetanus and citrus canker.

**Mycoplasmas** : Completely lack cell wall. Smallest living cells. Can survive without oxygen. Pathogenic in animals and plants.

## 1. Artificial System of Classification

1. It utilises one or two morphological traits.
2. Homology is never standard.
3. The system does not employ characters from anatomy, cytology, biochemistry, genetics etc. for grouping of organisms.

## 2. Natural System of Classification

1. The system employs several morphological characters for grouping of organisms.
2. It studies homology in all characters including morphology, anatomy etc.
3. This system gives information about both Natural relationship and phylogeny.



### 3. Phylogenetic System of Classification

It was proposed by Engler and Prantl. They arranged flowering plants according to increasing complexity of their floral morphology.

It was based on possible evolution of different traits.

### 4. Objections to two kingdom system

1. Lichen with dual mode.
2. Fungi remain fixed but nutrition saprophytic.
3. No distribution of unicellular and multicellular organism.
4. No distribution of prokaryotic and eukaryotic organisation.
5. Euglena can move as well as can do photosynthesis.

## Kingdom PROTISTA

(Comprises of all single celled eukaryotes)

- Forms a link between plants, animals and fungi.

#### (i) **Chrysophytes** (Has diatoms and golden algae/desmids)

Fresh water/marine, photosynthetic, microscopic plankton.

- Chief producers in Ocean.
- Cell walls have silica which makes it indestructible and cell walls overlap to fit together like a soap box.
- Their accumulation forms ‘Diatomaceous Earth’ (gritty soil)
- Used in polishing, filtration of oils and syrups.

#### (ii) **Dinoflagellates :**

- Marine, photosynthetic, cell wall has stiff cellulose plates.
- Two flagella—one longitudinal and other transverse in a furrow between wall plates.
- **Example :** *Gonyaulax* multiplies rapidly, make sea appear red (red tides) and produce toxins to kill marine animals.

#### (iii) **Euglenoids :**

- Found in stagnant fresh water.

Have protein rich layer 'pellicle' which makes body flexible.

- Photosynthetic in presence of sunlight but become heterotrophs if they do not get sunlight. (Mixotrophic nutrition)

- **Example :** *Euglena*

(iv) **Slime Moulds :**

- Saprophytic protists
- Under suitable conditions form an aggregates called plasmodium, grows on decaying twigs and leaves.
- During unfavourable conditions, plasmodium differentiates and forms fruiting bodies bearing spores at their tips.
- Spores have true walls which are extremely resistant and survive for many years and dispersed by air currents.

(v) **Protozoans :** Are heterotrophs and live as parasites. Have four major groups.

**Amoeboid :** Catch prey using pseudopodia, *e.g., Amoeba. Entamoeba* are parasite.

**Flagellated :** Have one or more flagella. Cause disease like Sleeping Sickness *e.g., trypanosoma*.

**Ciliated :** Have cilia to move food into gullet and help in locomotion. *e.g., Paramecium*.

**Sporozoans :** Have infective spore like stage in life cycle, *e.g., Plasmodium* which causes malaria.

## Kingdom Fungi

1. Heterotrophic organisms
2. Non chlorophyllous hyphae
3. Network of hyphae called mycelium
4. Hyphae which have multinucleated cytoplasm are called coenocytic hyphae
5. Cell wall of chitin and polysaccharides
6. Cosmopolitan. Grow in warm and humid places.

7. Saprophytic, parasitic, symbiotic (Lichen and Mycorrhiza) *e.g.*, ***Puccinia***, (wheat rust disease), ***Penicillium***, Yeast (unicellular fungus).
8. Reproduction can take place by vegetative means fragmentation, fission and budding. Asexual reproduction by spores–conidia, sporangiospores or zoospores. Sexual reproduction by oospores, ascospores and basidiospores–produced in fruiting bodies.
9. **Sexual cycle involves 3 steps :**
  - (i) Plasmogamy (fusion of Protoplasms.)
  - (ii) Karyogamy (fusion of two nuclei.)
  - (iii) Meiosis in zygote resulting in haploid spores.
10. Dikaryophase is a condition of having dikaryon in an intervening dikaryotic stage ( $n + n$  *i.e.*, two nuclei per cell) between plasmogamy and karyogamy in fungi like ascomycetes and basidiomycetes.

## Classes of Fungi

### (i) Phycomycetes :

- grow on decaying wood or as obligate parasites on plants
- Mycelium aseptate and coenocytic
- Spores produced endogenously in sporangium.
- Asexual reproduction by Zoospores or Aplanospores
- Zygosporangia are formed by the fusion of gametes.

*e.g.*, ***Rhizopus***, ***Albugo***, ***Mucor***

### (ii) Ascomycetes :

- also known as ‘sac fungi’
- Are saprophytic, decomposers, parasitic or coprophilous (growing on dung).
- Mycelium branched and septate
- Asexual spores are called conidia produced exogenously on the conidiophores.

Sexual spores are called ascospores produced endogenously in ascus, produced inside fruiting body called Ascocarp.

*e.g., Aspergillus, Neurospora, Saccharomyces (Unicellular fungi), Claviceps, morels, truffles*

### (iii) Basidiomycetes :

- Mycelium septate and branched.
- Generally asexual spores are not found.
- Vegetative reproduction by fragmentation.
- Sexual reproduction by fusion of vegetative or somatic cells to form basidium produced in basidiocarp.
- Basidium produces four basidiospores exogenously after meiosis.

*e.g., Agaricus, Ustilago, Puccinia*

### (iv) Deuteromycetes :

- Called as 'Fungi Imperfecti' as sexual form (perfect stage) is not known for them.
- Once sexual form is discovered the member is moved to Ascomycetes or Basidiomycetes.
- Mycelium is septate and branched.
- Are saprophytic parasitic or decomposers.

*e.g., Alternaria, Colletotrichum, Trichoderma.*

Taxonomic of Fungi	Hypha	Type of Reproduction	Characteristic spore	Origin of Spore	Examples of Fungi
Phycomycetes	Septate	Asexually	Sporangio-spore Zygospore Aplanospore	Sporangio-phore	Nuisance fungi including genera <i>Albugo</i> , <i>Mucor</i> , and <i>Rhizopus</i>
		Sexually	Zygospore or oospore	Fusion of nuclei	

Ascomycetes	Septate	Asexually	Blastospore	Budding	<i>Penicillium</i>
			Conidium	Conidio- phore	<i>Aspergillus</i>
		Sexually	Ascospore	Ascus	<i>Clavicep</i>
					<i>Neurospora</i>
					<i>Sacchaaro- myces</i> (perfect yeast)
Basidiomy- cetes	Septate	Sexually	Basidiospore	Basidium	Mushrooms, smuts and rusts
Deuteromy- cetes (fungi imperfecti)	Septate	Asexually	Thallospore	Thallus (hypha)	Most sapro- phytes and pathogens encountered in medical mycology (Imperfect mould and yeast
			Conidium	Conidio- phore	

## Viruses :

- They did not find a place in biological classification.
- Not truly living.
- Non-cellular organisms which take over the machinery of host cell on entering it and become living but as such they have inert crystalline structure appear non-living. So, difficult to call them living or non-living.
- Virus means venom or poisonous fluid. Pasteur gave the term ‘virus’.
- D.J. Ivanowsky found out that certain microbes caused Tobacco Mosaic Disease in tobacco plant.
- M.W. Beijerinck called fluid as ‘Contagium vivum fluidum’ as extracts of infected plants of tobacco could cause infection in healthy plants.

- W.M. Stanely showed viruses could be crystallized to form crystals of protein which are inert outside their specific host.
- Viruses are obligate parasites.

### Structure of Virus :

- It is a nucleoprotein made up of protein coat called Capsid. Capsid is made up of capsomeres arranged in helical or polyhedral-geometric forms. Have either DNA or RNA as genetic material which may be single or double stranded.
- Usually plant viruses have single stranded RNA; bacteriophages have double stranded DNA and animal viruses have single or double stranded RNA or double stranded DNA.

### Diseases caused in humans :

Mumps, Small pox, herpes, influenza and AIDS etc. In plants, symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

### Viroids :

- Infectious agent, free RNA (lack protein coat)
- RNA has low molecular weight.
- Causes potato spindle tuber disease.
- Discovered by T.O. Diener.

### Prions

- They are highly resistant glycoproteins molecule which function as infectious agent.

### Lichens :

- Symbiotic association between algal component (Phycobiont) and fungal component (mycobiont). Algae provides food. Fungi provides shelter and absorb nutrients and water for alga.
- Good pollution indicators as they do not grow in polluted areas.

## Questions

### Very Short Answer Question

(1 mark each)

1. *Nostoc* and *Anabaena* have specialized cells called heterocysts. What is the function of these cells ?
2. Which group comprises of single celled eukaryotes only ?
3. Which organisms are the chief producers in oceans ?
4. Name the fungus which causes disease in wheat (i) rust (ii) smut.
5. Which Ascomycetes has been used extensively in biochemical and genetic work ?
6. What is the principle underlying the use of cyanobacteria in agriculture ?
7. Define dikaryon stage. Where do you observe this stage?
8. Differentiate between zoospore and zygospore?

### Short Answer Question-I

(2 marks each)

9. How are bacteria classified on the basis of their shapes ?
10. What is the mode of reproduction in bacteria ?
11. Why are red tides caused and why are they harmful ?
12. Viruses and viroids differ in structure and the diseases they cause. How ?
13. Which class of kingdom fungi has both unicellular as well as multicellular member ? When is a fungus called coprophilous ?
14. Why two kingdom classification was not sufficient? Explain with the help of two examples.
15. What is the difference between Archaeobacteria and Eubacteria?
16. How flexibility is maintained in the body of Euglena?

## Short Answer Question-II

(3 marks each)

17. Who gave five kingdom classification ? What was the criteria used for such classification ?
18. What are the modes of nutrition in fungi ?
19. Some symbiotic organisms are very good pollution indicators and composed of a chlorophyllous and a non-chlorophyllous member. Describe them.
20. Who gave two kingdom classification? Write its drawbacks?
21. Explain how reproduction takes place in phycomycetes?
22. Differentiate between mode of sexual reproduction in ascomycete and Basidiomycetes.

## Long Answer Questions

(5 mark each)

23. Some primitive relatives of animals live as predators or parasites and are divided into four major groups. Elaborate.
24. Differentiate between various classes of kingdom Fungi on the basis of their (i) Mycelium, (ii) Types of spores and (iii) Types of fruiting body. Also give two examples for each class.
25. Describe sexual reproduction in fungi.
26. Draw a labelled diagram of bacteriophage. Write its characters also.
27. Discuss how the system of biological classification has been evolved in past?

## Answers

## Very Short Answers

(1 mark each)

1. Help in nitrogen fixation.
2. Kingdom Protista.
3. Diatoms
4. (i) *Puccinia*, (ii) *Ustilago*



5. *Neurospora*
6. Capability of nitrogen fixation
7. Refer to point to remember on page 10.
8. Motile asexual spores of class phycomycetes are known as zoospores whereas zygospores are formed by fusion of two gametes.

### Short Answers-I

(2 marks each)

9. Bacillus (rod-shaped), Coccus (spherical), Vibrio (comma shaped) and Spirillum (spiral shaped).
10. Mainly by fission; Production of spores in unfavourable conditions. Sexual reproduction by DNA transfer.
11. Rapid multiplication of dinoflagellates like *Gonyaulax*. Harmful as they release toxins which kill marine animals.
12. Refer 'Points to Remember'.
13. Ascomycetes : Yeast (Unicellular), *Penicillium* (Multicellular), Coprophilous, means fungi which grow on dung.
14. Refer page no. 17 and 18, NCERT, Text book of Biology class XI.
15. Refer page no. 19, NCERT, Text book of Biology class XI.
16. Instead of cell wall, they have a protein rich layer called pellicle which makes their body flexible.

### Short Answers-II

(3 marks each)

17. R.H. Whittaker, Criteria for classification : Cell structure, thallus organisation, mode of nutrition, reproduction and phylogenetic relationships.
18. Saprophytes, Parasites, Symbionts-Lichens and Mycorrhiza.
19. Lichens, Refer 'Points to Remember'.
20. Carolous Linnaeus. Refer to points.
21. Refer page no. 23, NCERT, Text Book Biology class XI.
22. Refer page no. 23 and 24, NCERT, Text Book Biology class XI.

## Long Answers

(5 marks each)

23. Protozoans. Refer page no 21-22, NCERT Text Book of Biology for Class XI.
24. Refer NCERT Text Book of Biology for Class XI, Page no. 23-24.
25. Refer NCERT text book of Biology for Class XI Page 23. (Plasmogamy, Karyogamy, Meiosis in zygote, Dikaryophase)

The steps are :

- (i) Plasmogamy : fusion of protoplasm of two motile or non-motile gametes.
  - (ii) Karyogamy : fusion of two nuclei.
  - (iii) Zygotic Meiosis to form haploid spores.
  - (iv) Dikaryophase in ascomycetes and basidiomycetes where before karyogamy two nuclei per cell (dikaryon) are found.
26. NCERT page no. 26 Fig 2.6(mb)
  27. Refer to point to remember on page 6, 7 and 8.

## Long Answers Question

### 28. Case study

Corona viruses are a large family of viruses that illness ranging from cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). A Novel Corona Viruses (nCoV), 19 is a new strain that has not been previously identified in humans. Coronaviruses are zoonotic, meaning they are transmitted between animals are people. Common signs of infection include fever, cough, shortness of breath and breathing difficulties. In more severe cases, infection can cause pneumonia, severe acute respiratory syndrome, kidney failure and even death. Standard recommendations to prevent infection spread include regular hand

washing, covering mouth and nose when coughing and sneezing, thoroughly cooking meat and eggs. Avoid close contact with anyone showing symptoms of respiratory illness such as coughing and sneezing.

1. Novel corona virus belongs to the category of viruses having :

- (a) DNA as genetic material
- (b) Double stranded RNA as genetic material
- (c) Single stranded DNA as genetic material
- (d) Single stand RNA as genetic material

Ans.: (d)

2. **Assertion:** An effective antibiotic should be used to prevent the disease caused by Novel corona virus.

**Reason :** Effective antibiotic will reduce the chance of getting infection from viruses including Novel corona virus.

- (a) Both assertion and reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both assertion and reason are false.

Ans.: (d)

3. Read the following statements :

Statement I : The new coronavirus can be transmitted through mosquito bites

Statement II : The COVID-19 virus does not transmit through water while swimming.

Choose from below the correct alternative.

- (a) Only I is true.
- (b) I and II true.
- (c) I is true but II is false.
- (d) I is false but II is true.

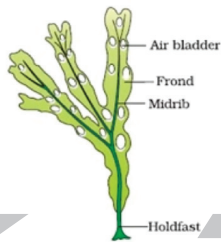
Ans.: (d)

4. Which of the following methods should not be used to prevent infection from Novel corona virus?

- (a) Regular hand washing.
- (b) Covering mouth and nose when coughing and sneezing.
- (c) Thorough cooking of meat and eggs.
- (d) Use of Hand dryers

Ans.: (d)

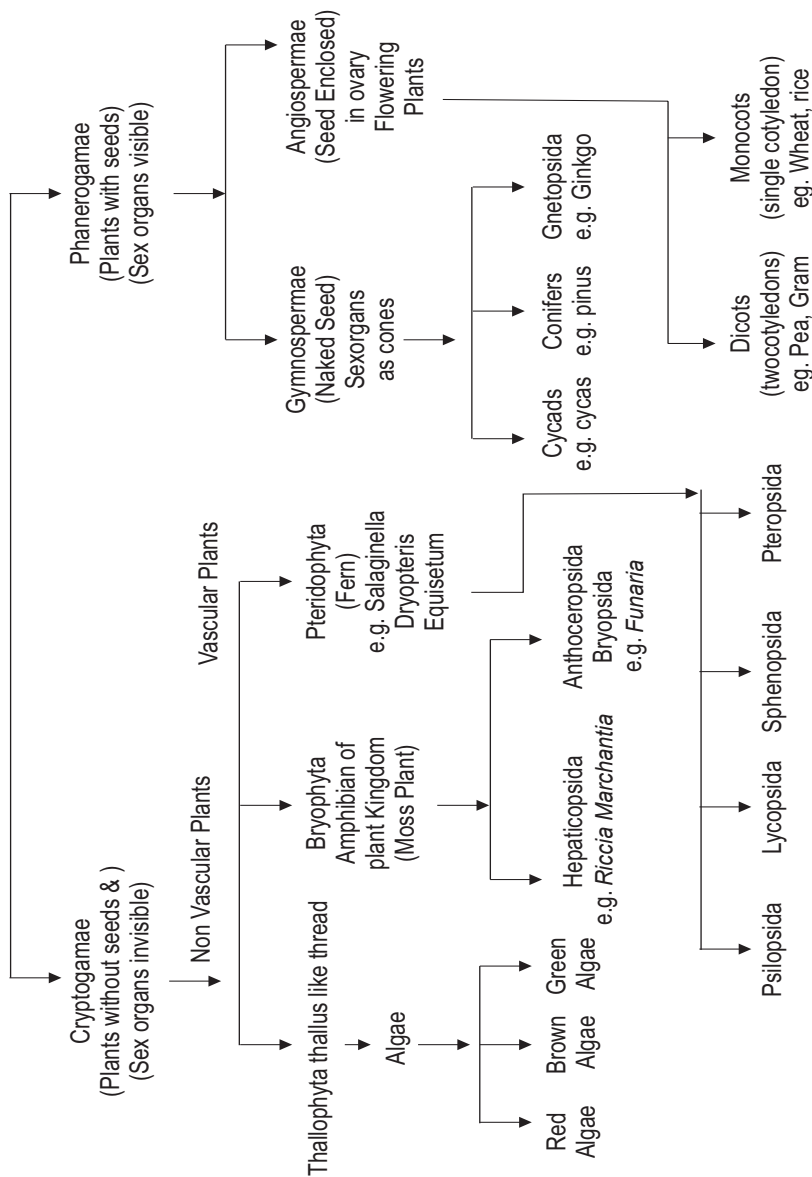




## Chapter - 3

# Plant Kingdom

### PLANT KINGDOM



## Points to Remember

### Classification :

- **Artificial System of Classification**
  - By Carolus Linnaeus, based on androecium structure and vegetative characters.
- **Natural System of Classification**
  - Based on natural affinities among organisms
  - Included external as well as *internal features*
  - By Gerge Bentham and J.D. Hooker
- **Phylogenetic System of Classification**
  - Based on evolutionary relationships between the various organisms
  - By Engler and Prantl
  - Later on By Hutchinson

### Numerical Taxonomy :

- Carried out using computers
- Based on all observable characteristics
- Data processed after assigning number and codes to all the characters.

**Advantages :** Each character gets equal importance and a number of characters can be considered.

### Cytotaxonomy :

- Based on *cytological informations*.
- Gives importance to chromosome number, structure and behaviour.

### Chemotaxonomy :

- Based on Chemical constituents of the plants.

### Algae :

- Chlorophyll bearing, simple, thalloid, autotrophic and largely aquatic organisms.

## Importance of Algae :

- Help in carbon dioxide fixation by carrying out photosynthesis and have immense economic importance.
- At least half of the total carbon dioxide fixation on earth carried out by them.
- Increases dissolved oxygen level in their environment.
- Many species like *Laminaria*, *Sargassum*, *Porphyra* etc. are used as food.
- *Agar* obtained from *Gelidium* and *Gracilaria* which is used in ice-creams and jellies and to grow microbes.
- *Algin* obtained from brown algae and *carrageen* from red algae used commercially as *hydrocolloids*.
- *Chlorella* and *Spirulina* are unicellular algae, rich in protein and used even by space travellers.
- Algae are unicellular like *Chlamydomonas*, colonial like *Volvox* or or filamentous like *spirogyra* and *Ulothrix*. Occur in water, soil, wood moist stones etc.

Algae are divided into 3 classes.

### (i) Chlorophyceae

- Green algae, Main pigment is chlorophyll 'a' and 'b'.
- Cell wall has inner layer of cellulose and outer layer of pectose.
- Has pyrenoids made up of starch and proteins.
- Pigment and pyrenoids are located in *Chloroplast*.

*e.g., Chlamydomonas, Volvox, Spirogyra, Ulothrix, Chara.*

### (ii) Phaeophyceae

- Brown algae are brown coloured due to main pigments chlorophyll 'a', 'c' and fucoxanthin (xanthophyll)
- Cell wall has cellulose with gelatinous coating of algin.

- Has mannitol and laminarin (complex carbohydrate) as reserve food material.
- Body divisible into holdfast, stipe and frond.
- *e.g., Ectocarpus, Fucus, Laminaria, Dictyota, Sargassum*

### (iii) Rhodophyceae

- Red algae are red coloured due to pigments chlorophyll 'a', 'd' and r-phycoerythrin.
- Found on surface as well great depths in oceans.
- Cell wall has cellulose.
- Reserve food material is floridean starch.

*e.g., Polysiphonia, Porphyra, Gelidium, Gracilaria.*

## Reproduction in Algae

**Vegetative reproduction :** by fragmentation

**Asexual Reproduction :** Flagellated zoospores in Chlorophyceae, Biflagellated zoospores in Phaeophyceae, By non-motile spores in Rhodophyceae.

**Sexual Reproduction :** Isogamous, anisogamous or oogamous in chlorophyceae and Phaeophyceae.

By non-motile gametes and oogamous in Rhodophyceae.

## Bryophytes :

- 'Amphibians of plant kingdom'.
- Occur in damp, humid and shaded places.
- Lack true roots, stem or leaves.
- Main plant body is haploid and thallus like (prostrate or erect)
- **Economic Importance :** Food for herbaceous animals.

*Sphagnum* in form of peat is used as fuel and also used as packing material for trans-shipment of living material, as it has water holding capacity.

Prevents soil erosion, alongwith lichens are first colonizers on barren rock.

- Is divided into two classes *Liverworts* (thalloid body, dorsiventral, *e.g.,*



*Marchantia*) and *Mosses* (have two stages in gametophyte—creeping, green, branched, filamentous **protonema stage** and the **leafy stage** having spirally arranged leaves e.g., *Funaria*, *Polytrichum* and *Sphagnum*).

## Reproduction in Bryophytes

- Vegetative reproduction by fragmentation.
- Asexual reproduction by gemmae formed in gemma cups.
- Sexual reproduction : Main plant body is haploid, produces gametes and so called **Gametophyte**. By fusion of antherozoids produced in antheridium and egg cell produced in archegonium, results in formation of zygote which develops into sporophytic structure differentiated into foot, seta and capsule. **Spores** produced in a capsule germinate to form free-living gametophyte (Protonema). **Sporophyte** is not free living but attached to photosynthetic gametophyte from which it derives nutrition.

## Pteridophytes :

- First terrestrial plants.
- Prefer cool, damp and shady places to grow.
- Grown as ornamentals.
- Used for medicinal purpose, as soil binder.
- Main plant body is sporophyte which is differentiated into true root, stem and leaves.
- Leaves may be small as in *Selaginella* or large as in ferns.
- Sporangia having spores are subtended by leaf-like appendages called sporophylls. (Sporophylls may be arranged to form strobili or cones.)
- In Sporangia, the spore mother cells give to spores after meiosis.
- Spores germinate to form haploid gametophytic structure called **prothallus** which is free living, small, unicellular and photosynthetic.
- Prothallus bears antheridia and archegonia which bear antherozoids and egg cell respectively which on fertilisation form zygote. Zygote produces multicellular, well differentiated sporophyte.

- The four classes are : Psilopsida (*Psilotum*), Lycopsida (*Selaginella*), Sphenopsida (*Equisetum*) and Pteropsida (*Pteris*).

**Heterospory :** Two kinds of spores *i.e.*, large (macro) and small (micro) spores are produced. *e.g.*, *Selaginella* and *Salvinia*.

**Seed Habit :** The development of zygote into young embryos takes place within the female gametophyte which is retained on parent sporophyte. This event is precursor to seed habit and this is an important step in evolution and is found *Selaginella* and *Salvinia* among the pteridophytes.

## Gymnosperms :

- Have naked seeds as the ovules are not enclosed by any ovary wall and remain exposed.
- Includes shrubs and trees (medium and tall sized).
- Have generally tap roots, stem may be unbranched (*Cycas*) or branched (*Pinus*, *Cedrus*), leaves–needle like (*Pinus*) and pinnate (*Cycas*).
- Roots of *Pinus* have fungal association in the form of mycorrhiza.
- *Cycas* have small specialized roots called **coralloid root** which are associated with N<sub>2</sub> fixing cyanobacteria.
- Heterosporous–Produce haploid microspores and megaspores.
- Male cone has microsporophylls which bear microsporangia having microspores which develop into reduced gametophyte called pollengrain.
- Female cone has megasporophylls which bear megasporangia having megaspores which are enclosed within the megasporangium (Nucellus). One megaspore develops into female gametophyte bearing two or more archegonia.
- Pollen grains carried in air currents reach ovules, form pollen tube which reach archegonia and release male gametes which fertilise egg cell and form zygote which produce embryos. Ovules develop into seeds which are not covered.

## Angiosperms :

- Called flowering plants and have seeds enclosed in fruits.

- Divided into two classes—Dicotyledons (have two cotyledons) and Monocotyledons (have one cotyledon).
- **Smallest angiosperm** : *Wolffia*
- **Large tree** : *Eucalyptus* (Over 100 meters)
- Stamen has filament and anther. Anthers bear pollen grains. Pollen grains have two male gametes.
- Pistil has stigma, style and ovary. Ovary has ovule in which female gametophyte (embryo sac) develops.
- Embryo sac has 7 cells and 8 nuclei. One egg cell 2 synergids, 3 antipodals and two polar nuclei which fuse to form secondary nucleus.
- Pollen grain is carried by wind, water, insects and other agents reaches to stigma and produces pollen tube which enters embryo sac.
- **Double fertilisation** : One male gamete fuses with egg cell (Syngamy) to form zygote which develops into embryo.

Other male gamete fuses with secondary nucleus (triple fusion) which forms triploid primary endosperm nucleus (PEN). PEN develops into endosperm which nourishes the developing embryo.

- Ovules develop into seeds and ovaries into fruits.

### Questions

#### Very Short Answer Question

(1 mark each)

1. What is a pyrenoid body ?
2. Define gemma.
3. Which group of plants is regarded as first terrestrial plants ? Why ?
4. Which organism is regarded as one of the tallest tree species ?
5. The gametes and spores of phaeophyceae have a distinct morphology. Give its name.
6. Which substance has structural similarity to floridean starch ?
7. Name the organism which exhibit heterospory and seed habit.

### Short Answer Question-I

(2 marks each)

8. *Sphagnum* has a lot of economic importance. Justify.
9. Gymnosperms can show polyembryony. Why do you think so ?
10. How is leafy stage formed in mosses ? How is it different from protonema ?

### Short Answer Question-II

(3 marks each)

11. The leaves in gymnosperms are adapted to withstand xerophytic conditions. Justify.
12. The gametophytes of bryophytes and pteridophytes are different from that of gymnosperms. How ?
13. Roots in some gymnosperms have fungal or algal association. Give examples, their names and role in the plants.
14. Why is presence of water a must for fertilisation in pteridophytes ?
15. Draw a neatly labelled diagram of *Funaria*?
16. Differentiate between three classes of algae.
17. Mention any three economic importance of algae.
18. Differentiate between isogamous, anisogamous and oogamous reproduction in algae.
19. Explain the life cycle of bryophytes.

### Long Answer Questions

(5 marks each)

20. Draw the life cycle of an angiosperm alongwith a brief note on double fertilisation.
21. Explain alternation of generation in plants.
22. Explain various classes of Algae.

## Answers

### Very Short Answers

(1 mark each)

1. Proteinaceous body usually surrounded by starch found in algae.
2. Gemma are green, multicellular, asexual buds which develop in receptacles called as gemma cups.
3. Pteridophytes. As they possess vascular tissues—xylem and phloem.
4. *Sequoia*
5. Pyriform (pear-shaped), bear two laterally attached flagella.
6. Amylopectin and glycogen.
7. *Selaginella* and *Salvinia*.

### Short Answers-I

(2 marks each)

8. Provide peat used as fuel : used as packing material for trans-shipment of living material.
9. Have two or more archegonia, so polyembryony can occur.
10. Leafy stage develops from secondary protonema as a lateral bud. Protonema is creeping, green, branched frequently filamentous stage whereas leafy stage is upright with spirally arranged leaves.

### Short Answers-II

(3 marks each)

11. Gymnosperms like conifers have : needle shaped leaves to reduce surface area, thick cuticle and sunken stomata to reduce water loss.
12. Male and female gametophyte have free existence in bryophytes and pteridophytes but not in Gymnosperms. They remain within sporangia retained on sporophytes.
13. *Pinus* has fungal association to form mycorrhiza which helps in absorption of water and minerals. *Cycas* has algal association in coralloid roots which are associated with  $N_2$  fixing cyanobacteria.
14. The antheridia produces male gametes, antherozoids which swim in water to reach archegonia, bearing non-motile egg. Thus fertilisation can occur only when water is present in the surrounding medium.
15. Refer page no. 34, NCERT, Text book of Biology class XI.

16. Refer page no. 33, NCERT, Text book of Biology class XI.
17. Refer to point to remember on page 18.
18. Refer page no. 30, NCERT, Text book of Biology class XI.
19. Refer page no. 33, NCERT, Text book of Biology class XI.

### Long Answers (5 mark each)

20. Refer Figure 3.6, page no. 41, NCERT, Text Book of Biology for Class XI.
21. Refer 'Points to Remember' and Page No. 42, NCERT, Text book of Biology for class XI.
22. Rhodophyceae/Phaeophyceae and chlorophyceae with correct explanation.
23. **Case Study**

Bryophytes, the amphibians of the plant kingdom, can be seen growing on varied surfaces like rocks, soil, tree trunks, bones, rotting wood etc. A unique feature of these plants is that they can survive on bare rocks and soil, therefore play an important role in plant succession in xeric conditions. In recent years, bryophytes have emerged as a potential biopharming tool for the production of complex compounds and have been investigated for their properties like antimicrobial, antioxidant, anti-inflammatory, anti-venomous etc. Mosses are among the most sensitive components of the vegetation which respect to pollutant deposition, and can be sensitive to both acidity and N, which dominate today's anthropogenic deposition. Like lichens, many mosses have become extinct from urban/industrial environments. Too much N can change morphology, often leading to sparser mats that are desiccation prone and less efficient at suppressing competitors. Mosses play an important role in nutrient cycling, immobilization of N in some habitats, effectively traps reactive N and facilitates deposition preventing it from leaching into the pore water, making it unavailable to the roots of higher plants.

1. Bryophytes are called amphibian of plant kingdom because.
  - (a) They live in damp and shady places
  - (b) They can hop like amphibians
  - (c) They require water to complete the process of sexual reproduction
  - (d) They can survive on bare rock.

Ans.: (c)

2. Mosses show sensitivity towards
- (a) Soil acidity
  - (b) Level of nitrogen
  - (c) Both acidity and Nitrogen
  - (d) Carbon dioxide level increase in air

Ans.: (c)

3. Assertion : Like lichens, many mosses have become extinct from urban/ industrial environments

Reason : Mosses are among the most sensitive group to both acidity and Nitrogen

- (a) Both assertion and reason are true, and the reason is the correct explanation of the assertion
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion
- (c) Assertion is true but reason is false
- (d) Both assertion and reason are false

Ans.: (a)

4. Read the following statement

Statement I : Mosses play an important role in nutrient cycling

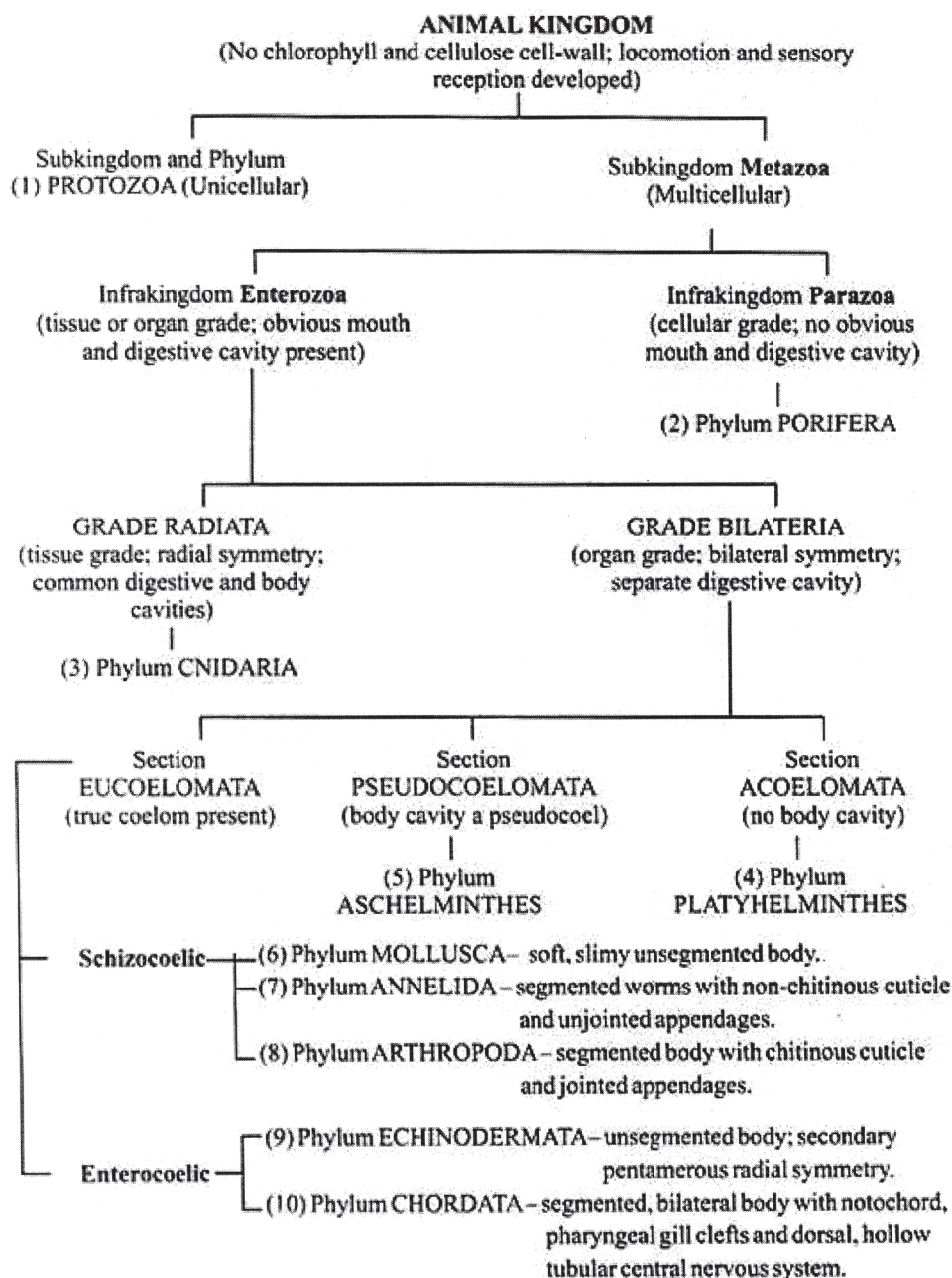
Statement II : Some mosses show antimicrobial, antioxidant, anti-inflammatory, anti-venomous properties

Choose from below the correct alternative.

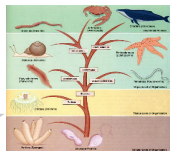
- (a) Only I is true
- (b) I and II are true
- (c) I is true but II is false
- (d) I is false but II is true

Ans.: (b)









## Chapter - 4

# Animal Kingdom

### Point to Remember

#### Basis of Classification :

Animals are classified on the basis of following few fundamental features—

##### 1. Levels of Organisation :

- (1) Cellular level : Cells are arranged as loose cell aggregates, *e.g.*, sponges.
- (2) Tissue level : The cells performing the same function are arranged into tissues, *e.g.*, Coelenterates.
- (3) Organ level : Tissues are grouped together to form organs, each specialised for a particular function. *e.g.*, platyhelminthes.
- (4) Organ system level : organs are associated to form functional systems *e.g.*, Annelids, Arthropods, Molluscs, Echinoderms and Chordates.

**Example :** Circulatory System.

**Open type :** Blood pumped out through heart. Not confined to blood vessels. Cells and tissues are directly bathed in it.

**Closed types :** Blood is circulated through blood vessels (arteries, veins and capillaries)

##### 2. Symmetry :

- **Asymmetrical :** Cannot be divided into equal halves through median plane *e.g.*, Sponges.
- **Radial symmetry :** Any plane passing through central axis can divide organism into identical halves. *e.g.*, coelenterates, Ctenophores and echinoderms.
- **Bilateral symmetry :** Only one plane can divide the organism into two identical left and right halves *e.g.*, Annelids and Arthropods.

##### 3. Germinal Layers :

**Diploblastic :** Cells arranged in two embryonic layers *i.e.*, external ectoderm and internal endoderm. (Mesoglea may be present in between ectoderm and endoderm) *e.g.*, porifers and Coelenterates. (Cnidarians)

**Triploblastic :** Three layers present in developing embryo *i.e.*, ectoderm, mesoderm and endoderm. *e.g.*, Platyhelminthes to Chordates.

#### 4. Coelom (Body cavity which is lined by mesoderm)

**Coelomates :** Have coelom *e.g.*, Annelids, Arthropods, molluscs, Echinoderms, Chordates etc.

**Pseudocoelomates :** No true coelom as mesoderm is present in scattered pouches between ectoderm and endoderm. *e.g.*, Aschelminthes.

**Acoelomates :** Body cavity is absent *e.g.*, Platyhelminthes.

#### 5. Segmentation (A) True Metamerism : Found Annelida, Arthropoda, Chordata :

- Segmentation is external as well as a internal in Annelids.
- Segmentation is external in Arthropods.
- Segmentation is internal in chordates.
- **Metamerism :** If body is externally and internally divided into segments (metameres) with serial repetition of atleast some organs, then phenomenon is called metamerism *e.g.*, Earthworm. (B) Pseudometamerism : Found in tapeworm. The proglottids (segments of tapeworm) budded off from neck not embryonic in origin.

#### 6. Notochord :

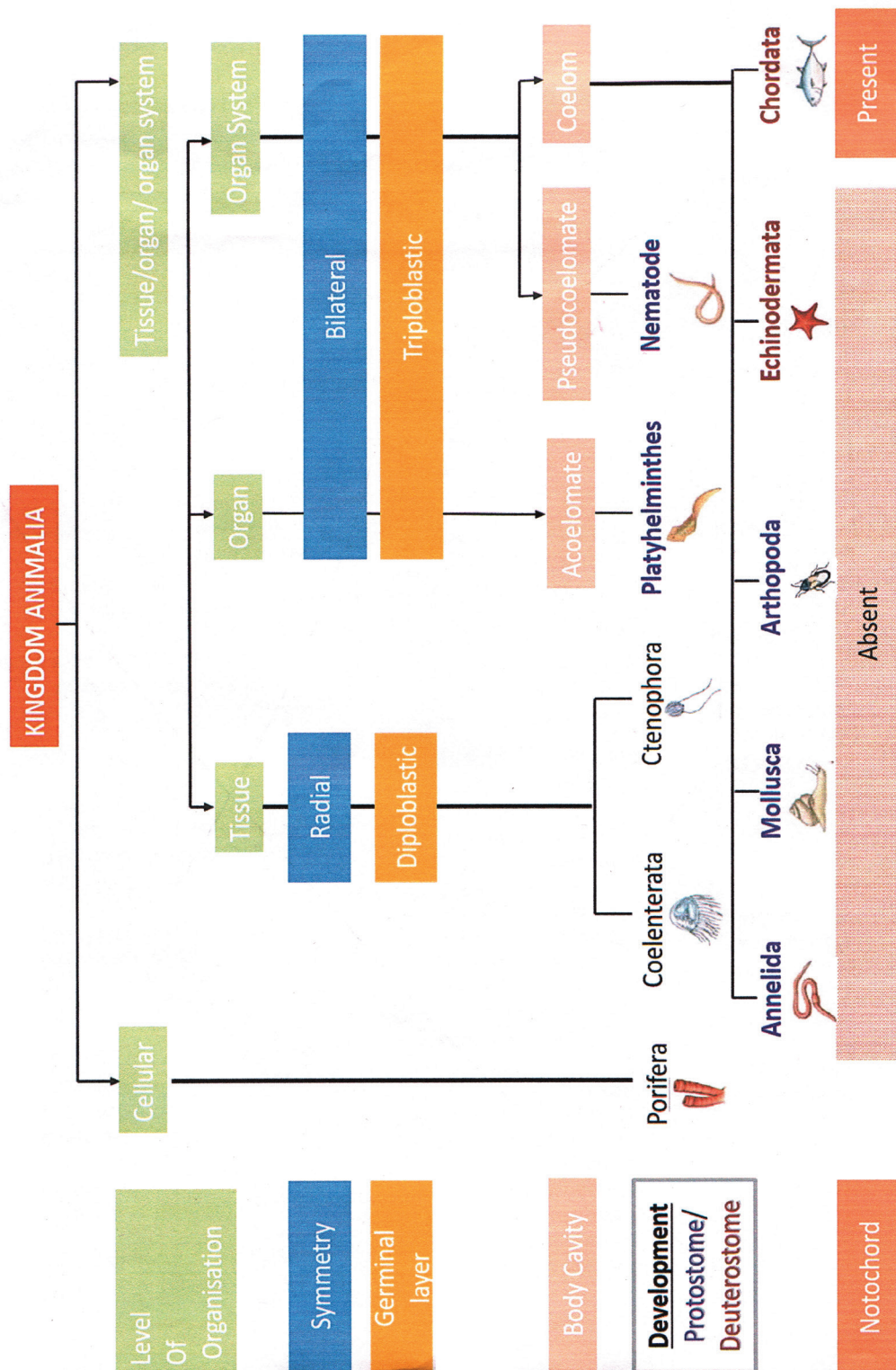
- Rod-like structure formed during embryonic development on the dorsal side. It is mesodermally derived *e.g.*, Chordates.
- Non-chordates do not have notochord *e.g.*, porifera to echinoderms.

### Phylum Porifera :

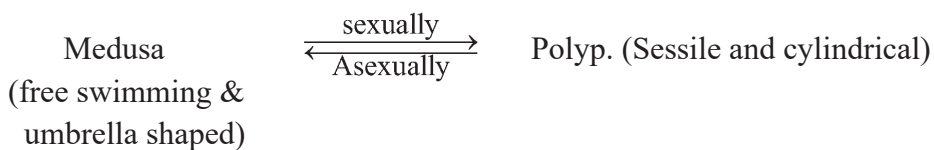
- Also called sponges.
- Are usually marine and asymmetrical.
- Have cellular level of organisation and diploblastic animals.
- Food gathering, respiratory exchange and removal of wastes occurs through water canal system. Digestion intracellular.
- Ostia (minute pores on body), spongocoel (body cavity) and osculum help in water transport. They are lined by choanocytes (collar cells).
- *Body wall* has skeleton of spicules or spongin fibres.
- Animals are hermaphrodite. Fertilisation internal. Development is indirect (*i.e.*, has a larval stage distinct from adult stage) *e.g.*, *Sycon*, *Euspongia*. *Spongilla* (Fresh water sponge)

### Phylum Coelenterata :

- Also called Cnidarians.
- Are usually marine and radially symmetrical.
- Sessile or free swimming.



- Have tissue level of organisation.
- Are diploblastic (with mesogloea)
- Capture of prey, anchorage and defence occurs through cnidoblasts/cnidocytes (have stinging capsules nematocytes) present on tentacles.
- Digestion extracellular and intracellular.
- Have a central gastro-vascular cavity and an opening, hypostome.
- Body wall of some composed of calcium carbonate. e.g. corals.
- exhibit two body forms : polyp and medusa e.g., *Hydra*, *Aurelia*.
- Alternation of generation between body forms called **metagenesis** occurs in *Obelia* where :



- e.g., *Physalia*, *Adamsia*, *Pennatula*, *Gorgonia*, *Meandrina*.

## Phylum Ctenophora :

- Also called as sea walnuts or comb jellies.
- Are exclusively marine, radially symmetrical.
- Have tissue level organisation, are diploblastic.
- Digestion both extra and intracellular.
- Body has eight external rows of ciliated comb plates for locomotion.
- Show Bioluminescence (Property of living organisms to emit light).
- Hermaphrodite (sexes are not separate).
- Only sexual reproduction occurs. External fertilization. Indirect development.
- e.g., *Ctenoplana*, *Pleurobrachia*.

## Phylum Platyhelminthes :

- Also called as ‘flat worms’.
- Have dorsoventrally flattened body. Are mostly endoparasites in animals.
- Are bilaterally symmetrical, triploblastic, acoelomate, with organ level of organisation.
- Absorb nutrients through body surface.
- Parasitic forms have hooks and suckers.
- ‘Flame cells’ help in osmoregulation and excretion.

- Sexes not separate.
- Fertilisation internal. Many larval stages present. *Planaria* has high regeneration capacity. *e.g., Taenia, Fasciola*.

### Phylum Aschelminthes :

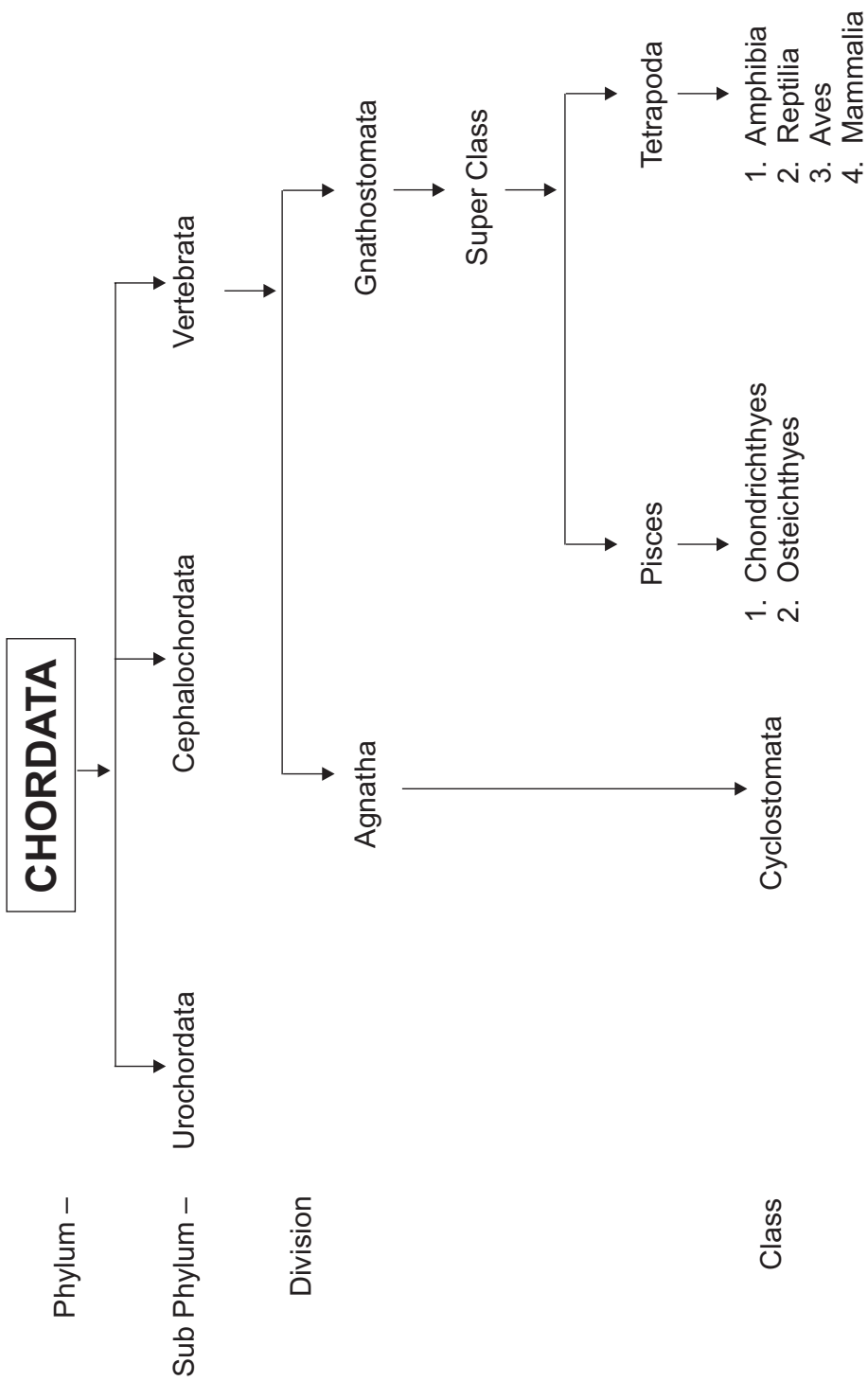
- Also called 'round worms'.
- May be free living, parasitic, aquatic or terrestrial.
- Are bilaterally symmetrical, triploblastic, pseudocoelomate.
- Alimentary canal complete (has muscular pharynx), wastes removed through excretory pore.
- Sexes separate. (dioecious)
- Females longer than males.
- Fertilisation internal. Development direct or indirect. *e.g., Ascaris, Wuchereria, Ancylostoma*.

### Phylum Annelida :

- Are aquatic or terrestrial, free-living or parasitic.
- Are bilaterally symmetrical, triploblastic, organ-system level of organisation and metamerically segmented body.
- Are coelomate animals.
- Have longitudinal and circular muscles for locomotion.
- Have closed circulatory system.
- *Nereis* (dioecious and aquatic annelid) has lateral appendages called parapodia for swimming.
- Have nephridia for osmoregulation and excretion.
- Neural system consists of paired ganglia connected by lateral nerves to a double ventral nerve cord.
- Reproduction is sexual.
- *e.g., Earthworm (Pheretima)* and *Leech (Hirudinaria)* which are hermaphrodites (*i.e., monoecious*).

### Phylum Arthropoda :

- Largest phylum of Animalia.
- Are bilaterally symmetrical, triploblastic, segmented externally and organ system level of organisation, coelomate.
- Body divisible into head, thorax, abdomen and has a chitinous exoskeleton. Jointed appendages are present.



- Respiration by gills, book gills, book lungs or tracheal system. Excretion through **malpighian tubules**.
- Sensory organs : Antennae, eyes; Organs of balance : **Statocysts**.
- Fertilisation usually internal. Development is indirect or direct. Are mostly oviparous.  
*e.g., Apis, Bombyx, Laccifer, Anopheles, Culex, Aedes, Locusta, Limulus.*

## Phylum Mollusca :

- Second largest phylum of Animalia.
- Terrestrial or aquatic
- Are bilaterally symmetrical, triploblastic and organ system level of organisation, coelomate.
- Body visible into **head, muscular foot and visceral hump** and is covered by calcareous shell and is unsegmented.
- **Mantle** : Soft and spongy layer of skin; **Mantle cavity** : Space between visceral hump and mantle.
- Respiration and excretion by feather like gills in mantle cavity.
- Head has sensory tentacles. Radula a rasping organ for feeding in mouth.
- Are oviparous, dioecious, have indirect development.  
*e.g., Plia, Pinctada, Octopus, Sepia, Loligo, Aplysia, Dentalium, Chaetopleura.*

## Phylum Echinodermata :

- Are spiny bodied organisms with endoskeleton of calcareous ossicles.
- Are exclusively marine, **radially symmetrical** in **adult** but **bilaterally symmetrical** in **larval stage**. Organ system level of organisation.
- Triploblastic and coelomate.
- Digestive system complete. Mouth ventral, Anus on dorsal side.
- Food gathering, respiration, locomotion carried out by **water vascular system**.
- Excretory system is absent.
- Reproduction—sexual, sexes are separate.
- Fertilisation external. Development indirect (free swimming larva)
- *e.g., Asterias, Cucumaria, Antedon, Echinus, ophiura.*

## Phylum Hemichordata :

- Represents small group of worm-like organisms.
- Was earlier placed as sub-phylum of Phylum Chordata.



- Bilaterally symmetrical, triploblastic and coelomate with organ system level of organisation.
- Body cylindrical, has proboscis, collar and trunk.
- Circulatory System—open.
- Respiration by gills, excretion by proboscis gland.
- Sexes separate, external fertilisation, indirect development.  
*e.g. Balanoglossus, Saccoglossus.*

## Phylum Chordata :

- Presence of **Notochord**.
- Have **dorsal hollow nerve cord**.
- Have **paired pharyngeal gill slits**.
- Bilaterally symmetrical, triploblastic, coelomate, organ system level of organisation.
- Heart is ventral.
- Post anal tail present, closed circulatory system.

### (i) Sub-Phyla Urochordata /Tunicata

- Notochord present only in larval tail.  
*e.g., Ascidia, Salpa, Doliolum*

### (ii) Sub-phyla Cephalochordata

- Notochord extends from head to tail (Persistent)  
*e.g., Amphioxus.*

### (iii) Sub-Phyla Vertebrata

- Have notochord only during embryonic period.
- Notochord gets replaced by bony or cartilaginous vertebral column.
- Have ventral muscular heart, kidneys for excretion and osmoregulation, paired appendages (fins or limbs)

## Vertebrata have two Division :

### (a) Agnatha (Lacks Jaw) : Class : Cyclostomata

- Live as ectoparasites on some fishes.
- Have sucking and circular mouth without jaws.
- Have 6-15 pairs of gill slits for respiration.
- No scales, no paired fins.
- Cranium and vertebral column is cartilaginous.



- Marine, Migrate to fresh water for spawning and die after spawning.
- Larva returns to ocean after metamorphosis.

*e.g., Petromyzon, Myxine*

**(b) Gnathostomata (Bear Jaws)—divides into two super classes :**

## **Super-class : Pisces**

### **1. Class : Chondrichthyes :**

- Have cartilaginous endoskeleton, are marine with streamlined body.
- Mouth ventral.
- Gill slits without operculum (gill cover).
- Skin has placoid scales; jaws—very powerful.
- No air bladder, so swim constantly to avoid sinking.
- Teeth are backwardly directed, modified placoid scales.
- Notochord is persistent throughout life.
- Two chambered heart; poikilotherms (cold-blooded)
- Sexes separate; males have *claspers* on pelvic fins.
- Internal fertilisation; viviparous.

*e.g., Torpedo, Trygon, Scoliodon, Pristis, Carcharodon*

### **2. Class : Osteichthyes**

- Have bony endoskeleton, Aquatic
- Mouth is usually terminal. Body-Streamlined
- Four pairs of gill slits covered by operculum, heart two chambered, cold blooded.
- Skin has cycloid/ctenoid scales.
- Have air bladder which regulates buoyancy.
- Sexes separate.
- Usually oviparous, fertilisation external.
- Development direct.
- *e.g., Hippocampus, Labeo, Catla, Betla, Clarias, Exocoetus*

## **Sub-Phylum Vertebrata : Gnathostomata**

## **Super Class : Tetrapoda**

### **1. Class : Amphibia**

- Can live in aquatic as well as terrestrial habitats.
- Body divisible into head and trunk, paired limbs.

- Skin moist. No scales.
- Tympanum represents ear. Eyes have eyelids.
- Cloaca is the common chamber where alimentary canal, urinary and reproductive tracts open.
- Respiration by gills, lungs or skin.
- Heart is 3-chambered; cold-blooded; Sexes separate; fertilisation external.
- Oviparous. Indirect development.
- *e.g., Bufo, Rana, Hyla, Salamandra, Ichthyophis*

## 2. Class : Reptilia

- Creep or crawl to locomote. Mostly terrestrial.
- Body has dry and cornified skin and epidermal *scales or scutes*.
- Tympanum represents ear.
- Limbs, when present, are two pairs
- Snakes and lizards shed scales as *skin cast*.
- Heart 3-chambered but 4-chambered in crocodiles.
- Sexes Separate; fertilisation internal.
- Oviparous. Direct development.
- *e.g., Testudo, Naja, Vipera, Calotes, Crocodilus, Hemidactylus*

## 3. Class : Aves

- Presence of feathers except flightless birds and beak (modified jaws) without teeth.
- Forelimbs are modified into wings.
- Hind limbs have scales, modified for walking, swimming or clasp.
- Skin is dry as no glands on skin except oil gland at base of tail.
- Endoskeleton bony with air cavities (pneumatic) and hollow bones to assist in flight.
- Crop and Gizzard—Additional chamber in digestive tract.
- Air sacs are connected to lungs to supplement respiration.
- Warm blooded (homoiothermous), Heart—Four chambered.
- Sexes separate, fertilization internal
- Oviparous. Direct development.
- *e.g., Columba, Struthio, Pavo, Corvus, Neophron, Psittacula, Aptenodytes.*

## 4. Class : Mammalia

- Have mammary glands to nourish young ones.
- Have two pairs of limbs, adapted to perform special work.

- Skin has hairs.
- External ears or, pinna present.
- Different types of teeth in jaw.
- Homoiothermous; Heart–Four chambered, Lungs for respiration.
- Sexes are separate, fertilisation internal.
- Viviparous. Direct development.
- e.g., *Rattus*, *Canis*, *Elephas*, *Equus*. Oviparous mammal is *Ornithorhynchus*.

## Questions

### Very Short Answer Questions

(1 mark each)

1. What is mesogloea ? Where is it found.
2. When is the development of an organism called as Indirect ?
3. Why are corals important ?
4. What is the difference between class Amphibia and class Reptilia in respect of their skin ?
5. Which phylum consists of organisms with cellular level of organisation ?
6. Name the arthropod which is a (i) Living fossil, (ii) Gregarious pest.
7. Which organ helps in excretion in (i) Arthropods, (ii) Hemichordates ?
8. Why the segmentation in flatworms referred as pseudo-segmentations?

### Short Answer Questions-I

(2 marks each)

9. Distinguish between poikilothermous and homoiothermous organisms.
10. Define metagenesis with a suitable example.
11. List the characteristic features of class Mammalia.
12. How will you distinguish between male and female round worms?
13. How the water vascular system of echinoderms is different from poriferans?
14. What do you understand by the term ‘indirect development’?

### Short Answer Questions-II

(3 marks each)

15. What is the difference between organisms on the basis of the coelom ? Give examples for each.
16. Compare the water transport (vascular) system of poriferans and the echinoderms.

17. What are the feature of class Aves which help them in flying ?
18. Write any three adaptations observed in Aves.

### Long Answer Questions

(5 marks each)

19. Distinguish between the chordates and non-chordates.
20. Differentiate between class Chondrichthyes and class Osteichthyes.

## Answers

### Very Short Answers

(1 mark each)

1. Undifferentiated layer present between ectoderm and endoderm. It is found in Coelenterates.
2. Have a larval stage morphologically distinct from adult.
3. Have skeleton composed of calcium carbonate which gets deposited and can lead to formation of land forms, e.g., Lakshadweep (a coral island).
4. **Class Amphibia** : Have moist skin without scales.  
**Class Reptilia** : Have dry cornified skin with scales.
5. Phylum Porifera.
6. (i) *Limulus* (King crab), (ii) *Locusta* (Locust)
7. (i) Malpighian tubules, (ii) Proboscis gland.
8. Refer to point to remember on page 28.

### Short Answers-I

(2 marks each)

9. **Poikilothermous** (cold blooded); Lack ability to regulate their body temperature.  
**Homoiothermous** (Warm) : Can regulate body temperature.
10. Refer 'Points to Remember'.
11. Refer 'Points to Remember'.
12. Refer page no. 52, NCERT, Text book of Biology class XI.
13. Refer page no 50 and 54, NCERT, Text book of Biology class XI.
14. Development through larval state.

### Short Answers-II

(3 marks each)

15. Refer 'Points to Remember'.
16. Refer 'Points to Remember, NCERT, Text Book of Biology for Class XI.
17. Wings, bones long and hollow with air cavities, air sacs connected to lungs to supplement respiration.
18. Refer to point to remember on page 36.

## Long Answers

(5 marks each)

19. Refer Table 4.1, page 55, NCERT, Text Book of Biology for Class XI.

20. Refer 'Points to Remember'.

### 21. Case Study

Coral reefs are very beautiful, brightly coloured backgrounds for serene snorkelling experiences. The stunning colours in corals come from a marine alga called zooxanthellae, which live inside them. These algae do photosynthesis for the corals so that the corals get energy to grow and reproduce. When corals get environmental stresses like heat or pollution, they react by expelling these algae, leaving a ghostly, transparent skeleton behind. This is known as 'coral bleaching'. Without zooxanthellae most corals starve and would die. At least a quarter of the world's marine life needs coral reefs around the world are disappearing fast. At the local level, Water pollution, overfishing and coastal development are taking their toll on coral reefs. At worldwide level, carbon pollution is warming our oceans and causing corals release carbon pollution into the air, which is heating our planet and warming our oceans. If we continue to pollute the air and the ocean with carbon emissions at our high rate, coral reefs around the world will face a catastrophic future in coming decades - in our lifetime.

1. To which of the following phylum coral reefs belong?

- (a) Echinodermata
- (b) Platyhelminthes
- (c) Cnidaria
- (d) Porifera

Ans.: (c)

2. Corals are made by deposition of

- (a) Endoskeleton made up of silica
- (b) Exoskeleton made of protein fibre
- (c) Exoskeleton made up of calcium carbonate
- (d) Endoskeleton made up of protein fibres

3. Which one the following could not be a possible reason for coral bleaching?

- (a) Water pollution
- (b) Carbon pollution
- (c) Soil pollution
- (d) Overfishing and coastal development

Ans. : (c)

4. The type of association shown by zooxanthellae and corals is known as

- (a) Commensalism
- (b) Symbiotic
- (c) Predation
- (d) Parasitism

Ans.: (b)

5. Assertion : Coral reefs are very beautiful, brightly coloured backgrounds for serene snorkelling experiences

Reason: A marine algae zooxanthellae live inside them and do photosynthesis

- (a) Both assertion and reason are correct and reason is correct explanation of assertion
- (b) The assertion is incorrect, but the reason is correct
- (c) Both assertion and reason are incorrect
- (d) The assertion is correct, but the reason is incorrect

Ans.: (a)

## 22. Case Study

In 2020, India has battled its worst desert locust outbreak in decades with infestations in Gujarat, Rajasthan, Maharashtra, Madhya Pradesh, Punjab, Haryana and Uttar Pradesh. The swarms of desert locusts, known for feeding on green leaves and caused extensive damage to vegetation.

Locust is a large, mainly tropical grasshopper, with strong powers of flight and it migrates in vast swarms causing widespread crop loss. Locusts entered Rajasthan from Pakistan earlier this month, and then drifted into other parts of western India. Locusts aren't dangerous as long as they are individual hoppers/moths or small isolated groups of insect, in what is called the "solitary phase". It is when their population grows to large numbers – the resultant crowding induces behavioural changes and transformation from the "solitary" to "gregarious" phase – then they start forming swarms. A single swarm contains up to 40-80 million adults in one square km and these can

travel up to 150 km in one day. Locusts are edible insects. Several cultures throughout the world consume insects, and locusts are considered a delicacy and eaten in many African, Middle Eastern, and Asian countries.

1. Locust belongs to which phyla of animal kingdom :

- (a) Insecta
- (b) Arthropoda
- (c) Mollusca
- (d) Cnidaria

Ans.: (b)

2. **Assertion** : Locust are gregarious pests

**Reason** : A single swarm contains up to 40-80 million adults in one square km

- (a) Both assertion and reason are correct and reason is correct explanation of assertion
- (b) The assertion is incorrect, but the reason is correct
- (c) Both assertion and reason are incorrect
- (d) The assertion is correct, but the reason is incorrect

Ans.: (a)

3. Read the following statement

Statement I : The swarms of desert locusts, known for feeding on green leaves and caused extensive damage to vegetation

Statement II : Locust are not always dangerous and do not usually attack human

- (a) Only I if true
- (b) I and II are true
- (c) I is true but II is false
- (d) I is false but II is true

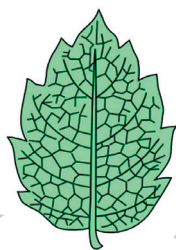
Ans. : (b)

4. Which of the following statement about locust is not true.

- (a) Locusts are not edible insects
- (b) Locust form swarm
- (c) Locust are not harmful in its solitary phase
- (d) Locust is a large, mainly tropical grasshopper

Ans. : (a)





## Chapter - 5

# Morphology of Flowering Plants

### Points to Remember

**Morphology :** The study of various external features, forms and relative position of different organs of the organism is known as morphology. It may be further divided into internal and external morphology.

**External Morphology :** It deals with external forms like shape, size, colour, structure and relative position of different organs.

**Internal Morphology :** Further divided into anatomy and histology.

**Anatomy :** It deals with the study of internal structure exposed after dissection and opening of various parts of an organ.

**Histology :** The study of tissues, their composition and structure.

**Adaptation :** Any alteration in the structure or function of an organism or any of its part that results from natural selection and by which the organism becomes better fitted to survive and multiply in its environment.

**The Root :** The root is underground part of the plant and develops from elongation of radicle of the embryo.

**Characteristics :** It is inside the soil, chlorophyll is absent, absence of nodes, internodes, leaves and buds; positive geotropic and hydrotropic and negative phototropic.

**Main functions of root system :**

1. Absorption of water and minerals from the soil.
2. Provides anchorage to plant parts.
3. Stores reserve food material and synthesises plant growth regulators (cytokinins)



### Various types of root

↓		
Tap root	Fibrous root	Adventitious root
↓	↓	↓
<p>Originates from radical</p> <p>Dicotyledonous plants, e.g., gram, pea, mango, mustard.</p>	<p>Originates from base of the stem</p> <p>Monocotyledonous plants, e.g., wheat, paddy, grasses.</p>	<p>Originates from parts of the plant other than radicle</p> <p>Banyan tree (Prop roots)</p> <p>Maize (stilt roots)</p> <p>Rhizophora (Respiratory roots)</p>

### Regions of Roots

**Root Cap :** The root is covered at the apex by the thimble-like structure which protect the tender apical part.

**Region of meristematic activity :** Cells of this region have the capability to divide; cells are small, thin walled with dense protoplasm.

**Region of elongation :** Cell of this region are elongated and enlarged. This region is responsible for the growth of root in length.

**Region of Maturation :** This region has differentiated and matured cells. Some epidermal cells form very fine and delicate thread like structures called root hairs.

**Modifications of Root :** Roots are modified for support, storage of food, respiration.

- **For support :** Prop roots in banyan tree, stilt roots in maize and sugarcane.
- **For respiration :** Pneumatophores in Rhizophora (Mangrove).
- **For storage of food :** Fusiform (radish), Napiform (turnip), Conical (carrot), Fasciculated fleshy roots (Asparagus).

**The Stem :** Stem is the aerial part of the plant and develops from plumule of the embryo. It bears nodes and internodes.

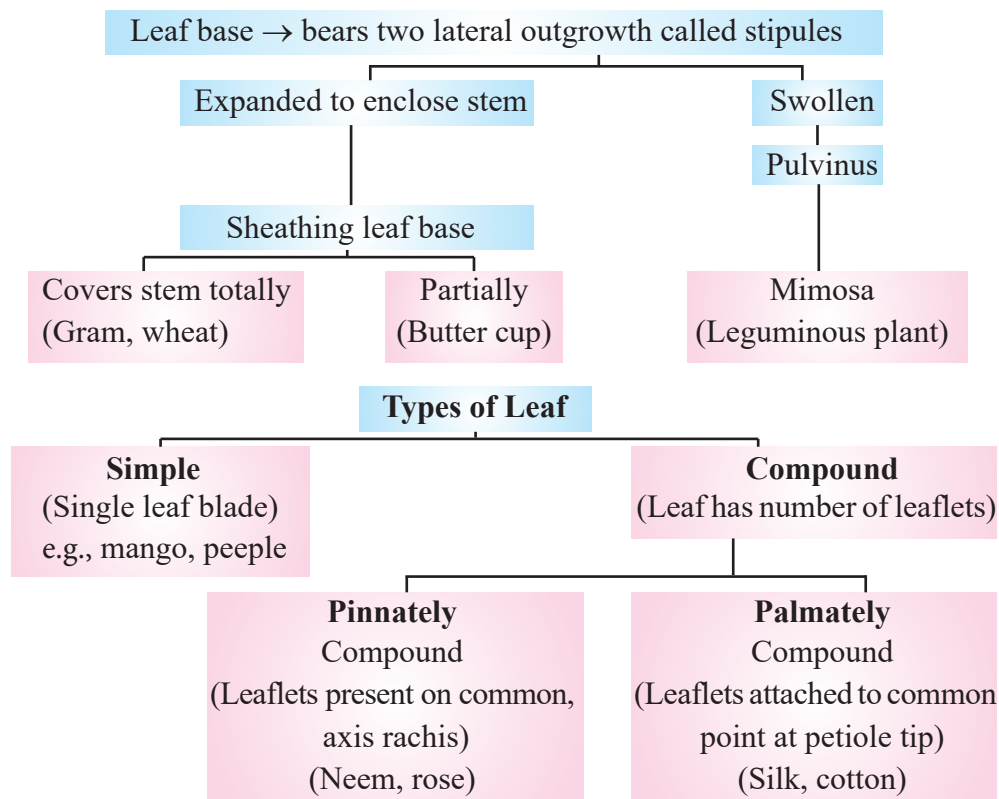
**Functions of stem :** Exposure of leaves, conduction of water and minerals, translocation of food, exposure of flowers and fruits.

## Modifications of Stem :

In some plants the stems are modified to perform the function of storage of food, support, protection and vegetative propagation.

- **For food storage :** Rhizome (ginger, turmeric), Tuber (potato), Bulb (onion), Corm (Colocasia, Amorphophallus/Zamin-kand)
- **For support :** Stem tendrils of watermelon, grapevine, cucumber, pumpkins.
- **For protection :** Axillary buds of stem of Citrus, Bougainvillea get modified into pointed thorns. They protect the plants from animals.
- **For vegetative propagation :** Underground stems of grass (runner), strawberry (stolons), lateral branches of mint and jasmine, Eichhornia (offsets).
- **For assimilation of food :** Flattened stem of *Opuntia* and cylindrical stem of *Euphorbia* contains chlorophyll and performs photosynthesis.

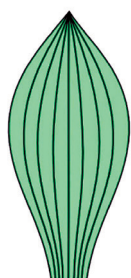
**The Leaf :** Develops from shoot apical meristem, flattened, green structure acropetally arranged manufacture the food by photosynthesis. It has bud in axil. A typical leaf has leaf base, petiole and lamina (leaf blade). In some leguminous plants the leaf base may become swollen which is called as pulvinus.



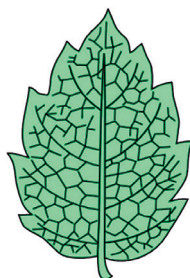
**Venation :** The arrangement of veins and veinlets in the lamina of leaf.

**Types of Venation :**

1. **Reticulate :** Veinlets form a network as in leaves of dicotyledonous plants (China rose, peepal).
2. **Parallel :** Veins are parallel to each other as in leaves of monocotyledonous plants (grass, maize, sugarcane).



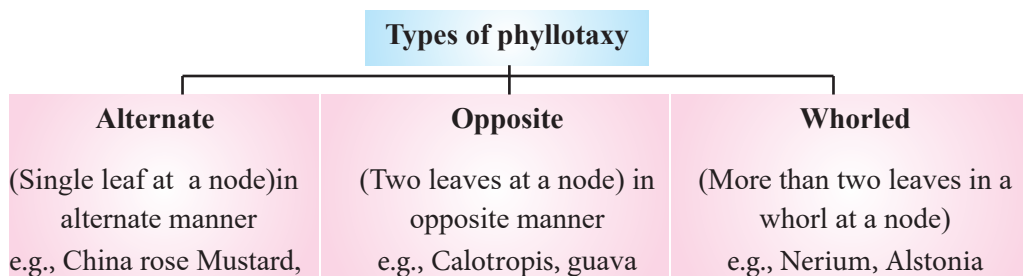
1. Reticulate



2. Parallel

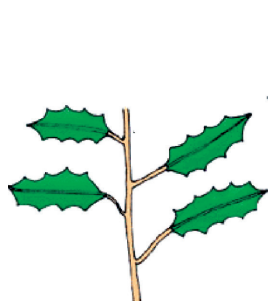
**Types of Venation**

**Phyllotaxy :** The pattern of arrangement of leaves on the stem or branch.



**Functions of Leaf**

photosynthesis, gaseous exchange, transpiration, protection of buds and conduction.



1. Alternate



2. Opposite



3. Whorled

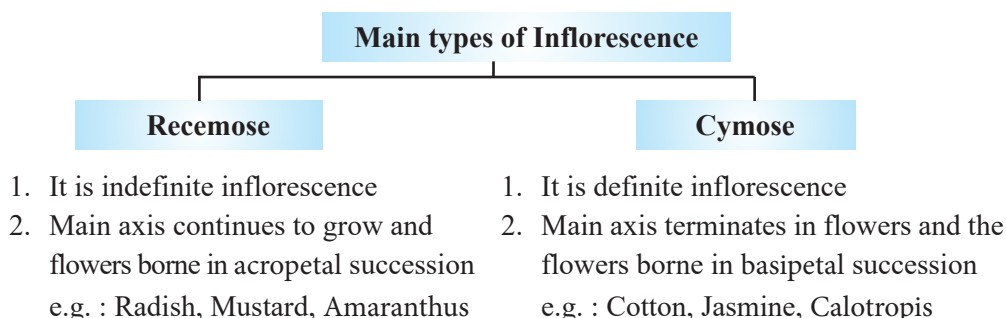
**Types of Phyllotaxy**

## Modifications of Leaves :

Type	Function	Example
● Tendrils	: (Climbing)	— Sweet Pea, Pea
● Spines	: (Protection)	— Aloe, Opuntia, Argemone
● Pitcher	: (Nutrition)	— Nepenthes
● Hook	: (Support) —	Cat's nail
● Fleshy Leaves	: (Stored food)	— Onion and Garlic

**Inflorescence** : The arrangement of flowers on the floral axis (Peduncle)

### Main types of Inflorescence



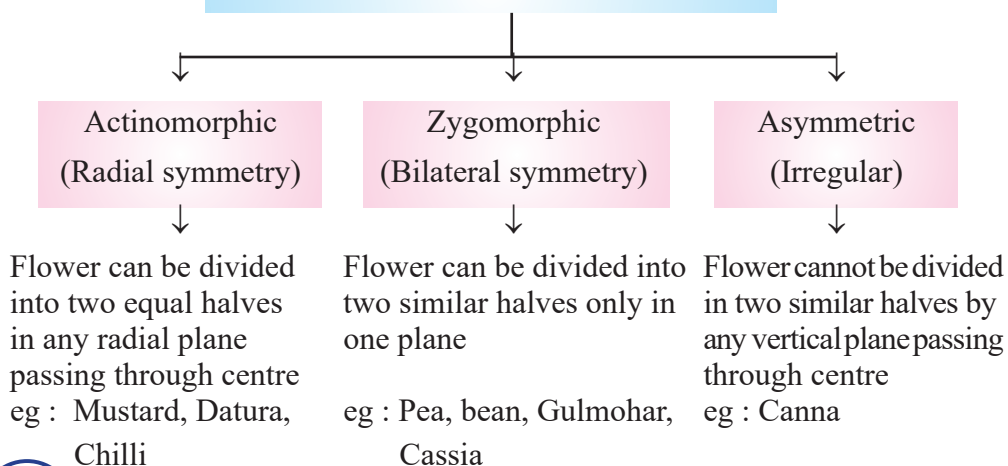
**Special Inflorescence type**— *Ficus, Salvia, Euphorbia*, Sunflower

**Flower**—Modified shoot meant for reproduction

### Gamopetalous



On the basis of symmetry flower can be :



On the basis of floral appendages flower can be :

Trimerous  
(multiples of 3)

Tetramerous  
(multiples of 4)

Pentamerous  
(multiples of 5)

On the basis of position of Calyx, corolla and androecium in respect of ovary, flower can be—

of position of Calyx, corolla and androecium

Hypogynous  
(Superior Ovary)

Perigynous  
(Half inferior ovary)

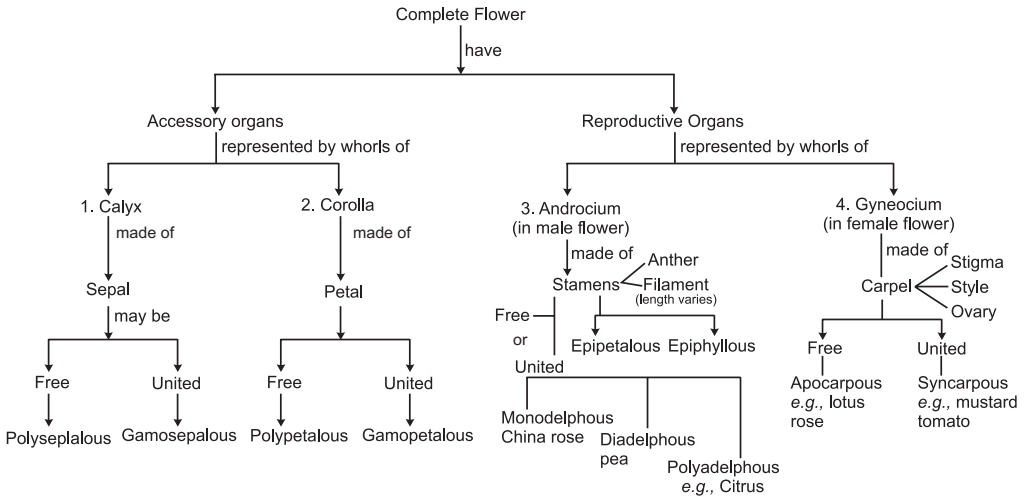
Epigynous  
(inferior ovary)

Mustard, China rose,  
Brinjal

Plum, Rose, Peach

Guava, Cucumber  
ray florets (sun flower)

Thalamus/Receptacle : Swollen end of flower stalk (pedicel) which bears four whorls of flower viz., Calyx (K), Corolla (C), Androecium (A) and Gynoecium (G).



Flower can be

Bisexual  
if have both Androecium  
and Gynoecium

Staminate flower  
(Male  
flower)

Unisexual

Pistillate flower  
(Female  
flower)

have only  
Androecium/Stamen

have only Gynoecium  
Carpel

**Bract**—Reduced leaf base found at the base of pedicel. Flowers with bracts are called bracteale and without bracts are called ebracteate.

**Perianth** : If calyx and corolla are not distinguishable, they are called perianth.

Example : Lily

**Aestivation**: The mode of arrangement of sepals or petals in floral bud.

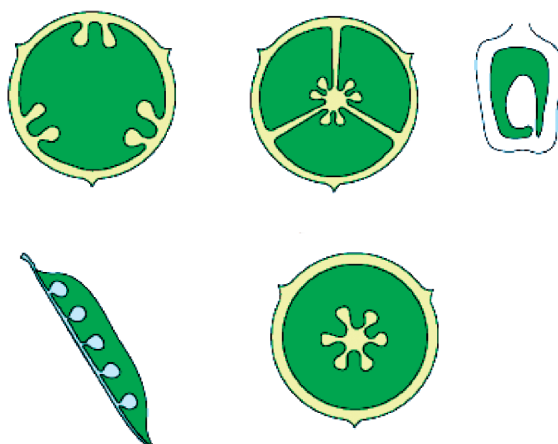
### Types of aestivation :

1. **Valvate** : Sepals or petals just touch one another at the margin, without overlapping. e.g., Calotropis
2. **Twisted** : Sepals or petals overlap the next sepal or petal e.g., China rose, Cotton, lady's finger.
3. **Imbricate** : The margins of sepals or petals overlap one another but not in any definite direction, e.g., Cassia, Gulmohar.
4. **Vexillary** : The largest petal overlaps the two lateral petals which in turn overlap two smallest anterior petals, e.g., Bean, Pea.

**Placentation** : The arrangement of ovules within the ovary.

### Types of Placentation :

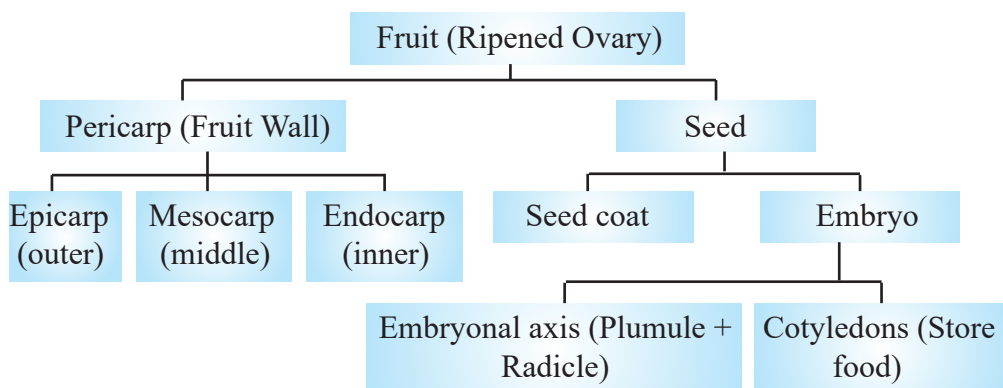
1. **Marginal** : Placenta forms a ridge along the ventral suture of ovary, e.g., Pea.
2. **Axile** : Margins of carpels fuse to form central axis, e.g., China rose, Tomato, Lemon
3. **Perietal** : Ovules develop on inner wall of ovary, e.g., Mustard, Argemone
4. **Free central** : Ovules borne on central axis, lacking septa, e.g., Dianthus, Primrose



5. **Basal** : Placenta develop at the base of ovary, e.g., Sunflower, Marigold

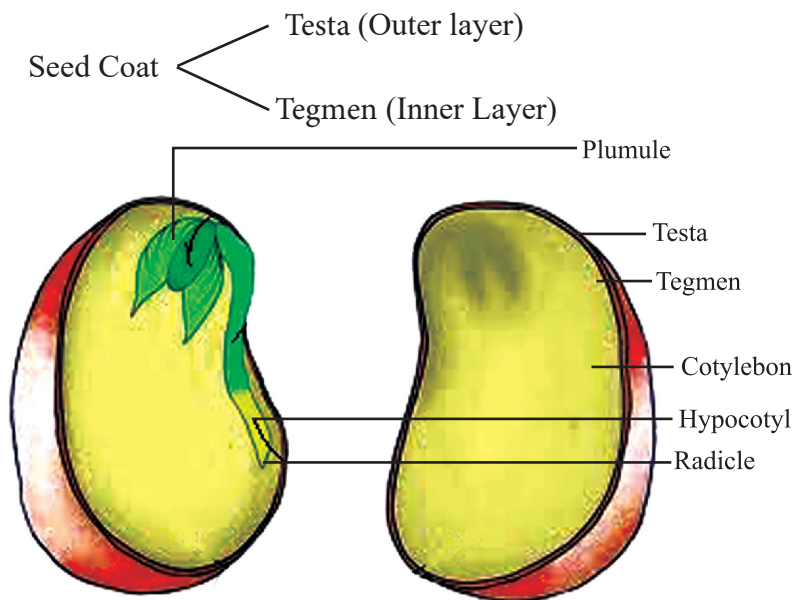
**Placenta :** Parenchymatous flattened cushion inside ovary where ovules are borne.

**The fruit :** After fertilisation, the mature ovary develops into fruit. The parthenocarpic fruits are formed from ovary without fertilisation (seedless fruit-Banana)



**Monocotyledonous seed**—Endosperm bulky and stores food, covered by proteinaceous Aleurone layer. Seed has single large cotyledon—scutellum. Plumule is enclosed in Coleoptile and Radicle is enclosed in Coleorrhiza.

**Dicotyledonous Seed**—



**Hilum** —is a scar on the seed coat through which seeds attached to the fruit.

**Micropyle**—small pore, above hilum

**Cotyledons**—two; fleshy, full of preserve food materials

**Embryonal axis**—Radicle and plumule.

**Endospermous seed**—endosperm present in mature seed. eg. castor

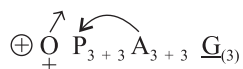
**Non-endospermous seed**—endosperm not present in mature seeds, eg. bean,

## Questions

### Very Short Answer Question

(1 mark each)

1. Which part of Opuntia is modified to form spines ?
2. Name one plant in which leaf is pinnately compound.
3. In mangroves, pneumatophores are the modified adventitious roots. How are these roots helpful to the plant ?
4. Which part in Ginger and Onion are edible ?
5. Why do various plants have different type of phyllotaxy ?
6. State the main function of leaf tendril.
7. Which plant family represent the following floral formula :



8. The endosperm is formed as a result of double fertilisation (triple fusion). What is its function ?
9. Which type of venation do you observe in dicot leaf ?
10. In pea flower, the aestivation in corolla is known as vexillary. Give reason.
11. What is the name given to the cotyledon in case of Monocots.
12. Name the part modified for food storage in the following (a) carrot (b) Radish (c) Potato (d) Dahlia (e) Turmeric (f) Sweet potato

### Short Answer Questions-I

(2 marks each)

13. Flower is a modified shoot Justify.
14. Name the type of root of the following :
  - (a) Roots performing the function of photosynthesis.
  - (b) Roots come above the surface of the soil to absorb air.
  - (c) The pillar like roots developed from lateral branches for providing mechanical support.
  - (d) Roots coming out of the lower nodes of the stem and provide the support to the plant.
15. Identify the type of tendrils found in the following plants—
  - (a) Cucumber (b) Pea (c) Grape vines (d) Water Melon
16. Fill up the blank spaces (a), (b), (c) and (d) in the table given below :



Type of flower	Position of calyx, corolla and respect of the ovary on thalamus	Type of ovary
Hypogynous	..... (a) .....	Superior
Perigynous	On the rim of the thalamus almost at the same level of ovary.	.....(b).....
..... (c) .....	..... (d) .....	Inferior

17. Provide the scientific terms for the following :

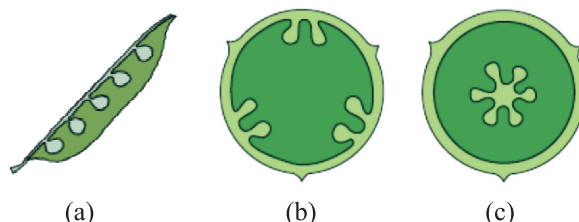
- The leaf without a petiole (stalk).
- The flat and expanded portion of a leaf.
- Orderly arrangement of leaves on the node.
- Lateral appendages on either side of the leaf.

18. Differentiate between peduncle and Pedicel

### Short Answer Question-II

(3 marks each)

19. Observe the given figure showing various types of placentration. Identify the type of placentation. Give one example of each.



20. 'Potato is a stem and sweet potato is a root.' Justify the statement on the basis of external features.

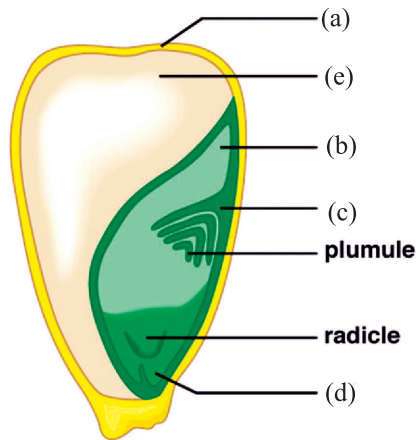
21. Define aestivation. Which type of aestivation is found in China rose, Calotropis Gulmohar and Pea?

22. Give two example of each type of phyllotaxy.

23. Differentiate between :

- Actinomorphic flower and Zygomorphic flower
- Apocarpous ovary and Syncarpous ovary
- Racemose inflorescence and Cymose inflorescence

24. In the given structure of a Monocotyledonous seed label the parts a, b, c, d, e. Give the function of part 'a'.



25. Maize grain usually called as a fruit and not a seed. Why ?

### Long Answer Questions (5 marks each)

26. Describe various stem modifications associated with food storage, climbing and protection.

## Answers

### Very Short Answers

(1 mark each)

1. Leaves
2. Neem, Rose, Acacia.
3. Pneumatophores in mangroves help in respiration.
4. **Ginger**—Rhizome and **Onion**—bulb
5. For proper exposure of leaves to get sunlight.
6. The leaf tendrils help the plant for climbing.
7. Liliaceae
8. Endosperm stores the food.
9. Reticulate venation.
10. In peas, there are five petals. The largest one (standard) overlaps the two lateral petals (wings) which in turn overlap the two smallest anterior petals (keel).
11. Scutellum.
12. (a) and (b) Fleshy tap root (c) Stem tuber (d) root tuber  
(e) Rhizome (f) Fleshy root tuber

**(2 marks each)**

13. The flower is considered to be a modified shoot because the internodes in flower are highly condensed and the appendages such as sepals, petals, stamens and carpels (pistil) are generally large in number.
14. (a) Assimilatory roots      (b) Respiratory roots  
(c) Prop roots                (d) Stilt roots
15. (a) Stem tendril                (b) leaf tendril  
(c) and                                (d) both stem tendrils
16. (a) Floral parts are situated below the ovary.  
(b) Half inferior  
(c) Epigynous  
(d) Floral parts are situated above the ovary.
17. (i) Sessile  
(ii) Lamina  
(iii) Phyllotaxy  
(iv) Stipules

**(3 marks each)**

18. **Peduncle** is the axis of inflorescence which generally bears a number of flowers.

**Pedicle** is the stalk of the flower which bears a single flower.

**(3 marks each)**

19. (a) Marginal placentation — Pea  
(b) Parietal placentation — Mustard, Argemone  
(c) Free central placentation — Dianthus, Primrose
20. Potato is the swollen tip of an underground stem branch (stolon). It has nodes (eyes) which consist of one or more buds subtended by a leaf scar. Adventitious roots also arise during sprouting. On the other hand sweet potato is a swollen adventitious root (tuberous root). It has no nodes, internodes and buds like a stem.
21. The mode of arrangement of sepals or petals in a floral bud is known as aestivation.  
China rose – twisted                      Calotropis – valvate  
Gulmohar – imbricate                  Pea – vexillary

**22. Type of phyllotaxy**

- (i) Alternate
- (ii) Opposite
- (iii) Whorled

**Examples**

China rose, mustard  
 Calotropis, guava  
 Nerium, Alstonia

<b>23. (a) Actinomorphic Flower</b>  (1) Two equal halves are formed by any vertical division passing through the centre. (2) It has a radial symmetry.	<b>Zygomorphic flower</b>  (1) Two equal halves are produced only by one vertical division (2) It has a bilateral symmetry.
<b>(b) Apocarpous Ovary</b>  (1) The flower has several free carpels (ovary). (2) On maturity it forms fruitlet of aggregate type.	<b>Syncarpous Ovary</b>  (1) The flower has fused carpels. (2) On maturity it forms a single fruit.
<b>(c) Racemose inflorescence</b>  (1) The main axis has unlimited growth. (2) Flowers are arranged acropetally i.e., the lower flower are younger	<b>Cymose inflorescence</b>  (1) The main axis has a limited growth. (2) Flowers are arranged basipetally i.e., the lower flowers are older

**24. (a) Endosperm****(c) Coleoptile****(e) Aleurone layer****(b) Scutellum****(d) Coleorrhiza**

Function of (a)—Provide nutrition.

25. Maize grain is a single seeded fruit in which the seed covering or testa is fused with pericarp or fruit wall. A micropyle is not found but base of style is present.

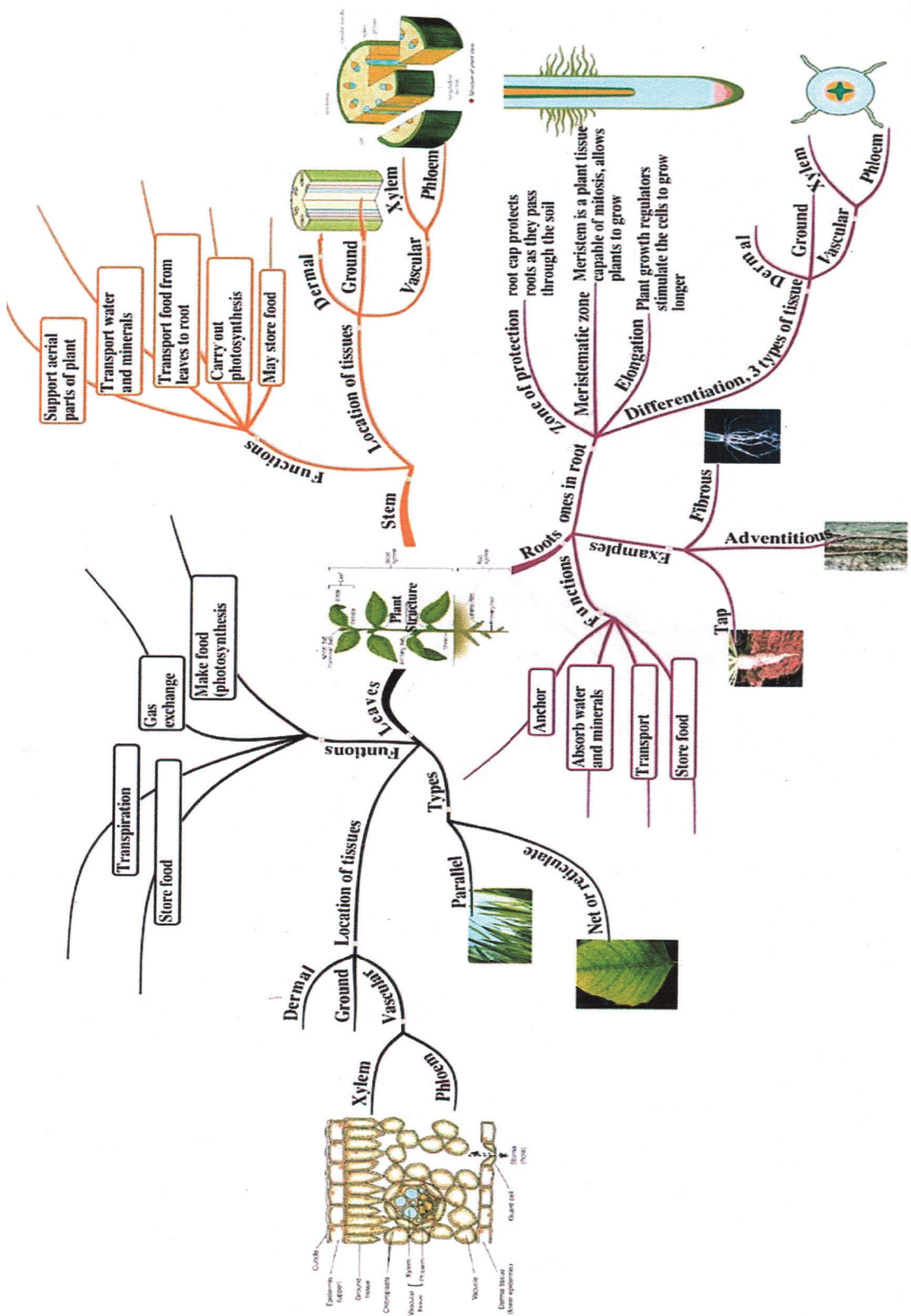
## Long Answers

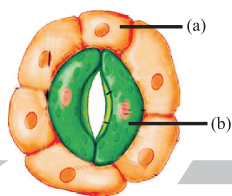
(5 marks each)

### 26. Stem Modification :

- **For food storage :** Ginger (Rhizome), Potato (Tuber), Onion (Bulb), Colocasia (Corm).
- **For climbing (support) :** Stem tendril (cucumber, grapevine, watermelon)
- **For protection :** Thorn (Bougainvillea, Citrus, Duranta) **Description :**  
Refer page 68, NCERT, Text Book of Biology for Class XI.







## Chapter - 6

# Anatomy of Flowering Plants

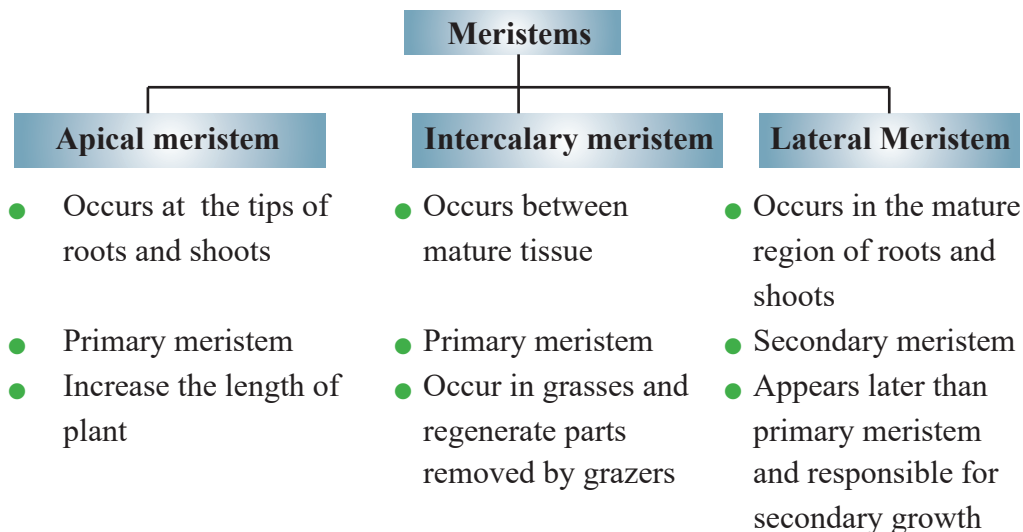
### Points to Remember

**Anatomy :** Anatomy is the study of internal structure of organisms. Plant anatomy includes organisation and structure of tissues.

Tissue is a group of cells having a common origin and usually performing a common function.

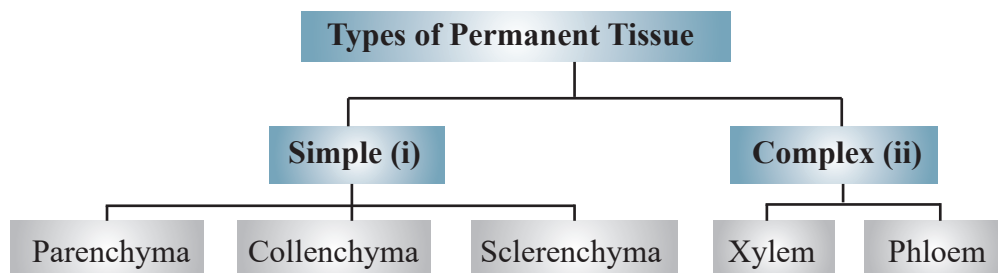
There are two types of tissues (i) Meristematic (ii) Permanent

**Meristematic tissues :** The meristematic tissue is made up of the cells which have the capability to divide. Meristems in plants are restricted to specialised regions and responsible to the growth of plants.



**Axillary bud :** The buds which are present in the axils of leaves (Consist of cells left behind from shoot apical meristem) and are responsible for forming branches of flowers.

**Permanent tissues :** The permanent tissues are derived from meristematic tissue, are composed of cells, which have lost the ability to divide and have become structurally and functionally specialised.



**Parenchyma** : Living, thin walled isodiametric cells, with intercellular spaces, cell wall is made up of cellulose. It performs the functions like photosynthesis, storage, secretion.

**Collenchyma** : It is formed of living, closely packed cells. Its cells are thickened at the corners due to deposition of cellulose and pectin. It provides mechanical support to the growing parts of the plant. It is either found in a homogeneous layer or patches.

**Sclerenchyma** : It is formed of dead cells with thick and lignified walls. Provide mechanical support to organs. They have two types of cells : fibres and sclereids.

**(a) Fibers**—are thick walled, elongated and pointed cells.

**(b) Sclereids**—are spherical, oval or cylindrical, highly thickened dead cells with narrow lumen. Found in walls of nut, pulp of fruits like guava, seed coat of legumes and leaves of tea.

**Xylem** : Xylem consists of tracheids, vessels, xylem fibres and xylem parenchyma. It conducts water and minerals from roots to other parts of plant.

**(a) Tracheids**—Tube like cells with thick and lignified walls and tapering ends; dead, without protoplasm.

**(b) Vessel**—long cylindrical structure made up of many cells with large central cavity, devoid of protoplasm. Present in angiosperms.

**(c) Xylem fibres**—highly thickened walls; with obliterated lumens; septate or aseptate.

**(d) Xylem parenchyma**—living and thin walled; cell walls made up of cellulose, store food material in form of starch or fat.

Radial conduction of water takes place by ray parenchymatous cells

**Protoxylem** : The first formed primary xylem elements.

**Metaxylem** : The later formed primary xylem.

**Endarch** : Protoxylem lies towards the centre and metaxylem towards the periphery of the organ; in stem



**Exarch** : Protoxylem toward periphery and metaxylem towards centre; in roots.

**Phloem** : Phloem consists of sieve tube elements, companion cells, phloem fibres and phloem parenchyma; Phloem transports the food material from leaves to various parts of the plant.

**(a) Sieve tube elements :**

- long tube like structures arranged longitudinally.
- associated with companion cells.
- end walls are perforated to form sieve plates.
- functions of sieve tubes are controlled by the nucleus of companion cells.

**(b) Companion cells**

- Specialised parenchymatous cells associated with sieve tube elements
- Connected with sieve tube elements by pit fields present between their common longitudinal walls
- Help to maintain pressure gradient in sieve tubes.

**(c) Phloem Parenchyma**

- made up of elongated, tapering cylindrical cells with dense cytoplasm and nucleus.
- cell wall made of cellulose with pits through which plasmodesmatal connections exist between cells.
- store food material.

**(d) Phloem fibers (bast fibers)**

- are sclerenchymatous; absent in primary phloem but present in secondary phloem.
- elongated, unbranched pointed, needle like apices with thick cell walls.

**Protophloem** : First formed phloem with narrow sieve tubes.

**Metaphloem** : Later formed phloem with bigger sieve tubes.

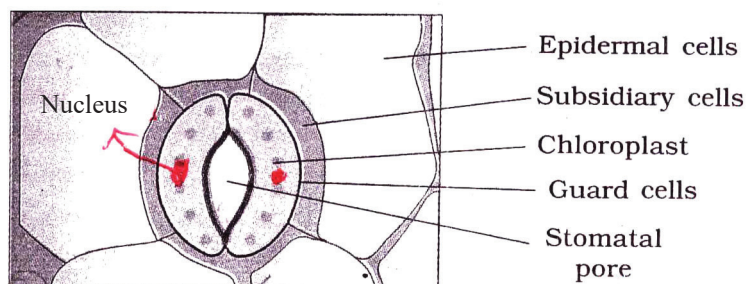
## **The Tissue System :**

**1. Epidermal tissue system** : It includes cuticle, epidermis, epidermal hairs, root hairs, trichomes and stomata.

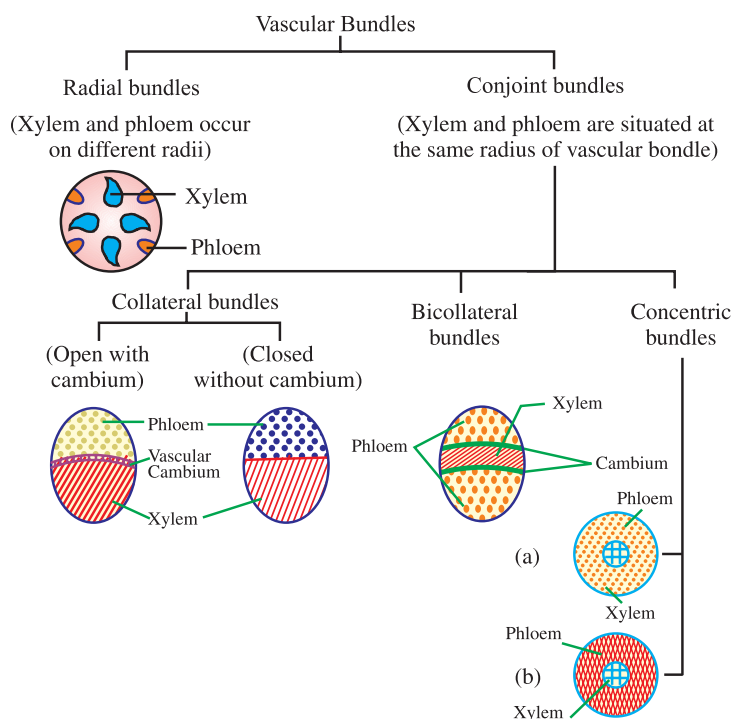
- (a) Cuticle—Waxy thick layer outside epidermis, prevents the loss of water.
- (b) Epidermis : Outer most layer of primary plant body.
- (c) Epidermal hair : help in absorbing water and mineral from soil.
- (d) Trichomes : help in preventing water loss due to transpiration.

(e) Stomata : Regulate process of transpiration and gaseous exchange.

**Stomatal apparatus** : The stomatal aperture, guard cells and surrounding subsidiary cells are together called stomatal apparatus.



2. **The ground tissue system** : It is made up of parenchyma, collenchyma, sclerenchyma. In dicot stems and roots (both monocots and dicots) the ground tissue is divided into hypodermis, cortex, endodermis, pericycle, medullary rays and pith.
3. **The vascular tissue system** : It includes vascular bundles which are made up of xylem and phloem.



Anatomy of Root

Dicot Root	Monocot Root
<div>1. Cortex is comparatively narrow.</div> <div>2. Endodermis is less thickened casparian strips are more prominent.</div> <div>3. The xylem and phloem bundles varies from 2 to 5.</div> <div>4. Pith is absent or very small.</div> <div>5. Secondary growth takes place with the help of vascular cambium and cork cambium.</div>	<div>1. Cortex is very wide.</div> <div>2. Endodermal cells are highly thickened casparian strips are visible only in young roots.</div> <div>3. Xylem and phloem are more than 6 (polyarch).</div> <div>4. Well developed pith is present.</div> <div>5. Secondary growth is absent.</div>

**Casparian Strips**—The tangential as well as radial walls of endodermal cells of dicot roots have deposition of water impermeable, waxy material, suberin in the form of casparian strips.

Anatomy of Stem

Dicot Stem	Monocot Stem
<div>1. The ground tissue is differentiated into cortex, endodermis, pericycle and pitch.</div> <div>2. The vascular bundles are arranged in a ring.</div> <div>3. Vascular bundles are open, without bundle sheath and wedge-shaped outline.</div> <div>4. The stem shows secondary growth due to presence of cambium between xylem and phloem.</div>	<div>1. The ground tissue is made up of similar cells.</div> <div>2. The vascular bundles are scattered throughout the ground tissue.</div> <div>3. Vascular bundles are closed, surrounded by sclerenchymatous bundle sheath, oval or rounded in shape.</div> <div>4. Secondary growth is absent.</div>

**Secondary growth dicot stem**—An increase in the girth (diameter) in plants, vascular cambium and cork cambium (lateral meristems) are involved in secondary growth.



1. Formation of cambial ring : Intrafascicular cambium + interfascicular cambium.
2. Formation of secondary xylem and secondary phloem from cambial ring.
3. Formation of spring wood and autumn wood.
4. Development of cork cambium(phellogen)

Cork Cambium (Phellogen) — { Cork (phellem) – From outer cells  
 Sec. cortex (phelloderm) – from inner cells

(Phellogen + Phellem + Phelloderm) = Periderm

**Secondary growth in dicot roots :** Secondary growth in dicot roots occur with the activity of secondary meristems (vascular cambium). This cambium is produced in the stele and cortex, and results in increasing the girth of dicot roots.

## Anatomy of Leaf

Dorsiverntal (Dicot) Leaf	Isobilateral (monocot) Leaf
<ol style="list-style-type: none"> <li>1. Stomata are absent or less abundant on the upper side.</li> <li>2. Mesophyll is differentiated into two parts upper palisade parenchyma and lower spongy parenchyma.</li> <li>3. Bundle sheath is single layered and formed of colourless cells.</li> <li>4. Hypodermis of the mid-rib region, is collenchymatous.</li> <li>5. Stomata have kidney shaped guard cells.</li> </ol>	<ol style="list-style-type: none"> <li>1. The stomata are equally distributed on both sides.</li> <li>2. Mesophyll is undifferentiated.</li> <li>3. Bundle sheath may be single or double layered.</li> <li>4. Hypodermis of the mid-rib region is sclerenchymatous.</li> <li>5. Stomata have dumb bell shaped guard cells.</li> </ol>

Spring Wood	Autumn Wood
<ol style="list-style-type: none"> <li>1. Also called early wood.</li> <li>2. Cambium is active</li> <li>3. Xylary elements more</li> <li>4. Vessels with wide cavities</li> <li>5. Light in colour, low density</li> </ol>	<ol style="list-style-type: none"> <li>1. Also called late wood</li> <li>2. Cambium less active</li> <li>3. Xylary elements less</li> <li>4. Vessels narrow</li> <li>5. Dark, high denisty</li> </ol>

Heartwood	Sapwood
<ol style="list-style-type: none"> <li>1. Central or innermost region of stem which is hard, durable and resistant to attack of microorganisms and insects.</li> <li>2. Not involved in conduction of water, gives mechanical support to stem</li> </ol>	<ol style="list-style-type: none"> <li>1. Peripheral region stem, light in colour</li> <li>2. Involved in conduction of water and mineral</li> </ol>

**Lenticels**—Produced when phellogen cuts off pachymatous cells on outer side. These cells rupture the epidermis forming lens shaped opening called lenticels.

**Function**—Permit exchange of gases.

**Bulliform Cells**—Large, empty, colourless adaxial cells with vein in leaves which maintain turgidity of leaves.

### Questions

#### Very Short Answer Question

(1 mark each)

1. Name the tissue represented by the jute fibres used for making the ropes.
2. Which kind of roots have polyarch vascular bundles ?
3. Write the significance and location of heart wood.
4. State the role of pith in stem.
5. Where are bulliform cells found in leaves ?
6. Why are xylem and phloem called complex tissues ?
7. Which meristem is responsible for longitudinal growth in plants ?
8. What forms the cambial ring in a dicot stem during the secondary growth ?
9. Name the anatomical layer in the root from which the lateral branches of root originate.
10. Which tissue of the leaf contains chloroplast ?
11. A plant tissue when stained, showed the presence of hemicellulose and pectin in cell wall of its cells. Name the tissue.
12. Write the function of phloem parenchyma.
13. Name the cells which make the leaves curl in plants during water stress.
14. Give the function of lenticels.

15. The vascular bundles are surrounded by a thick layer of cells in leaves. What is the name of cells ?
16. Mention the significance of casparian strips. Where do you find them ?
17. Give the function of companion cells.

### Short Answer Questions (SA-I)

(2 marks each)

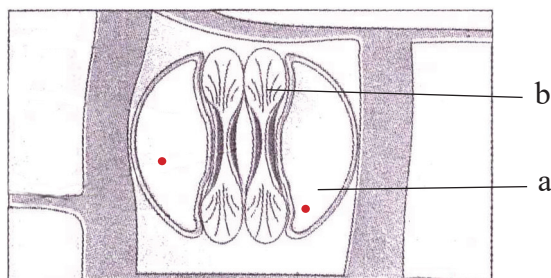
18. Why is cambium considered to be lateral meristem ?
19. Give any four differences between tracheids and vessels.
20. How are open vascular bundles differ from closed vascular bundles ?
21. What are trichomes ? State their functions.
22. Given below are the various types of tissue and their functions. Which out of these is not a matching pair and why;
  - (a) Collenchyma : provides mechanical support to the growing parts of plant.
  - (b) Sclerenchyma : photosynthesis, storage and secretion.
  - (c) Chlorenchyma : perform the function of photosynthesis
  - (d) Xylem : conduction of water and minerals.
23. In which part of the plant you would see the following :
  - (a) Radial vascular bundle
  - (b) Well developed pith

### Short Answer Question (SA-II)

(3 marks each)

24. Give the points of difference between lenticels and stomata.
25. Even being a monocotyledonous plant the Palm increases in girth. Why and how does it take place ?
26. Differentiate between endarch and exarch conditions.
27. If you are provided with microscopic preparation of transverse section of a meristemic tissue and permanent tissue, how would you distinguish them ?
28. Differentiate between aerenchyma and collenchyma on the basis of their structure and function.
29. Are there any tissue elements in phloem which are comparable to those of xylem ? Explain.

30. Observe the figure and answer the following questions :
- Name parts (a) and (b).
  - Are these types of stomata observed in monocot or in dicot plants ?
  - Which parts shown in figure constitute the stomatal apparatus ?



### Long Answer Questions

(5 marks each)

- What are meristems ?
    - Name the various kinds of meristems in plants.
    - State the location and functions of meristems.
  - Suppose you are examining a cross section of a stem under compound microscope, how would you determine whether it is monocot stem or dicot stem ?
    - Write the characteristics of collenchyma.
  - What is secondary growth in plants ? Describe various steps of secondary growth in dicot stem with the help of diagrams.
- DIRECTIONS:** In the following questions, a statement of assertion(A) is followed by a statement of the reason(R). mark the correct choice as :
- If both (A) and (R) are correct and (R) is the correct explanation of (A).
  - If both (A) and R are true, but (R) is not the correct explanation of (A).
  - If (A) is true but (R) is false.
  - If both (A) and (R) are false.
- Assertion : Apical meristem of the root is subterminal.

Reason : At the terminal end of the root, the root cap is present.
  - Assertion : Aerenchyma helps in buoyancy to hydrophyte plants.

Reason : The large air chambers are present in aerenchyma.
  - Assertion : A simple tissue is made of a single type of cells.

Reason : Various simple tissues are parenchyma, collenchyma and sclerenchyma.



## Answers

### Very Short Answers

(1 mark each)

1. Sclerenchyma.
2. Monocotyledonous roots.
3. The hard central region of tree trunk made up of xylem vessels, which provide mechanical strength to stem.
4. Pith stores the food material.
5. Bulliform cells are found in the upper epidermis of monocot leaves.
6. As they are made up of more than one kind of cells.
7. Primary meristem.
8. Fascicular and intrafascicular strips of meristem.
9. Pericycle of mature zone.
10. Mesophyll tissue.
11. Collenchyma.
12. Lateral conduction of food and supply of water from xylem.
13. Bulliform or motor cells.
14. Permit exchange of gases.
15. Bundle sheath cells.
16. Casparian strips are found in endodermis and make them water impermeable.
17. Maintain pressure gradient in sieve tubes.

### Short Answers (SA-I)

(2 marks each)

18. The cambium is considered as a lateral meristem because it occurs along the lateral sides of the stem and roots and appears later than primary meristem. Cells of this meristem divide periodically and increase the thickness of the plant body.

19.	<b>Tracheid</b>	<b>Vessels</b>
	<ol style="list-style-type: none"> <li>1. A tracheid is formed from a single cell.</li> <li>2. The ends are rounded or transverse.</li> <li>3. They are comparatively narrower.</li> <li>4. The lumen is narrower.</li> </ol>	<ol style="list-style-type: none"> <li>1. A vessel is made of a number of cells.</li> <li>2. The ends are generally oblique and tapering.</li> <li>3. They are comparatively wider.</li> <li>4. The lumen is wide.</li> </ol>



20. **Open Vascular bundles :** These vascular bundles contain a strip of cambium in between phloem and xylem. Open vascular bundles are collateral and bicollateral.

**Closed Vascular bundles :** Intrafascicular cambium is absent. Closed vascular bundles can be collateral or concentric.

21. Trichomes are multicellular epidermal hairs on the stem, seeds or fruits. Trichomes help in protection, dispersal of fruits and seeds and reduction in water loss.
22. (b) Sclerenchyma : photosynthesis, storage and secretion is not a matching pair. The function of sclerenchyma is to provide mechanical support to organs.
23. (a) Root (b) Monocot root

### Short Answers (SA-II)

(3 marks each)

24. **Lenticels :** Opening that are found in old stems and roots in the cork tissues containing a number of complimentary cells and they are permanently opened pores.

**Stomata :** Opening that are found in leaves and young stems in the epidermis and have two guard cells. They open and close in response to turgidity of their guard cells.

25. Palms possess residual meristem below their leaf primordial, which adds ground parenchyma and vascular bundles. The ground parenchyma can also undergo further divisions even after the completion of elongation.

26.	Endarch condition	Exarch condition
	1. Protoxylem towards pith and metaxylem towards periphery 2. Found in Stem	1. Protoxylem towards periphery and metaxylem towards pith 2. Found in root.

27. **Meristematic tissues** are composed of cells that have the capability to divide. These cells exist in different shapes without intercellular space. Cells are thin walled, rich in protoplasm, without vacuoles.

**Permanent tissues** are derived from meristematic tissue and are composed of cells have their definite shape, size and function. These cells may be thin walled (living) or thick walled (dead).

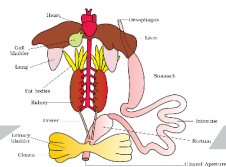
- |     | Aerenchyma   | Collenchyma   |
|-----|--|---|
| 28. | (a) Parenchymatous tissue containing large air space.<br>(b) Thin walled cells, isodiametric in shape with intercellular space.<br>(c) Provides buoyancy to the plant. | (a) Tissue contains deposits of cellulose and large pectin at the corner of cells.<br>(b) Consists of oval and polygonal cells without intercellular space.<br>(c) Provides elasticity and mechanical strength. |
29. (a) The sieve elements of phloem is comparable to the vessel of the xylem because both lack nucleus.  
 (b) Phloem fibre is similar to the xylem fibre because both provide tensile strength to the tissue.  
 (c) Phloem parenchyma and xylem parenchyma is the living components of phloem and xylem respectively.
30. (i) a : epidermal cell  
 b : guard cell  
 (ii) In dicot plants.  
 (iii) The stomatal apparatus includes the stomatal aperture, guard cells and the surrounding subsidiary cells.

## Long Answers

(5 mark each)

31. (i), (ii) and (iii) : Refer 'Points to remember'
32. (i) and (ii) : Refer 'Points to remember'.
33. ● **Secondary growth** : Refer 'Points to remember'.  
 ● **Steps of secondary growth** : Refer page 94–97, NCERT, Text Book of Biology for Class XI.  
 ● Figure 6.9, page 95 NCERT, Text Book of Biology for Class XI.
34. (a)  
 35. (c)  
 36. (b)





## Chapter - 7 Structural Organisation In Animals

### Points to Remember

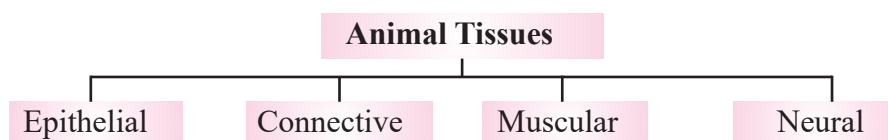
**Cell junctions**—In nearly all animal tissues, specialised junction provide structural and functional links between its individual cells.

#### Three Types of Cell junctions—

- 1. Tight junctions :** Plasma membranes of adjacent cells are fused at intervals. They help to stop substances from leaking across a tissue.
- 2. Adhering junctions :** Perform cementing function to keep neighbouring cells together.
- 3. Gap junction :** Facilitate the cells to communicate with each other by connecting the cytoplasm of adjoining cells for rapid transfer of ions, small molecules and sometimes big molecules.

#### Types of Fundamental Animal Tissues

S.No.	Type	Location	Functions
1.	Epithelial Tissues	Free Surfaces	Protection, Secretion, Excretion, absorption, Sensory and reproduction
2.	Connective Tissues	Inside body, in organs other tissues and below skin	Holding or binding, support, transport and circulation, protection and storage.
3.	Muscular Tissues	Inside movable parts	Movements and locomotion
4.	Nervous Tissues	Central Nervous System & every organ Peripheral Nervous System.	Communication and control



## Epithelial Tissue

**(A) Simple :** ● Composed of single layer of cells.

● Functions as lining for body cavities, ducts and tubes.

1. Squamous
  - single thin layer of flattened cells.
  - found in walls of blood vessels, air sacs of lungs.
2. Cuboidal
  - single layer of cube like cells.
  - found in ducts of glands and tubular parts of nephron.
3. Columnar
  - single layer of tall and slender cells.
  - free surface may have microvilli.
  - found in lining of stomach and intestine
4. Ciliated
  - columnar or cuboidal cells with cilia.
  - move particles or mucus in specific direction, in bronchioles, fallopian tubes.

**(B) Compound :**

- Made up of more than one layer of cells.
- Provide protection against chemical and mechanical stresses.
- Cover dry surface of skin, moist cavity, pharynx, inner lining of ducts of salivary glands and pancreatic ducts.

### Glandular epithelium

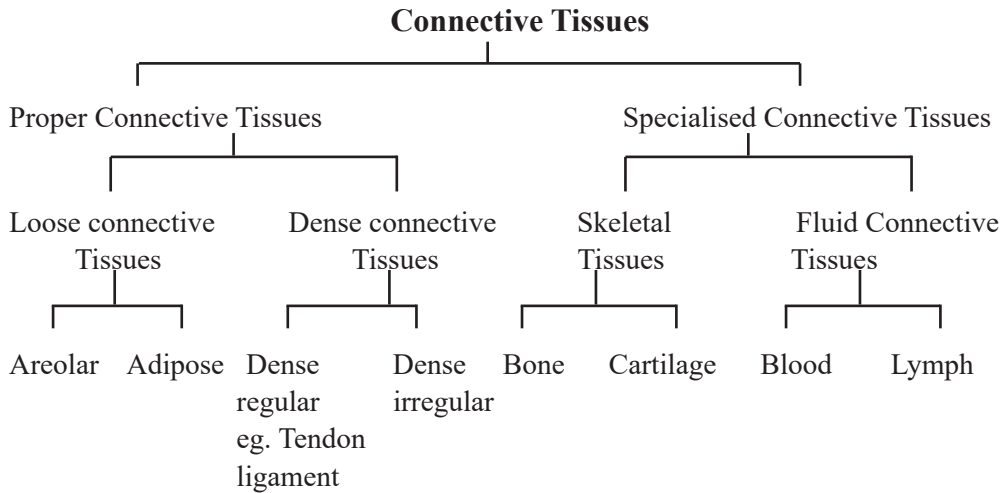
#### Exocrine glands

- secrete mucus, saliva, oil, milk digestive enzymes
- products released through ducts.

#### Endocrine glands

- secrete hormones.
- secrete directly into the fluid bathing the gland.

**Connective tissue :** Link and support other tissues/organs of the body.



## Loose Connective Tissue

(has cells and fibres loosely arranged in semi-fluid ground substance)

### (i) Areolar Tissue :

- present beneath the skin.
- contains fibroblasts, macrophages and mast cells.
- serves as a support framework for epithelium

### (ii) Adipose Tissue :

- located beneath the skin.
- cells are specialised to store fats.

## Dense Connective Tissue

Fibres and fibroblasts are compactly packed.

### (i) Dense Regular

- Collagen fibres present in rows.
- Tendons attach skeletal muscle to bone.
- Ligaments attach bone to bone.

### (ii) Dense Irregular

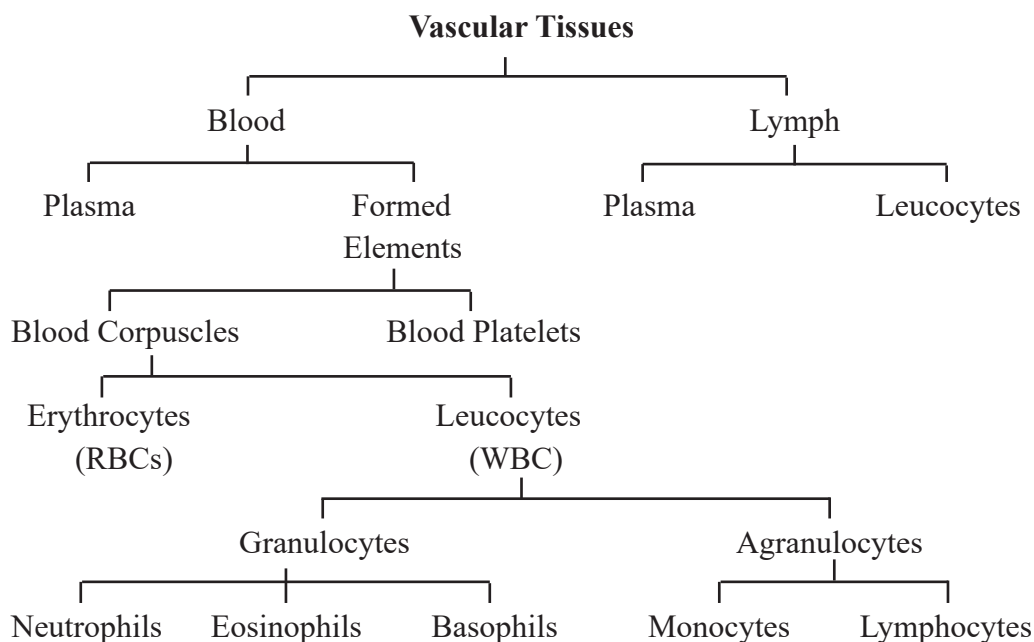
- Has collagen fibres and fibroblasts oriented differently.
- This tissue is present in the skin.

## Specialised Connective Tissues

- (i) **Cartilage** : made up of chondrocytes and collagen fibres; inter cellular material is solid and resists compression. Present in tip of nose outer ear joints, etc.

(ii) **Bones** : Ground substance is rich in calcium salts and collagen fibres Osteocytes are present in lacunae. Bones support and protect softer tissues and organs. They interact with skeletal muscles to bring about movements. Bone marrow in some bones is the site of blood cell formation.

(iii) **Blood** : Fluid connective tissue, consists of plasma and blood cells.



## MUSCULAR TISSUES

(long, contractile cells called fibres, bring about movement and locomotion)

Skeletal Muscle	Smooth Muscle	Cardiac Muscle
<ul style="list-style-type: none"> <li>● Striated</li> <li>● Closely attached to skeletal bones.</li> <li>● long cylindrical multinucleated fibres</li> </ul>	<ul style="list-style-type: none"> <li>● Non-striated</li> <li>● Forms wall of Internal Organs like blood vessels stomach, intestine</li> <li>● Spindle like uninucleated fibres.</li> </ul>	<ul style="list-style-type: none"> <li>● Striated with intercalated disc for communication</li> <li>● Occurs in heart wall</li> <li>● Short cylindrical uninucleated fibres</li> </ul>

## Neural Tissues

- Neurons are the functional unit and are excitable cells.
- Neuroglia cells make up more than half the volume of neural tissue.

They protect and support neurons.

**Cockroach**— *Periplaneta americana* (Phylum-Arthropoda, Class-Insecta)

**Habitat** : Cockroach is a terrestrial, nocturnal, omnivorous, unisexual, oviparous insect. Body covered by a chitinous, hard exoskeleton of hard plates called sclerites.

### Morphology :

**Head** : Triangular, formed by fusion of 6 segments. Bears a pair of antennae, compound eyes. Mouth parts consists of labrum (upper lip), a pair of mandibles, a pair of maxillae, labium (lower lip), hypopharynx (acts as tongue).

**Thorax** : 3 segments; prothorax, mesothorax and metathorax.

Bears 2 pairs of wings :

Forewings : tegmina (mesothoracic).

Hindwings : transparent, membranous (metathoracic)

3 pairs of legs in thoracic segments. (one pair in each thoracic segment.)

**Abdomen** : 10 segments. Bears a pair of long, segmented **anal cerci** in both sexes and a pair of short, unjoined **anal styles** in males only 7th segment is boat shaped.

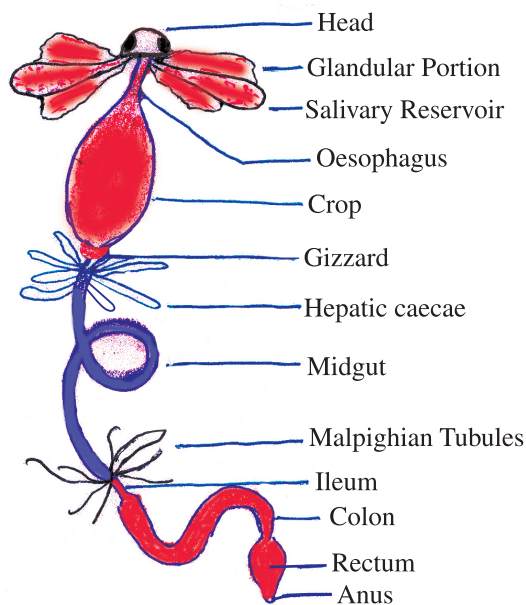
Also has anus and genital aperture at the hind end. Genital aperture surrounded by external genitalia called **gonapophysis or phallomere**.

Male Cockroach	Female Cockroach
1. Abdomen long and narrow	1. Abdomen short and broad
2. All nine sterna visible	2. Seven sterna visible. (7th sternum fused with 8th and 9th sterna)
3. Anal style present	3. Anal style absent

**Anatomy** : Study of the morphology of internal organs.

**Alimentary canal** : Divided into foregut, midgut and hindgut.

Mouth → Pharynx → Oesophagus → Crop (stores food) → Gizzard (grinding of food) → Hepatic caecae (at junction of fore and midgut; secretes digestive juice) → Hindgut (ileum, colon, rectum) → Anus.



### Alimentary Canal of Cockroach

**Blood vascular system :** Open type, visceral organs bathed in haemolymph (colourless plasma and haemocytes).

Heart consists of elongated muscular tube and differentiated into funnel shaped chambers with ostia on either side. Blood from sinuses enters heart through ostia and is pumped anteriorly to sinuses again. Blood is colourless (haemolymph).

**Respiratory system :** Network of trachea which open through 10 pairs of spiracles. Spiracles regulated by sphincters. Oxygen delivered directly to cells.

**Excretion and osmoregulation :** by malpighian tubules; uricotelic (Uric acid as excretory product).

**Nervous system :** Consists of series of fused segmentally arranged ganglia joined by paired longitudinally connectives on the ventral side, three ganglia in thorax, six in abdomen. Brain represented by supraoesophageal ganglion. Each eye consists of 200 hexagonal ommatidia.

### Reproductive system :

Male reproductive system : Pair of testes (4th-6th segments) → vas deferens → ejaculatory duct → male gonophore.

Glands—Seminal vesicle (stores sperms), mushroom shaped gland (6th-7th segment).



## Female reproductive system :

A pair of ovaries (with 8 ovarian tubules) → Oviduct → Genital chamber. Sperms transferred through spermatophores female produces 9–10 Ootheca. Fertilised eggs encased in capsules called oothecae (contains 14–16 eggs on an average) development of *P. americana* paurometabolous incomplected metamorphosis). Nymph grows by moulting 13 times to reach adult form.

### Interaction with man

- Pests as destroy food and contaminate it.
- Can transmit a variety of bacterial diseases (Vector).

## Questions

### Very Short Answer Questions

(1 mark each)

1. Name the tissue which contains Haversian canals.
2. Mention two special properties of nervous tissues.
3. Name the large cells present in adipose tissue.
4. Name the cells responsible for clotting of blood.
5. What are exocrine glands ?
6. Differentiate between tendon and ligament.
7. Where are RBC's formed ?
8. A muscular fiber having no striations and tapers at both ends. Name it.
9. Mention the site, where sclerite is present in cockroach.
10. Name the mouth part of cockroach which is comparable to our tongue.
11. "Sexual dimorphism is found in cockroach". Explain the statement.

### Short Answer Questions–I

(2 marks each)

11. What is the function of ciliated epithelium ? Where do we find this epithelium ?
12. What are the two types of fibres of connective tissues ? Distinguish between the two.
13. To which tissue do the following belong to :
  - (a) Osteocytes
  - (b) Chondrocytes
  - (c) Neuroglia
  - (d) Intercalated discs
14. Give the location of hepatic caecae in cockroach ? What is their function ?
15. Name the locomotory appendages of cockroach on the basis of external morphology.

## Short Answer Questions–II

(3 marks each)

16. Differentiate between skeletal and smooth muscles.
17. Differentiate between male and female cockroach on the basis of external morphology.
18. (a) What is open circulatory system ?  
(b) Explain the respiratory system of cockroach.
19. (a) Give the common name of *Periplaneta americana*.  
(b) How many spermathecae found in cockroach ?  
(c) What is the position of ovaries in cockroach ?  
(d) How many segments are present in the abdomen of cockroach ?  
(e) Where do you find malpighian tubules ?  
(f) What is mosaic vision ?
20. Name the different cell junctions found in tissues.
21. Mention the special features of eye in cockroach.
22. Write the appropriate type of tissue in column B accounting to the functions mentioned in column A.

Column A	Column B
a. Linking and supporting frame work	.....
b. Protective covering	.....
c. Secretion and absorption	.....

## Long Answer Questions

(5 marks each)

23. (a) What is compound epithelium ? What are their main function ?  
(b) Where do we find areolar tissue ?  
(c) How is adhering junction different from gap junction ?
24. Make a neat and well labelled diagram showing alimentary canal of cockroach.

## Answers

## Very Short Answers

(1 mark each)

1. Mammalian bone.
2. Excitability and conductivity.
3. Adipocytes.
4. Blood platelets.
5. Glands which discharge their secretions into ducts.

6. **Tendon**

Attach skeletal muscles to bones

**Ligament**

Attach bone to bone

7. Bone narrow
8. Smooth or non striated muscle fibre.
9. In the exoskeleton all over the body.
10. Hypopharynx = lingua
11. Male and female cockroaches show morphological differences.

**Short Answers-I**

**(2 marks each)**

11. Refer 'Points to Remember'.
12. White and yellow fibres. White fibres are thin, unbranched, inelastic, occur in bundles and formed of protein collagen. Yellow fibres are thick, straight, elastic, branched, occurring singly, formed of protein elastin.
13. (a) Bone tissue (b) Cartilage  
(c) Neural tissue (d) Cardiac muscle
14. Refer 'Points to Remember'.
15. Three pairs of legs and two pairs of wings.

**Short Answers-II**

**(3 marks each)**

16. Refer 'Points to Remember'.
17. Refer 'Points to Remember'.
18. Refer 'Points to Remember'.
19. (a) American Cockroach.  
(b) One pair, present in 6th segment.  
(c) Between 2nd and 6th abdominal terga.  
(d) 10 segments.  
(e) At the beginning of ileum in cockroach.  
(f) Vision where several images of an object are formed by compound eye.  
Helps to detect movement of objects very efficiently.
20. (i) Gap junctions (ii) Tight junctions  
(iii) Adhering junctions

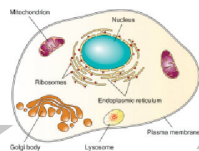
21. See text in NCERT at page No. 114.
- (i) Situated at dorsal surface of head.
  - (ii) Each eye consists of about 2000 hexagon ommatidia.
  - (iii) It can receive several images of an object.
  - (iv) This kind of vision is known as mosaic vision.
  - (v) It is more sensitivity but less resolution.
22. (a) Connective tissues
- (b) Stratified epithelium
- (c) Columnar epithelium

### Long Answers

(5 marks each)

23. Refer 'Points to Remember'.
24. Refer Fig. 7. 16 NCERT Text Book of Biology class-XI.

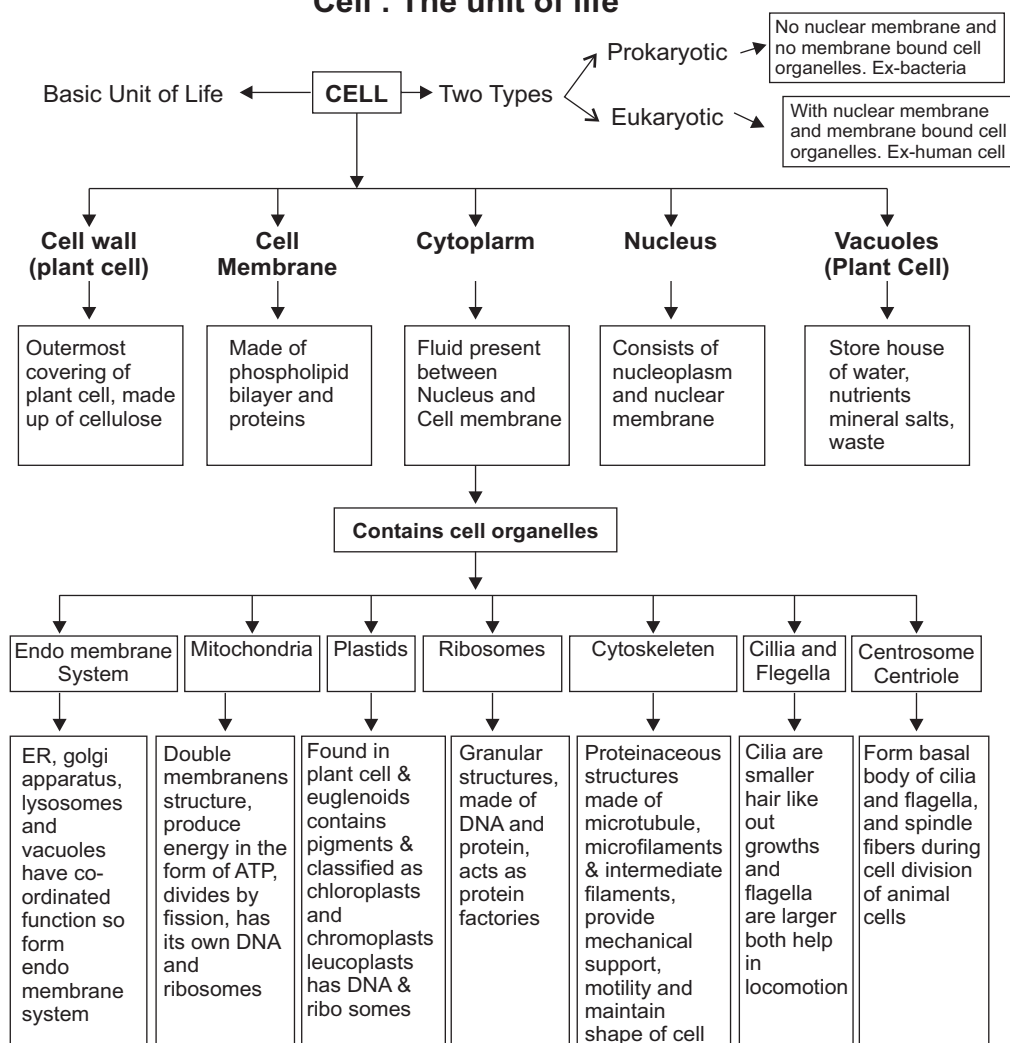




## Chapter - 8

# Cell : The Unit of Life

### Cell : The unit of life



- ER – Network of tiny tubular structures scattered in cytoplasm, which divide intracellular space into two compartments. They are two types– SER and RER
- Golgi bodies – Flat disc shaped sacs or cisternae, stacked parallel to each other, near nucleus.
- Lysosomes – Membrane bound vesicles formed by packaging in Golgi apparatus

## Points to Remember

**Cell Theory :** Cell Theory was formulated by Schleiden and Schwann, and was modified by Rudolf Virchow. Cell theory States that :

- (A) All living organisms are composed of cells and products of cells.
- (B) All cells arise from pre-existing cells.

**Cell :** Cell is the structural and functional unit of life.

### Prokaryotic Cell

- Generally small sized (1–10  $\mu\text{m}$ )
- Well defined nucleus absent
- Membrane bounded cell organelles absent
- DNA without histone protein  
e.g., Bacteria, Mycoplasma, Blue green Algae

### Gram Positive Bacteria

- Bacteria that take up gram Stain. e.g., Bacillus

### Eukaryotic Cells

- Generally large sized (5–10  $\mu\text{m}$ )
- Well defined nucleus present
- Membrane bounded cell organelles present
- DNA with histone protein  
e.g., Amoeba, Euglena and other higher organism

### Gram Negative Bacteria

- Bacteria do not take up gram stain  
e.g., Escherichia coli

## PROKARYOTIC CELL :

### Modification of cell envelope

- Cell envelope consists of tightly bound 3 layered structure – Outermost Glycocalyx followed by cell wall and plasma membrane
- Glycocalyx in form of loose sheath, is called slime same layer
- Glycocalyx in form of thick and tough sheath, is called capsule

- Mesosomes : Extension of plasma membrane. These can be in the form of vesicles, tubules and lamellae.

**Functions :** Cell wall formation, DNA replication and distribution to daughter cells, respiration, secretion processes, to increase surface area of plasma membrane and enzyme content.

- Flagella : Extension of cell wall. It is composed of three structures – filament, hook and basal body. It help in motility of bacteria.
- Pili and fimbriae : Surface structure of some bacteria which attaches them to rocks in streams and to host tissues.

**Genetic Material :** It is not covered by nuclear envelope. In addition to the genomic DNA (the single chromosome/circular DNA), many bacteria have small circular self replicating, double stranded DNA which is called as plasmid, plasmid contain genes like antibiotic resistance.

**Ribosomes :** Associated with plasma membrane of prokaryotic cell, site of protein synthesis. Several ribosomes may attach to a single mRNA and form a chain called polyribosomes or polysomes. They translate mRNA into Proteins.

**Inclusion Bodies :** Stores reserve material, lie freely in cytoplasm not bound by any membrane. e.g. phosphate granules, cyanophycean granules and glycogen granules.

## Eukaryotic cells

Possess an organized nucleus with nuclear envelope and have a variety of complex locomotory and cytoskeletal structures.

**Cell Membrane** — Singer and Nicolson (1972) gave ‘fluid mosaic model’. According to this the quasi-fluid nature of lipid enables lateral movement of proteins within the overall bilayer; two types of proteins (Peripheral and integral proteins) with cholesterol, glycolipids and glycoproteins. Erythrocyte membrane has 52% protein and 40% lipids.

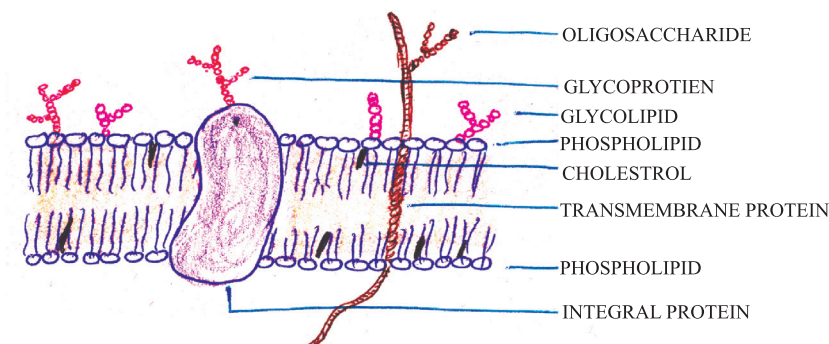
**Function**—It is selectively permeable and helps in transport of molecule across it.

### Passive transport

- Transport of molecules from higher to lower concentration.
- It do not utilise energy (ATP).  
e.g., diffusion

### Active transport

- Transport of molecules from lower to higher concentration
- It utilises energy (ATP)  
e.g.,  $\text{Na}^+/\text{K}^+$  ATPase Pump.



### Fluid Mosaic Model of Plasma Membrane

**Cell Wall** is non-living rigid structure which gives shape to the cell and protects cell from mechanical damage and infection, helps in cell-to-cell interaction and provides barrier to undesirable macromolecules.

Cell wall of algae is made of cellulose, galactans, mannans and minerals like calcium carbonate. Plant cell wall consists of cellulose, hemicellulose, pectins and proteins.

**Middle lamella** is made of calcium pectate which holds neighbouring cells together.

**Plasmodesmata** connect the cytoplasm of neighbouring cells.

### Endoplasmic Reticulum (ER)

Consists of network of tiny tubular structure. ER divides the intracellular space into two distinct compartments—luminal (inside ER) and extra luminal (cytoplasm).

(i) Rough Endoplasmic Reticulum (RER) :

- Ribosomes attached to outer surface.

**Function** : ● Involved in protein synthesis and secretion.

(ii) Smooth Endoplasmic Reticulum (SER) : ● Lack ribosomes.

**Function** ● Site for synthesis of lipid.

**Golgi apparatus** : First observed by Camillo Golgi (in 1898)

Consist of cisternae stacked parallel to each other. Two faces of the organelle are convex/cis or forming face and concave/**trans** or maturing face but inter connected.

**Functions** : Performs packaging of materials, to be delivered either to the intra-cellular targets or secreted outside the cell. Important site of formation of glycoproteins and glycolipids.



### Lysosomes :

Membrane bound vesicular structures formed by the process of packaging in the golgi apparatus. Contain hydrolysing enzymes (lipases, proteases, carbohydrases) which are active in acidic pH. Also called ‘Suicidal Bag’.

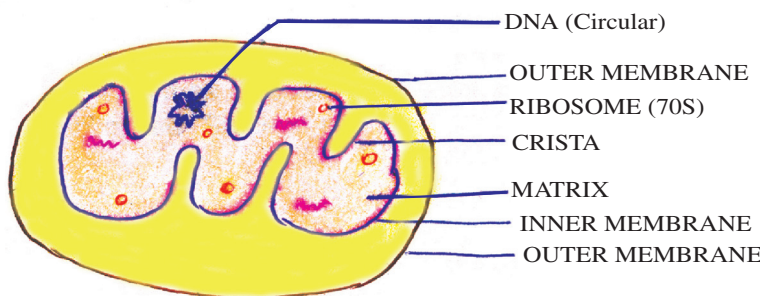
**Function :** Intracellular digestion.

**Vacuoles :** Membrane bound space found in the cytoplasm. Contain water, sap, excretory product, etc. In plant cell, vacuole occupies 90% of space.

**Function :** In plants **tonoplast** (single membrane of vacuole) facilitates transport of ions and other substances.

Contractile vacuole for excretion in *Amoeba* and food vacuoles formed in protists for digestion of food.

**Mitochondria :** Double membraned structure. Outer membrane smooth and inner membrane forms a number of infoldings called cristae. The inner compartment is called matrix. The cristae increase the surface area.



**Mitochondria**

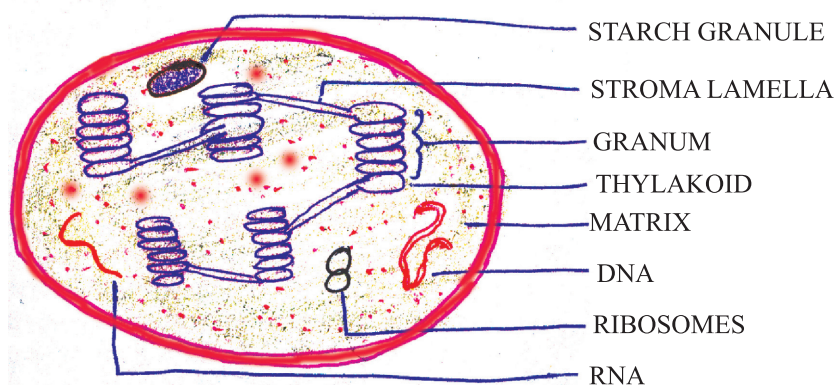
**Function :** Sites of aerobic respiration. Called ‘power houses’ of cell as produce cellular energy in the form of ATP. Matrix possesses single circular DNA molecule, a few RNA molecules, ribosomes (70S). It divides by binary fission.

**Plastids :** Found in plant cells and in euglenoids. Chloroplasts, chromoplasts and leucoplasts are 3 types of plastids depending on pigments contained.

### Types of Plastids

Chloroplast	Chromoplast	Leucoplast
(Green coloured plastids)		(Colourless plastids)
<ul style="list-style-type: none"><li>• Contain chlorophyll, and carotenoids double stranded DNA and 70S ribosomes.</li><li>• Trap light energy for photosynthesis</li></ul>	<ul style="list-style-type: none"><li>• Carotenoid (fat soluble) like Carotene, Xanthophylls and Others.</li><li>• Gives the part of plant a yellow orange and red colour</li></ul>	<ul style="list-style-type: none"><li>• Amyloplast (Starch)</li><li>• Elaioplasts (oil + fat)</li><li>• Aleuroplast (store proteins)</li></ul>

**Function :** Site of photosynthesis, and imparts colours to fruits and flowers.



**Chloroplast**

## Ribosomes

Composed of RNA and proteins; without membrane. Eucaryotic ribosomes are 80S. S = Svedberg's unit)

**Function :** Site of protein synthesis.

**Cytoskeleton :** Network of filaments.

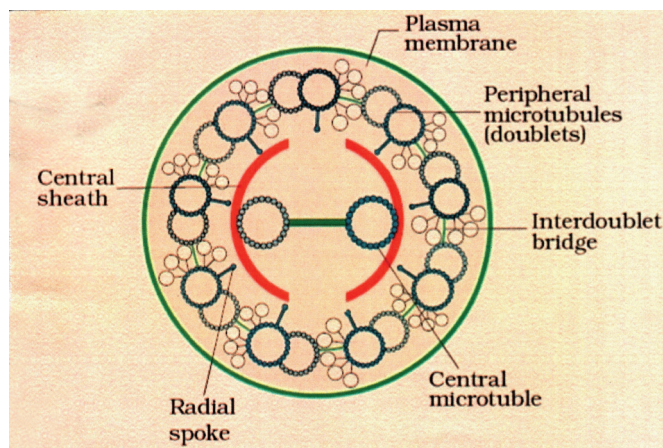
Proteinaceous structure in cytoplasm made up of microtubules and micro filaments.

**Function :** Mechanical support, motility, maintenance of the shape of the cell.

## Cilia and Flagella

Cilia are small structures which work like oars which help in movement.

Flagella are longer and responsible for cell movement. They are covered with a plasma membrane. Core is called **axoneme** which has 9 + 2 arrangement of axonemal microtubules.



## Centrosome and Centrioles

Centrosome contains two cylindrical structures called centrioles. Surrounded by amorphous pericentriolar material. Made up of nine evenly spaced peripheral fibrils of tubulin protein (9+0). Centrioles form the basal body of cilia or flagella and spindle fibres for cell division in animal cells. They produce spindle apparatus during cell division.

**Nucleus :** Double membranous with perinuclear space and nuclear pores; has Chromatin, nuclear matrix and nucleoli (site for rRNA synthesis). (Named by Robert Brown – 1831)

**Chromatin** DNA + nonhistone proteins. (Named by Fleming)

**Nucleoplasm** – Nucleolus + Chromatin

**Nuclear membrane**—It is with perinuclear space and nucleopores.

**Chromosomes**—DNA/RNA + Histone protein/Nonhistone protein.

**Centromere :** Primary constriction—in every chromosome

**Kinetochores :** Disc shaped structure on the sides of centromere.

No nucleus in Erythrocytes (RBC) of mammals and sieve tubes in vascular plants.

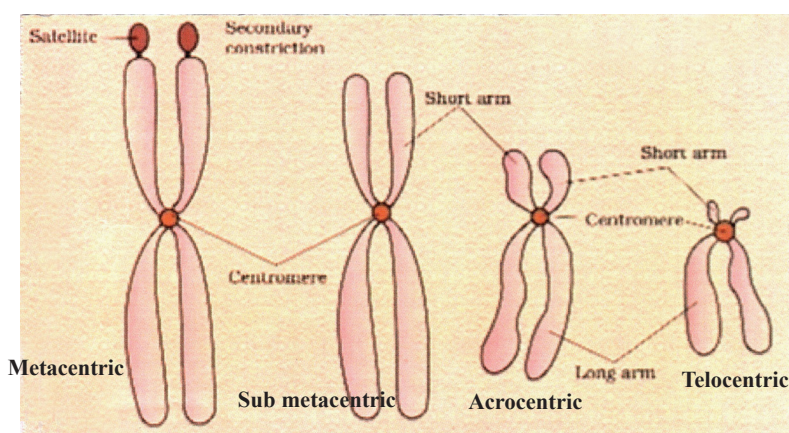
**Chromosomes (on basis of position of centromere) :**

**Metacentric :** Middle centromere.

**Sub-metacentric :** Centromere nearer to one end of chromosomes.

**Acrocentric :** Centromere situated close to its end.

**Telocentric :** Has terminal centromere.



**Satellite :** Some chromosomes have non-staining secondary constrictions at a constant location, which gives the appearance of small fragment called satellite.

## Questions

### Very Short Answer Questions

(1 mark each)

1. Name the parts of bacterial flagella.
2. Name the nutrient stored in (i) elaioplasts (ii) aleuroplasts
3. Name the scientist who first saw and described a living cell.
4. What are plasmids ?
5. Name the scientist who first explained that new cells arose from pre-existing cells (Omnis cellula-e-cellula)
6. What is the composition of plasma membrane of human erythrocyte.
7. Eukaryotic ribosomes are 80S. What does 'S' stand for ?
8. Write the function of cytoskeleton in a cell ?

### Short Answer Questions–I

(2 marks each)

9. What are nuclear pores ? State their function.
10. State the cell theory.
11. Differentiate between active and passive transport.
12. Differentiate between RER and SER.
13. List two functions of golgi apparatus.
14. List two functions of mesosome.
15. Differentiate between the electron microscopic structure of cilia/flagella and centriole.
16. Give the specific terms for the following :
  - (a) Cluster of ribosomes found in cytoplasm
  - (b) Extensive infolding in the inner membrane of mitochondria
  - (c) Stacks of closely packed thylakoids
  - (d) Stalked particles on the inner membrane of mitochondria
17.
  - (a) Write the function of inclusion bodies in prokaryotic cells ?
  - (b) Where are they present ?
  - (c) Give two examples of inclusion bodies.

### Short Answer Questions–II

(3 marks each)

18. With the help of labelled diagram explain the 'fluid mosaic model' structure of cell membrane.
19. Differentiate between a prokaryotic and eukaryotic cell.
20. What are lysosomes ? How are they formed ? Write their functions.
21. Give the structural details of an eukaryotic nucleus along with its diagram.

22. The ribosomes of prokaryotes are of 70 S type ribosomes and while of eukaryotes are of 80 S type as well as 70 S types.
- (a) Give the composition of 70 S type ribosomes and 80 S type ribosome (two sub units, from each of them are made of)
  - (b) Name two cell organelles of eukaryotic cells which have their own independent ribosomes of 70 S type

### Long Answer Questions

(5 marks each)

23. (a) Give the structural details of mitochondria.  
(b) Draw its diagram.  
(c) Why is it called 'powerhouse of the cell' ?
24. (a) Diagrammatically represent the types of chromosomes based on the position of centromere.  
(b) What does chromatin contain ?  
(c) What is perinuclear space ?

## Answers

### Very Short Answers

(1 mark each)

1. Filament, hook, basal body.
2. Elaioplasts : fats and oils.  
Aleuroplasts : proteins.
3. Anton Von Leeuwenhoek
4. The small circular DNA, outside the genomic DNA of bacteria.
5. Rudolf Virchow.
6. 52% proteins, 40% lipids.
7. Sedimentation coefficient (Svedberg unit)
8. Mechanical support, motility, maintenance of shape of cell.

### Short Answers–I

(2 marks each)

9. Minute pores present in the nuclear envelope; provide passage for movement of RNA and proteins between nucleus and cytoplasm.
10. Refer 'Points to Remember'.
12. Refer 'Points to Remember'.
13. Refer 'Points to Remember'.
14. Refer 'Points to Remember'.

15.	<b>Flegella/Cilia</b>	<b>Centriole</b>
(i)	Possess (9 + 2) pattern of axoneme microtubules enclosed by a membrane	: Possess (9 + 0) pattern, membrane less organelle
(ii)	Each tubule is doublet	: Each tubule is a triplet

16. (a) Polyribosome/Polysome  
(b) Cristae  
(c) Grana  
(d) Fo-F<sub>1</sub> particles ...
17. (a) Reserve materials are stored,  
(b) They are free in the cytoplasm  
(c) e.g., Phosphate granules, cyanophycean granules, glycogen granules.

### Short Answers–II

(3 marks each)

18. Refer page no. 131–132, NCERT, Text Book of Biology for Class XI.
19. Differences in nucleus/chromosomes/mesosome/membrane bound cell organelles/ribosomes/compartments in cell.
20. Refer page no. 134 NCERT, Text Book of Biology for Class XI.
21. Refer page no. 138, NCERT, Text Book of Biology for Class XI.
22. (a) 70 S ribosomes have 50 S and 30 S sub units; 80S ribosomes have 60 S and 40 S sub units.  
(b) Mitochondria and chloroplast.

### Long Answers

(5 marks each)

23. Refer page no. 134–135, NCERT, Text Book of Biology for Class XI.
24. Refer page no. 138–139, NCERT, Text Book of Biology for Class XI.

### Case Based :

25. Read the following and answer any four questions from 25 (i) to 25 (v) given below :

It is thought that life originated on earth around 4 billion years ago. The endosymbiotic theory states that some of the organelles in today's Eukaryotic



cells were once prokaryotic microbes. In this theory the first eukaryotic cell was probably an Amoeba like cell which ingested prokaryotic cells which survived within these amoeba host cells. Both organisms established symbiotic relationship. Mitochondria is formed when bacteria capable of aerobic respiration were injected, chloroplast formed when photosynthetic bacteria were ingested. They eventually lost their cell wall and much of their DNA.

**Some evidences which support this theory are :**

- (i) Mitochondria and chloroplast have their own circular DNA, just like prokaryotes.
- (ii) Both have 70s type of ribosomes.
- (iii) Both are of the same size as prokaryotic cells and divide by binary fission.
- (iv) Both are covered by double layered and contain respiratory enzymes on their inner surface.

Mitochondria and chloroplasts are semiautonomous organelles as they have their own DNA and ribosomes. They can synthesise some of their proteins on their own.

25. (i) Which feature have the prokaryotes lost during their evolution into mitochondria and chloroplast?
- (a) Cytoplasm
  - (b) Nucleus
  - (c) ER
  - (d) Cell wall
25. (ii) Theory of endosymbiosis explains the :
- (a) origin of organelles in eukaryotes
  - (b) how bacteria live
  - (c) how species evolve
  - (d) origin of multicellular life



25. (iii) Host cell received \_\_\_\_\_ from its endosymbiont and endosymbiont received \_\_\_\_\_ from its host :
- (a) Energy & shelter
  - (b) Shelter and energy
  - (c) Motility and reproduction
  - (d) Reproduction and motility
25. (iv) Which of the following evidence support endosymbiotic theory. Select all that which applies :
- (A) Chloroplasts and mitochondria have their own small circular DNA like prokaryotes
  - (B) They divide by binary fission
  - (C) 70s type of ribosomes in tem
  - (D) Respiratory enzymes on their inner surface
- (a) A & B
  - (b) A, B & C
  - (c) A, B, C & D
  - (d) B, C, & D
25. (v) **Assertion** : Mitochondria and chloroplast are semi autonomous organelles.
- Reason** : They are formed by the division of preexisting organelles as well as contain their own DNA but lack protein synthesizing machinery.
- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
  - (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  - (c) Assertion is true but reason is false.
  - (d) Both the assertion & reason are false.



## Assertion and Reason type Questions (1 mark each)

In each of the following questions, two statements are given, one is Assertion and other is Reason. Mark the correct answer as :

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion & reason are false.

26. **Assertion :** Specialization of cells is useful for organisms.

**Reason :** It increases the operational efficiency of an organism.

27. **Assertion :** Eukaryotic cells contain membrane bound organelles.

**Reason :** Prokaryotic cells do not contain membrane bound organelles.

### Answers:

Ans. 25. (i) (d) Cell wall

Ans. 25. (ii) (a) Origin of organelles in eukaryotes

Ans. 25. (iii) (a) energy and shelter

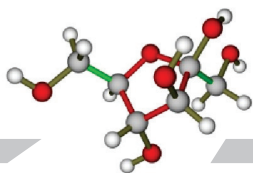
Ans. 25. (iv) (c) A, B, C and D

Ans. 25. (v) (c) Assertion is true but reason is false.

Ans. 26. (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.

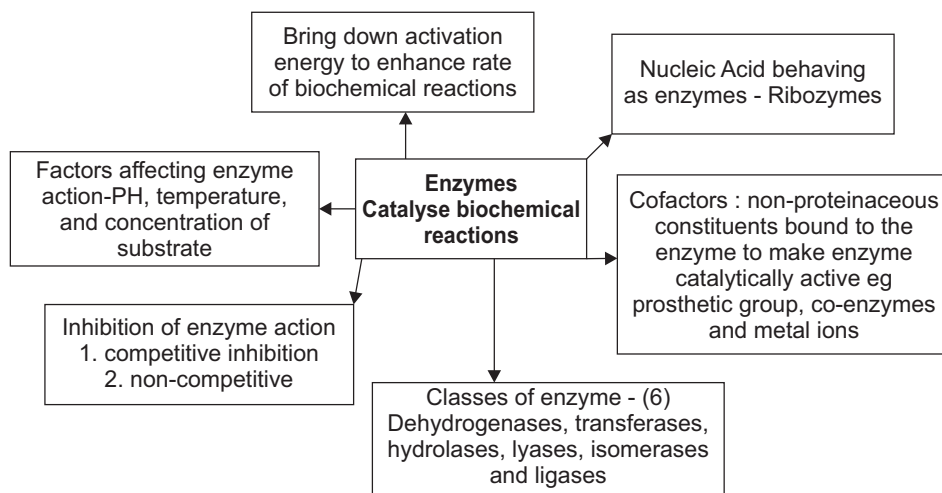
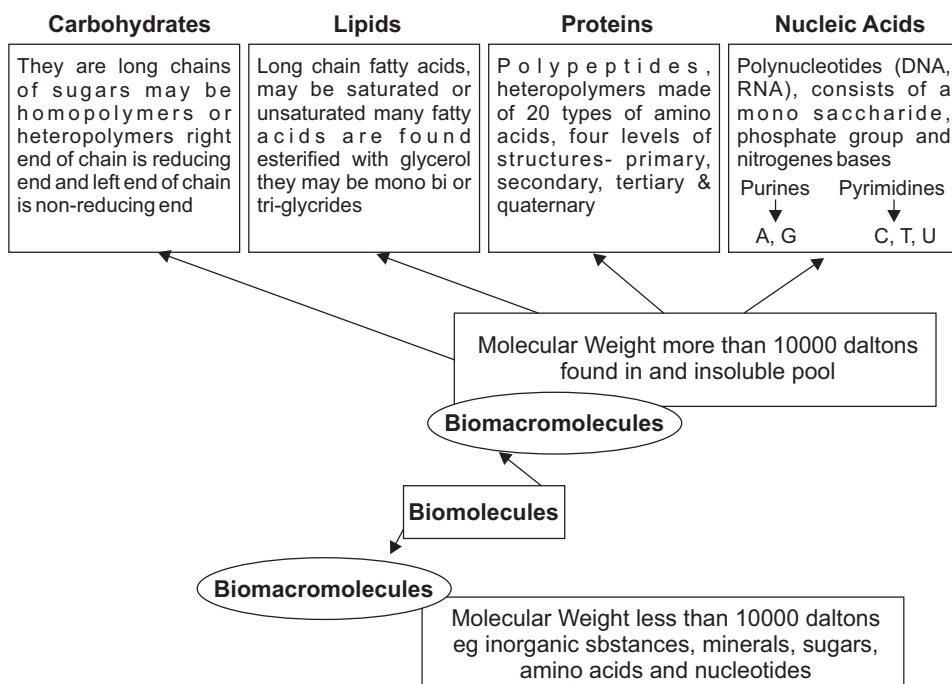
Ans. 27. (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.





## Chapter - 9

# Biomolecules



## Points to Remember

**Biomolecules :** All the carbon compounds that we get from living tissues.

**Biomicromolecules :** Molecules which have molecular weights less than one thousand dalton. They are also known as monomers. They are found in acid soluble fraction.

**Biomacromolecules :** A biomolecule with molecular weight in the range of ten thousand daltons and above; found in acid insoluble fraction. e.g. polysaccharides, nucleic acids, proteins and lipids.

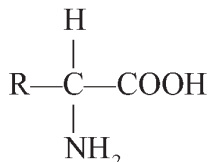
### How to analyse chemical composition of living tissues?

Living tissue + Trichloroacetic acid  $\longrightarrow$  Grinding  $\longrightarrow$  Thick Slurry  
 $\longrightarrow$  Filter through cheese cloth  $\begin{cases} \text{Filterate (Acid soluble)} \\ \text{Retentate (Acid insoluble)} \end{cases}$

## Primary and secondary metabolites :

- Primary metabolites have identifiable functions and play important roles in normal physiological process eg. Amino acids, nitrogenous bases, proteins and nucleic acid.
- Secondary metabolites are product of certain metabolic pathways from primary metabolites, eg. carotenoids, drugs, alkaloids, essential oils, rubber, gum, cellulose and resins etc.

**Amino acids :** Organic compounds containing an amino group and one carboxyl group (acid group) and both these groups are attached to the same carbon atom called  $\alpha$  carbon and so they are called  $\alpha$  amino acids.



e.g. (1) In Glycine R = H

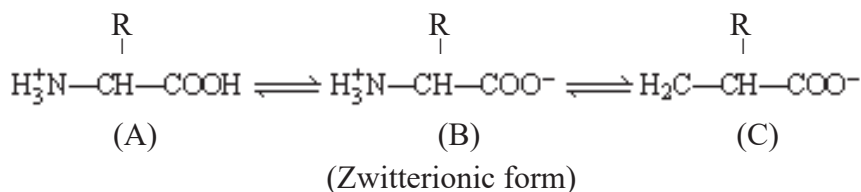
(2) In alanine R = CH<sub>3</sub>

(3) In serine R = CH<sub>2</sub> – OH



- Twenty types of amino acids.

Amino acid exists in Zwitterionic form at different pHs.



- Based on number of amino and carboxyl groups, amino acids can be :
  - (i) **Aromatic** – Tryptophan, phenylalanine and Tyrosine are aromatic (give smell) amino acids.
  - (ii) **Acidic Amino Acids** – (aspartic acid, glutamic acid). Basic amino acid (Arginine) and Neutral amino Acids (valine, Proline)

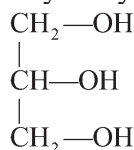
## Lipids :

Lipids are not strictly macromolecules as their molecular weight do not exceed 800 Da but form a part of the acid insoluble pool.

- Water insoluble, containing C, H, O.
- Fats on hydrolysis yield fatty acids.
- Fatty acid has a carboxyl group attached to an R group (contains 1 to 19 carbons).
- **Fatty Acids : Saturated** : With single bonds in carbon chain, *e.g.*, Palmitic acid, butyric acid.

**Unsaturated** : With one or more double bonds, *e.g.*, oleic acid, linoleic acid.

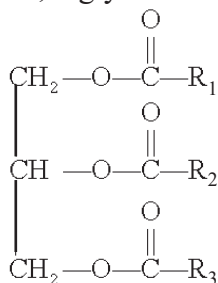
- **Glycerol** : A simple lipid, is trihydroxy propane.



- Some lipid have fatty acids esterified with glycerol.

Example of fatty acid (Palmitic acid)  $(\text{CH}_3 - (\text{CH}_2)_{14} - \text{COOH})$

- They can be monoglycerides, diglycerides and triglycerides.



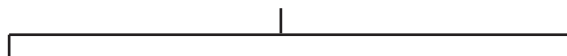
Triglyceride ( $R_1, R_2, R_3$  are alkyl groups in fatty acids.)

Phospholipids (Lecithin) found in cell membrane and lipids made complex structure in neural tissue.

- **Phospholipids** are compound lipids with phosphorus and a phosphorylated organic compound *e.g.*, Lecithin.

### Nitrogen bases

(Carbon compounds with heterocyclic rings)



**Purine** : Adenine, Guanine,      **Pyrimidine** : Cytosine, Uracil, Thymine.

**Nucleoside** : Nitrogenous base + Sugar *e.g.* Adenosine, guanosine.

**Nucleotide** : Nitrogenous base + Sugar + Phosphate group. *e.g.* Adenylic acid, Guanylic acid. Thymidylic acid.

**Nucleic acids** : Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

**DNA structure (Watson and Crick Model) :**

1. DNA is a right handed, double helix of two polynucleotide chains, having a major and minor groove.
2. The two chains are antiparallel, and held together by hydrogen bonds (two between A and T and three between C and G).
3. The backbone is formed by sugar-phosphate-sugar chain.
4. The nitrogen bases are projected more or less perpendicular to this, backbone and face inside.
5. The pitch is  $34\text{\AA}$ . At each step of ascent, the strand turns  $36^\circ$ . The rise per base pair is  $3.4^\circ\text{\AA}$ , so one full turn involves ten base pairs.

**Protein** : proteins are polypeptides.

- They are polymers of aminoacids linked by peptide bond.
- Is a heteropolymer (different monomers repeating 'n' number of times).
- Functions : Intercellular ground substance (collagen), as enzyme (Trypsin) as hormone (Insuline), to fight infections (Antibodies), as sensory receptors, and to enable glucose transport in cells (GLUT-4)

## Structure of Proteins

- (a) Primary structure** : Is found in the form of linear sequence of amino acids. First amino acid is called N-terminal amino acid and last amino acid is called C-terminal amino acid.
- (b) Secondary structure** : Polypeptide chain undergoes folding or coiling which is stabilized-by hydrogen bonding. Right handed helices are observed; *e.g.*, fibrous protein in hair, nails.



- (c) **Tertiary structure** : Long protein chain is folded upon itself like a hollow woollen ball. Gives a 3-dimensional view of protein, *e.g.*, myosin.
- (d) **Quaternary structure** : Two or more polypeptides with their foldings and coilings are arranged with respect to each other, *e.g.*, Human haemoglobin molecule has 4 peptide chains - 2  $\alpha$  and 2  $\beta$  Subunits.

**Monosaccharides** are joined by glycosidic bond, right end is reducing and left end is non reducing

**Polysaccharides** : Are long chain of polymers of monosaccharides.

- (a) **Starch** : Store house of energy in plant tissues. Forms helical secondary structures, made of only glucose monomers.
- (b) **Cellulose** : Homopolymer of glucose. It does not contain complex helices. Cotton fibre is cellulose.
- (c) **Glycogen** : Is a branched homopolymer, found as storage polysaccharide in animals.
- (d) **Inulin** : Is a polymer of fructose.
- (e) **Chitin** : Chemically modified sugar (amino-sugars) N-acetyl galactosamine form exoskeleton of arthropods; homopolymer.

## Metabolic Pathways :

- (a) **Anabolic pathways** : Lead to formation of more complex structure from a simpler structure with the consumption of energy, *e.g.*, Protein from amino acids., also known as biosynthetic pathways.
- (b) **Catabolic pathway** : Lead to formation of simpler structure from a complex structure, *e.g.*, Glucose  $\rightarrow$  Lactic Acid + energy

The most important energy currency in living systems is ATP (adenosine tri – phosphate).

**“There is no uncatalysed metabolic conversion in living system”**

The living state is a non-equilibrium steady state to be able to perform work. Without metabolism, there cannot be a living state.

## Bonds linking monomers in a polymer

**Peptide bond**—formed between the carboxyl ( $-\text{COOH}$ ) group of one amino acid, and the amino ( $-\text{NH}_2$ ) group of the next amino with the elimination of water moiety, (dehydration).

**Glycosidic bond**—bond formed between two carbon atoms of two adjacent monosaccharides., by dehydration.

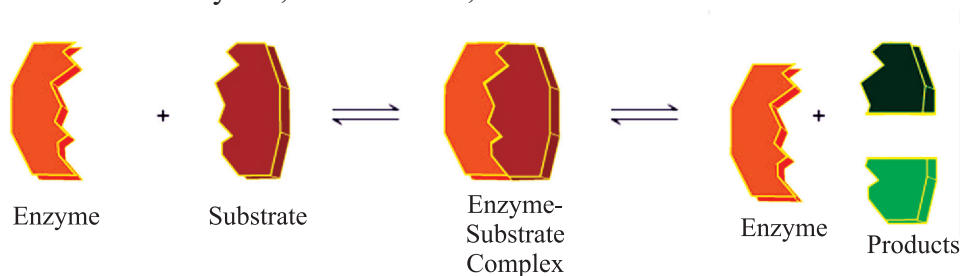
**Phosphodiester bond**—bond formed in nucleic acids where in a phosphate

moiety links the 3-carbon of one sugar of one nucleotide to the 5-carbon of the sugar of the succeeding nucleotide. (The bond between phosphate group and hydroxyl group of sugar)

**Ezymes** : Are biocatalyst.

- Almost all enzymes are proteins.
- Ribozymes–Nucleic acid that behave like enzymes.
- Has primary, secondary and tertiary structure.
- Active site of an enzyme is a crevice or pocket into which substrate fits.
- Enzymes get damaged at high temperatures.
- Enzymes isolated from thermophilic organisms (live under high temperatures) are thermostable.
- Enzymes accelerate the reactions many folds.
- Enzymes lower the activation energy of reactions. (Fig. 9.6, Page no. 156, NCERT Text Book of Biology for Class XI).
- $E + S \rightleftharpoons ES \rightarrow EP \rightarrow E + P$

where E = Ezymes, S = Substrate, P = Product



Steps of Enzyme Action

### Factors affecting enzyme activity :

- Temperature** : Show highest activity at optimum temperature. Activity declines above and below the optimum value.
- pH** : Enzymes function in a narrow range of pH. Highest activity at optimum pH. (Fig. 9.7, Page no. 157, NCERT, Text Book of Biology for Class XI).
- Concentration of substrate** : The velocity of enzymatic reaction rises with increases in substrate concentration till it reaches maximum velocity ( $V_{max}$ ). Further increase of substrate does not increase the rate of reaction as no free enzyme molecules are available to bind with additional substrate.

**Enzyme inhibition** : When the binding of a chemical shuts off enzyme activity, the process is called inhibition and chemical is called **inhibitor**.

**Competitive inhibition :** Inhibitor closely resembles the substrate in its molecular structure and inhibits the enzyme activity. E.g., inhibition of succinic dehydrogenase by malonate. (Actual substrate is succinic acid).

## Classification of enzymes :

1. **Oxidoreductase/dehydrogenases :** Catalyse oxidation-reduction between 2 substrates.  $S_{\text{reduced}} + S'_{\text{oxidised}} \rightarrow S'_{\text{oxidised}} + S_{\text{reduced}}$ .
2. **Transferases :** Catalyse transfer of a group between a pair of substrates.  
 $S - G + S' \rightarrow S + S' - G$
3. **Hydrolases :** Catalyse hydrolysis of ester, ether, peptide, glycosidic, C-C, P-N bonds.
4. **Lyases :** Catalyse removal of groups from substrates by mechanisms other than hydrolysis. Leave double bonds.
5. **Isomerases :** Catalyse inter-conversion of optical, geometrical or positional isomers.
6. **Ligases :** Catalyse linking together of 2 compounds.  
C-O, C-S, C-N, P-O

**Co-factors :** Enzymes become catalytically active when they bind to non protein constituent called co-factors. Protein portion of enzyme is called apoenzyme.

- **Prosthetic group :** These are organic compounds which are tightly bound to the apoenzyme.  
*e. g.,* Haem is prosthetic group in peroxidase and catalase.
- **Coenzyme :** These are organic compounds whose association with the apoenzyme is only transient, usually occurring during the course of catalysis.  
*e.g.,* Coenzyme Nicotinamide adenine dinucleotide (NAD) and NADP contain vitamin niacin.
- **Metal ions :** Metal ions form coordination bond with side chains at the active site and at the same time form one or more coordination bonds with substrate.  
*e.g.* zinc in enzyme carboxy peptidase.



## Questions

### Very Short Answer Questions

(1 mark each)

1. Why do oils generally remain in liquid state even in winters ?
2. Name an element found in proteins but not in lipids and carbohydrates.
3. What is the difference between RNA and DNA in terms of nitrogenous base ?
4. What does an enzyme do in terms of energy requirement of a reaction ?
5. What is the function of ATP in cell metabolism ?
6. Name the protein which form the intercellular ground substance.
7. What are biomacromolecules ?
8. Why enzymes are called bio-catalysts ?

### Short Answer Questions-I

(2 marks each)

9. Differentiate between prosthetic group and coenzyme ?
10. What are glycosidic bonds and peptide bonds ?
11. Why are amino acids also known as substituted methane?
12. Amino acids exist as zwitter ions. Give its structure. Why is it formed ?
13. Why do starch give blue black colour with iodine ?
14. Why are starch and glycogen more suitable than glucose as a storage product ?
15. What would happen when salivary amylase which acts on starch in mouth enter in stomach ?
16. Differentiate between homo polysaccharides saccharides and hetero polysaccharides.
17. Why do physicians recommend vegetable oils rich in polyunsaturated fat for persons suffering from cardiovascular diseases ?
18. Why does the shelf life of fruits and vegetables increase in a refrigerator ?

## Short Answer Questions-II

(3 mark each)

19. Differentiate between primary and secondary metabolites with examples ?
20. List out some major proteins and their function ?
21. Explain the structure of proteins.
22. Explain Watson-Crick model on DNA structure.
23. Explain peptide bond, glycosidic bond and phosphodiester bond.
24. Explain competitive inhibition along with an example.

## Long Answer Questions

(5 marks each)

25. List the 6 classes of enzymes along with their functions.

## Answers

### Very Short Answer

(1 marks each)

1. Oils are unsaturated lipids, hence have lower melting points.
2. Nitrogen.
3. RNA has uracil instead of thymine.
4. Lowers the activation energy of reaction.
5. Are the energy currency of cell.
6. Collagen.
7. Refer point to remember.
8. Enzymes are proteins that catalyze metabolic/chemical reactions inside the living being. That's why they are called biocatalysts.

### Short Answer-I

(2 marks each)

9. Refer 'Points to remember'.
10. Refer, 'Points to remembers'.
11. The  $\alpha$ -carbon has 4 substituted groups occupying the 4 valency positions :  
 $\text{H}-\text{COOH}-\text{NH}_2$  and  $-\text{R}$  group.
12. 
$$\begin{array}{c} \text{R} \\ | \\ \text{NH}_3 - \text{CH} - \text{COO}^- \end{array}$$

Due to ionizable nature of  $-\text{NH}_2$  and  $-\text{COOH}$  groups.

13. Starch form helical secondary structure which can hold I<sub>2</sub>.
14. Occupy lesser space as less bulky and can be hydrolysed to glucose when required.
15. In mouth, salivary amylase changes starch into maltose. Action of amylase stops in stomach as it cannot act in an acidic medium.
16.

Homopolysaccharides	Heteropolysaccharides
(a) Constituted of single type of monosaccharide units	Constituted by two or more type of monosaccharide unit and their derivatives
(b) e.g., starch, glycogen, cellulose	e.g., Peptidoglycans, chitin
17. Polyunsaturated oils contain fatty acids having one or more double bonds which does not clog arteries due to high proportion of polyunsaturated fatty acids.
18. Low temperature prevents growth of food spoiling micro organisms and also inhibits the action of enzymes present in the food, because, enzymes are inactivated at low temperature.

## Short Answers-I

**(3 marks each)**

19. **Secondary metabolites**—The metabolites like alkaloids, lectins, Drugs, Pigments, Spices and scents etc. which are useful to human welfare and have ecological importance.

**Primary metabolites**—The metabolites having identifiable functions and play important role in normal physiological processes, *e.g.*, sugars, amino acids, fats and oils and nucleotides, etc.

20. Refer Page No. 147, Table 9, 5, NCERT, text book of biology class XI.
21. Refer 'Points to remember'.
22. Refer 'Points to remember'.
23. Refer Page No. 151. NCERT, Text Book of Biology for Class XI.
24. Refer 'Points to remember'.

## Long Answers

**(5 marks each)**

25. Refer Page No. 158., NCERT, Text Book of Biology for Class XI.



## Case study based question

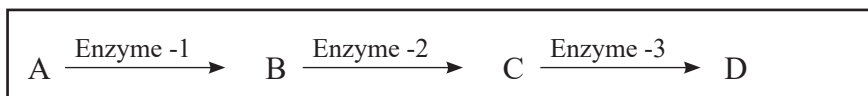
(4 marks each)

26. Read the following and answer any four questions from 26 (i) to 26 (v) given below :

Enzymes are proteins that act as biological catalysts (biocatalyst). Almost all enzymes are proteins. Some Nucleic acid behaves like enzymes. They are called ribozymes. Enzymes have tertiary structure and many crevices called 'active sites'. Enzymes act upon substrate and change them into products. Substrate binds to the active sites of enzymes. Like all catalyst enzymes increase the rate of reaction by lowering its activation energy. Some enzymes are used commercially, for example synthesis of antibiotics, smart detergent to remove fat stains on clothes, in biscuit factories and in meat tenderizer process.

26. (i) Which enzyme is used by the biscuit manufactures to lower the protein level of flour?
- (a) Amylases
  - (b) Proteases
  - (c) Cellulases
  - (d) Xylases
26. (ii) Which of the following statement is/are correct about enzymes?
- (a) An enzyme is a protein which acts as a biocatalyst to accelerate the rate of reaction.
  - (b) Life would not exist without the presence of enzymes in cells
  - (c) Enzymes participate in various cellular metabolic processes
  - (d) All the above
26. (iii) A protein having both structural and enzymatic properties is :
- (a) Collagen
  - (b) Trypsin
  - (c) Myosin
  - (d) Actin

26. (iv) The diagram shows a metabolic pathway :



What would happen to the rate of production of 'D', if enzyme 1 was not present?

- (a) It would stop
- (b) It would be increased
- (c) It would be decreased
- (d) No effect

26. (v) **Assertion :** All enzymes are not proteins.

**Reason :** RNA molecules that possess catalytic activity are called ribozymes.

- (a) Both assertion and reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion & reason are false.

### Assertion and Reason Type Questions (1 mark each)

In each of the following questions, two statements are given, one is Assertion and other is Reason. Mark the correct answer as :

- (a) Both assertion and reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion and reason are false.



27. **Assertion :** A coenzyme or metal ion tightly bound to enzyme protein is called prosthetic group.

**Reason :** A complete catalytically active enzyme together with its bound prosthetic group is called apoenzyme.

28. **Assertion :** Secondary metabolites are produced in small quantities and their extraction from the plant is difficult and expensive.

**Reason :** Secondary metabolites can be commercially produced by using tissue culture technique.

**Answers :**

Ans. 26 (i) (b) Proteases

Ans. 26 (ii) (d) All the above

Ans. 26 (iii) (c) Myosin

Ans. 26 (iv) (a) It would stop

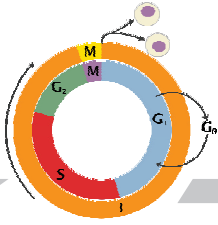
Ans. 26 (v) (a) Both assertion and reason are true, but the reason is the correct explanation of the assertion.

Ans. 27 (c) Assertion is true but reason is false.

Ans. 28 (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.

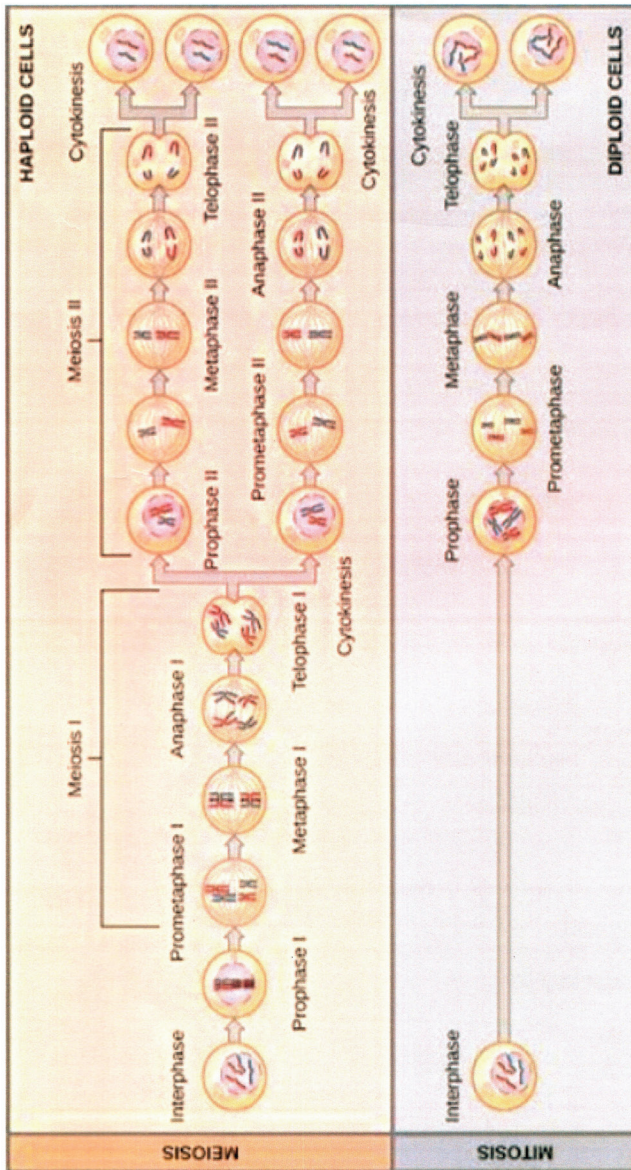






## Chapter - 10

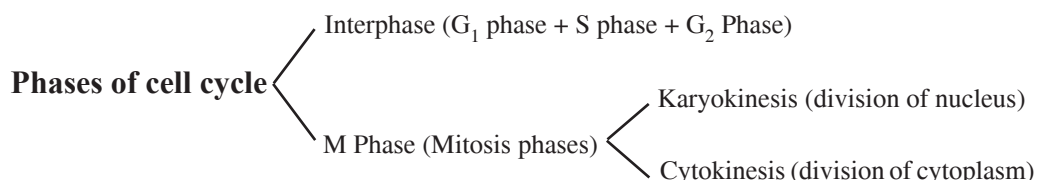
# Cell Cycle and Cell Division



PROCESS	MEIOSIS	MITOSIS
DNA synthesis	Occurs in S phase of interphase	Occurs in S phase of interphase
Synapsis of homologous chromosomes	During prophase I	Does not occur in mitosis
Crossover	During prophase I	Does not occur in mitosis
Homologous chromosomes line up at metaphase plate	During metaphase I	Does not occur in mitosis
Sister chromatids line up at metaphase plate	During metaphase II	During metaphase
OUTCOME	Four haploid cells at the end of meiosis II	Two diploid cells at the end of mitosis

## Points To Remember

**Cell cycle :** The sequence of events by which a cell duplicates its genome, synthesises the other constituents of the cell and eventually divides into two daughter cells.



### Interphase : (Resting Phase)

- **$G_1$  Phase :** Cell metabolically active and grows continuously but does not replicate DNA
- **S Phase :** DNA synthesis occurs, DNA content increases from  $2C$  to  $4C$ , but the number of chromosomes remains same *i.e.*,  $2n$ .
- **$G_2$  Phase :** Proteins are synthesised in preparation for mitosis while cell growth continues.

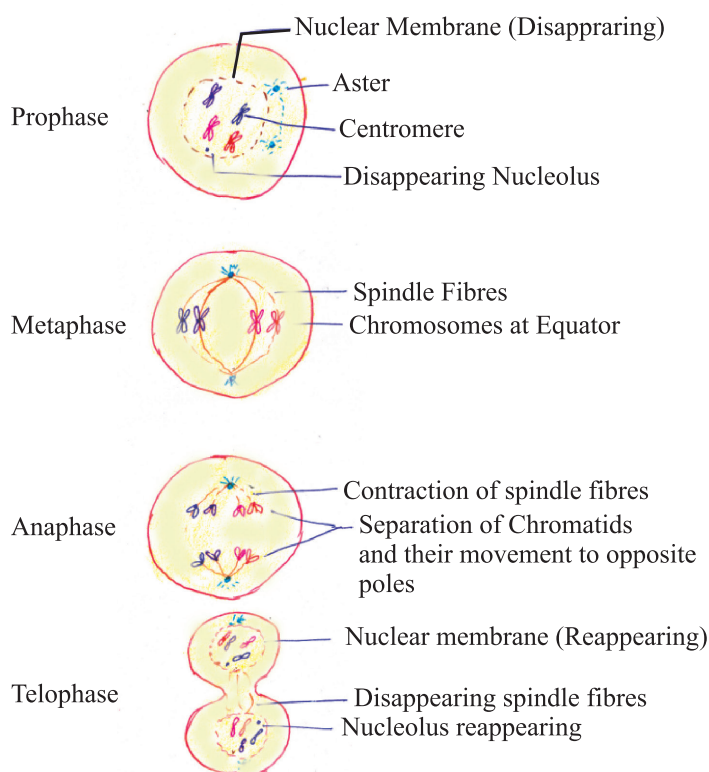
**M Phase (Mitosis Phase) :** Starts with nuclear division, corresponding to separation of daughter chromosomes (karyokinesis) and usually ends with division of cytoplasm, (cytokinesis).

**Quiescent stage ( $G_0$ )** In adult animal cells that do not divide and exit  $G_1$  phase to enter an inactive stage called  $G_0$ . Cells at this stage remain metabolically active but do not proliferate.

*e.g.*, Heart cells







### Stages of Mitosis

**Cytokinesis :** The division of protoplast of a cell into two daughter cells after karyokinesis (nuclear division)

#### Animal Cytokinesis :

Appearance of furrow in plasma membrane which deepens and joins in the centre, dividing cell cytoplasm into two.

**Plant cytokinesis :** Formation of new cell wall begins with the formation of a simple precursor — **cell plate** which represents the middle lamella between the walls of two adjacent cells.

- When karyokinesis is not followed by cytokinesis, a multinucleated condition arises. This is called **syncytium**.

### Significance of Mitosis :

1. Growth-addition of cells.
2. Maintenance of surface/volume ratio. Maintain Nucleo—cytoplasmic ratio.
3. Maintenance of chromosomes number.
4. Regeneration.

5. Reproduction in unicellular organisms, lower plants and some insects.
6. Repair and wound healing.
7. Vegetative reproduction in plants takes place by mitosis.

## Meiosis :

- Specialised kind of cell division that reduces the chromosomes number by half. Hence it is called reductional division.
- Occurs during gametogenesis in plants and animals.
- Involves two sequential cycles of nuclear and cell division called Meiosis I and Meiosis II.
- It results in 4 haploid daughter cells.
- Interphase occurs prior to meiosis which is similar to interphase of mitosis except the S phase is prolonged.

## Meiosis I

**Prophase I** : Subdivided into 5 phases.

**(i) Leptotene :**

- Chromosomes make their appearance as single stranded structures.
- Compaction of chromosomes continues.

**(ii) Zygotene :**

- Homologous chromosomes start pairing and this process of association is called synapsis.
- Chromosomal synapsis is accompanied by formation of Synaptonemal complex.
- Complex formed by a pair of synapsed homologous chromosomes is called bivalent or tetrad.

**(iii) Pachytene :** Crossing over occurs between non-sister chromatids of homologous chromosomes. The enzymes involved in the process is 'recombinase'. Recombination between homologous chromosomes is completed. Exchange of genetic material.

**(iv) Diplotene :** Dissolution of synaptonemal complex occurs and the recombined chromosomes separate from each other except at the sites of crossing over. These X-shaped structures are called **Chiasmata**. In oocytes of some vertebrates diplotene can last for month or years.

(v) **Diakinesis** : Terminalisation of chiasmata.

- Chromosomes are fully condensed and meiotic spindles assembled.
- Nucleolus disappear and nuclear envelope breaks down.

**Metaphase I** : Bivalent chromosomes align on the equatorial plate.

- Microtubules from opposite poles of the spindle attach to the pair of homologous chromosomes.

**Anaphase I** : Homologous chromosomes, separate while chromatids remain associated at their centromeres.

## **Telophase I :**

- Nuclear membrane and nucleus reappear.
- Cytokinesis follows (dyad of cells).

**Interkinesis** : Stage between two meiotic divisions, (meiosis I and meiosis II) generally short lived, No replication of DNA during this.

**Meiosis II:** (It resembles the normal mitosis).

## **Prophase II**

- Nuclear membrane disappears.
- Chromosomes again become compact.

**Metaphase II**

- Chromosomes align at the equator.
- Microtubules from opposite poles of spindle get attached to kinetochores of sister chromatids.

**Anaphase II**

- Simultaneous splitting of the centromere of each chromosome, allowing them to move towards opposite poles of the cell, by shortening of microtubules attached to kinetochores.

**Telophase II**

- Two groups of chromosomes get enclosed by a nuclear envelope.
- Cytokinesis follows resulting in the formation of tetrad of cells *i.e.*, 4 haploid cells.

## **Significance of Meiosis**

1. **Formation of gametes** : In sexually reproducing organisms.
2. **Genetic variability** : Variations are very important for evolution.
3. **Maintenance of chromosomal number** : By reducing the chromosome number in gametes. Chromosomal number is restored by fertilisation of gametes.

## Questions

### Very Short Answer Questions

(1 mark each)

1. What are kinetochores ?
2. Name the term used for the stage between two meiotic divisions.
3. Why is mitosis called equational division ?
4. Name the stage of meiosis during which synaptonemal complex is formed.
5. What is G<sub>0</sub> phase of cell cycle ?
6. Where does mitosis take place in plants and animals ?

### Short Answer Questions-I

(2 marks each)

7. Differentiate between cytokinesis of plant and animal cell.
8. What is chiasmata ? State its significance.
9. Differentiate between chromatin and chromatid.
10. Give the terms for the following :
  - (a) The period between 2 successive mitotic divisions.
  - (b) Cell division in which chromosome number is halved.
  - (c) Phase in cell cycle where DNA is synthesised.
  - (d) Division of nuclear material.
11. What happens during S phase of interphase ?
12. Distinguish between metaphase of mitosis and metaphase I of meiosis.
13. What will be the DNA content of a cell at G<sub>1</sub> after S and G<sub>2</sub> if the content after M phase is 2C.

### Short Answer Questions-II

(3 marks each)

14. Differentiate between mitosis and meiosis.
15. List the significance of mitosis.
16. Describe the following :
  - (a) Synapse
  - (b) Bivalent
  - (c) Leptotene

### Long Answer Questions

(5 marks each)

17. With the help of labelled diagram, explain the following :
  - (a) Diplotene
  - (b) Anaphase of mitosis
  - (c) Prophase I of meiosis

18. What is cell cycle ? Explain the events occurring in this cycle.
19. With the help of labelled diagrams, explain various stages of mitosis cell division.
20. (a) Write a note on significance of meiosis.  
 (b) Differentiate between anaphase 1 of meiosis and Anaphase of mitosis.  
 (c) In which phase of interphase duplication of DNA will occur ?

## Answers

### Very Short Answers

(1 mark each)

1. Small disc-shaped structure at the surface of the centromeres.
2. Interkinesis.
3. The chromosomes number in daughter cells is equal to that of the parent.
4. Zygotene.
5. Cells which enter a stage where they are Metabolically active but no longer proliferate.
6. Plant – Meristematic tissue; Animals – somatic cells.

### Short Answers-I

(2 marks each)

7. Refer 'Points to Remember'.
8. Refer 'Points to Remember'.
9. **Chromatin Chromatid :**
  - (a) Diffuse, deep staining hereditary material longitudinally split half of a chromosome, light staining hereditary material.
  - (b) Metabolically inert Metabolically active.
10. (a) Interphase  
 (b) Meiosis  
 (c) S phase  
 (d) Karyokinesis
11. Refer 'Points to Remember' :

12.	Metaphase	Metaphase I
	(a) Chromosome align along the equator of the cell	(a) Bivalent chromosomes arrange along the equatorial plane.
	(b) Figure 10.2 (b) page 165, Text Book of Biology for Class XI for	(b) Figure 10.3, meta phase I page 169, NCERT Text Book of Biology Class XI.

13.  $G_1 - 2C$ ,  $S_1 - 4C$ ,  $G_2 - 4C$

### Short Answers-II

(3 marks each)

14.	Mitosis	Meiosis
(a)	Occurs in Somatic cells	(a) Occurs in germ cells
(b)	Number of chromosomes remain same in daughter cells	(b) Number of chromosomes reduces to half in daughter cells.
(c)	No exchange of genetic material	(c) Exchange of genetic material occurs due to crossing over
(d)	Involve single division	(d) Involve two successive division

15. Refer 'Points to Remember'.

16. Refer 'Points to Remember'.

### Long Answer

(5 marks each)

17. Refer 'Points of Remember'.

18. Refer 'Points of Remember'.

19. Refer 'Points of Remember'.

20. (a) Refer 'Points of Remember'

(b) Refer 'Points of Remember'.

(c) During A phase or synthesis phase.

### Case Study based Question

(4 marks each)

21. Read the following and answer any four questions from 21 (i) to 21 (v) given below :

The sequence of events by which a cell duplicates its genome, synthesizes the other constituents of the cell and eventually divides into two daughter cells is termed cell cycle. Cell cycle is divided into interphase and M Phase. The interphase, though called the resting phase, cell is preparing for division by undergoing both cell growth and DNA replication. Interphase is divided into three phases-  $G_1$  phase, S phase and  $G_2$  phase. In  $G_1$  phase, cell prepares proteins and enzymes. In S phase, DNA replication and centrioles duplication takes place. After S phase, chromosome number of the cell does not change but amount of DNA becomes double ( $4C$ ). In  $G_2$  phase synthesis of protein especially tubulin, which is used in the formation of spindle fibres, occurs. During M phase, cell division occurs through karyokinesis and cytokinesis.

21. (i) How many chromosomes and DNA content will the onion cell have in G<sub>1</sub> phase, after completing S phase and after M phase respectively, if onion plant possess 14 chromosomes initially?

- (a) 14 / 2C, 28 / 4C and 14 / 4C
- (b) 14 / 2C, 14 / 4C and 14 / 2C
- (c) 14 / 2C, 14 / 2C and 14 / 2C
- (d) 28 / 4C, 28 / 4C and 14 / 2C

21. (ii) Choose the correct option for a human cell before it enters prophase?

	Number of Chromatids	Number of Chromosomes
(a)	46	92
(b)	46	46
(c)	92	46
(d)	92	92

21. (iii) Non-dividing cells like muscles, neurons are in \_\_\_\_\_ phase

- (a) G<sub>1</sub>
- (b) G<sub>2</sub>
- (c) G<sub>0</sub>
- (d) M Phase

21. (iv) How many mitotic divisions are required to form 128 cells from a single onion root tip cell (mitosis)?

- (a) 14
- (b) 21
- (c) 6
- (d) 7

21. (v) **Assertion :** Interphase is called resting stage.

**Reason :** In interphase the cell is metabolically inactive.

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion and reason are false.



## Assertion and Reason Type Questions

(1 mark each)

In each of the following questions, two statements are given, one is Assertion and other is Reason. Mark the correct answer as :

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion and reason are false.

22. **Assertion :** Daughter somatic cells formed by mitosis are genetically similar to parental cell.

**Reason :** Chromosomes do not undergo crossing over in mitosis.

23. **Assertion :** Meiosis–II is similar to mitosis.

**Reason :** Meiosis–I cannot occur in haploid cells.

Answers :

Ans. 21 (i) (b)  $14 / 2C$ ,  $14 / 4C$  and  $14 / 2C$

Ans. 21 (ii) (c) 92, 46

Ans. 21 (iii) (c)  $G_0$  phase

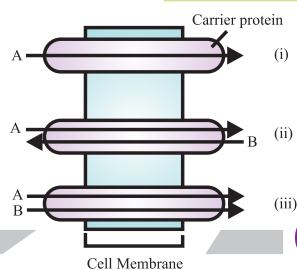
Ans. 21 (iv) (d) 7

Ans. 21 (v) (c) Assertion is true but reason is false.

Ans. 22 (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.

Ans. 23. (b) Both assertion and reason are true but the reason is not the correct explanation of the assertion.





## Chapter - 11

# Transport In Plants

**Active transport** :- Movement of substances from their lower conc. to higher conc. through selectively permeable membrane using energy.

**Facilitated transport** :- Movement of substances from higher conc. to lower conc. with the help of transport proteins.

It may be symport antiport or uniport.

**Diffusion** :- Movement of substances from higher conc. to lower conc. without involving transport protein.

### Means of transport

**Pressure Potential** :- Magnitude of increase in water potential when it measures greater than atmospheric pressure, is applied to pure water.

**Solution potential** :- Magnitude of lowering of water potential when solute is added to water.

**Water potential** :- It is the measure of conc. of water or kinetic energy of water in a system. It is zero for pure water.

### Plant water relations

**Osmosis** :- Movement of solvent from their higher chemical potential to their lower chemical potential through selectively permeable membrane.

**Plasmolysis** :- Shrinkage of protoplasm away from the cell wall due to exosmosis in hypertonic solution.

**Imbibition** :- Absorption of water by solid particles of an adsorbent resulting in increase in volume.

**Transpiration** :- Removal of water in the form of water vapours through stomata of leaves.

**Guttation** :- Removal of water droplets through hydathodes.

### Some important reactions

## TRANSPORT OF SUBSTANCES IN PLANTS (source to sink)

### Uptake and transport of mineral nutrients and food

**Xylem Transport** :- Uptake and transport of mineral nutrients through xylem. It occurs by active or passive absorption and moves along with water.

**Phloem Transport** :- Movement of sugar, hormones and amino acids by pressure flow or mass flow hypothesis.

Absorption of sugar takes place actively.

### Features involved in water movement upward

#### SURFACE TENSION

#### Cohesion-Tension - Transpiration pull theory :-

Forces of adhesion and cohesion maintain water column and transpiration pull is major force driving water upward.

**Root pressure theory** :- A hydrostatic pressure existing in roots which pushes the water up in xylem vessels upto certain height in herbaceous plants.

### Methods of water absorptions and movement to root xylem

**Apoplastic Pathway** : Movement through inter cellular spaces or cell wall movement is fast and most of water enters through this way.

**Symplastic Pathway** :- Water enters the cell through cell membrane and travel through cytoplasm and plasmodesmata; movement is slow.

At casparian strips region, water moves through symplast only.

## Points To Remember

**Translocation (Long distance transport) :** Transport of substances in plants over longer distances through the vascular tissue (Xylem and Phloem) The transport of water and mineral in Xylem is unidirectional while transport of organic and mineral nutrients in phloem is multi-directional.

**Means of transport (Short distance transport) :** The transport of material into and out of the cells is carried out by a number of methods. These are diffusion, facilitated diffusion and active transport.

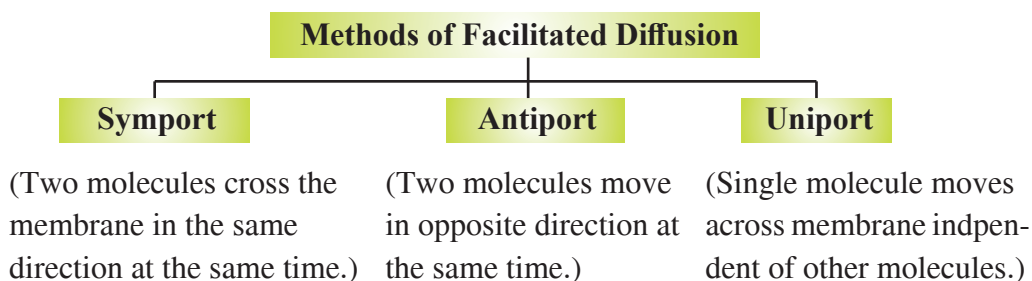
(i) **Diffusion :** Diffusion occurs from region of higher concentration to region of lower concentration. It is passive and slow process. No energy expenditure takes place. No membrane required

**Factors affecting diffusion :** Permeability of membrane, Temperature, pressure, gradient of concentration and the size of substances.

(ii) **Facilitated diffusion :** The diffusion of hydrophilic substances along the concentration gradient through fixed membrane transport protein without involving energy expenditure. For this the membrane possess aquaporins and ion channels. No ATP energy is utilized in this process.

**Porins**—The proteins that form huge pores in the outer membranes of the plastids, mitochondria and some bacteria which allow the small size molecules to pass through.

**Aquaporins**—Proteins that facilitate diffusion of water molecules through/ across the plasma membrane of cell.



**Transport Proteins**—They are present in the membrane. They allow the passage of substances through membrane.

(i) **Carrier Proteins**—They bind to the particular solute particle to be transported and deliver these to other side of membrane.

(ii) **Channel Proteins**—**Ion Channel**—They are specific for different ions like  $K^+$ ,  $Cl^-$ ,  $NO_3^-$ ,  $PO_4^{3-}$ ,  $Mg^{2+}$

**Water Channel**—Surrounded by eight proteins called Aquaporins and allow passage of water or water soluble substance.

(iii) **Active transport** : Active transport is carried by the movable carrier proteins (pumps) of membrane. Active transport uses energy to pump molecules against a concentration gradient from a low concentration to high concentration (uphill-transport). It is faster than passive transport.

## Different Transport Mechanisms

S. No.	Property	Simple Diffusion	Facilitated Transport	Active Transport
1.	Required Special membrane protein	No	Yes	Yes
2.	Uphill transport	No	No	Yes
3.	Requires ATP Energy	No	No	No

- **Water potential**—( $\psi_w$ )—Greater the concentration of water in a system, greater is its kinetic energy and greater is the water potential. It is measured in pascal (Pa). or mega pascal.
- If two systems are in contact, then there is movement of water from the solution with higher potential to lower water potential.
- **Solute potential**—( $\psi_s$ )—Magnitude of lowering of water potential, when a solute is added to the water.
- **Pressure Potential**—( $\psi_p$ )—Magnitude of increase of water potential, when pressure greater than atmospheric pressure is applied to pure water or a solution.
- Water potential of pure water is zero (0).
- Solute potential is always negative (–) and pressure potential is always positive (+).

$$\psi_w = \psi_s + \psi_p$$

- **Osmotic Pressure**—External pressure applied to prevent the diffusion of water. It depends upon solute concentration.
- Numerically, osmotic pressure is equal to osmotic potential. Osmotic pressure has positive (+) sign. Osmotic potential has negative (–) sign.

**Turgor Pressure**—Due to osmotic entry of water, the protoplasm of a plant cell presses the cell wall towards the outside with a force, it is called Turgor Pressure.

**Diffusion Pressure**—The pressure exerted by the tendency of the particles to diffuse from the area of higher concentration to lower concentration. It is directly proportional to the concentration of particles of diffusing substance.

**Osmosis** : Osmosis is movement of solvent or water molecules from the region of their higher chemical potential to the region of their lower potential across a semipermeable membrane.

Water molecules move from higher water potential to lower water potential until equilibrium is reached.

**Plasmolysis** : Process of shrinkage of protoplasm away from its cell wall due to exosmosis in hypertonic solution. If a plasmolysed cell is placed in water or a hypotonic solution it becomes turgid.

**Hypotonic solution** : The external solution which is more dilute than the cytoplasm. Cell kept in hypotonic solution become turgid.

**Hypertonic solution** : The external solution, which is more concentrated than the cytoplasm. Cell kept in hypertonic solution get plasmolysed

**Isotonic solution** : When the external solution balances the osmotic pressure of the cytoplasm. Cell kept in isotonic solution become flaccid.

**Casparian strip** : It is the tangential as well as radial walls of endodermal cells having the deposition of water impermeable suberin.

**Imbibition** : Imbibition is the phenomenon of absorption of water by the solid particles of an adsorbent causing it to enormously increase in volume without forming a solution.

### Some examples of Imbibition :

- (i) If a dry piece of wood is placed in water, it swells and increases in its volume.
- (ii) If dry gum or pieces of agar-agar are placed in water, they swell and their volume increases.
- (iii) When seeds are placed in water they swell up.
- (iv) Swelling of wooden door during rainy season.

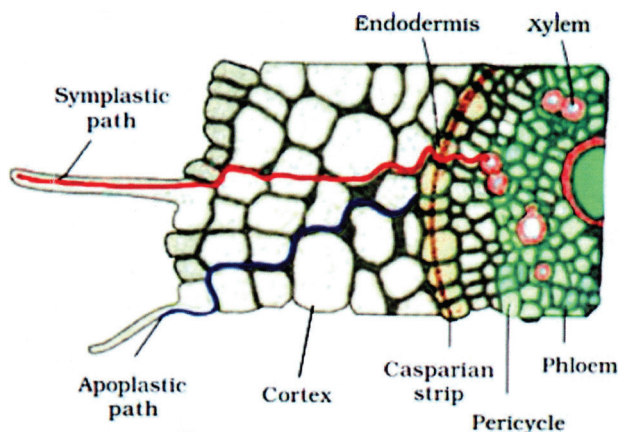
### Conditions essential for imbibition

1. Water potential gradient between the surface of the adsorbent and the imbibed liquid, is essential.
2. Affinity between the adsorbent and the imbibed liquid.

**Transport of water in plants :** Water is absorbed by root hairs by diffusion. Then water moves up to xylem by two pathways—apoplast and symplast pathway.

**Apoplast Pathway**—Movement occurs through the intercellular spaces or walls of the cell, without entering the cytoplasm. This movement is fast. In roots, movement of water occurs via apoplast except at the Casparian strip, most of water enters through apoplast.

**Symplast Pathway**—Water enters the cell through cell membrane and travels intercellularly through plasmodesmata. This movement is slow. At Casparian strip region water moves only through symplast.



### Apoplastic And Symplastic Pathways of Water Transport

**Ascent of Sap**—Upward movement of water in the form of dilute solution of mineral ions from roots to the top aerial parts of plants through tracheary elements of xylem against the gravitational force is called ascent of sap. It involves two theories—

(i) **Cohesion–Tension–Transpiration pull theory.**

(ii) **Root pressure theory.**

(1) **Cohesion-Tension-Transpiration pull theory—**

(i) **Continuity of water column**—The transport of water to the top of trees occurs through xylem vessels. The forces of adhesion and cohesion maintain a thin and unbroken column of water in the capillaries of xylem vessels through which it travels which is travels upward. Water is mainly pulled by transpiration from leaves.

(ii) **Transpiration Pull**—Transpiration accounts for loss of 99% of water in the form of water vapours the surface of leaves. The loss is mainly through stomata.

- Pull of water as a result of tension created by transpiration is the major driving force of water movement upward in a plant.

Three physical properties of water which affect the ascent of xylem sap due to transpiration pull.

(iii) **Cohesion force or Tensile strength of water—**

- **Cohesion**—Mutual attraction between water molecules.
- **Adhesion**—Attraction of water molecules to polar surface.
- **Surface tension**—Attraction of water to each other in liquid phase to a greater extent than to water in gaseous phase.

(2) **Root pressure Theory** : A hydrostatic pressure existing in roots which pushes the water up in xylem vessels upto certain height to herbaceous plant.

**Guttation** : The water loss in its liquid phase in the form of water droplets at night and early morning through special openings of vein near the tip of leaves. These openings are called hydathodes.

**Transpiration** : The loss of water through stomata of leaves and other aerial parts of plants in form of water vapours.

**Factors affecting transpiration** : Temperature, light, relative humidity, wind speed, number and distribution of stomata, water status of plant, canopy structure.

**Significance of transpiration**—Advantages—Helps in ascent of sap, removal of excess water, cooling effect, distribution of mineral salts, supply water for photosynthesis.

**Disadvantages**—May cause reduced growth, wilting (loss of turgidity), reduced yield and waste of energy.

Since there are advantages as well as disadvantages of transpiration so—‘Transpiration is called a necessary evil’.

**Opening and closing of stomata**—Opening and closing of stomata happens due to following two reasons—

- (i) Change in the turgidity of guard cells.
- (ii) Orientation of cellulose microfibrils in the cell wall of guard cells.

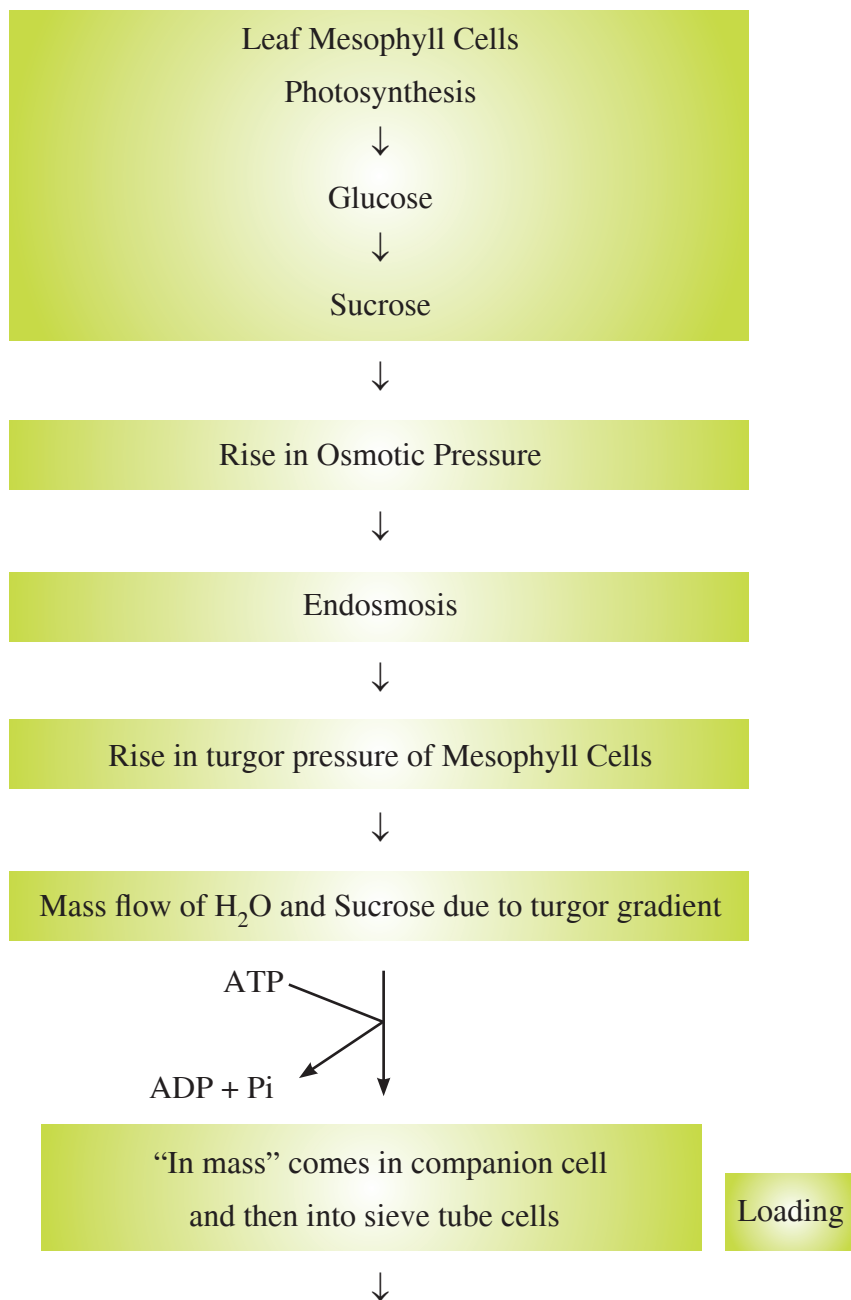
**Endosmosis**—When a cell is placed in water or hypotonic solution, water enters into the cell. This is called endosmosis. Due to it the volume of cell increases and it creates turgor pressure.

**Exosmosis**—When a cell is placed in hypertonic solution, water comes out of the cell, this is called exosmosis. It decreases volume of the cell.

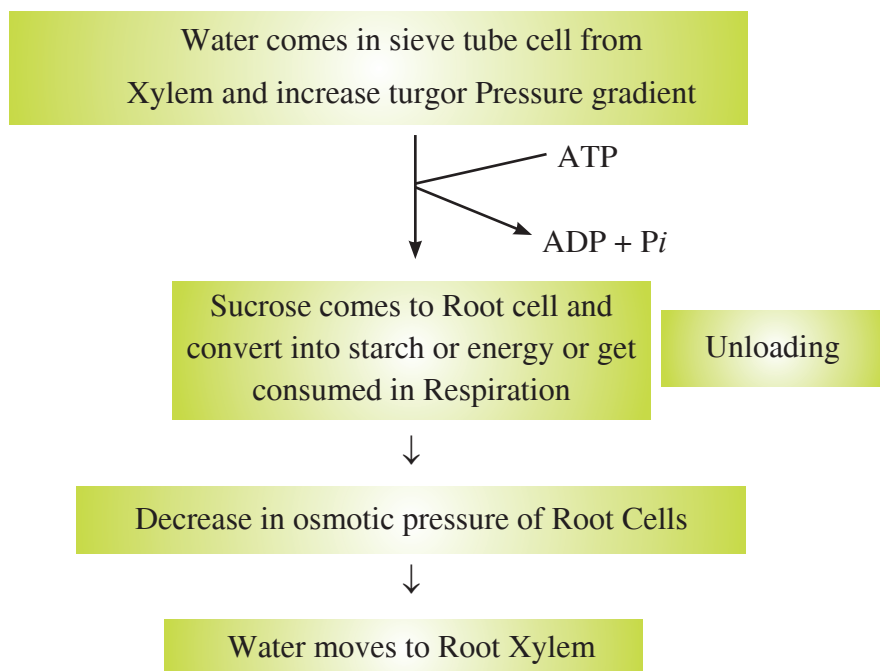
**Uptake and transport of mineral nutrients**—Ions are absorbed by the roots by passive and active transport. The active uptake of ions requires ATP energy. Specific proteins in membranes of root hair cells actively pump ions from the soil into the cytoplasm of epidermal cells and then xylem. The further transport of ions to all parts of the plant is carried through the water stream. Older dying leaves export much of their mineral content to younger leaves. Elements phosphorus, sulphur, nitrogen and potassium are most readily mobilised. Structural components such as calcium are not remobilised.

**Mass flow :** Mass flow is the movement of substances (water, minerals and food) in bulk from one point to another as a result of pressure differences between two points.

### The pressure or mass flow Hypothesis :







**Mycorrhiza**—A mycorrhiza is a symbiotic association of a fungus with a root system. The fungal hyphae absorb mineral ions (phosphorous) and water from the soil, and provide them to the roots of plant, in turn the roots provide sugars and nitrogen containing compounds to the mycorrhizae.

## Questions

### Very Short Answer Questions

(1 mark each)

1. Which part of the root is related with the absorption of water ?
2. What makes the raisins to swell up when kept in water ?
3. Casparian strip is made of a substance which is impervious to water. Name this substance.
4. What will happen to water potential when a solute is added to water ?
5. A plant cell when kept in a solution got plasmolysed. What was the nature of the solution.
6. Mention two ways of absorption of water by root hairs in plants.
7. Which form of sugar is transported through phloem ?
8. Give one example of imbibition.

9. A flowering plant is planted in an earthen pot and irrigated. Urea is added to make the plant grow faster, but after some time the plant dies. Give its possible reason.
10. Why is energy required to develop root pressure ?
11. Correct the statements :
  - (a) Imbibition is a special type of diffusion when water is absorbed by living cell.
  - (b) Most of water flow in the roots occurs via symplast.
  - (c) Cells shrink in hypotonic solution and swell in hypertonic solution.

### Short Answer Questions-I

(2 marks each)

12. A well watered potted herbaceous plant shows wilting in the afternoon of a dry sunny day. Give reason.
13. Do different species of plants growing in the same soil show the same rate of transpiration at a particular time ? Justify your answer.
14. What is casparian strip ? Write its significance in plants.
15. Xylem transport is unidirectional and phloem transport bi-directional why ?
16. How is transpiration different from guttation ? Give two points.
17. Suggest two methods to increase the life of cut plants in a vase.
18. Write the chemical composition of xylem and phloem sap.
19. Transpiration is a necessary evil in plants. Explain.

### Short Answer Questions-II

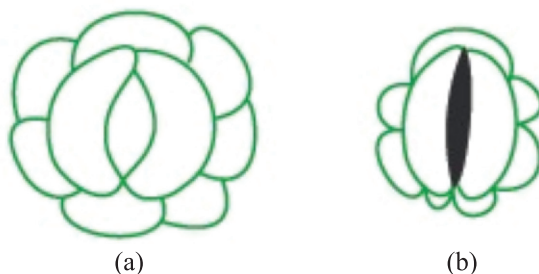
(3 marks each)

20. Why is solute potential always negative ? Explain.

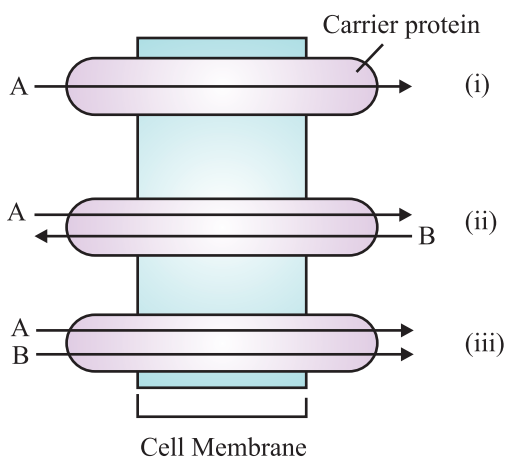
$$\Psi_w = \Psi_s + \Psi_p$$

21. Water has a very important role in sustaining the life list properties of water which make it useful for all biological processes on earth.
22. When any dry plant material or seeds is/are kept in water, they swell up.
  - (a) Name the phenomenon involved in this change.
  - (b) Define this phenomenon.
  - (c) Give two conditions essential for the phenomenon to occur.
23. Differentiate between temporary and permanent wilting. Do any of them indicate the water status of the soil ?

24. Observe the diagram and answer the following :



- (a) Which of these guard cells show a higher water content, A or B ?
  - (b) Are these types of guard cells found in monocots or dicots ?
  - (c) Name the element which play an important role in the opening and closing of stomata.
25. What is mycorrhiza ? How is the mycorrhizal association helpful in absorption of water and minerals in plants ?
26. Observe the given figure and give the answers of the following :
- (a) Identify the process occurring in (I), (II) and (III).
  - (b) Differentiate between the process II and III.
  - (c) How many types of aquaporins from the water channels in the cell membrane.



27. Give scientific term for the following statements/processes :

- (a) Movement of water in roots exclusively, through the cell wall
- (b) The positive hydrostatic pressure developed inside the cell or cell wall.
- (c) A solution having relatively less concentration.
- (d) Loss of water vapour from the aerial parts of the plants in the form of water vapours.

- (e) Movement of a molecule across a membrane independent of other molecule.
- (f) Water loss in its liquid phase through the special opening of veins near the tip of leaves of many herbaceous plants.

### Long Answer Questions

(5 marks each)

- 28. Minerals are present in the soil in sufficient amount. Do plants need to adjust the types of solutes that reach the xylem ? Which molecules help to adjust this ? How do plants regulate the type and quantity of solutes that reach xylem.
- 29. How do plants absorb water ? Explain transpiration pull model in this regard.
- 30. (a) Describe the pressure flow hypothesis of translocation of sugar in plants.  
(b) Explain the mechanism of closing and opening of stomata.

## Answers

### Very Short Answer

(1 mark each)

- 1. Root hairs.
- 2. Endosmosis.
- 3. Suberin
- 4. Water potential will decrease.
- 5. Hypertonic.
- 6. Apoplast and symplast pathway.
- 7. Sucrose.
- 8. Swelling of seed when put in water/moist soil.
- 9. Due to exosmosis *i.e.*, water comes out the plant.
- 10. Every activity requires energy. Root pressure develops due to activity of living cell.
- 11. (a) Osmosis is a special type, of diffusion when water is absorbed by living cells.  
(b) Most of the water flows in the roots occurs via the apoplast.  
(c) Cells shrink in hypertonic, solution and swell in a hypotonic solution.

### Short Answers-I

(2 marks each)

- 12. During noon, the rate of transpiration becomes higher than the rate of water absorption by plant. It causes loss of turgidity and leads to wilting.

13. Rate of transpiration is not same because transpiration is affected by numbers and distribution of stomata, and their opening.
14. Refer page 185, NCERT, Text Book of Biology for Class XI
15. Refer page 190, NCERT, Text Book of Biology for Class XI

16.	<b>Transpiration</b>	<b>Guttation</b>
	(i) Loss of water by a plant in form of vapours.	(i) The loss of water in the form of liquid droplets from the plant.
	(ii) Occurs through the general surface of leaves (stomata) and the young stems.	(ii) Occurs at the margins and the tips of the leaves.

17. (a) By adding cytokinin into water of the vase.
- (b) Preventing entry of air in the cut plants by immediately immersing the cut end in water.
18. Xylem Sap-Water, traces of all minerals.  
Phloem sap-5-10% sucrose, 1% amino acids, traces of bound mineral, hormones, other organic substances and rest is water.
19. Refer to 'Points of Remember' (Significance and disadvantages of Transpiration)

## Short Answers-II

(3 marks each)

20. Refer to 'Points of Remember'. (Solute Potential, Pressure Potential and Water potential)
21. Refer to 'Points of Remember', (Cohesion, Adhesion and surface tension)
22. (a) Imbibition.
- (b) Refer to 'Points to Remember.'
- (c) Condition necessary to imbibition.
  - (i) Water potential between the absorbent and the liquid imbibed.
  - (ii) Affinity between the adsorbent and the liquid imbibed.



23.	<b>Temporary wilting</b> (i) Plant recovers from temporary wilting after sometimes. (ii) Much damage is not caused. (iii) It commonly occurs during mid-day only.	<b>Permanent wilting</b> (i) Automatic recovery is not possible. It may recover if water is provided soon. (ii) Much damage is caused. (iii) It occurs throughout day and night.
-----	--	---

When wilting is permanent, water present in soil is largely unavailable form. The soil contains 10-15% water depending, upon its texture.

24. (a) A  
 (b) Dicots  
 (c)  $K^+$  (Potassium ions)
25. Refer points to remember.
26. (a) (i) Uniport (ii) Antiport (iii) Symport  
 (b) Refer 'Points to Remember'.  
 (c) 8 types of aquaporins.
27. (a) Apoplast pathway  
 (b) Turgor pressure  
 (c) Hypotonic  
 (d) Transpiration  
 (e) Uniport  
 (f) Guttation

## Long Answers

(5 marks each)

28. Refer page 189, NCERT, Text Book of Biology for Class XI.
29. Refer page 186-187, NCERT, Text Book of Biology for Class XI.
30. (a) Refer points to remember.  
 (b) Refer page 191, NCERT, Text Book of Biology for Class XI.

## Assertion Reasoning

The following question consists of 2 statements- Assertion (A) and Reason (R).

Answer the question by selecting the appropriate option below :

31. **Assertion (A)** : Facilitated diffusion occurs due to channel proteins.

**Reason (R)** : The proteins are of extrinsic type.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) The assertion is true but the reason is false
  - (c) Both the assertion and reason are false
  - (d) The assertion is false but the reason is true
32. **Assertion (A)** : Transpiration is considered as a necessary evil.

**Reason (R)** : Ascent of sap occurs due to three physical properties of water

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both the assertion and reason are true but the reason is not a correct
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false

## SOLUTIONS

### Assertion Reasoning

31. (b)  
32. (b)

### Source-based/Case-based/Passage-based/Integrated Assessment questions

Read the following and answer any four questions from (i) to (v) given below :

33. Translocation in plants occurs by mass flow. This was a hypothesis first given by Munch and then was elaborated by Crafts. According to this theory, organic solutes are translocated 'en masse' through the sieve tubes from the source to the sink. The hypothesis fails to explain the bidirectional movement of metabolites which is common in plants. Munch and Crafts could not explain how osmotic pressure is maintained in and balanced in mesophyll cells and that of root hair. This hypothesis placed sieve tube and protoplasm in a secondary role of mass flow whereas xylem and movement of water plays important role in maintaining turgor pressure for the mass flow. Turgor

pressure gradient is established across the protoplasm between the cells of the source and the cells of the sink.

- (i) What are the source and sink referred to?
- (ii) Why does water move from the xylem into the lumen of sieve tubes and causes turgor pressure gradient?
- (iii) The movement of sugars at the sink is removed by \_\_\_\_\_ (active/passive transport). Choose the correct option.
- (iv) Food prepared in leaves is moved from higher concentration to lower concentration. (T/F).
- (v) Bidirectional movement occurs in which part of the transporting tissue(s) present in plants?

## SOLUTIONS

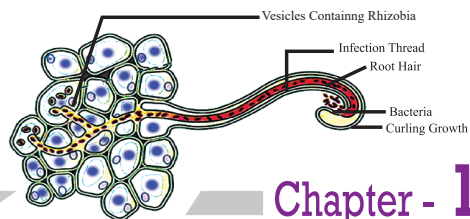
### Source-based/Case-based/Passage-based/Integrated Assessment questions

#### 33. Solution

- (i) Source is leaves, sink is the storage organs such fruits, or other parts of the plant.
- (ii) As the solute concentration increase, the water from xylem moves into the lumen of sieve tubes due to osmosis and causes turgor pressure gradient.
- (iii) Active transport
- (iv) True
- (v) Phloem







## Chapter - 12

# Mineral Nutrition

### Based on functions :-

- Components of bio molecules of C, H, O, N
- components of energy related chemicals e.g. Mg, P
- Activator/Inhibitor of enzymes e.g.  $Zn^{2+}$ , Mo
- Alter osmotic potential of cell e.g. K, Na, Cl

### Types of essential elements :- (based on quantity)

**Macronutrients** :- Present in plant tissue in excess of 10 mole/kg of dry matter. e.g. C, H, O, N, P, S, K, Ca, Mg

#### **Micronutrients** :-

Present in plant tissue less than 10 mole/kg of dry matter. e.g. Fe, Mn, Cu, Mo, Zn, B, Cl, Ni

### Criteria for Essentiality :-

- must be absolutely necessary for supporting normal growth and reproduction.
- requirement must be specific, not replaceable.
- must be directly involved in metabolism of the plant.
- ★ There are 17 essential elements.

## MINERAL NUTRITION

### Deficiency symptoms :-

**Chlorosis** :- Loss of chlorophyll, caused by deficiency of N, Mg, S, Fe, Mn, Zn & Mo

**Necrosis** :- Death of tissue caused by deficiency of Ca, Mg, Cu, K

**Initiating of cell division** :- Plays major role of N, K, S, Mo.

#### **Delay flowering** :

Caused by deficiency of N, S, Mo.

### Toxicity of micro-nutrients :-

Moderate increase in micro-nutrient. Causes toxicity e.g. Mn toxicity causes appearance of brown spots surrounded by chlorotic veins. Excess Mn induce deficiency of Fe, Mg, Ca.

### Minerals are absorbed as ions :-

- Nitrogen as  $NO_3^-/NO_2^-/NH_4^+$
- Phosphorous as  $H_2PO_4^-/HPO_4^{2-}$
- Potassium as  $K^+$
- Calcium as  $Ca^{2+}$
- Magnesium as  $Mg^{2+}$
- Sulphur as  $SO_4^{2-}$
- Iron as  $Fe^{3+}$
- Manganese as  $Mn^{2+}$
- Zinc as  $Zn^{2+}$
- Copper as  $Cu^{2+}$
- Boron as  $Bo_3^{3-}$  or  $B_4O_7^{2-}$
- Molybdenum as  $MoO_4^{2-}$
- Chlorine as  $Cl^-$

## Points To Remember

**Autotroph :** An organism that synthesizes its required nutrients (organic components) from simple and inorganic substance; Example—plants, blue green algae (cyanobacteria)

**Heterotroph :** An organism that cannot synthesise its own nutrients and depend on others. Example—Bacteria, protists, members of animalia.

**Biological nitrogen fixation:** Conversion of atmospheric nitrogen into organic compounds by living organisms.

**Chlorosis :** Yellowing of leaves due to loss of chlorophyll.

**Nitrification :** Conversion of ammonia ( $\text{NH}_3$ ) into nitrite and then to nitrate.

**Denitrification :** A process of conversion of nitrate into nitrous oxide and nitrogen gas ( $\text{N}_2$ ).

**Leg-hemoglobin :** Pinkish pigment found in the root nodules of legumes. It acts as oxygen scavenger and protects the nitrogenase enzyme from oxidation.

**Flux :** The movement of ions is called flux. Influx is inward movement of ions into the cells and efflux is the outward movement of ions.

**Inhibition of cell division :** Deficiency of N, K, S. and Mo.

**Necrosis :** Death of tissues particularly leaf tissue due to deficiency of Ca, Mg, Cu, K.

**Delayed Flowering :** due to deficiency of N, S, Mo.

**Mineral Nutrition :** Plants require mineral elements for their growth and development. The utilization of various absorbed ions by a plant for growth and development is called mineral nutrition of the plant.

**Hydroponics :** Soil-less culture of plants, where roots are immersed in nutrient solution (without soil) is called hydroponics. The result obtained from hydroponics may be used to determine deficiency symptoms of essential elements.

**Active Transport :** Absorption occurring at the expense of metabolic energy.

**Passive Transport :** Absorption of minerals with concentration gradient by the process of diffusion without the expense of metabolic energy.

## Essential Elements

Macronutrients	Micro-nutrients
Macronutrients are present in plant tissues in concentrations of more than 10 m mole $\text{Kg}^{-1}$ of dry matter. C, H, O, N, P, K, S, Ca, Mg	Micro-nutrients are needed in very low amounts : less than 10 m mole $\text{Kg}^{-1}$ matter. Fe, Mn, Cu, Mo, Zn, B, Cl, Ni

In addition to the 17 essential elements, Na, Si, Co and Si are required by some higher plants.

### Criteria for essentiality :

1. The element must be necessary for supporting normal growth and reproduction.
2. Requirement must be specific and not replaceable by another element.
3. The element must be directly involved in the metabolism of the plant.

### Role of Minerals Elements in Plants

#### MACRO NUTRIENTS

Element	Obtained as	Functions	Deficiency symptoms
Nitrogen (N)	Mainly as $\text{NO}_3^-$ some as $\text{NO}_2^-$ or $\text{NH}_4^+$	Constituent of proteins, nucleic acids, vitamins and hormones.	Stunted growth Chlorosis, dormancy of causal buds.
Phosphorus (P)	Phosphate ions ( $\text{H}_2\text{PO}_4^-$ or $\text{HPO}_4^{2-}$ )	Constituent of cell membrane. Required for the synthesis of nucleic acids, nucleotides, ATP NAD and NADP for phosphorylation reactions.	Poor growth of plant.  Leaves dull green, delay in seed germination purple or red spots on leaves, premature leaf fall.

Potassium (K)	$K^+$	Helps to maintain an anion-cation balance in cells. Involved in protein synthesis, in opening and closing of stomata; activation of enzymes; maintenance of turgidity of cells.	Stunted growth; yellow leaves edges of leaves; mottled appearance of leaves. Premature death.
Calcium (Ca)	$Ca^{2+}$	Required in formation of mitotic spindle; involved in normal functioning of cell membranes; activates certain enzymes; as calcium pectate in middle lamella of the cell wall.	Stunted growth, chlorosis of young leaves.
Magnesium (Mg)	$Mg^{2+}$	Activates enzymes in phosphate metabolism, constituent of chlorophyll; maintains ribosome structure.	Chlorosis between the leaf veins, necrosis, purple colours spots on older leaves.
Sulphur (S)	$SO_4^{2-}$	Constituent of two amino-acids-Cysteine and methionine and proteins, coenzymes, vitamins and ferredoxin.	Chlorosis of younger leaves, stunted growth

### MICRO NUTRIENTS

Element	Obtained as	Functions	Deficiency symptoms
Iron (Fe)	$Fe^{3+}$	Constituent of Ferredoxin and cytochrome; needed for synthesis of chlorophyll.	Chlorosis of leaves
Manganese (Mn)	$Mn^{2+}$	Activates certain enzymes involved in photosynthesis, respiration and nitrogen metabolism.	Chlorosis, grey spots on leaves.

Zinc (Zn)	$\text{Zn}^{2+}$	Activates various enzymes like carboxylases. Required for synthesis of auxins.	Malformation of leaves
Copper (Cu)	$\text{Cu}^{2+}$	Activates certain enzymes. Essential for overall metabolism	Stunted growth, inter-veinal chlorosis in leaves. Necrosis of the tip of young leaves, die back of shoot.
Boron (B)	$\text{BO}_3^{3-}$ , $\text{B}_4\text{O}_7^{2-}$	Required for uptake of water and Ca, for membrane functioning, pollen germination, cell elongation carbohydrate translocation.	Death of stem and root apex, loss of a foical dominance, abscission of flowers, small size of fruits
Molybdenum (Mo)	$\text{MoO}_4^{2-}$ (molybdate ions)	Activates certain metabolism.	Nitrogen deficiency inter-veinal chlorosis retardation of growth
Chlorine (Cl)	$\text{Cl}^-$	Maintains solute concentration along with $\text{Na}^+$ & $\text{K}^+$ ; maintain anion-cation balance in cells; essential for oxygen evolution in photosynthesis.	Wilted leaves; stunted root growth and reduced fruiting.

**Critical Concentration :** The concentration of the essential element below which plant growth is retarded. The element is said to be deficient when present below the critical concentration.

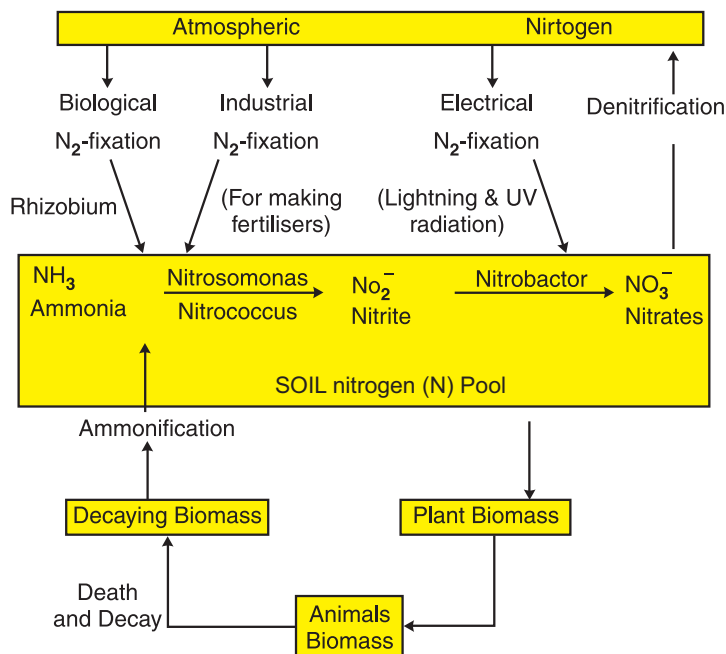
**Deficiency symptoms :** Chlorosis, necrosis, stunted growth, premature fall of leaves and buds and inhibition of cell division.

**Toxicity of micronutrient :** Any mineral ion concentration in tissues that reduces the dry weight of tissues by 10% is considered toxic. Toxicity of one element may lead to deficiency of other element since the former may inhibit the uptake of latter., e.g., Mn competes with Fe, Mg for uptake and also inhibits Ca translocation to shoot apex. Therefore Mn toxicity symptoms are actually same as deficiency symptoms of Fe, Mg and Ca.

## Role of microbes in nitrogen cycle :

- *Rhizobium*, *Azotobacter*, *Rhodospirillum*; Fix atmospheric nitrogen
- *Nitrosomonas* and/or *Nitrococcus* :—Conversion of ammonia to nitrite
- *Nitrobacter* : Conversion of nitrite into nitrate.
- *Pseudomonas* and *Thiobacillus* : reduce nitrate into nitrogen.

### Nitrogen Cycle:



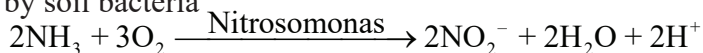
## Nitrogen Cycle

**Nitrogen fixation**—The process of conversion of Nitrogen (N<sub>2</sub>) into ammonia (NH<sub>3</sub>).

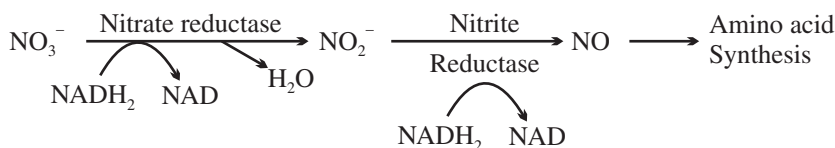
**Ammonification**—The process of decomposition of organic nitrogen of plants and animals (proteins) into ammonia.



**Nitrification**—The ammonia so formed may volatilise and re-enter the atmosphere, or some of the ammonia may be converted first into nitrite and then into nitrate by soil bacteria



The Nitrate so formed can be easily absorbed by the plants and transported to leaves. In leaves, nitrate is reduced to ammonia to form amino-acids, because nitrate can not be used by plants as such.



**Denitrification**—Process of reduction of the nitrate present in soil to nitrogen. It is carried out by bacteria like *Pseudomonas* and *Thiobacillus*.

**Biological Nitrogen Fixation**—Reduction of nitrogen to ammonia by living organisms. Certain prokaryotes are able to fix nitrogen because of presence of ‘nitrogenase’ enzyme in them.

### Nitrogen fixing microbes may be

- (a) Free living—(i) Aerobic—*Azotobacter*  
(ii) Anaerobic—*Rhodospirillum*
- (b) Cyanobacteria—*Nostoc*, *Anabaena*
- (c) Symbiotic—(i) With leguminous plants—*Rhizobium*  
(ii) With non-leguminous plants—*Frankia*

**Enzyme nitrogenase**—The enzyme nitrogenase is Mo-Fe protein and catalysis the conversion of atmospheric nitrogen to ammonia (First stable product of nitrogen fixation)

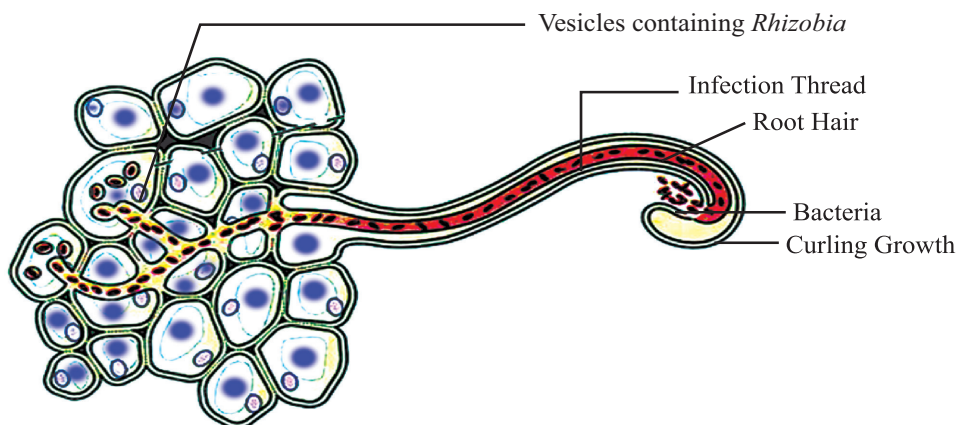
**Leg-hemoglobin**—A pink colour pigment, similar to hemoglobin of vertebrates and functions as an oxygen scavenger and protects nitrogenase from oxygen.

### Steps of nodule formation :

- (a) *Rhizobium* bacteria present in soil contact a susceptible root hair.
- (b) Infection of the root hair cause it to curve and deformed due to chemical secretion.
- (c) An infection thread is produced carrying the bacteria into the cortex of the root.
- (d) The bacteria get modified into rod-shaped bacteria and cause inner cortical and pericycle cells to divide plant produce cytokinin and auxin to stimulate cell division and enlarge to form nodules.



- (e) Division and growth of cortical and pericycle cells lead to nodule formation.

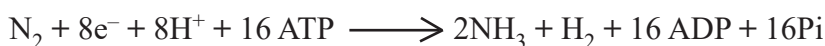


Nodule Formation in Roots of Leguminous Plants

## Mechanisms of $N_2$ fixation

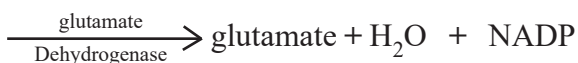
It requires 4 components—

- A strong reducing agent like  $FADH_2$ ,  $NADPH_2$
- Nitrogenase enzyme
- ATP (as energy service)
- Nitrogen gas molecule (as substrate)



**Fate of Ammonia :-** At physiological pH, the ammonia is protonated to form  $NH_4^+$ , which is quite toxic to plants and hence can not accumulate in them. It is used by plants in following ways—

- Reductive amination :-**  $\alpha$  – ketoglutaric acid +  $NH_4^+$  + NADP



- Transamination :-** Transfer of amino group from one amino acid to the keto group of a keto acid to form amino acid with the help of enzyme transaminase.
- Formation of Amides :-** The hydroxyl part of the acid is replaced by another amino radical to form amides. e.g. asparagine and glutamine are formed from aspartic acid and glutamic acid.



## Questions

### Very Short Answer Questions

(1 mark each)

1. Name one symbiotic nitrogen-fixing bacteria.
2. Give two examples of photosynthetic microorganisms, which also fix atmospheric nitrogen.
3. Name two organisms each which fix nitrogen *symbiotically* and *asymbiotically*.
4. Which substance impart pink colour to the root nodule of a leguminous plant and also mention its role ?
5. What is the term used for mineral deficiency symptom in plants in which leaves become yellow in different pattern ?
6. Define hydroponics.
7. Give the name of an insectivorous angiosperm plant.
8. Give the name of one non-symbiotic nitrogen fixing prokaryote.
9. Name the green house gas produced in rice fields.
10. Name the element which is essential for the photolysis of water during photosynthesis.
11. Why do deficiency symptoms appear in older leaves first?

### Short Answer Questions-I

(2 marks each)

12. Differentiate between two types of absorption of minerals in plants from soil.
13. Name the following :
  - (a) Bacteria which converts ammonia into nitrite.
  - (b) Bacteria which oxidises nitrite into nitrate.
14. How does Leghemoglobin protect the enzyme nitrogenase ?
15. Name the enzyme found in root modules for  $N_2$  fixation ? Name the pink coloured pigment required for its functioning.

## Short Answer Questions-II

(3 marks each)

16. Write the deficiency symptoms of the following three elements :
  - (a) Phosphorus
  - (b) Magnesium
  - (c) Potassium
17. Describe the following three deficiency symptoms and co-relate them with concerned mineral deficiency :
  - (a) Phosphorus
  - (b) Magnesium
  - (c) Potassium
18. Explain in brief the steps involved in biological nitrogen fixation.
19. Describe the two main processes of synthesis of amino acids from Ammonium ion ( $\text{NH}_4^+$ ) in plants.
20. Define critical concentration, also mention four deficiency symptoms of nutrients in plants.
21. Write a short note on toxicity of micronutrient. Give an example which show toxicity of one element may lead to deficiency of other element.

## Long Answers

(5 marks each)

22. Describe all the steps of nitrogen cycle in nature.
23. Describe with diagrams how root nodules are formed in leguminous plants.
24. Explain adaptations in leguminous root nodules for  $\text{N}_2$  fixation.

## Answers

## Very Short Answers

(1 mark each)

1. *Rhizobium*
2. *Anabaena*, *Nostoc*
3. **Asymbiotically**-*Azotobacter*, *Bacillus polymyxa* **Symbiotically**-*Rhizobium*, *Anabaena*.
4. Leghemoglobin. It is an oxygen scavenger, which protects the enzyme nitrogenase.

5. Necrosis.
6. The technique of growing plants in a nutrient solution without soil is called hydroponics.
7. *Nepenthes* (Pitcher plant)
8. *Azotobacter*
9. Methane (CH<sub>4</sub>)
10. Calcium
11. It happens because the elements are mobilized to the younger parts of the plant from older leaves.

### Short Answers-I

(2 marks each)

12. Refer to NCERT Book, Page no. 200 (12.3).
13. (i) Nitrifying Bacteria—*Nitrosomonas*.  
(ii) Nitrifying Bacteria—*Nitrobacter*
14. Refer to page no. 203.
15. Enzyme-Nitrogenase  
Pink coloured pigment-Leghaemoglobin

### Short Answers-II

(3 marks each)

16. Refer to 'Points to Remember'.
17. Refer to 'Points to Remember'.
18. Refer to 'Points to Remember'.
19. Refer to 'Points to Remember' (Fate of Ammonia)
20. Refer to 'Points to Remember'.
21. Refer to 'Points to Remember'.

### Long Answers

(5 marks each)

22. Refer to 'Points to Remember'.
23. Refer to 'Points to Remember'.
24. Refer to NCERT Book Page No. 203.

## Assertion Reasoning

(1 mark each)

The following question consists of 2 statements - Assertion (A) and Reason (R). Answer the question by selecting the appropriate option below :

25. **Assertion (A) :** Leguminous plants are grown alternatively with grain crops to replenish nitrogen in the soil.

**Reason (R) :** Rhizobium is a symbiotic bacterium that can fix nitrogen while living in the roots of leguminous plants

- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) The assertion is true but the reason is false
  - (c) Both the assertion and reason are false
  - (d) The assertion is false but the reason is true
26. **Assertion (A) :** If any mineral concentration in tissues that reduces the dry weight of tissues by about 10 percent is considered toxic.

**Reason (R) :** It is difficult to analyse the symptoms of mineral toxicity

- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) Both A and R are true and the reason is not a correct explanation of the assertion
  - (c) The assertion is true but the reason is false
  - (d) Both the assertion and reason are false
  - (e) The assertion is false but the reason is true
27. **Assertion (A) :** Calcium is required by meristematic and differentiating tissues.

**Reason (R) :** It is essential for the formation of the mitotic spindle and cell wall formation.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

28. **Assertion (A)** : Hydroponic is a soil-less method to grow plants.  
**Reason (R)** : Commercial production of vegetable such as tomato, seedless cucumber and lettuce is done only with the help of hydroponics.
- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) Both A and R are true and the reason is not a correct explanation of the assertion
  - (c) The assertion is true but the reason is false
  - (d) Both the assertion and reason are false
  - (e) The assertion is false but the reason is true
29. **Assertion (A)** : Influx of nutrients always occurs via facilitated diffusion.  
**Reason (R)** : Energy is always required when there is an influx.
- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) Both A and R are true and the reason is not a correct explanation of the assertion
  - (c) The assertion is true but the reason is false
  - (d) Both the assertion and reason are false
  - (e) The assertion is false but the reason is true

## Solution

### Assertion Reasoning

- 25. (a)
- 26. (b)
- 27. (a)
- 28. (c)
- 29. (d)

### Source-based/Case-based/Passage-based/Integrated assessment questions (4 marks each)

Read the following and answer any four questions from (i) to (v) given below :

30. Soil is the reservoir of nutrients and the properties of soil depend upon the type of minerals present. In addition to essential mineral elements, there are some other minerals too that are grouped according to their biochemical behaviour and physiological functions in plants metabolism. Biogeochemical cycles replenish mineral nutrients in the soil. One of such important nutrients

is nitrogen, plants cannot use nitrogen directly from the atmosphere. many microbes play an important role in the absorption and recycling of nitrogen in an ecosystem. As plants use minerals, the soil becomes deficient in some nutrients. They are either added artificially or are enhanced using biofertilizers. These biofertilizers help plants to absorb certain minerals either symbiotically or non-symbiotically.

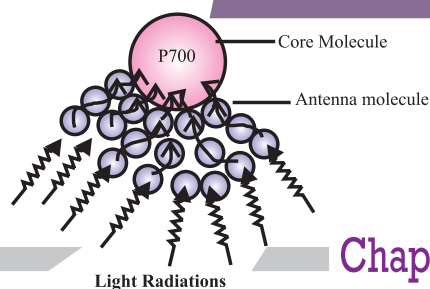
- (i) Which of the following is a micronutrient?
  - (a) Carbon
  - (b) Nitrogen
  - (c) Iron
  - (d) Oxygen
- (ii) What will happen if one of the micronutrients is available in the plant in excess?
- (iii) In which of the following forms nitrogen is absorbed by the plants?
  - (a) Nitrates and dimeric nitrogen
  - (b) Nitrates and nitrites
  - (c) Nitrites and ammonia
  - (d) Dimeric nitrogen and ammonia
- (iv) Name any two symbiotic nitrogen-fixing microbes.
- (v) Deficiency of \_\_\_\_\_ leads to premature fall of leaves and they turn dark green in colour.
  - (a) Phosphorous
  - (b) Iron
  - (c) Nitrogen
  - (d) Potassium

## Solution

### Source-based/Case-based/Passage-based/Integrated assessment questions

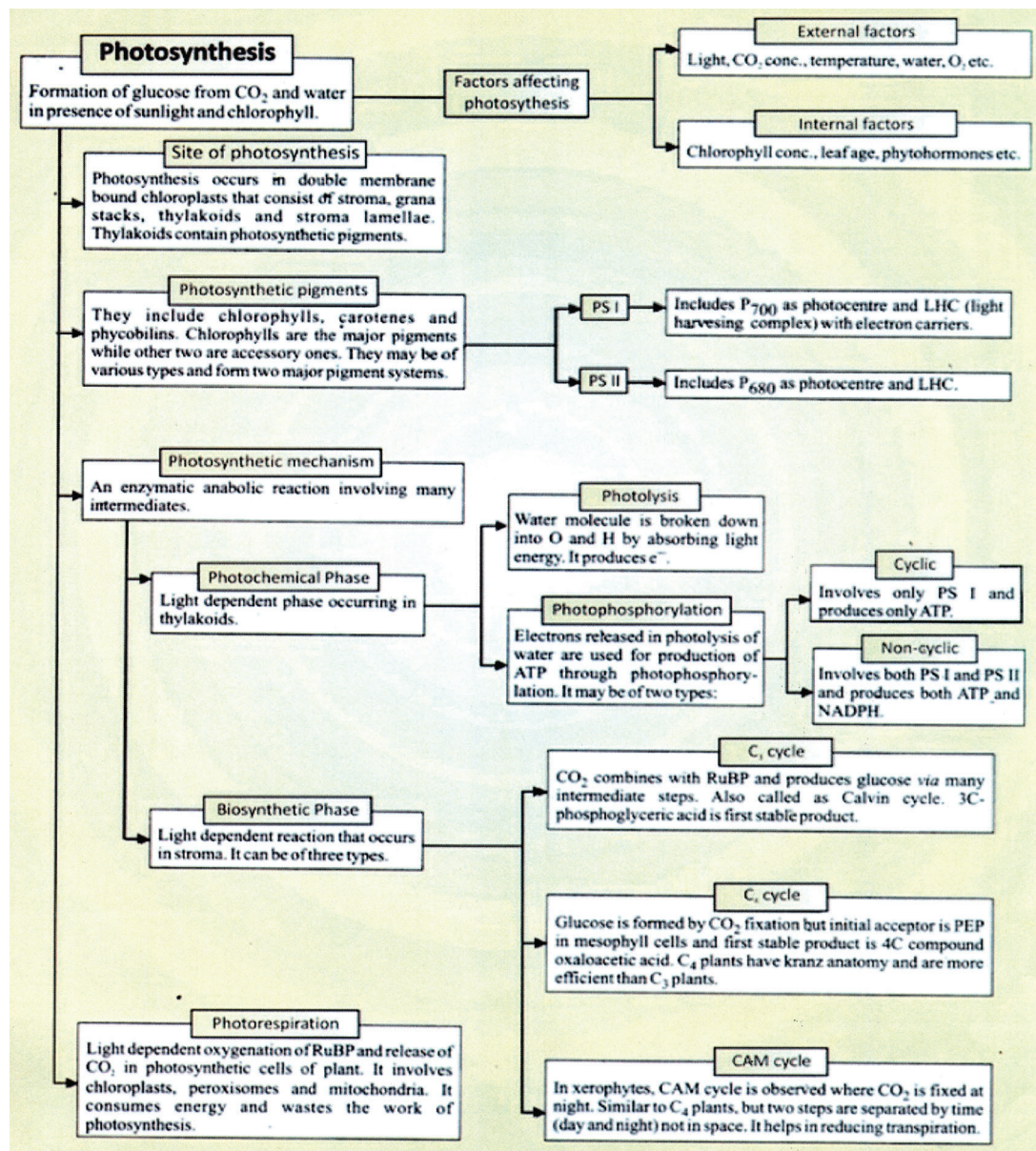
- (i) (c) Iron
- (ii) It will cause mineral toxicity and will interfere with the metabolism of other micronutrients.
- (iii) (b) Nitrates and nitrites
- (iv) *Frankia*, *Rhizobium*
- (v) Phosphorous





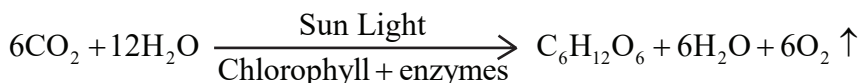
## Chapter - 13

# Photosynthesis in Higher Plants



## Points To Remember

**Photosynthesis** : Photosynthesis is an enzyme regulated anabolic process to manufacture organic compounds inside the chlorophyll containing cells from carbon dioxide and water with the help of sunlight as a source of energy.



## Historical Perspective

**Josheph Priestley (1770)** : Showed that plants have the ability to take up  $\text{CO}_2$  from atmosphere and release  $\text{O}_2$ . (Candle with bell jar and mouse expt.)

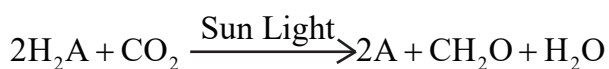
**Jan Ingenhousz (1779)** : Release of  $\text{O}_2$  by plants was possible only in sunlight and only by the green parts of plants. (Expt. with aquatic plant in light & dark)

**Theodore de Saussure (1804)** : Water is an essential requirement for photosynthesis to occur.

**Julius Von Sachs (1854)** : Green parts in plant produce glucose which is stored as starch.

**T.W. Engelmann (1888)** : The effect of different wavelength of light on photosynthesis and plotted the first action spectrum of photosynthesis.

**C.B. Van Niel (1931)** : Photosynthesis is essentially a light dependent reaction in which hydrogen from an oxidisable compound reduces  $\text{CO}_2$  to form sugar. He gave a simplified chemical equation of photosynthesis.



**Hill (1937)** : Evolution of oxygen occurs in light reaction.

**Calvin (1954-55)** : Traced the pathway of carbon fixation.

**Hatch. and Slack (1965)** : Discovered  $\text{C}_4$  pathway of  $\text{CO}_2$  fixation.

**Site for photosynthesis** : Photosynthesis takes place only in green parts of the plant, mostly in leaves. Within a leaf, photosynthesis occurs in mesophyll cells which contain the chloroplasts. Chloroplasts are the actual sites for photosynthesis. The thylakoids in chloroplast contain most of pigments required for capturing solar energy to initiate photosynthesis : The membrane system (grana) is responsible for trapping the light energy and for the synthesis of ATP and NADPH. Biosynthetic phase (dark reaction) is carried in stroma.



**Importance of Photosynthesis**—(1) Synthesis of organic compounds (2) Change of radiant energy into chemical energy (3) Useful products are obtained from plants gums, oils timber fire wood, resins rubber, fibers and drugs, etc. (4) Balance the percentage of  $O_2$  and  $CO_2$  in atmosphere (5) Fossil fuels like coal, natural gas and petroleum have been formed inside the earth indirectly as a product of photosynthesis.

### Pigments involved in photosynthesis :

**Chlorophyll a** : (Bright or blue green in chromatograph). Major pigment, act as reaction centre, involved in trapping and converting light into chemical energy. It is called universal photo-synthetic pigment.

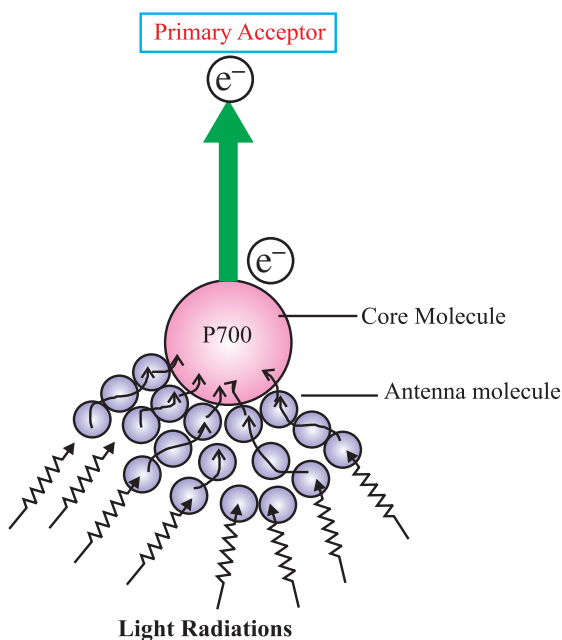
**Chlorophyll b** : (Yellow green)

**Xanthophylls** : (Yellow)

**Carotenoids** : (Yellow to yellow-orange)

- In the blue and red regions of spectrum shows higher rate of photosynthesis.

**Light Harvesting Complexes (LHC)** : The light harvesting complexes are made up of hundreds of pigment molecules bound to protein within the photosystem I (PS-I) and photosystem II (PS-II). Each photosystem has all the pigments (except one molecule of chlorophyll 'a') forming a light harvesting system (antennae). The reaction centre (chlorophyll a) is different in both the photosystems.



Light Harvesting Complex

**Photosystem I (PS-I) :** Chlorophyll 'a' has an absorption peak at 700 nm (P700).

**Photosystem II (PS-II) :** Chlorophyll 'a' has absorption peak at 680 nm (P680),

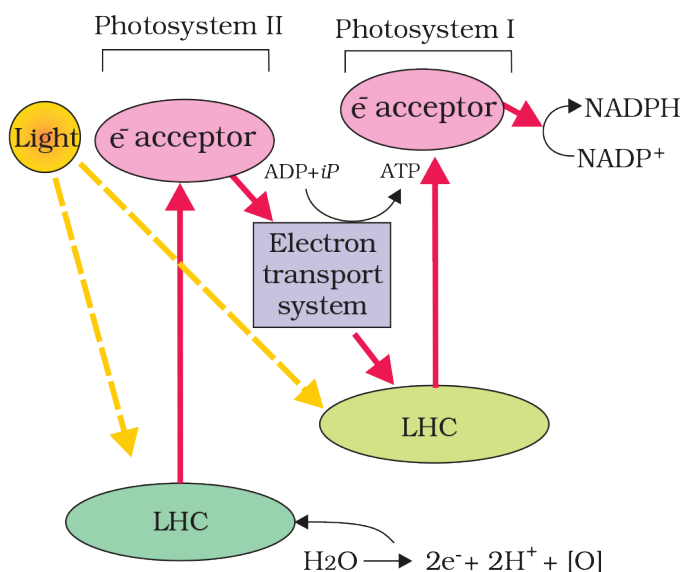
**Process of photosynthesis :** It includes two phases-Photochemical phase and biosynthetic phase. (Formerly known as Light reaction and dark reaction)

(i) **Photochemical phase (Light reaction) :** This phase includes-light absorption, splitting of water, oxygen release and formation of ATP and NADPH. It occurs in grana region of chloroplast.

(ii) **Biosynthetic phase (Dark reaction) :** It is light independent phase, synthesis of food material (sugars). (Calvin cycle). It occurs in stroma region of chloroplast.

**Photophosphorylation :** The process of formation of high-energy chemicals (ATP and NADPH) in presence of light.

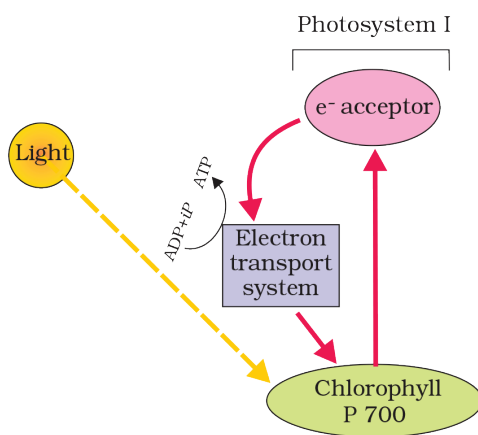
**Non-Cyclic photophosphorylation :** Two photosystems work in series—First PSII and then PSI. These two photosystems are connected through an electron transport chain (Z. Scheme). Both ATP and NADPH + H<sup>+</sup> are synthesised by this process. PSI and PSII are found in lamellae of grana, hence this process is carried here.



**Figure 13.5** Z scheme of light reaction

**The electron transport (Z-Scheme) :** In PS II, reaction centre (chlorophyll a) absorbs 680 nm wavelength of red light which make the electrons to become excited. These electrons are taken up by the electron acceptor that passes them to an electron transport system (ETS) consisting of cytochromes. The movement of electron is down hill. Then, the electron pass to PS I and move down hill further to  $\text{NADP}^+$ .  $\text{NADP}^+$  is then reduced to  $\text{NADPH} + \text{H}^+$ .

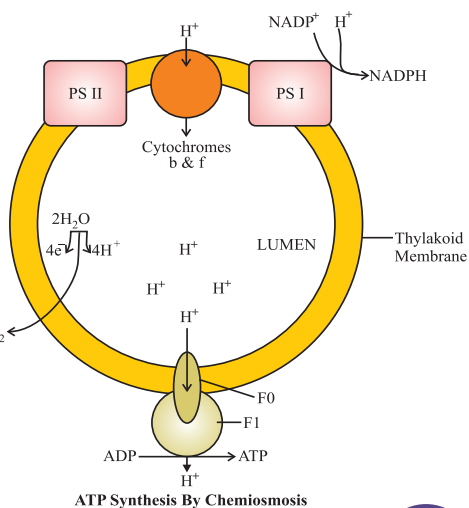
**The splitting of water :** It is linked to PS II. Water splits into  $\text{H}^+$ ,  $[\text{O}]$  and electrons.  $2\text{H}_2\text{O} \longrightarrow 4\text{H}^+ + \text{O}_2 + 4\text{e}^-$

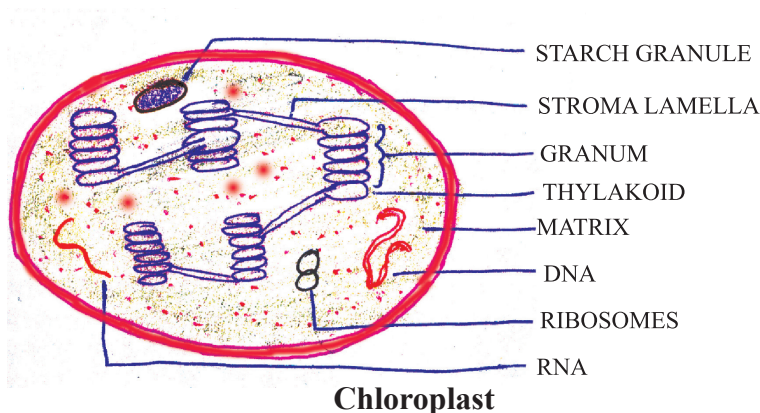


**Figure 13.6** Cyclic photophosphorylation

**Cyclic photophosphorylation :** Only PS-I works, the electron circulates within the photosystem. It happens in the stroma lamellae (possible location) because in this region PSII and NADP reductase enzyme are absent. Hence only ATP molecules are synthesised. It occurs when only light of wavelengths beyond 680 nm are available for excitation.

**Chemiosmotic Hypothesis :** Chemiosmotic hypothesis explain the mechanism of ATP synthesis in chloroplast. In photosynthesis, ATP synthesis is linked to development of a proton gradient across a membrane. The protons are accumulated inside of membrane of thylakoids (in lumen). ATPase enzyme has a channel of that allow diffusion of protons back across the membrane. This release energy to activate ATPase enzyme that catalyses the formation of ATP.





## Biosynthesis phase in $C_3$ plants :

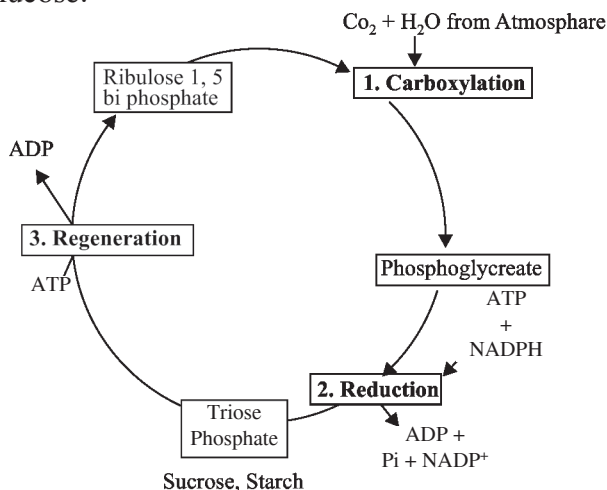
ATP and NADPH, the products of light reaction are used in synthesis of food. The first  $CO_2$  fixation product in  $C_3$  plant is 3-phosphoglyceric acid or PGA. The  $CO_2$  acceptor molecule is RuBP (ribulose biphosphate). The cyclic path of sugar formation is called Calvin cycle on the name of Melvin Calvin, the discover of this pathway. **Calvin cycle** proceeds in three stages.

**(1) Carboxylation :**  $CO_2$  combines with ribulose 1, 5-bisphosphate to form 3 PGA in the presence of RuBisCo enzyme (present in stroma)

**(2) Reduction :** Carbohydrate is formed at the expense of ATP and NADPH. It involves 2ATP for phosphorylation and 2NADPH for reduction per  $CO_2$  molecule fixed.

**(3) Regeneration :** The  $CO_2$  acceptor ribulose 1, 5-bisphosphate is formed again.

6 turns of Calvin cycles and 18 ATP molecules are required to synthesize one molecule of glucose.

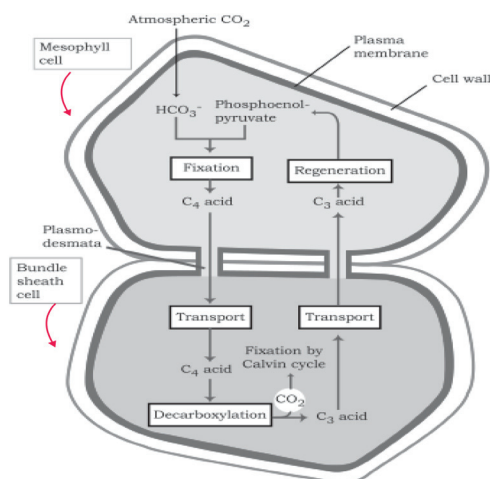




Input	Output
$6\text{CO}_2$	One Glucose
18 ATP	18 ADP
18NADPH	12 NADP

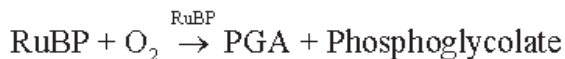
**The C<sub>4</sub> pathway :** C<sub>4</sub> plants such as maize, sorghum, sugarcane have a four carbon compound special type, of leaf anatomy, they tolerate higher temperatures. In this pathway, oxaloacetic acid (OAA) is the first stable product formed. It is 4 carbon atoms compound, hence called C<sub>4</sub> pathway (Hatch and Slack Cycle). The leaf has two types of cells : mesophyll cells and bundle sheath cells (Kranz anatomy). Initially CO<sub>2</sub> is taken up by phosphoenol pyruvate (PEP) in mesophyll cell and changed to oxaloacetic acid (OAA) in the presence of PEP carboxylase. Oxaloacetate is reduced to maltate/aspartate that reach into bundle sheath cells.

The decarboxylation of maltate/aspartate occurs with the release of CO<sub>2</sub> and formation of pyruvate (3C). In high CO<sub>2</sub> concentration RuBisCO behaves as carboxylase and not as oxygenase, hence the photosynthetic losses are prevented. RuBP operates now under Calvin cycle and pyruvate transported back to mesophyll cells and changed into phosphoenol pyruvate (PEP) to keep the cycle continue.



**Figure 13.9** diagrammatic representation of the Hatch and Slack Pathway

**Photorespiration :** The light induced respiration in green plants is called photorespiration. In C<sub>3</sub> plants some O<sub>2</sub> binds with RuBisCO and hence CO<sub>2</sub> fixation is decreased. In this process RuBP instead of being converted to 2 molecules of PGA binds with O<sub>2</sub> to form one molecule of PGA and phosphoglycolate.



There is neither synthesis of ATP nor  $\text{NADPH}_2$  or sugar. Rather it results in release of  $\text{CO}_2$  with utilisation of ATP. The biological function of photorespiration is not known yet.

## **C<sub>4</sub> Plants :**

- (1) Lack Photorespiration
- (2) Show response to high light intensities
- (3) Have greater productivity of biomass.

## **Adaptations in C<sub>4</sub> Plants :**

- (i) Kranz Anatomy
- (ii) Occurrence of two types of cells
- (iii) Dimorphic chloroplast
- (iv) Presence of RuBisCO in Bundle Sheath cells and PEPcase in mesophyll cells.
- (v) Mechanism to increase  $\text{CO}_2$  concentration near RuBisCO in Bundle Sheath cells.

**CAM (Crassulacean Acid Metabolism)** Plants—Stomata open at night. *e.g.*, Cacti, Bryophyllum, Pineapple.

**Law of Limiting Factors :** If a chemical process is affected by more than one factor, then its rate will be determined by the factor which is nearest to its minimal value. It is the factor which directly affects the process if its quantity is changed. Factors affecting photosynthesis :

1. **Light :** Rate of photo-synthesis increases at low light intensities. At high intensities of light beyond a point the rate of  $\text{CO}_2$  fixation decreases. Longer hours of light duration favour more photosynthesis rate.
2. **Carbon dioxide :** Increase in  $\text{CO}_2$  concentration causes increases in  $\text{CO}_2$  fixation. It is the major limiting factor for photosynthesis.
3. **Temperature :** The rate of photosynthesis at optimum temperature is, high. It is  $20^\circ\text{C}$ - $25^\circ\text{C}$  For  $\text{C}_3$  plants and  $30$ - $45^\circ\text{C}$  for  $\text{C}_4$  plants.
4. **Water :** Water is one of the reactant in photosynthesis, but it effects the rate of  $\text{CO}_2$  fixation. Low water content causes the stomata to close and reduces the  $\text{CO}_2$  availability.

## Questions

### Very Short Answer Questions

(1 marks each)

1. Name two photosynthetic pigments belonging to Carotenoids :
2. How many molecules of ATP are required for synthesis of one molecule of glucose in  $C_3$  and  $C_4$  pathways ?
3. What part of sunlight is most suitable for photosynthesis ?
4. Which one of the photosystems can carry on photophosphorylation independently ?
5. Name two plants that can carry out photosynthesis at night.
6. Name the most abundant enzyme found in the world.
7. Name the scientist who proposed the  $C_4$  pathway. Name one such plants.
8. Where does carbon fixation occur in chloroplast ?
9. Which compound acts as  $CO_2$  acceptor in Calvin cycle ?
10. Name the end products of light reaction.
11. Does the photosynthesis occur in moon light ? Why ?

### Short Answer Questions-I

(2 marks each)

12. Why does the rate of photosynthesis decline in the presence of continuous light ?
13. Why do green plants start evolving carbon dioxide instead of oxygen on a hot sunny day ?
14. Fill in the space, left blank in the given table to bring the difference between  $C_3$  and  $C_4$  plants :

S.No.	Characteristics	$C_3$ plants	$C_4$ plants
1.	Cell type	mesophyll	...(a)... and mesophyll
2.	$CO_2$ acceptor	...(b)...	Phosphoenolpyruvate (PEP)
3.	First $CO_2$ fixation product	3-PGA	...(c)...
4.	Optimum temperature	...(d)...	30° C to 45° C

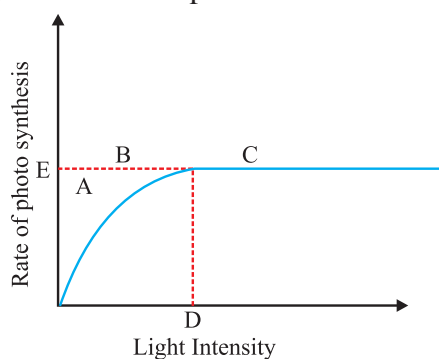
15. State two functions of accessory pigments, found in thylakoids.

16. Why do  $C_4$  plants are more expensive (in energy requirement) than  $C_3$  plants ?
17. What is limiting factor ? State the law of limiting factors.

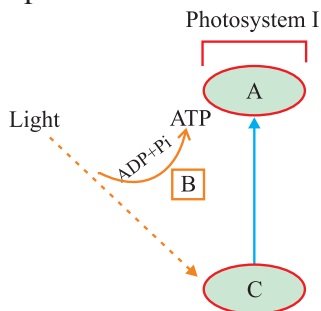
## Short Answer Questions-II

(3 marks each)

18. The figure shows the effect of light on the rate of photosynthesis. Based on the graph, answer the following questions :
  - (i) At which point(s) A, B or C in the curve, light is a limiting factor ?
  - (ii) What could be the limiting factor(s) in region A ?
  - (iii) What do region C and D represent on the curve ?



19. When and why does photorespiration take place in plants ? How does this process result in a loss to the plant ?
20. What are the steps that are common to  $C_3$  and  $C_4$  photosynthesis ?
21. Two potted plants were kept in an oxygen free environment in transparent containers, one in total darkness and the other in sunlight. Which one of the two is likely to survive more ? Justify your answer by giving the reason.
22. (a) In the diagram shown below, label A, B and C. What type of phosphorylation is possible in this ?



- (b) Give any two points of difference between cyclic and non-cyclic photophosphorylation.



23. Name the pigment found in tomato, carrots, chillies etc. which gives red colour to them. Is it a photosynthetic pigment ?
24. Chloroplast and mitochondria are believed to be semi-autonomous organelles. Justify the statement.
25. Mention the conditions under which the  $C_4$  plants are superior to  $C_3$  plants.

### Long Answer Questions

(5 marks each)

26. Describe  $C_4$  pathway in a paddy plant. How is this pathway an adaptive advantage to the plant ?
27. Explain, the process, of biosynthetic phase of photosynthesis occurring in chloroplast.
28. (a) Give steps to ATP synthesis in chloroplasts through chemiosmosis.  
(b) Schematically represent non-cyclic photophosphorylation in plants.

## Answers

### Very Short Answer

(1 mark each)

1. Carotene and Xanthophyll.
2. In  $C_3$  pathway = 18 ATP molecules In  $C_4$  pathway = 30 ATP molecules
3. Blue and red regions of the light spectrum are the most effective in photosynthesis.
4. PS-I.
5. Opuntia, Chenopodium, Bougainvillea.
6. RuBisCO.
7. Hatch and Slack. Maize and Sorghum.
8. Carbon fixation takes place in stroma.
9. Ribulose 1, 5 bisphosphate.
10. ATP, NADPH and  $O_2$ .
11. No, the moonlight is unable to perform light reactions of photosynthesis (ATP-NADPH Synthesis as it is 1/50,000 the intensity of sunlight and not strong enough to enable plants to photosynthesise).

### Short Answers-I

(2 marks each)

12. Increase incident light beyond a point causes the breakdown of chlorophyll.
13. On a hot sunny day, enzyme RuBP carboxylase becomes active and its affinity for  $\text{CO}_2$  decreases and for  $\text{O}_2$  increases. Consequently more and more photosynthetically fixed carbon is lost by photorespiration.
14. (a) Bundle sheath  
(b) RuBP  
(c) OAA (oxaloacetic acid)  
(d)  $20^\circ\text{C}$ - $25^\circ\text{C}$
15. (a) Absorption of light and transfer of energy to chlorophyll 'a'.  
(b) Protect chlorophyll 'a' from photo oxidation.
16. Because they require more energy (30 ATPs) in synthesizing one glucose molecule as compared to  $\text{C}_3$ —(18ATPs).
17. Limiting Factor—A factor which is deficient to such an extent that increase in its concentration directly increase the rate of the process.  
(For the law of limiting factors see text in NCERT Book.) Page 222

### Short Answers-II

(3 marks each)

18. (i) 'B'  
(ii)  $\text{CO}_2$  and temperature  
(iii) 'C' represents to constant rate of photosynthesis, 'D' is the light saturation intensify at which rate of photosynthesis is maximum.
19. Refer Page no. 220, NCERT, Text Book Biology for class XI.
20. **Hints :**
  - (a) Photolysis of  $\text{H}_2\text{O}$  and photophosphorylation occurs in both  $\text{C}_3$  and  $\text{C}_4$  plants.
  - (b) In both, dark reaction occurs in stroma.
  - (c) Calvin cycle results in the formation of starch in both the plants.
  - (d) During dark reaction both types of plants undergo the phases of carboxylation and regeneration :

21. **Hints :**

- The plant in sunlight will survive for longer period.
- Light is essential for photosynthesis.

22. (a) (A)  $e^-$  acceptor

(B) Electron transport system

(C) Chlorophyll P700

(b) Refer A Page no. 212, NCERT Text Book of Biology for Class XI.

23. **Carotenoid :** It is an accessory photosynthetic pigment which takes part in harvesting light energy only if chlorophyll is present.

24. Mitochondria and chloroplast both contain DNA and can reproduce independently of the cell and chloroplasts even have a built in feeding mechanism both have their own ribosomes of 70S type and capable of synthesising their own kind of proteins.

25.  $C_4$  Plant grow in regions with high temperatures and intense light. The rate of transpiration in  $C_4$  plant is 25% of a  $C_3$  plant, thus they conserve water and have greater photosynthetic rate gives greater rate of growth in intense sunshine and high temperature.

**Long Answers**

**(5 marks each)**

26. Refer Page no. 218, NCERT Text Book of Biology for Class XI.

27. Refer Points to Remember.

**Hints :** Three stages of Calvin cycle : Carboxylation, Reduction and Regeneration.

28. (a) Refer Page no. 213 (Chemiosmotic Hypothesis), NCERT Text Book of Biology for Class XI.

(b) Refer Fig. 13.5 (Z-Scheme of light reaction), NCERT Text Book of Biology for Class XI.



## Assertion Reasoning

(1 mark each)

The following question consists of 2 statements - Assertion (A) and Reason (R). answer the question by selecting the appropriate option below :

29. **Assertion (A)** : C<sub>4</sub> cycle is found in CAM plants.

**Reason (R)** : Photorespiration does not occur in C<sub>4</sub> plants.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

30. **Assertion (A)** : Higher the concentration of O<sub>2</sub> in the atmosphere, lower is the photosynthesis are.

**Reason (R)** : Lower respiration rate is due to oxidation of RuBisCo.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

31. **Assertion (A)** : For the formation of one molecule of glucose, 6 molecules of CO<sub>2</sub> and 12 molecules of NADPH<sup>+</sup> + H<sup>+</sup> and 18 ATP are used.

**Reason (R)** : In light reaction ATP and NADPH<sub>2</sub> are formed.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion

- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

## Solution:

### Assertion Reasoning

- 29. (e)
- 30. (a)
- 31. (b)

### Source-based/Case-based/Passage-based/Integrated assessment question (4 marks each)

Read the following and answer any four questions from (i) to (v) given below :

32. Photosystems are of two types, PS I and PS II, and are found in thylakoid membranes. Each photosystem consists of a light harvesting complex and each LHC is made up of hundreds of pigment molecules bound to proteins. Each photosystem has all the pigments complexes except one molecule of chlorophyll a, a single chlorophyll forms a reaction centre. Each photosystem absorbs different wavelengths of light. In PS I the reaction centre chlorophyll a has an absorption peak at 700 nm, hence is called P700, while in PS II it has absorption maxima at 680 nm, and is called P680. It was named PSII because it was discovered after PSI was discovered. Only light reaction takes place in these systems. PSII is the first system which traps light and the most important function is splitting of water and molecular oxygen. The electron is released while the splitting of water. These electrons are passed through PSII and PSI before ending up in NADPH as they move down in the electron transport chain. NADPH, thus produced is used in the dark reaction of photosynthesis.

- (i) Photosystem I and II respectively are found in \_\_\_\_\_
  - (a) Inner and outer surface of thylakoid in mitochondria
  - (b) Outer and inner surface of thylakoid in mitochondria
  - (c) Inner and outer surface of thylakoid in chloroplast
  - (d) Outer and inner surface of thylakoid in chloroplast



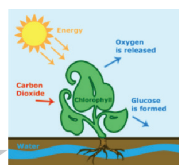
- (ii) Will photolysis of water occur in PSI? (Yes/No)
- (iii) What is the correct sequence?
- I. Antenna molecule 700
  - II. NADPH
  - III. PSI
  - IV. PSII
  - V. Thylakoid membrane
- (a) I, II, III, IV, V
  - (b) II, III, IV, I, V
  - (c) V, IV, III, I, II
  - (d) V, III, IV, I, II
- (iv) The dark reaction cannot take place during the day. (True/False)
- (v) Which one of the following is not true about the light reaction in photosynthesis?
- (a) Photosystems are arrangements of chlorophyll and other pigments packed into thylakoids
  - (b) Photolysis of water occurs in PSI
  - (c) NADP is reduced
  - (d) Magnesium ions are required for the formation of chlorophyll

### **Solution:**

#### **Source-based/Case-based/Passage-based/Integrated assessment questions**

- (i) (d) Outer and inner surface of thylakoid in chloroplast
- (ii) No
- (iii) (c) V, IV, III, I, II
- (iv) False (dark reaction takes place both during the day and the night)
- (v) (b) Photolysis of water occurs in PSI





## Chapter - 14

# Respiration in Plants

### Points To Remember

**Aerobic respiration :** Complete oxidation of organic food in presence of oxygen thereby producing  $\text{CO}_2$ , water and energy.

**Anaerobic respiration :** Incomplete breakdown of organic food to liberate energy in the absence of oxygen.

**ATP Synthetase :** An enzyme complex that catalysis synthesis of ATP during oxidative phosphorylation.

**Biological oxidation :** Oxidation in a series of reaction inside a cell.

**Cytochromes :** A group of iron containing compounds of electron transport system present in inner wall of mitochondria.

**Dehydrogenase :** Enzyme that catalyses removal of H atom from the substrate.

**Electron acceptor :** Organic compound which receive electrons produced during oxidation-reduction reactions.

**Electron transport :** Movement of electron from substrate to oxygen through respiratory chain during respiration.

**Fermentation :** Breakdown of organic substance that takes place in certain microbe like yeast under anaerobic condition with the production of  $\text{CO}_2$  and ethanol.

**Glycolysis :** Enzymatic breakdown of glucose into pyruvic acid that occurs in the cytoplasm.

**Oxidative phosphorylation :** Process of formation of ATP from ADP and  $\text{P}_i$  (Inorganic phosphate) using the energy from proton gradient.

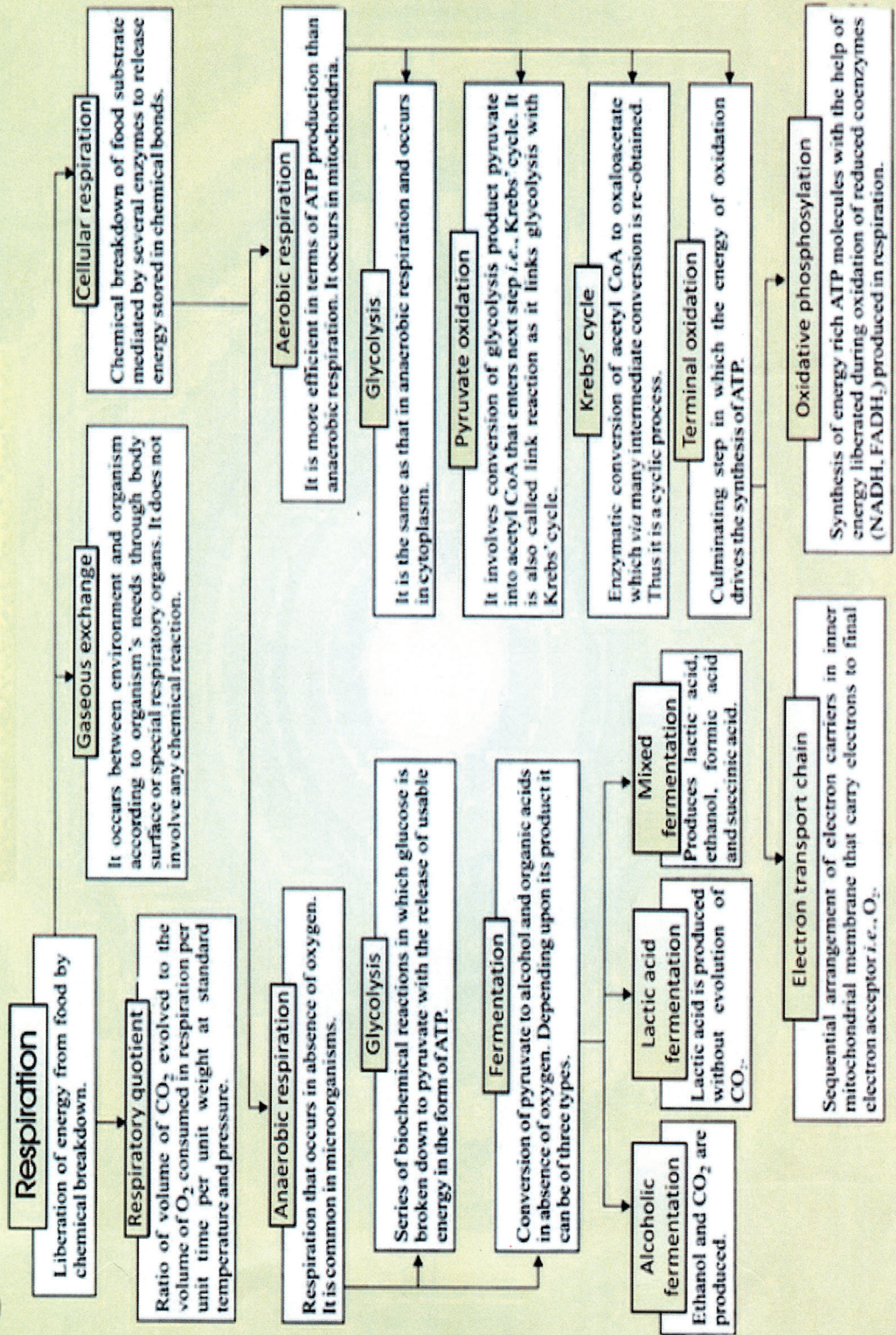
**Respiration :** Biochemical oxidation food to release energy.

**Respiratory Quotient :** The ratio of the volume of  $\text{CO}_2$  produced to the volume of oxygen consumed.

**Proton gradient :** Difference in proton concentration across the tissue membrane.



# RESPIRATION IN PLANT





**Mitochondrial matrix :** The ground material of mitochondria in which pyruvic acid undergoes aerobic oxidation through Kreb's cycle.

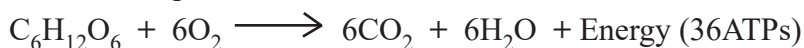
**Electron Transport Chains (ETC)**—A series of co-enzymes and electron carriers where electrons can pass along increasing redox potential losing a bit of energy at every step of transfer.

### Abbreviations

ATP	—	Adenosine-tri-phosphate
ADP	—	Adenosne-di-phosphate
NAD	—	Nicotinamide Adenine dinucleotide
NADP	—	Nicotinamide Adenine dinucleotide Phosphate
NADH	—	Reduced Nicotinamide Adenine dinucleotide
PGA	—	Phosphoglyceric acid
PGAL	—	Phospho glyceraldehyde
FAD	—	Flavin adenine dinucleotide
ETS	—	Electron transport system
ETC	—	Electron transport chain
TCA	—	Tricarboxylic acid
OAA	—	Oxalo acetic acid
FMN	—	Flavin mono nucleotide
PPP	—	Pentose phosphate pathway

**Cellular Respiration**—The process of oxidation/breakdown of food materials within the cell to release energy. Respiratory substrate to be oxidized during respiration is usually glucose, but these can also be proteins, fats or organic acids. In plants, respiratory gaseous exchange occurs through stomata and lenticels :

Overall cellular respiration is :



### Aerobic Respiration

Overall mechanism of aerobic respiration can be studied under the following steps :

- (A) Glycolysis (EMP pathway) in cytoplasm
- (B) Oxidative Decarboxylation—(Gateway Reaction)—in Mitochondrial matrix
- (C) Kreb's cycle (TCA—cycle)—Matrix of mitochondria
- (D) Oxidative phosphorylation



**A. Glycolysis :** The term has originated from the Greek word, *glycos* = glucose, *lysis* = splitting, or breakdown means breakdown of glucose molecule to pyruvic acid. It was given by Embden Meyerhof and Parnas. It is a chain of 10 reactions to convert glucose into pyruvate. It is common for aerobic and anaerobic respiration.

### Steps for Glycolysis—(EMP Pathway)

1. Phosphorylation of Glucose into Glucose-6-phosphate (ATP used)
2. Isomerisation of Glucose-6-Phosphate into fructose-6-phosphate
3. Second phosphorylation in which Fructose-6-phosphate changes into Fructose-1, 6-biphosphate (ATP used)
4. Splitting of Fructose-1, 6-biphosphate into DiHAP and PGAL
5. Isomerisation of DiHAP into PGAL
6. Oxidation of PGAL into 1, 3-biphosphoglycerate (NADH Produced)
7. Synthesis of ATP and conversion of 1, 3-biphosphoglycerate into 3-phosphoglycerate
8. Isomerisation of 3-phosphoglycerate into 2-phosphoglycerate
9. Dehydration of 2-phosphoglycerate into PEP (Removal of water)
10. Substrate level ATP synthesis and formation of Pyruvic Acid.
  - It is also called Embden—Meyerhof—Paranas pathway. (EMP pathway)
  - It is common in both aerobic and anaerobic respiration.
  - It takes place outside the mitochondria, in the cytoplasm.
  - One molecule of glucose (Hexose sugar) ultimately produces two molecules of pyruvic acid through glycolysis.
  - During this process 4 molecules of ATP are produced while 2 molecules ATP are utilised. Thus net gain of ATP is of 2 molecules.

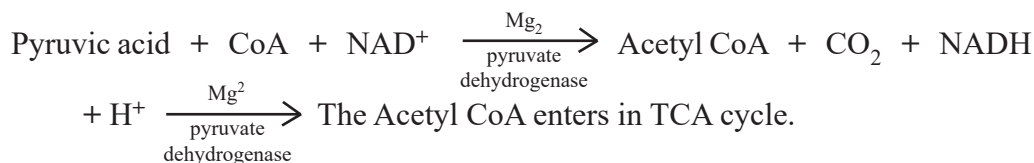
### Input and Output of glycolysis

S. No.	Input	Output
1.	Glucose, (6—C), 1 molecule	Pyruvate, (3—C), 2 molecules
2.	2 ATP	2 ADP
3.	4 ADP + 2 $P_i$	4 ADP + 2 $H_2O$
4.	2 $NAD^+$	2 NADH ( $H^+$ )

**Net out put ..... 2 Pyruvate + 2ATP + 2NADH (+  $H^+$ ) OR 2 Pyruvate + 8 ATP**

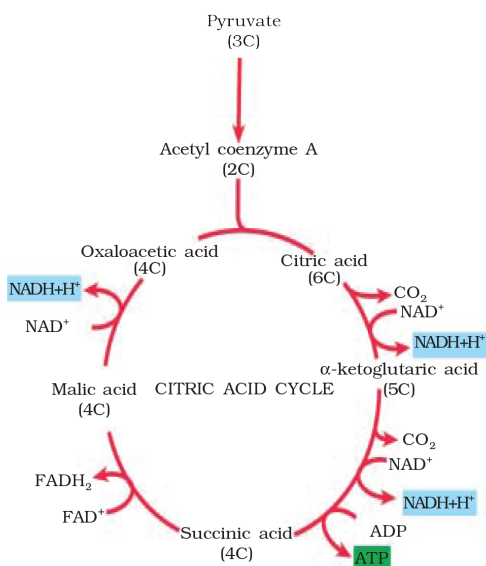
The pyruvate, so produced, may under go (i) Lactic acid fermentation, (ii) Alcoholic fermentation (iii) Aerobic Respiration (Krebs Cycle)

**B. Oxidative decarboxylation :** Pyruvic acid is converted into Acetyl CoA in presence of pyruvate dehydrogenase complex.



**C. Tri Carboxylic Acid Cycle (Kereb's cycle) or Citric acid Cycle :** This cycle starts with condensation of acetyl group with oxaloacetic acid and water to yield citric acid which under goes a series of reactions.

- It is aerobic and takes a place in mitochondrial matrix.
- Each pyruvic acid molecule produces 4 NADH + H<sup>+</sup>, one FADH<sub>2</sub>, one ATP.
- One glucose molecule has been broken down to release CO<sub>2</sub> and eight molecules of NADH + H<sup>+</sup>, two molecules of FADH<sub>2</sub> and 2 molecules of ATP.



**Figure 14.3** The Citric acid cycle

**Compensation Point :** It is the value of a factor at which the rate of photosynthesis controlled by it is just equal to the rate of respiration and photorespiration so that there is not net exchange of gases between the photosynthetic organ and the environment.

At compensation point the photosynthetic tissue manufacture only such amount of food which of sufficient for it to remain alive. No food is supplied to rest of the plant. Therefore, net photosynthesis is zero.

#### (D) Oxidative Phosphorylation

The synthesis of ATP from ADP and inorganic phosphate using energy from proton gradient is called oxidative phosphorylation. This takes place in elementary particles present on the inner membrane of cristae of mitochondria.

This process in mitochondria is catalysed by ATP synthetase (complex V). This complex has two major components  $F_0$  and  $F_1$ ,  $F_0$  acts a channel for proton and  $F_1$  acts as an ATP synthetase.

## Electron Transport System and Oxidative Phosphorylation

Name of Complex	Components of ETS
Complex I	FMN and FeS are prosthetic groups and NADH dehydrogenase
Complex II	$FADH_2$ dehydrogenase (succinate dehydrogenase), FeS, UQ
Complex III	Cytochrome bc, complex–cytochrome b, cytochrome C, FeS, UQ
Complex IV	Cytochrome oxidase–Cytochrome $a_1$ , cytochrome $a_3$ which posses two copper centres.
Complex V	$F_0$ – $F_1$ particles, Flow of protein through $F_0$ channel induces $F_1$ particile to function as ATP synthetase.

## Respiratory Balance Sheet :



### Total ATP Production

Process	Total ATP produced
1. Glycolysis	$2ATP + 2NADH_2$ (6ATP) = 8ATP
2. Oxidative decarboxylation	$2NADH_2$ (6ATP) = 6ATP
3. Kreb's Cycle	$2GTP$ (2ATP) + $6NADH_2$ (18ATP) + $2FADH_2$ (4ATP) = 24 ATP

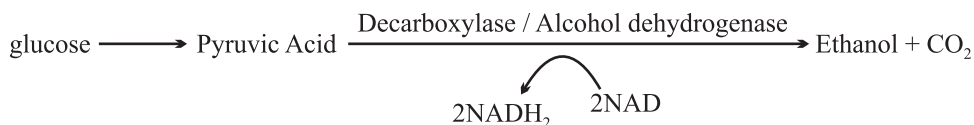
Energy production in prokaryotes during aerobic respiration = 38 ATP

Energy poroduction in eukaryotes during aerobic respiration =  $38 - 2 = 36$  ATP

In eukaryotes 2 ATP are used in transporting 2 molucules of  $NADH + H^+$  formed in glycolysis from cytoplasm to mitochondria for oxidation through ETS shuttle.

(2) **Anaerobic Respiration**—In anaerobic respiration, Glycolysis is followed by formation of ethanol or lactic acid in the cytoplasm.

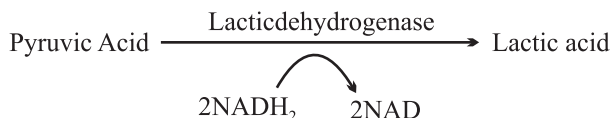
**Fermentation :** It is the process of anaerobic respiration which occurs in yeast and some bacteria. Fermentation involves incomplete oxidation of food into ethanol and carbon-dio-oxide. It results in the production of 2 ATP molecules.



- (i) Conversion of Acetyl CoA into fatty acid and PGA.
- (ii) Synthesis of chlorophyll and cytochromes from Succinyl CoA
- (iii) Synthesis of Amino acids from OAA and  $\alpha$ -ketoglutaric acid
- (iv) Synthesis of Alkaloid from OAA.

Enzymes involved-Pyruvic acid decarboxylase, Alcohol dehydrogenase

**Anaerobic respiration in muscles :** During vigorous exercise a person feels pain and fatigue in his muscles. This is due to accumulation of lactic acid in muscles. When oxygen is inadequate pyruvic acid is reduced to lactic acid in presence of enzyme-lactic dehydrogenase.



During rest lactic acid is reconverted to pyruvic acid.

## Amphibolic Pathway :

During the process of cellular respiration Carbohydrates, fats and proteins are broken down to release energy and hence respiration is a catabolic process/ catabolic pathway. From this pathway many compound are withdrawn for synthesis of substrates. Some anabolic processes are formation of pyruvic acid from amino acids, and formation of Acetyl CoA from Fatty acid. So—Respiratory pathway is involved in both catabolism and anabolism, it is better to consider the respiratory pathway as an amphibolic pathway.

## RQ (Respiratory quotient)

- (a)  $\text{RQ} = 1$  (When carbohydrate is used as substrate)



- (b) RQ is less than 1 (*i.e.*,  $< 1$ ) (When fats are used as substrate)



Tripalmitin

$$R.Q. \Rightarrow \frac{102 CO_2}{145 O_2} = 0.7$$

- (c) RQ is 0.9 for proteins.
- (d) RQ is more than 1 (*i.e.*, > 1) for organic acids.
- (e) RQ is infinite in case of anaerobic respiration, because  $CO_2$  is evolved but  $O_2$  is not consumed.

## Questions

### Very Short Answer Question

(1 mark each)

1. Name the molecule which is terminal acceptor of electron.
2. How many ATP molecules are produced from a molecule of glucose on its complete oxidation in eukaryotes ?
3. Where does ETC found in eukaryotic cell ?
4. Name the enzyme which convert sugar into glucose and fructose.
5. How many molecules of ATP are produced by the oxidation of one molecule of  $FADH_2$  ?
6. Why do the person with sufficient white fibres get fatigued in a short period ?
7. Write the name of end product of glycolysis.
8. Name the first product formed in Krebs's cycle.
9. Define the term 'Respiratory substrate'.
10. Which intermediate undergoes lysis in glycolysis ?
11. Write the other two names of Krebs cycle.
12. Name the acceptor molecule of Krebs cycle.
13. Name the substrate entrant of Krebs cycle.

14. Name the first chemical produced in Krebs cycle.
15. What is Electron Transport Chain ? (ETC).
16.  $F_0-F_1$  Protein complexes participate in the synthesis of .....

### Short Answer Questions-I

(2 mark each)

17. Differentiate between aerobic respiration and anaerobic respiration.
18. Mention two steps of glycolysis in which ATP is utilised.
19. Why does anaerobic respiration produces less energy than aerobic respiration?
20. Define Respiration Quotient. What is its value for fat and protein ?
21. Distinguish between glycolysis and fermentation.
22. What are respiratory substrates ? Name the most common respiratory substrate.

### Short Answer Questions-II

(3 marks each)

23. Pyruvic acid is the end product of glycolysis. What are the three metabolic fates of pyruvic acid under aerobic and anaerobic conditions ?
24. Give the schematic representation of an overall view of TCA cycle.
25. Where does electron transport system operative in mitochondria ? Explain the system giving the role of oxygen ?
26. Give a brief account of ATP molecules produced in aerobic respiration in eukaryotes.
27. Discuss the respiratory pathway is an amphibolic pathway.
28. Expand ETC., ETS and TCA.

### Long Answer Questions

(5 marks each)

29. What is glycolysis ? Where does glycolysis takes place in a cell ? Give schematic representation of glycolysis.



## Answers

### Very Short Answers

(1 mark each)

1. Oxygen.
2. 36 ATP.
3. Mitochondrial membrane.
4. Invertase.
5. 2 ATP molecules.
6. due to formation of Lactic acid.
7. Pyruvic acid.
8. Citric acid.
9. The organic substances which is catabolised or broken down enzymatically in cellular respiration for releasing energy.
10. Fructose, 6-bisphosphate.
11. (i) Citric acid cycle (ii) Tricarboxylic acid cycle.
12. Oxaloacetate.
13. Acetyl Co-A.
14. Citrate
15. See text (Points to remember)
16. ATP

### Short Answers-I

(2 mark each)

17. Refer NCERT Text Book Chapter 14 (14.3 and 14.4).
18. (i) Phosphorylation of Glucose into Glucose-6-phosphate.  
(ii) Phosphorylation of Fructose-6-phosphate into Fructose-1,6-bisphosphate.
19. Refer NCERT Text Book Chapter 14, Page 230.



20. Refer NCERT Text Book Page no. 236.  
21. Refer NCERT Text Book Page no. 229 and page no. 230.  
22. Refer NCERT Text Book Page no. 227.

### Short Answers-II

(3 marks each)

23. (i) Aerobic conditions— $\text{CO}_2 + \text{H}_2\text{O} + \text{Energy}$   
(ii) Anaerobic conditions—(fermentation)  
(a) In muscles – Lactic acid + Energy  
(b) Yeast-Ethanol +  $\text{CO}_2$  + Energy  
24. Refer NCERT Text Book Fig. 14.3 Page 232.  
25. Refer NCERT Text Book Page no. 232 and page no. 233.  
26. Refer notes.  
27. Refer NCERT Text Book Page no. 235.  
28. See text (abbreviations).

### Long Answers

(5 mark each)

29. Refer NCERT Text Book Page no. 228 and page no. 229.

### Assertion Reasoning

(1 mark each)

The following question consists of 2 statements - Assertion (A) and Reason (R). answer the question by selecting the appropriate option below :

30. **Assertion (A) :** More ATPs are produced during aerobic respiration than anaerobic respiration.

**Reason (R) :** Site for aerobic respiration is mitochondria and that of anaerobic respiration is cytoplasm.

- (a) Both A and R are true and the reason is a correct explanation of the assertion  
(b) Both A and R are true and the reason is not a correct explanation of the assertion  
(c) The assertion is true but the reason is false  
(d) Both the assertion and reason are false  
(e) The assertion is false but the reason is true

31. **Assertion (A) :** Respiration is called an amphibolic pathway.

**Reason (R) :** In respiration both anabolism and catabolism occur on many substrates.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

32. **Assertion (A) :** During carbon-di-oxide fixation, the acetyl-coA comes from glycolysis.

**Reason (R) :** Acetyl-coA gives energy for the formation of glucose.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

### **Solution:**

#### **Assertion Reasoning**

30. (b)

31. (a)

32. (d)

**Source-based/Case-based/Passage-based/Integrated assessment question**  
**(4 marks each)**

Read the following and answer any four questions from (i) to (v) given below :

33. Electron transport chain is the final stage of aerobic respiration which is located on the mitochondrial membrane. There are two mitochondrial membranes, outer and inner. All proton pumps are located on the inner mitochondrial membrane which is arranged into folds called cristae. These folds increase the surface area available for the transport chain. Electron transport chain is the series of redox reactions in which there is transfer of electrons from electron donors to electron acceptors. The energy is released and stored within the reduced hydrogen carriers which are then used to synthesise ATP. This is called oxidative phosphorylation. Oxidative phosphorylation occurs in distinct steps. First, the proton pumps create an electrochemical gradient called as proton motive force, second, ATP synthase uses the subsequent diffusions of protons, this step is called chemiosmosis. ATP is synthesised in this step. Third and final, oxygen accepts electrons and protons to form water.

(i) The correct series of electron acceptors present in mitochondrial membrane is

- (a) Cyt c, b, a, a<sub>3</sub>
- (b) Cyt b, c, a, a<sub>3</sub>
- (c) Cyt a, a, b, c
- (d) Cyt b, c, a<sub>3</sub>, a

(ii) How many ATPs will be produced from three molecules of NADPH and two molecules of P<sub>ADH</sub><sub>2</sub>?

- (a) 5
- (b) 9
- (c) 13
- (d) 18

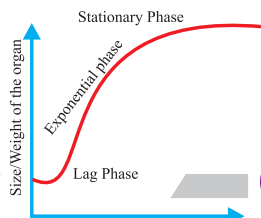
- (iii) In amphibolic pathway fatty acids will produce
- (a) Glucose-6-phosphate
  - (b) Glucose-1-6-phosphate
  - (c) Pyruvate
  - (d) Acetyl coA
- (iv) The  $F_0F_1$  complex acts as a site for ATP synthesis when protons enter inner membrane space. (T/F)
- (v) Ubiquinone (UQ) transfers its electrons to
- (a) Cytochrome b in complex III
  - (b) Cytochrome a in complex IV
  - (c) FAD in Complex II
  - (d) Mitochondrial matrix

**Solution:**

**Source-based/Case-based/Passage-based/Integrated assessment questions**

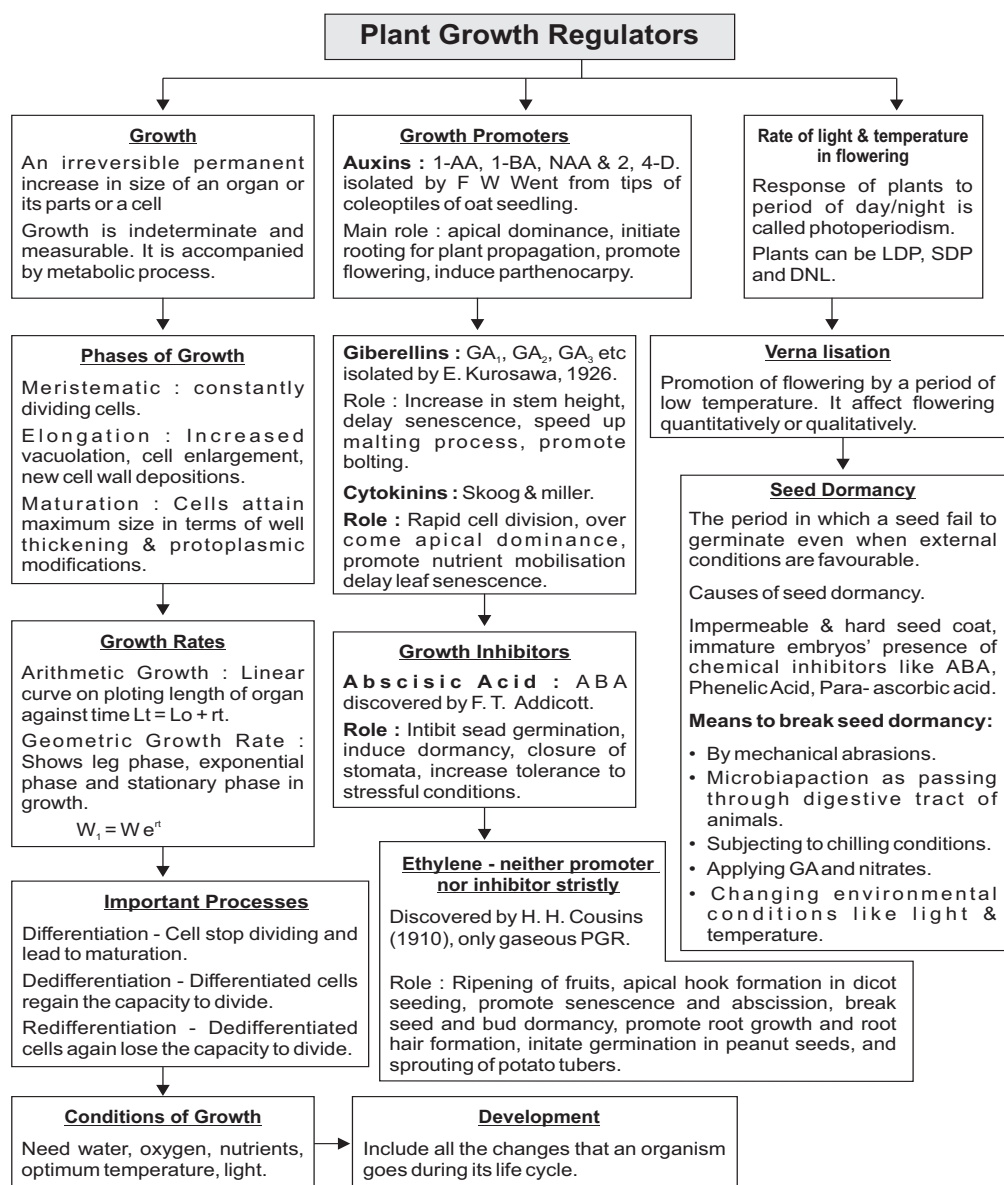
33. (i) (b) Cyt b, c, a, a<sub>3</sub>
- (ii) (c) 13
- (iii) (d) Pyruvate
- (iv) False,  $F_0F_1$  complex is acts as site for ATP synthesis when protons leave inner membrane space.
- (v) (a) Cytochrome b in complex III





## Chapter - 15

# Plant Growth and Development



## Points To Remember

**Seed Germination :** The seed germinates only when favourable conditions for growth exists in the environment. In absence of favourable conditions it goes into a period of suspended growth or rest, called dormancy.

**Abscission :** Shedding of plant organs like leaves, flowers and fruits etc. from the mature plant.

**Apical dominance :** Suppression of the growth of lateral buds in presence of apical bud.

**Dormancy :** A period of suspended activity and growth usually associated with low metabolic rate. Some, seeds undergo a period of dormancy and can germinate only after dormancy period gets over.

**Phytochrome :** A pigment, found in plants which control the light dependent developmental process.

**Phytohormone :** Chemicals' secreted by plants in minute quantities which influence the physiological activities.

**Senescence :** The last phase of growth when metabolic activities decrease.

**Vernalisation :** A method of promoting flowering by exposing the young plant to low temperature.

**Growth :** An irreversible permanent increase in size, volume and weight of an organ or its parts or even of an individual.

**Quiescence :** Non germination of a viable seed due to non-availability of proper environmental conditions.

**Vivipary :** It is the germination of seed while it is still attached to the parent plant and is nourished by it. *e.g., Rhizophora* and *Sonneratia*. As the germinating seed forms a seedling. It fall down into the mud due to increase in weights. In the mud, lateral roots develops for anchorage.

**Heterophylly :** Occurrence of more than one type of leaves in plants *e.g.,* larkspur, coriander leaves of Juvenile plant are different in shape from mature plant.

**Bolting :** Elongation of internodes prior to flowering in plants like Cabbage.

**Photoperiodism :** Response of Plants to relative periods of day/night to induce flowering.

According to duration of exposure of plants to light, plants are divided in 3 categories :

1. **Long Day Plants (LDP)**—Plants which need exposure to light for period exceeding critical duration *e.g.,* wheat, rice, cucumber.

2. **Short Day Plants (SDP)**—Plants that need exposure to light for period less than the critical length *e.g.*, Cabbage.
3. **Day Neutral Plants (DNP)**—There is no correlation between exposure to light duration & induction of flowering *e.g.*, Tomato.

#### Abbreviations

IAA	Indole acetic acid
NAA	Napththalene acetic acid
ABA	Absciscic acid
IBA	Indole-3 butyric acid
2.4D	2.4 dichlorophenoxy acetic acid
PGR	Plant growth regulator

Seed Dormancy	Quiescence
It is the condition of seed when it is unable to germinate in spite of the availability of all environmental conditions suitable for germination. It can be due to immature embryo or pressure of growth inhibitors.	The condition of a seed when it is unable to germinate because the conditions for germination are not available, such as moisture, temperature etc.

**Measurement of growth :** Plant growth can be measured by a variety of parameters like increase in fresh weight, dry weight, length, area, volume and cell number.

**Phases of growth :** The period of growth is generally divided into three phases, namely, meristematic, elongation and maturation.

- (i) **Meristematic :** New cell produced by mitotic division at root-tip and shoot-tip thereby show increase in size. Cells are rich in protoplasm and nuclei.
- (ii) **Elongation :** Zone of elongation lies just behind the meristematic zone of roots and concerned with enlargement of cells.
- (iii) **Maturation :** The portion lies proximal to the zone of elongation in roots. The cells of this zone attain their maximum size in terms of wall thickening and protoplasmic modification.

**Growth rate :** The increased growth per unit time is termed as growth rate. The growth rate shows an increase that may be arithmetic or geometrical.

Growth	Mathematical expression	Curve
<b>In Arithmetic growth :</b> Only one daughter cell continues to divide mitotically while other differentiate and matures.	$L_1 = L_0 + rt$ $L_1$ = Length at time $t$ $L_0$ = Length at time zero $r$ = growth rate	Linear curve

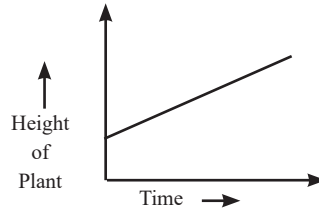


Fig. Linear growth curve

### Sigmoid Growth Curve

Geometrical growth	Formula	Shape of curve
The initial growth is slow (lag phase) and increase rapidly there-after at an exponential rate (log phase) In both, the progeny cells divide mitotically and continue to do so. However, with limited nutrient supply, the growth slow down leading to stationary phase.	$W_1 = W_0 e^{rt}$ $W_0$ = Initial size $W_1$ = Final Size $r$ = growth rate $t$ = time of growth $e$ = base of natural logarithms	Sigmoid or S-curve

### Sigmoid growth curve

**Lag phase :** Growth is slow in initial stage.

**Exponential phase :** Period of maximum growth

**Stationary phase :** When the nutrients become limiting, growth slows down.

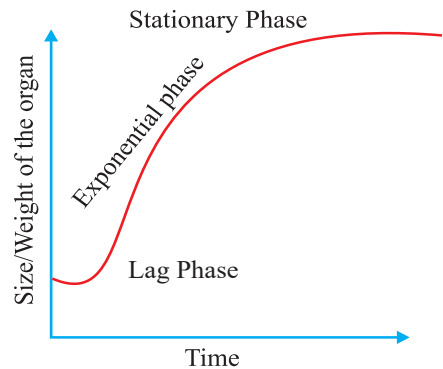


Fig. Sigmoid growth curve



**Relative Growth : The growth per unit time as percentage of initial size**

$$\text{RGR} = \frac{\text{Growth per unit time}}{\text{Initial size}} \times 100$$

**Differentiation :** A biochemical or morphological change in meristemic cell (at root apex and shoot apex) to differentiate into permanent cell is called differentiation. e.g. loss of protoplasm by tracheary elements.

**Dedifferentiation :** The phenomenon of regeneration of permanent tissue to become meristematic is called dedifferentiation. eg. formation of interfascicular cambium and cork cambium from parenchymatous cells.

**Redifferentiation :** Meristems/tissue are able to produce new cells that once again lose the capacity to divide but mature to perform specific functions. eg secondary cortex, secondary xylem etc.

## Conditions or factors influencing Growth

1. Nutrition 2. Availability of water 3. Temperature 4. Oxygen 5. Light 6. Gravity 7. Stress factors like minerals, water or temperature etc.

### Phytohormone or Plant Growth-Regulator

**Growth promoting hormones :** These are involved in growth promoting activities such as cell division, cell enlargement, flowering, fruiting and seed formation. e.g., Auxin, gibberellins, cytokinins.

**Growth inhibitor :** Involved in growth inhibiting activities such as dormancy and abscission. e.g., Absciscic acid and Ethylene.

Hormones	Functions
1. Auxins (Growth Promoters) e.g. Indole 3-Acetic Acid [2, 4-D and 2, 4, 5-T etc.]	1. Apical dominance, cell elongation, Promote flowering prevent premature leaf and fruit falling, initiate rooting in stem cutting, as weedicide, induce parthenocarpy.
2. Gibberellins eg. $\left[ \begin{array}{c} \text{GA}_3 (\text{C}_{19}\text{H}_{22}\text{O}_6) \\ \text{GA}_4, \text{GA}_7, \text{GA}_{19} \text{ and} \\ \text{GA}_{20} \text{ etc.} \end{array} \right]$	2. Delay senescence, speed up malting process, increase in length of axis (grape stalk), increase in length of stem (sugarcane), bolting in beet, cabbages and many plants with rosette habit.

<p>3. Cytokinins (Growth Promoters)  <i>e.g.</i> [ Zeatin (trans 6-purine  DMAA-Dimethylalyl  adenine and Isopentyl  adenine (IP) etc. ]</p>	<p>3. Promote cell division, induce cell enlargement, reduce apical dominance, induce growth in auxiliary bud, chlorophyll preservation, lateral shoot growth, adventitious root formation.</p>
<p>4. [Ethylene (<math>H_2C = CH</math>)  A gaseous PGR which acts as growth promoters as well growth inhibitor (mainly as growth inhibitor)]</p>	<p>4. Promotes senescence and abscission of leaf and fruits, promotes ripening of fruits, break seed and bud dormancy, initiate germination in peanut, sprouting of potato tuber, promotes root growth and root hair formation.</p>
<p>5. Absciscic acid (ABA)  <i>eg.</i> (Abscisin II Dormin)</p>	<p>5. Inhibit seed germination, stimulate closure of stomata, increase tolerance to various stress, induce dormancy in seed and bud, promotes ageing of leaf (senescence).  Can delay the ripening of stored fruits as it absorbs the ethylene.</p>

**Vernalisation :** The phenomenon in which flowering is either quantitatively or qualitatively dependent on exposure to low temperature. eg wheat, barley, rye, biennial plants like sugarbeet cabbage, carrots. It prevents precocious reproductive development late in the growing season and enables the plant to have sufficient time to reach maturity

## Questions

### Very Short Answer Question

(1 mark each)

1. Write the cause of 'Bakane' disease of rice.
2. Name the plant hormone which was first isolated from human urine.
3. Name the only gaseous plant hormone.
4. How does abscisic acid acts as stress hormone in drought condition ?
5. A farmer observed some broad-leaved weeds in a wheat crop farm. Which plant hormone would you suggest remove them ?

6. Name the plant growth regulators you should use to (a) Increase the yield of sugarcane (b) Promote lateral growth (c) Cause sprouting of potato tuber (d) Inhibit seed germination.
7. Why do lateral buds start developing into branches when apical bud is removed ?
8. Flowering in certain plant occur only when they are exposed to low temperature for a few weeks. Name this phenomenon.
9. Name, the hormone released from over-ripe apples and affects all other apples in a small wooden box.

### Short Answer Question-I

(2 marks each)

10. How will you induce lateral branching in a plant which normally does not produce them ? Give reason.
11. What induces ethylene formation in plants ? Give any two different action of ethylene on plants.
12. What is meant by abscission ? Name phytohormone involved in it.
13. What is meant by apical dominance ? Which hormone control it ?
14. Differentiate between photoperiodism and vernalization.
15. Name a hormone which is :
  - (a) gaseous in nature (b) responsible for photo tropism (c) used for killing dicot weeds (d) Induces flowering in long day plants.

### Short Answer Questions-II

(3 marks each)

16. A primary root grows from 5 cm to 19 cm in a week. Calculate the growth rate and relative growth over the period.
17. Where are the following hormones synthesised in plants (a) IAA (b) Gibberellins (c) cytokinins.
18. What would be expected to happen if :
  - (a)  $GA_3$  is applied to rice seedling.
  - (b) a rotten fruit get mixed with unripe fruits.
  - (c) you forget to add cytokinin to the culture medium.

19. Which growth hormone is responsible for the following :
- (a) induce rooting in a twig
  - (b) quick ripening of a fruit
  - (c) delay leaf senescence
  - (d) 'bolt' a rosette plant
  - (e) induce immediate stomatal closure in leaves (f) Induce growth in axillary buds.
20. Define differentiation, dedifferentiation and redifferentiation.
21. Where are auxins generally produced in a plant ? Name any one naturally occurring plant auxin and any one synthetic auxin.
22. Define growth rate. Name two types of growth. Give the shape of curve for these growth.
23. Mention various parameters taken into consideration for measuring the growth.

### Long Answer Question

(5 marks each)

24. In list the five categories of phytohormone. Write atleast two uses of each.

## Answers

### Very Short Answer

(1 mark each)

1. *Gibberella fujikuroi*.
2. Auxin
3. Ethylene
4. ABA cause rapid closure of stomata, preventing loss of water by transpiration.
5. 2,4-D
6. (a) Gibberellin (b) Cytokinin
- (c) Ethylene (d) Absciscic acid
7. Due to inhibit activity of Auxin lateral growth starts.
8. Vernalisation
9. Ethylene

### Short Answers-I

(2 marks each)

10. When apical bud is removed, lateral branches are produced. Removal of apical bud effect the auxin is destroyed inducing the lateral buds to grow rapidly.
11. Refer NCERT Book Page no. 250.
12. ● Premature fall of leaf and fruit is called abscission.  
● Absciscic acid
13. Refer NCERT Boof Page no. 250.
14. Refer NCERT Boof Page no. 252.
15. (a) Ethylene  $C_2H_2$  (b) Auxin (c) 2, 4-D (d) Gibberellin

### Short Answers-II

(3 marks each)

16. (a) Growth =  $19 - 5 = 14$  cm, Period = 7 days  
Growth rate =  $\frac{14}{7} = 2$  cm/day  
(b) Initial growth =  $\frac{7}{5}$  cm  
Growth rate per day  $\frac{19 - 5}{7} = 2$  cm  
Relative growth rate =  $\frac{2}{5} \times 100 = 40\%$
17. (a) 1AA = Shoot apex  
(b) Gibberellin – young leaves of buds, root tips  
(c) Cytokinins – Root apical meristan
18. (a) Hyper elongation of intenodes of rice seedlings will occur.  
(b) Unripe fruit s will lead to early ripening and ultimately it will result in rotting.  
(c) Short but formation will not occur.
19. Refer NCERT Book.
20. Refer NCERT Text Book Page no. 245.
21. Refer NCERT Text Book Page no. 248.
22. Refer NCERT Text Book Page no. 242 and 243.
23. Refer NCERT Text Book Page no. 241.

### Long Answers

(5 marks each)

24. Refer NCERT Text Book Page no. 241-250.

## Assertion Reasoning

(1 mark each)

The following question consists of 2 statements - Assertion (A) and Reason (R). Answer the question by selecting the appropriate option below :

25. **Assertion (A) :** Plant growth regulators are phytohormones, they are required for various metabolic activities for growth in plants.

**Reason (R) :** Auxins, if applied on *Pinus*, will not induce flowering.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) Both A and R are true and the reason is not a correct explanation of the assertion
  - (c) The assertion A is true but the reason R is false
  - (d) Both the assertion A and reason R are false
  - (e) The assertion A is false but the reason R is true
26. **Assertion (A) :** Plant growth is measurable.

**Reason (R) :** Growth only means addition of dry weight in the plant.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
  - (b) Both A and R are true and the reason is not a correct explanation of the assertion
  - (c) The assertion is true but the reason is false
  - (d) Both the assertion and reason are false
  - (e) The assertion is false but the reason is true
27. **Assertion (A) :** 'r' in logistic growth means exponential growth.

**Reason (R) :** It is also known as the efficiency index.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

28. **Assertion (A) :** Heterophylly in larkspur is due to dedifferentiation.

**Reason (R) :** There is no role of environment in plasticity.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

29. **Assertion (A) :** Cytokinin is produced in actively dividing cells.

**Reason (R) :** It helps in producing new leaves and shoots in plants.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) Both A and R are true and the reason is not a correct explanation of the assertion
- (c) The assertion is true but the reason is false
- (d) Both the assertion and reason are false
- (e) The assertion is false but the reason is true

### **Solution:**

#### **Assertion Reasoning**

- 25. (b) (Plant growth regulators regulate growth but will not induce flowering)
- 26. (c) (Growth is measured by a variety of parameters some of which are: increase in fresh weight, dry weight, length, area, volume and cell number)
- 27. (e) ('r' is relative growth rate)
- 28. (d)
- 29. (a)

**Source-based/Case-based/Passage-based/Integrated assessment questions**  
**(4 marks each)**

Read the following and answer any **four** questions from (i) to (v) given below :

30. The process by which prolonged exposure to cold temperatures.  $4^{\circ}\text{C}$  or less, promotes flowering is called vernalisation. It was first studied in 1918 by Gassner. It is believed that due to prolonged cold treatment, a hypothetical hormone like substance vernalin is produced in meristematic regions which induce flowering. Some monocarpic plants, which die one they flower, require vernalism to flower, mostly requiring two seasons to complete the life cycle. Such plants are biennials or winter annuals. Cold exposure is a most for such plants to flower. Some monocarpic plants that are annuals but they do not require any cold treatment for flowering, such plants are called summer annuals. Many perennial such as stone fruit plants also require cold treatment to flower. Winter cereals such as autumn wheat also require cold treatment to flower. If such wheat is grown in spring, it will continue growing vegetatively and will flower only after the upcoming winter season. Vernalisation can be reversed. It is done for sowing seeds of onions which are stored in cold storage for long. Applying plant growth regulators which cause bakanae disease can also help some seeds to germinate and skip prolonged cold periods.

(i) Which hypothetical precursor hormone is believed to be produced in meristematic regions of plants after vernalisation?

- (a) Photolin
- (b) Vernalin
- (c) florigen
- (d) morphactin

(ii) The plants which die after flowering are called \_\_\_\_\_?

- (a) Polycarpic plants
- (b) Bicarpic plants
- (c) Monocarpic plants
- (d) Plietesialic plants



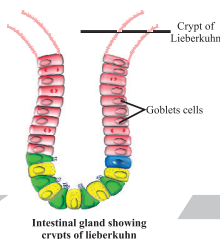
- (iii) Spring wheat does not require prolonged cold treatment for flowering. (T/F)
- (iv) Name any two monocarpic plants that require vernalisation.
- (v) Which of the following plant growth regulators can replace vernalisation?
  - (a) Gibberellin
  - (b) Auxin
  - (c) Cytokinin
  - (d) Ethylene

### **Solutions:**

#### **Source-based/Case-based/Passage-based/Integrated assessment questions**

30. (i) (b) Vernalin
- (ii) (c) Monocarpic plants
- (iii) True
- (iv) Sugarbeet, cabbage, carrots (any two)
- (v) (a) Gibberellin





## Chapter - 16

# Digestion and Absorption

### Points To Remember

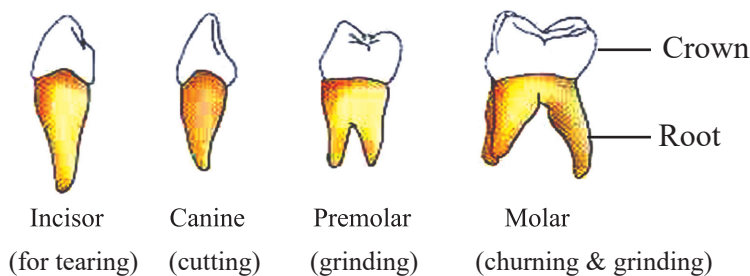
**Digestion :** The process in alimentary canal by which the complex food is converted mechanically and biochemically into simple substances suitable for absorption and assimilation in the body of animals/organisms.

**Food :** A substance which is taken and digested in the body to provide material for growth, repair & energy for reproduction and resistance from disease or regulation of body processes.

**Thecodont :** The teeth embedded in the sockets of the jaw bone, *e.g.*, in mammals.

**Diphyodont :** The teeth formed twice in life time *e.g.*, in mammals.

**Heterodont :** Different types of teeth. An adult human has 32 permanent teeth which are of four different types.



### Different Types of Teeth DENTAL FORMULA OF HYMANS

Milk Teeth

I C PM M.

2 1 2 0 X2 = 20

2 1 2 0

Upper half jaw

Lower half jaw

Permanent Teeth

I C PM M.

2 1 2 3

2 1 2 3

**Peristalsis** : The involuntary movement of the gut by which the food bolus is pushed forward.

**Deglutition** : The process of swallowing of food bolus. It is partly voluntary and partly involuntary.

**Ruminants** : The herbivorous animals (*e.g.*, cow, buffalo etc.) which have symbiotic bacteria in the rumen of their stomach, which synthesize enzymes to hydrolyse cellulose into monosaccharides.

**Diarrhoea** : The abnormal frequent discharge of semisolid or fluid faecal matter from the bowel.

**Vomiting** : The ejection of stomach contents through the mouth, caused by antiperistalsis.

**Dysentery** : Frequent watery stools often with blood and mucus, along with pain, fever and causes dehydration.

**Chyme** : The semifluid mass, into which food is converted by gastric secretion, which passes from the stomach into the small intestine.

**Gastric** : Anything associated with stomach is given a prefix ‘gastric’.

**Proenzyme** : The inactive forms of enzymes.

**Sphincter** : A flap like structure at various junctions of the alimentary canal which facilitates one way traffic (movement of material) in the alimentary canal.

**Bolus** : The masticated food mixed with saliva.

**Hepatic** : Anything associated with liver is given a prefix ‘hepatic’.

**Goblet cells** : The cells of intestinal mucosal epithelium which secrete mucus.

**Glisson’s capsule** : The connective tissue sheath which covers the hepatic lobules of liver.

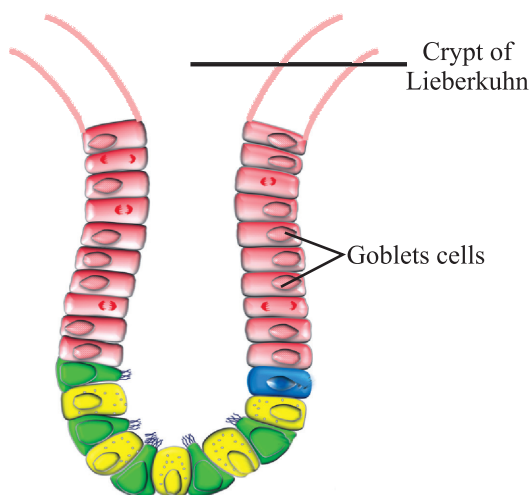
**Hepatic lobules** : The structural and functional units of liver containing hepatic cells which are arranged in the form of cords.

**Sphincter of Oddi** : The sphincter which guard the opening of common hepatopancreatic duct.

**Villi** : The small finger-like folding in the small intestine which increase the surface area for absorption of digested food.

**Crypts of Lieberkuhn**—pits of intestine/tubular intestinal glands.

**Succus entericus**—Intestinal juices, secreted in small intestine.



Intestinal gland showing  
crypts of lieberkuhn

### Basic Steps of Holozoic Nutrition :

- (1) **Ingestion** : Intake of food.
- (2) **Digestion** : Breaking down of complex organic food materials into simpler, smaller water soluble molecules.
- (3) **Absorption and assimilation** : Absorption of digested food into blood or lymph and its use in the body cells for synthesis of complex components.
- (4) **Egestion** : Elimination of undigested food as faeces :

**Digestive glands : (A) Salivary gland**—3 types are (1) Parotids (cheek)

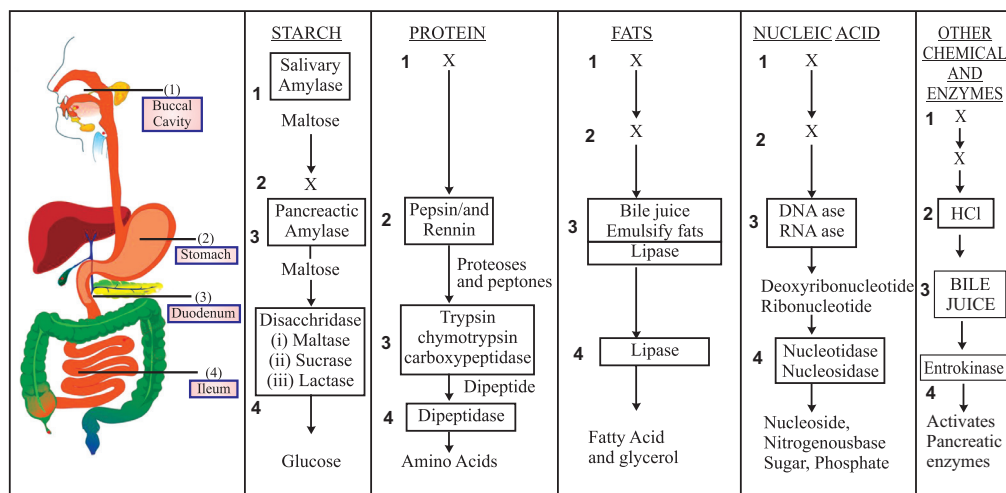
(ii) Sublinguals (Below the tongue) (iii) Submaxillary or submandibular (lower jaw) Secrete saliva which contains ptyalin (Salivary Amylase).

**(B) Pancreas** : A dual gland that secretes pancreatic juice and also secretes Hormones. Located between limbs of U shaped duodenum.

**(C) Liver** : In abdominal cavity (1.2–1.5 kg.)

2 lobed → Hepatic lobules → Hepatic cells (arranged as cords) → Secrete bile  
→ Goes to hepatic ducts → bile stored in gall bladder.

## COMPLETE PROCESS OF DIGESTION



## ABSORPTION OF FATS

- Fatty acids and monoglycerides and Glycerol (insoluble).
- Micelles (tiny spheres with hydrophilic ends) formed.
- Absorbed by epithelial cells of small intestine (simple diffusion)
- They are reformed into very small protein coated fat globules called chylo-microns.
- Chylomicrons transported into lymph vessels (lacteals) in the villi.
- Lymph vessels release the absorbed substances into bloodstream
- **Malnutrition**—When a person is not getting enough food or getting unbalanced diet.

## PEM—Protein Energy Malnutrition

Kwashiorkar	Marasmus
<p>The word means ‘rejected child’</p> <ul style="list-style-type: none"> <li>• It is a disorder found in children 1-5 years of age, where child is weaned off mother’s milk very early.</li> <li>• Children get low protein and low carbohydrate diet are affected.</li> </ul>	<p>Word marasmus means wasting away</p> <ul style="list-style-type: none"> <li>• Child remaining under-nourished suffer from marasmus. Usually found in children below the age of 1 year.</li> <li>• It is caused by deficiency of protein &amp; carbohydrate &amp; fat.</li> </ul>

DIGESTION AND ABSORPTION					
Part of alimentary canal	Name of glands	Enzymes/ secretion	Substrate	End Products	pH
Buccal cavity	Salivary glands	Salivary amylase	Starch	Maltose	Slightly acidic
oesophagus	—	—	—	—	—
Stomach	Gastric glands (mucosal)	Gastric Juice	Activates pep-sinogen	Pepsin	Highly Acidic
		HCL			
		Pepsin	Protein	Peptone	
		Renin (in calves & infants)	caesin (milk protein)	Ca++ & paracae-sinate	
		Mucus (protects stomach walls)			
Small intestine. (duodenum)	Liver (through duct)	Bile Juice	Fats	Emulsify fats	Alkaline
	Pancreas (through duct)	Pancreatic Juice			Alkaline
		Trypsin	Proteins	Peptones/ polypeptides	
		Carboxypepti-dase	Milk proteins/ peptides	Dipeptides or amino acids	
		Amylase	Starch	Glucose	
		Lipase	Lipids	Fatty acids & Glycerol	
	Nucleases	RNA, DNA	nucleotides		
	Intestinal mucosa	Succus entericus			Alkaline
		Enterokinase	Trypsinogen	Trypsin	
		Dipeptidase	Dipeptides	Amino acids	
		Lipase	Lipids	Fatty acids + Glycerol	
		Maltase/sucrase/ lactase	Maltose/ sucrose/ lactose	Glucose/ Fructose/ Galactose	
		Nucleotidase/ Nucleosidase	Nucleotides/ Nucleosides	Nucleoside/free base	
Small Intestine (Ileum)	ABSORPTION OF DIGESTED FOOD				
	Passive diffusion	Active Diffusion		Facilitated Diffusion	
	Movement of molecules as per conc. gradient	against concen. gradient		Diffusion of some ions and polar molecules	
	No ATP utilised	ATP used		membrane proteins required	
	glucose, amino acids, chloride ions	amioacids, glucose, sodium		Fructose and some amino acids	

## Symptoms

<u><b>Kwashiorkar</b></u>	<u><b>Marasmus</b></u>
1. Stunted growth	1. Low body weight
2. Dry & scaly skin	2. Wasting of muscles
3. Odema (retention of water in tissues)	3. Prominent ribs
4. Match stick legs	4. Sunken Eyes
5. Protrude Belly	5. Lean body with thin limbs
	6. Mental retardation

## Cure

Feeding the child with protein rich diet including milk, soyabean, egg etc.	Child should be given protein diet with enough quantity of carbohydrates & fats.
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**Calorific Value :** Amount of heat energy released by 1 gm of substrate after complete oxidation.

Calorific value of Carbohydrates is  $4.1 \text{ k.cal/g} = 17.1 \text{ kj/g}$

Protein is  $5.6 \text{ kcal/g} = 23.4 \text{ kj/gm}$

Fats is  $9.4 \text{ kcal/g (app.)} = 39.2 \text{ kj/gm}$

## Questions

### Very Short Answer Questions

(1 mark each)

1. What do you mean by the term malnutrition ?
2. Name the hardest substance in the body.
3. What is a lacteal and what is its function ?
4. Name the small projections, found on the upper surface of tongue.
5. Mention the function of epiglottis.
6. Write the names of major parts of stomach.
7. Name the enzyme that digests fats. Mention the end products of fat digestion.
8. In which part of alimentary canal absorption of water, simple sugars and alcohol takes place ?
9. Why are proteases generally released in inactive form ?

10. Trypsinogen is an inactive enzyme of pancreatic juice. An enzyme, enterokinase, activates it. Which tissue/cell secrete this enzyme ? How is it activated ?
11. What is the role of insulin ?
12. Name any one country where children affected from PEM are found more.

### Short Answer Questions-I

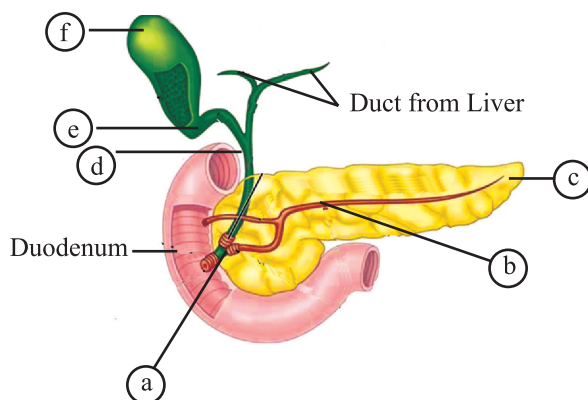
(2 marks each)

13. What is emulsification ? Where and how does it occur ?
14. Name three parts of large intestine. Which vestigial organ arises from the first part of it ?
15. Name the digestive gland which acts as exocrine and endocrine. Also name the products which are secreted by it.
16. The wall of alimentary canal is made up of four layers. Give the names of these four layers.
17. Hydrochloric acid is found in our stomach. What purpose does it serve in alimentary canal ?
18. In which part of the digestive system the absorption of following substances takes place ?
  - (a) Certain drugs
  - (b) Glucose, fructose and fatty acids
  - (c) Water, some minerals and drugs
  - (d) Simple sugar and alcohol
19. Differentiate between chylomicron and micelles.

### Short Answer Question-II

(3 mark each)

20. In the following diagram of duct system of liver, gallbladder and pancreas, label a, b, c, d, e and f :





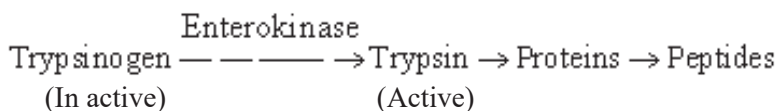
21. Give a diagrammatic representation of transverse section of gut.
22. Draw the sketch of anatomical regions of human stomach and label any four parts in it.
23. How does the nervous system control the activities of gastro-intestinal tract ?
24. Draw a labelled figure of digestive system of human.
25. Give a summary of cause and symptoms of following disorders of digestive system :
  - (a) Jaundice
  - (b) Vomiting
  - (c) Diarrhoea
  - (d) Constipation
  - (e) Indigestion

## Answers

### Very Short Answer

(1 mark each)

1. The state of health due to improper intake of food or nutrients. It covers both under nutrition as well as over nutrition.
2. Enamel
3. Lymph vessel found in villi. They help in absorption of fat globules and then release them into blood stream.
4. Papillae. Some Papillae have taste buds.
5. Prevent the entry of food into the glottis.
6. Cardiac, fundic, pyloric.
7. Lipase, fatty acids and glycerol.
8. Stomach
9. If released in active form, they will start digesting the membranes and muscular walls of the alimentary canal.
10. Intestinal Mucosa.



11. Metabolism of sugar.
12. African countries– Somalia & others.

### Short Answer Questions–I

(2 marks each)

13. The process of breakdown of large fat droplets into smaller ones. It occurs in duodenum of small intestine. It is brought about by bile salts through reduction of surface tension of large fat droplets.
14. Caecum, colon and rectum. Vermiform appendix.
15. Pancreas. Exocrine secretion is pancreatic juice containing enzymes and endocrine secretions are hormones : Insulin and glucagon.
16. Serosa, muscularis, submucosa and mucosa.
17. (i) Killing of germs present in food  
(ii) Conversion of inactive pepsinogen into active form pepsin.
18. (a) Mouth  
(b) Small intestine  
(c) Large intestine  
(d) Stomach

19.	<b>Chylomicron</b>	<b>Micelles</b>
	1. Protein coated water soluble fat droplets released into the lymph.	Formed by combination of fatty acid, monoglycerides and bile salts.
	2. In this form fats lipids are put into circulation	In this form digested fats are absorbed in intestinal cells in alimentary canal.

### Short Answers Questions–II

(3 marks each)

19. Refer Fig. 16.6, Page no. 261 (NCERT Text Book, XI Biology).
20. Refer Fig. 16.4, Page no. 260 (NCERT Text Book, XI Biology).
21. Refer Fig. 16.3, Page no. 259 (NCERT Text Book, XI Biology).
22. Refer page. 264 (NCERT Text Book, XI Biology).
23. (a) Sight/smell of food → secretion of saliva.  
(b) Neural signal → gastric intestinal secretion.  
(c) CNS and local control over muscular movement.

### Long Answers

(5 marks each)

24. Refer Fig. 16.1, Page no. 258 (NCERT Text Book, Class XI Biology).
25. Refer Page no. 265-266 (NCERT Text Book, Class XI Biology).

### Case-based questions :

26. When I do not sleep... then the metabolic activities of my body get affected badly. Various food components once ingested, voluntarily by me are passed on to my oesophagus. This process now is an involuntary action which is now called peristalsis. My stomach works hard to grind the food which was chewed up by my mouth, it also secretes HCl to make surroundings acidic, so as to help in protein digestion. My liver gets filled up by the toxicity from the proteins (ammonia), which were completely digested in the small intestine. My hard working liver also converts fats into an energy source for the body. My intestines look forward to the much-needed rest they need, after their villi have absorbed the final products of digestion and passed it over to my blood. My pancreas screams for help as the Insulin secreted by it, unable to control the increase of the glucose in my blood.. My brain starts getting electrocuted by constantly responding to the huge variety of stimuli being fed into my system continuously... thus increasing my stress. So dear eyes close yourself on time and sleep peacefully. This much needed sleep on time, provides the much-needed rejuvenation to the metabolism of our body!
1. What is the end product of the digestion of proteins in the intestines, which is passed on to the blood?
    - (a) Monosaccharides
    - (b) Amino acids
    - (c) Fatty acids
    - (d) Nucleosides
  2. Define metabolism.
    - (a) Sum total of catabolic processes
    - (b) Sum total of anabolic processes
    - (c) Sum total of catabolic and anabolic processes.
    - (d) None of the above
  3. Which hormone is secreted by the pancreas?
    - (a) Salivary amylase
    - (b) Insulin
    - (c) Glucagon
    - (d) Insulin and glucagon

4. Why sleeping on time is essential for the body?

- (a) To have a perfect circadian rhythm
- (b) To rejuvenate metabolism
- (c) To pass time
- (d) Both (a) & (b)

5. **Assertion :** The liver is the largest gland of the body.

**Reason :** Each lobule is covered by a thin connective tissue sheath called Glisson's capsule.

DIRECTION, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
- (b) If both (A) and (R) true, but (R) is not the correct explanation of (A)
- (c) If (A) is true but (R) is false
- (d) If both (A) and (R) are false

**Assertion reasoning questions:**

DIRECTIONS, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
- (b) If both (A) and (R) true, but (R) is not the correct explanation of (A)
- (c) If (A) is true but (R) is false
- (d) If both (A) and (R) are false

27. **Assertion :** The innermost layer lining the lumen of the small intestine is mucosa and is called villi.

**Reason :** It increases the surface area of the small intestine.

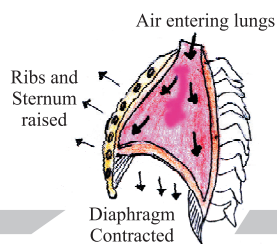
28. **Assertion :** The teeth help in the mastication of food.

**Reason :** The hard chewing surface of the teeth is made up of enamel.

**Solutions :**

- 26. 1. (b)
  - 2. (c)
  - 3. (b)
  - 4. (d)
  - 5. (b)
27. (a)
28. (a)





## Chapter - 17

# Breathing and Exchange of Gases

### Points To Remember

**Breathing :** (External respiration) The process of exchange of  $O_2$  from the atmosphere with  $CO_2$  produced by the cells.

**Carbamino haemoglobin :** Compound formed in RBCs when  $CO_2$  combine with haemoglobin.

**Inspiration :** Oxygen from fresh air taken in by lungs and diffused into the blood.

**Expiration :**  $CO_2$  given up by venous blood in the lungs is sent out to exterior.

**Respiration :** The sum total of physical and chemical processes by which oxygen and carbohydrates (main food nutrient) etc are assimilated into the system and the oxidation products like carbon dioxide and water are given off.

**Diaphragm :** A muscular, membranous partition separating the thoracic cavity from the abdominal cavity.

**Hypoxia**—Shortage of oxygen in tissues.

**Partial Pressure**—The pressure contributed by an individual gas in a mixture of gases. It is represented as  $pO_2$  for oxygen and  $pCO_2$  for carbondioxide.

**Pharynx :** The tube or cavity which connects the mouth and nasal passages with oesophagus. It has three parts (i) Nasopharynx (anterior part) (ii) Oropharynx (middle part) and (iii) Laryngopharynx (posterior part which continues to larynx)

**Adam's Apple :** The projection formed by the thyroid cartilage and surrounds the larynx at the front of the neck.

**Tidal volume (TV) :** Volume of air taken in/given out during normal respiration (500 mL.)

**Inspiratory Reserve Volume (IRV) :** Additional volume of air inspired by a forcible inspiration. 2500mL to 3000mL.

**Expiratory Reserve Volume (ERV) :** Additional volume of air, a person can expire by a forcible expiration.

**Residual volume (RV) :** Volume of air remaining in the lungs even after a forcible expiration (1100 mL to 1200 mL)

**PULMONARY CAPACITIES :** Use in clinical diagnosis.

**Inspiratory capacity (IC)** = (TV + IRV) Total volume of air a person can inspire after a normal expiration.

**Expiratory Capacity**—Total Volume of air a person can expire after a normal inspiration E.C. = TV + ERV

**Functional Residual Capacity**—Volume of air that will remain in lungs after a normal expiration (FRC) = (ERV + RV)

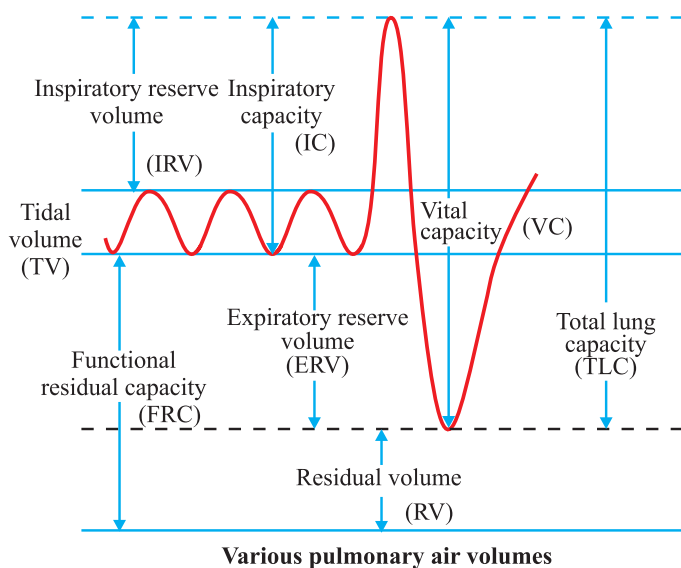
**Vital Capacity (VC)** = (ERV + TV + IRV) or the maximum volume of air a person can breath out after a forced inspiration.

**Total Lung Capacity :** It includes RV, ERV, TV and IRV or vital capacity + residual volume.

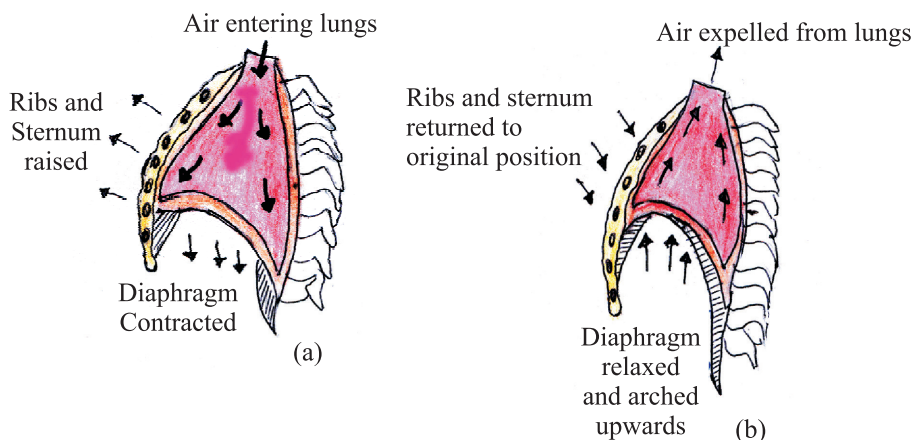
**Pulmonary**—Anything associated with the lungs is given the prefix ‘pulmonary’

**Steps involved in respiration—**

- (i) Breathing or pulmonary ventilation (intake of atmospheric air and releasing out  $\text{CO}_2$  rich alveolar air)
- (ii) Diffusion of gases ( $\text{O}_2$  and  $\text{CO}_2$ ) across alveolar membrane & blood vessel (capillaries).
- (iii) Transport of gases by the blood.
- (iv) Diffusion of  $\text{O}_2$  and  $\text{CO}_2$  between blood and tissues.
- (v) Utilisation of  $\text{O}_2$  by the cells for catabolic reactions and resultant release of  $\text{CO}_2$ .



## Mechanism of Breathing



Mechanism of breathing showing (a) Inspiration (b) Expiration

Inspiration	Expiration
Contraction of diaphragm and external intercostal muscles	Relaxation of diaphragm and sternum
↓	↓
Increase in the volume of thoracic chamber	Decrease in the volume of thoracic chamber
↓	↓
Lungs expand	Lungs contract
↓	↓
Pressure inside the lungs fall	Pressure inside the lungs increase
↓	↓
Air rushes into lungs from Atmosphere	Air rushes out from lungs in to Atmosphere

### Respiratory Tract :

A pair of external nostrils → nasal chamber through nasal passage → pharynx → glottis → larynx → trachea → Left and right primary bronchi → secondary and tertiary bronchi → bronchioles → vascularised bag like structures (alveoli) or air-sacs. Each lung is covered with double layered membrane known as pleura with pleural fluid between them.

### Respiratory organs in animals :

- (i) Protozoans, annelids Frogs—**Body surface**

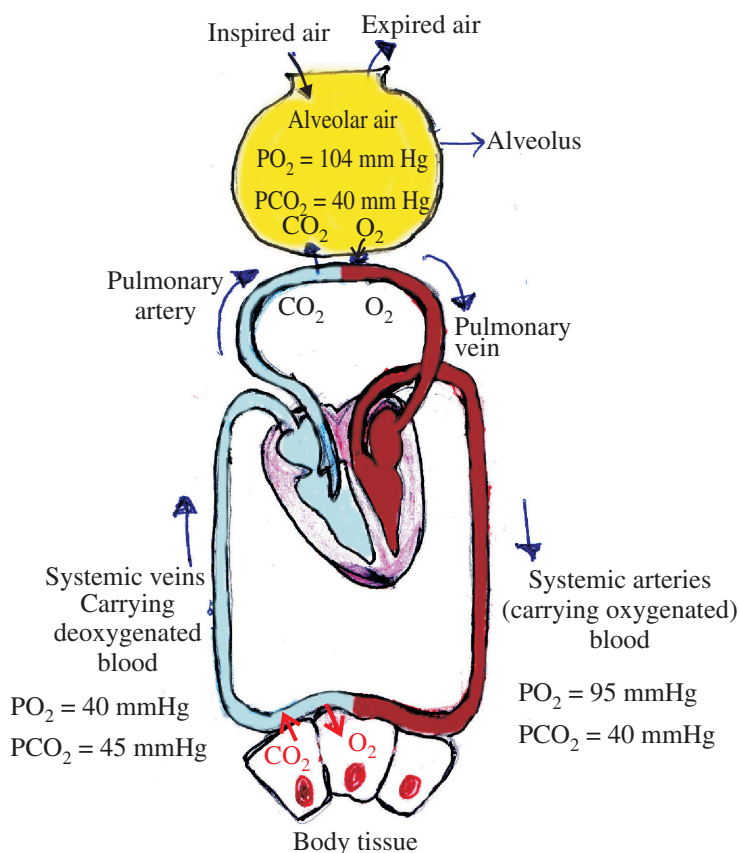
- (ii) Fishes, tadpole stage of frog and many other aquatic animals—**Gills** (Branchial Respiration)
- (iii) Insects and a few other arthropods—**Tracheal tubes**
- (iv) All land vertebrates (amphibians, reptiles, aves and mammal)—**Lungs**. (Pulmonary Respiration)

### Conditions required for (cutaneous respiration)

Skin should be moist and thin. It should be highly vascularised.

### Physiology of Respiration :

- (a) **Exchange of gases**—Diffusion of gases takes place from the region of higher partial pressure to lower (lesser) partial pressure)
- (i)  $pO_2$  in alveolar air = 104 mm Hg.
  - (ii)  $pO_2$  in venous blood = 40 mm Hg.  
 $O_2$  diffuses from alveoli to venous blood.
  - (iii)  $pCO_2$  in venous blood = 45 mm Hg.  
 $pCO_2$  in alveolar air = 40 mm Hg.  
 $CO_2$  diffuses from venous blood to alveoli





**(b) Transport of O<sub>2</sub> by the blood** — (i) About 3% of O<sub>2</sub> in dissolved state through plasma.

**(ii) As oxyhaemoglobin :** 97% of O<sub>2</sub> diffuses from plasma into RBCs.

Haemoglobin carry 1-4 molecules of O<sub>2</sub>.



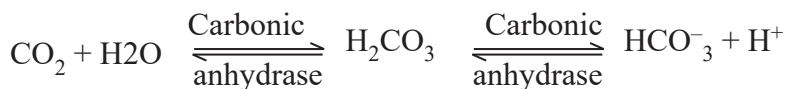
### Oxygen dissociation curve

- A sigmoid curve showing relationship between the % of saturation of haemoglobin with oxygen in blood and pO<sub>2</sub> of the blood.
- Fully saturated each gram of haemoglobin combines with nearly 1.34 ml of oxygen.
- H<sup>+</sup> concn., CO<sub>2</sub> tension, temperature affect the curve. Increase in their concentration decreases the affinity of hemoglobin for oxygen.

### (c) Transport of CO<sub>2</sub>

(i) As solution – 7% of CO<sub>2</sub> dissolves and carried by the plasma.

(ii) As Bicarbonate – 70% of CO<sub>2</sub> in RBCs combines with water form carbonic acid. Carbonic acid dissociates into bicarbonate ions and H<sup>+</sup>, Carbonic anhydrase enzyme help in these reactions.



(iii) As carbaminohaemoglobin – 23% CO<sub>2</sub> combines in RBC with amino group of haemoglobin, form carbaminohaemoglobin.

## Regulation of Respiration

- Respiratory rhythm centre in medulla of brain responsible for this regulation.
- Pneumotaxic centre in pons region moderates function of respiratory rhythm centre.
- Chemosensitive area adjacent to rhythm centre is highly sensitive to CO<sub>2</sub> and H<sup>+</sup> ions.

- Increase in  $\text{CO}_2$  and  $\text{H}^+$  ions activates this centre, which in turn signal the rhythm centre to make necessary adjustments and respiratory process by which these substances can be eliminated.

## Disorders of Respiratory System

- Emphysema– chronic disorder in which alveolar walls damaged due to cigarette smoking
- Asthma–difficulty in breathing due to inflammation of bronchi or bronchioles,
- Occupational disorders– people working in stone grinding or breaking industries, the dust produced damage the defence system of body leading to servere lung damage.

## Questions

### Very Short Answer Questions

(1 mark each)

1. Name the organ in human respiratory system which produces sound.
2. How many oxygen molecules can be carried out by one haemoglobin molecule.
3. Give the name and function of a fluid filled double membranous layer which surrounds the lungs.
4. Which organ of our respiratory system acts as primary site of exchange of gases ?
5. Cigarette smoking causes emphysema. Give reason.
6. Name the principle or process of exchange of gases.
7. What is the role of oxyhaemoglobin after releasing molecular oxygen in the tissues ?
8. Name the muscles which facilitate breathing.
9. How is the entry of food prevented in the respiratory tract ?
10. About 97% of  $\text{O}_2$  is transported by RBCs in the blood. How does the remaining 3% of  $\text{O}_2$  transported ?

### Short Answer Questions

(2 marks each)

11. Draw a labelled diagram of a section of an alveolus with a pulmonary capillary.
12. Following is the table showing partial pressure (in mm Hg) of oxygen and carbondioxide) at different parts involved in diffusion in comparison to those in atmosphere. Fill in the blank –a, b, c and d.

Respiratory gases	Atmospheric air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissue
O <sub>2</sub>	(a)	104	40	(d)	40
CO <sub>2</sub>	0.3	(b)	(c)	40	45

13. Name the organs of respiration in the organisms.

(a) Flatworms    (b) Birds    (c) Frog    (d) Cockroach

14. What are occupational respiratory disorders ? What are their harmful effects ? What precautions should a person take to prevent such disorders ?

15. How is respiration different from breathing ?

### Short Answer Questions-II

(3 marks each)

16. Explain the role of neural system in regulation of respiration in human.

17. How is carbon dioxide transported in blood?

### Long Answer Questions

(5 marks each)

18. With the help of labelled diagram explain the structure of human respiratory system.

19. Explain the mechanism of breathing with the help of labelled diagram involving both stages—inspiration and expiration.

20. Explain the process of exchange of gases with the help of a diagrammatic representation in human respiratory system.

### Case Based

21. Breathing is a physical phenomenon where oxygen from the atmosphere is exchanged with the carbon dioxide produced by the cells. Various organisms have different mechanisms for breathing depending upon their needs and habitat. For example, lower invertebrates like sponges exchange gases by simple diffusion while earthworms use cuticle and insects have a network of tubes to transport atmospheric air within the body. Special vascularized structures called gills are used by aquatic arthropods and mollusks whereas

vascularised bags called lungs are used by terrestrial forms for the exchange of gases. Fishes use gills while birds and mammals have lungs and amphibians use their moist skin to exchange gases.

1. **Assertion (A)** : Breathing is different from respiration.

**Reason (R)** : Breathing is physical and respiration is biochemical.

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
  - (b) If both (A) and (R) are true, but (R) is not the explanation of (A)
  - (c) If (A) is true but (R) is false
  - (d) If both (A) and (R) are false
2. Why is the mechanism of breathing different for different organisms?
- (a) To meet their needs
  - (b) To help them adapt to their environment
  - (c) To suit their mode of life
  - (d) All of the above
3. What special name is given to the vascularised bags of terrestrial animals and vascularised structures of aquatic arthropods and molluscs?
- (a) Gills and lungs respectively
  - (b) Lungs and trachea respectively
  - (c) Lungs and gills respectively
  - (d) Gills and trachea respectively
4. How do lower invertebrates like sponges exchange gases?
- (a) Diffusion
  - (b) Osmosis
  - (c) Breathing
  - (d) Cuticle exchange

5. **Assertion :** The larynx is called the sound box.

**Reason :** The larynx is a cartilaginous box that helps in sound production.

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
- (b) If both (A) and (R) are true, but (R) is not the explanation of (A)
- (c) If (A) is true but (R) is false
- (d) If both (A) and (R) are false

**Assertion reasoning type questions :**

**DIRECTIONS :** In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
- (b) If both (A) and (R) are true, but (R) is not the explanation of (A)
- (c) If (A) is true but (R) is false
- (d) If both (A) and (R) are false

22. **Assertion :** Most fish when out of water die of suffocation.

**Reason :** Atmospheric air contains far less oxygen content than the dissolved oxygen in water.

23. **Assertion :** Aerobic animals are not truly aerobic.

**Reason :** They produce lactic acid anaerobically.

24. **Assertion :** During inspiration pressure of air falls in the thorax.

**Reason :** There is a rise in the volume of the thorax during inspiration.

25. **Assertion :** Symptoms of emphysema develop when a person living on planes ascends and stays on a mountain.

**Reason :** Air pressure and partial pressure of oxygen fall with the rise in altitude.

## Answers

### Very Short Answers

(1 mark each)

1. Larynx (Sound box)
2. Four molecules of  $O_2$ .
3. Pleura. It reduces the friction and the two pleura together and the protect the lungs.
4. Alveoli of lungs.
5. Cigarette smoking damages alveolar walls due to alveolar sacs remaining filled with air leading to decreased respiratory surface for exchange of gases.
6. Diffusion.
7. Amino group of reduced haemoglobin combines with  $CO_2$  forming carbamino haemoglobin to transport  $CO_2$ .
8. External and internal intercostals muscles, situated between ribs.
9. During swallowing a cartilaginous flap like structure called epiglottis covers the glottis and prevents the entry of food into respiratory tract.
10. In simple solution form through plasma.

### Short Answers-I

(2 marks each)

11. Refer fig 17.4, page 273 (NCERT Text Book Class XI Biology)
12. Refer fig 17.1, page 272 (NCERT Text Book Class XI Biology)
13. (a) Body surface (b) lungs (c) skin and lungs (d) Network of trachea
14. Refer Topic 27.6 at page 275 (NCERT Text Book Class XI Biology)
15. Slow oxidation of food to release energy is called respiration while breathing is a biophysical process which is the first step of respiration.

### Short Answers-II

(3 marks each)

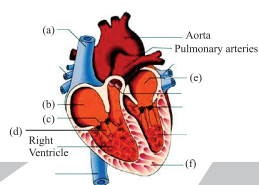
16. Refer page 275 (17.5) (NCERT Text Book Class XI Biology).
17. Refer content 17.4.2 transport of Carbon dioxide on page no. 274-275 (NCERT Text book XI Biology).

### Long Answers-II

(5 marks each)

18. Refer content 17.1.1 page 269, diagrams 17.1, page 269 (NCERT Text Book Class XI Biology).
19. Refer content 17.2 and fig 17.2 page 270–271 (NCERT Text Book Class XI Biology)/Support material “Points to remember” of this chapter.
20. Refer content 17.3 and fig 17.3 page 272–273 (NCERT Text Book Class XI Biology)/Support material “Points to remember” of this chapter.
21.
  1. (a)
  2. (d)
  3. (c)
  4. (a)
  5. (a)
22. (c)
23. (a)
24. (a)
25. (a)





## Chapter - 18

## Body Fluids and Circulation

### Points To Remember

**Blood :** A special connective tissue that circulates in principal vascular system of man and other vertebrates consisting of fluid matrix, plasma and formed elements (Blood = Plasma + All blood cells).

**Plasma :** (Blood – All blood cells = Plasma) The liquid part of blood which is straw coloured, viscous fluid and contains about 90-92% of water and 6-8% proteins.

**Lymph :** A clear yellowish, slightly alkaline, coagulable tissue fluid, containing white blood cells (Only lymphocytes), a liquid resembling blood plasma.

**Serum :** Blood plasma from which fibrinogen and other clotting factors have been removed. [Plasma– (fibrinogen & other clotting factor)] = blood serum.

**Heart Beat :** The rhythmic contraction and relaxation of the heart, which includes one systole (contraction phase) and one diastole (relaxation phase) of the heart. Heart beat count of healthy person is 72 times per minute.

**Stroke Volume :** The volume of blood pumped out by the heart during a systole. It is approximately 70 ml.

**Cardiac output :** The amount of blood pumped by heart per minute is called cardiac or heart output. The value of cardiac output of a normal person is about  $72 \times 70 = 5040$  mL or about 5L per minutes.

**Cardiac Cycle :** The rhythmic contraction and dilation of different parts of heart in one beat.

**Systole :** Contraction of heart muscles.

**Diastole :** Relaxation of heart muscles



## TYPES OF BLOOD CELLS THEIR NUMBER, STRUCTURE & FUNCTIONS

Name and Number/ Percentage	Structure	Life Span and Formation	Function
<b>(A) Erythrocytes RBCs</b> - 4.5 to 5.5 million per cubic millimetre of blood	Red colour Circular, biconcave denucleated, elastic lack of cell organelles like ER, ribosomes, mitochondria etc.	Formed from birth onward by red bone marrow Life-120 days excess RBCs are stored in spleen	Transport of oxygen and some amount of carbon dioxide through haemoglobin
<b>(B) Leucocytes</b> (WBCs) 5000-8000 per cubic mm of blood	Colourless rounded or irregular, nucleated 12 to 20mm wide, life 1-4 days	Formed in red bone marrow, Lymph nodes, spleen and thymus, life-1-4 days	Acts as soldiers scavenger and some help in healing
(i) Agranulocytes (a) Lymphocytes 20-45% of leucocytes	Large rounded nucleus, 6-10 mm	Lymph nodes, spleen, thymus red bone marrow, life few days to months or even years	Non Phagocytic secrete antibodies
(b) Monocytes 6-8% of leucocytes,	Largest of all (12-15 mm) bean shaped nucleus	Red Bone marrow, life 10-20 hours	phagocytic, very motiles engulf germs
(ii) Granulocytes (a) Eosinophils 2-3% of leucocytes	bilobed nucleus, granules in cytoplasm	Red Bone marrow, life 4 to 8 hrs. in blood	play role in immunity non phagocytic
(b) Basophils 0-5% of leucocytes	Three lobed nucleus (s-shaped)	Red Bone marrow, life 4 to 8 hours in blood	release heparin and histamine
(c) Neutrophils 60-65% of leucocytes	Many lobed nucleus fine granules	Red Bone marrow, life 4 to 8 hours in blood	phagocytic, engulf germ and dead cells
<b>(C) Platelets</b> thrombocytes 1,50,000-3,50,000 per cubic mm of blood	Colourless, rounded or oval, or irregular non-nucleated fragments	Red Bone marrow worn out ones phagocytized in blood	help in blood clotting

**Blood Pressure**—The resistance offered by the lumen of the artery to the flow of Blood.

**Hypertension** : The condition when blood pressure is higher than normal (120/80 mmHg)

**Electrocardiograph** : (ECG) the machine used to record electrocardiogram.

**Electrocardiogram ECG** : The print out of pattern of heart beat taken on a graph paper from Electrocardiograph. (ECG machine)

## Lymph

The colourless mobile fluid connective tissue drains into the lymphatic capillaries from the intercellular spaces. It is formed by squeezing of blood through capillaries, within tissues. Its flow is unidirectional *i.e.*, from tissues to heart.

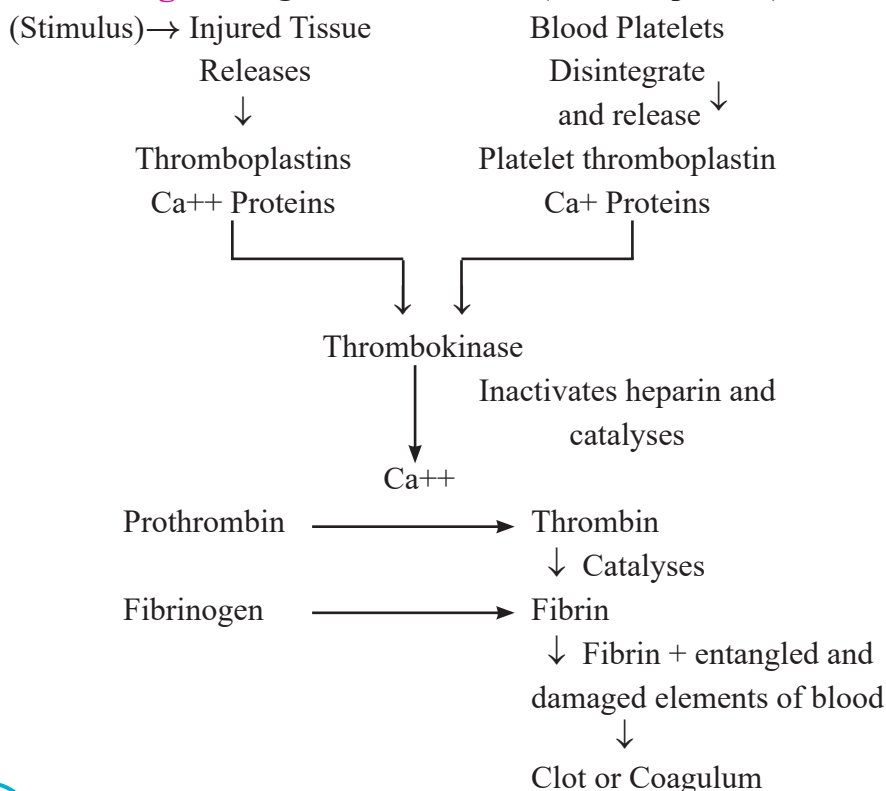
**Composition** : It is composed of fluid matrix, plasma having only lymphocytes of white blood corpuscles or leucocytes.

**Functions** : (i) It drains excess of tissue fluid from extra cellular spaces back into the blood.

(ii) It contain lymphocytes and antibodies.

(iii) It transport digested fats.

## Blood Clotting : Coagulation of Blood : (Cascade process)



## Functions of Blood

Transport, of food, respiratory gases ( $O_2$  and  $CO_2$ ), hormones, metabolic intermediates, waste products, supply of raw materials, regulation of water balance, regulation of pH and body temperature, and provides immunity.

**Blood Groups :** Based on presence of Antigens and Antibodies in blood.

Blood Group	Antigen (on the Surface of R.B.Cs)	Anti body : (in plasma)	Possible recipients having blood group	Possible donors having blood group	Remarks
A	A	Anti B	A, AB	O, A	—
B	B	Anti A	B, AB	O, B,	—
AB	A and B	None	AB	O, A, B, AB	Universal recipient
O	None	Anti A and Anti B	O, A, B, AB	O	Universal Donor

## Rh (Rhesus) Group :

- Rh positive (Rh + ve) – Rh antigen similar one present in rhesus monkey. Observed on the surface of RBCs (nearly 80% of humans)
- Rh negative (Rh–ve) – those in whom this antigen is absent.
- Compatibility is crucial during transfusion and pregnancy as if Rh -ve person exposed to Rh +ve blood forms specific antibodies against Rh antigens.

Rh incompatibility in pregnancy

### 1st PREGNANCY

Rh+ve (Father)	$\xrightarrow[\text{Foetal maternal blood mixes during delivery}]{\text{No mixing of two bloods due to placenta}}$	First newborn Rh +ve (safe)
Rh-ve (Mother)		But mother (Rh-ve) prepare antibodies against Rh factor
Rh+ve (Foetus)		

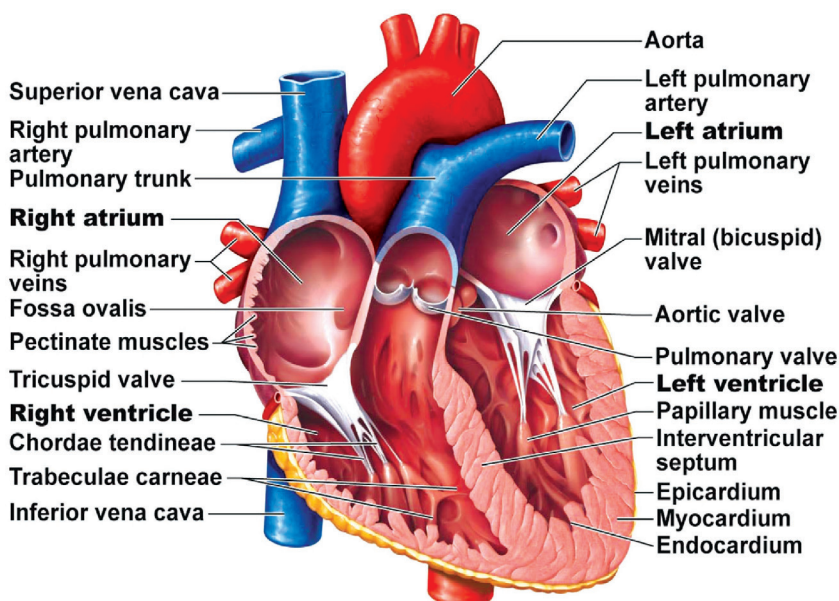
### 2nd PREGNANCY

Rh+ve (Father)	$\xrightarrow{\text{Antibodies leak into the blood of foetus}}$	Destroy foetal RBCs
Rh-ve (Mother)		Leads to erythroblastosis foetalis
Rh+ve (Foetus)		

→ **SAN (Sino-atrial node)** : A patch of tissues present in the right upper corner of the right atrium, acts as pacemaker due to having a unique property of self excitation.

→ **AVN (Atrio Ventricular Node)** : A mass of tissues seen in the lower left corner of the right atrium close to the atrio-ventricular septum. Fresh wave of contraction generated here, passes over both the ventricles simultaneously along the bundle of HIS.

## Human Heart



## Human Heart

- It is the mesodermally derived organ situated in thoracic cavity in between the two lungs. Protected by a double membrane covering called Pericardium.
- Four chambers—two (left and right) atria, and two ventricles (left and right)
- Inter-atrial septum separates the two atria and inter ventricular septum separates the two ventricles, while the atria and ventricles are separated by atrioventricular septum.
- The valves between right atrium and right ventricle is tricuspid while between left atrium and left ventricle is bicuspid or mitral value.
- The opening of the right ventricle into the pulmonary artery and the opening of left ventricle in to aorta are guarded by semilunar values.

- The valves allow the flow of blood only in one direction, *i.e.*, from atria to ventricles and from ventricles to pulmonary artery or aorta.

## Heart Valves

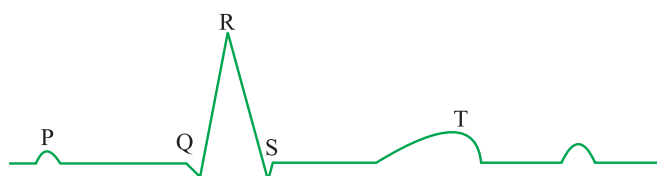
**Tricuspid Valve :** The valves formed of three muscular flaps or cups, which guard the opening between the right atrium and the right ventricle.

**Bicuspid Valve (Mitral Valve) :** The valves which guard the opening between the left atrium and the left ventricle, made up of two flaps.

**Semilunar Valves :** The valves present at the opening of the right and the left ventricles and allow the entry of blood into pulmonary artery and the aorta respectively.

**Electrocardiogram ECG :** The graphic record of the electric current produced by the excitation of the cardiac muscles. It is composed of a 'P' wave, 'QRS' wave. (complex) and 'T' wave.

**Standard ECG and Reading of ECG :** 'P' Wave represents the electrical excitation (or depolarisation) of the atria and leads to the contraction of both the atria.

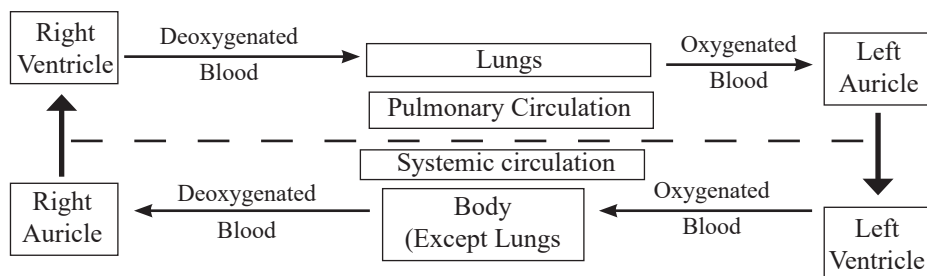


Diagrammatic presentation of a standard ECG.

**'QRS' complex :** represents the depolarisation of the ventricles, which initiates the ventricular contraction.

**'T' Wave :** represents the return of the ventricles from excited to normal state (repolarisation). The end of T-wave marks the end of systole.

## Double circulation :



**CARDIAC CYCLE :** The rhythmic contraction and dilation of different parts of heart in one beat.

Systole : contraction of heart muscles.

Diastole : relaxation of heart muscles.

- ☐ Joint diastole :-All chambers of heart in relaxed state.
  - Tricuspid and bicuspid valves– open
  - Blood from pulmonary vein and vena cava flows into left and right atrium respectively.
- ☐ Atrial systole :- contraction of atrias
  - SAN generates action potential to stimulate atrias to contract simultaneously
  - Blood flows to respective ventricles
- ☐ Ventricular systole : contraction of ventricles
  - AV node and AV bundle conduct the wave of contraction to the ventricles via bundle of HIS.
  - Ventricles contract as a closed chamber (as AV valves and semilunar valves are close).
  - Pressure of blood opens the semilunar valves and blood flows to respective arteries.
- ☐ Joint diastole : Relaxation of all chambers.

## HEART SOUNDS

- Closure of bicuspid and tricuspid valves produces first heart sound ‘lub’
- Closure of semilunar valves produces second heart sound ‘dub’

## Disorders of circulatory System

**Hypertension (High blood Pressure) :** It results from narrowing of arterial lumen and reduced elasticity of arterial walls in old age. It can cause rupturing of capillaries. It is a silent killer.

**Coronary Artery Disease : (CAD)** Atherosclerosis. The supply of the blood to heart muscles is affected. It is “caused by deposits of Calcium, fat, cholesterol and fibrous tissues to make the lumen of arteries narrower.

**Angina Pectoris :** Caused due to arteriosclerosis, when no enough oxygen is reaching the heart muscle due to which the person experiences acute chest pain.

**Heart attack :** Caused when the heart muscle is suddenly damaged by an inadequate blood supply.

**Cardiac arrest :** The state in which the heart stops beating.

**Arteriosclerosis :** The state of hardening of arteries and arterioles due to thickening of the fibrous tissue and consequent loss of elasticity. It causes hypertension.

## Questions

### Very Short Answer Questions

(1 mark each)

1. Name the instrument used for measuring blood pressure.
2. What is lymph node ?
3. A cardiologist observed an enlarged QRS wave in the ECG of a patient. What does it indicate ?
4. Name the enzyme that catalyses the formation of carbonic acid in erythrocytes.
5. What is systemic circulation ?
6. Give two examples of extra-cellular fluids.
7. What name is given to the blood vessels which generally bring blood to an organ ?
8. Which adrenal hormone accelerates heart beat under normal conditions ?
9. Name the blood vessel that carries blood from the intestine to liver.
10. Define cardiac cycle.
11. Name the protein found in RBCs.
12. What happens to a person suffering from hemophilia ?

### Short Answer Questions-I

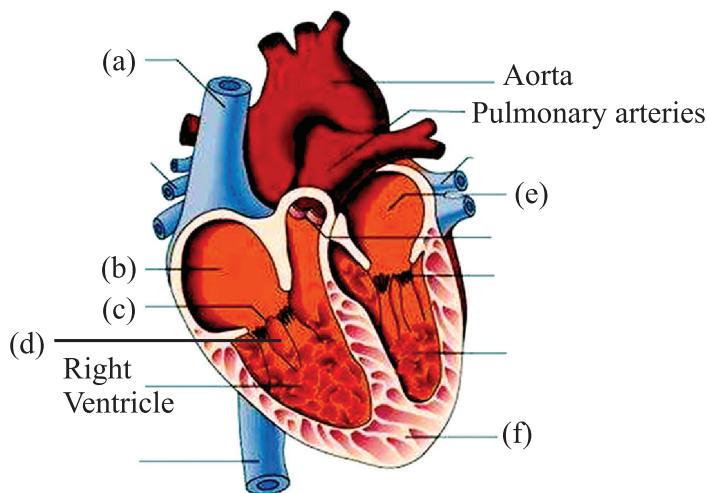
(2 marks each)

13. Explain when and how the two sounds of heart are produced.
14. Define joint diastole. What are constituents of the conducting system of human heart ?
15. Give the names of various types of formed elements present in the blood.

## Short Answer Questions-II

(3 marks each)

16. Why is the SA node called pacemaker of the heart ? Write its full form.
17. Draw a diagram showing schematic plan of blood circulation in human.
18. In the following diagram of section of a human heart, label a, b, c, d, e and f.



19. What is lymph ? Describe its circulation in brief.
20. What is stroke volume ? What is its relation with cardiac output ?
21. A person suffering from fever is advised to take blood test. What may happen to his WBC count and why ?

## Long Answer Questions

(5 marks each)

22. Neena is having blood group A-ve while her husband's blood group is O +ve. Their first child is having blood gp. A +ve. Her second child was born with severe anemia and jaundice. What could be the reason ? How this situation could have been avoided ?
23. Draw a diagram to show the internal structure of human heart. Label any two heart chambers, any two heart valves and chordae tendinae in it.
24. Describe the structure of human heart.
25. What is cardiac cycle ? Describe the event that occurs during it.
26. Explain Rh grouping and its incompatibility in humans.



27. Blood is a fluid connective tissue made up of fluid matrix plasma, and formed elements, Red blood cells, (erythrocytes) white blood cells (leukocytes), and platelets (thrombocytes) constitute the formed elements. The blood of humans is grouped into A, B, AB and O systems based on the presence or absence of two surface antigens A, B on the RBCs. Another blood grouping is also done based on the presence or absence of another antigen called Rhesus factor (Rh) on the surface of RBCs. the spaces between cells in the tissues contain a fluid derived from the blood called tissue fluid this fluid called lymph is almost similar to blood except for the protein content and the formed elements.
1. Why is blood called a fluid connective tissue?
    - (a) Because of fluid matrix plasma
    - (b) Because of osteocytes
    - (c) Because of the solid matrix
    - (d) None of the above
  2. Name the formed elements of blood.
    - (a) RBCs, WBCs only
    - (b) Platelets only
    - (c) Plasma only
    - (d) RBCs, WBCs and Platelets
  3. Which blood group is considered a universal donor and why?
    - (a) A
    - (b) B
    - (c) AB
    - (d) O
  4. Name the complication which arises when a Rh+foetus is developing the womb of a Rh-mother.
    - (a) Erythroblastosis foetalis
    - (b) Angina
    - (c) Cardiac arrest
    - (d) None of the above

5. Give the basic difference between tissue fluid and blood.

- (a) Tissue fluid has no proteins
- (b) Tissue fluid has no RBCs
- (c) Tissue fluid has no WBCs and platelets
- (d) All of the above

**DIRECTIONS :** In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
- (b) If both (A) and (R) true, but (R) is not the correct explanation of (A)
- (c) If (A) is true but (R) is false
- (d) If both (A) and (R) are false

28. **Assertion :** Blood coagulates in uninjured blood vessels.

**Reason :** Uninjured Blood vessels release an anticoagulant Heparin.

29. **Assertion :** Left atrium possess the thicket muscles.

**Reason :** Left atrium receives blood from the lungs.

30. **Assertion :** In the human heart there is no mixing of oxygenated and deoxygenated blood.

**Reason :** The presence of valves in the heart allows the movement of blood in one direction.

## Answers

### Very Short Answer

(1 mark each)

1. Sphygmomanometer.
2. A lymph node is specialised structure in lymphatic vessel concerned with the filtration of foreign bodies by the lymphocytes.
3. QRS waves denotes ventricular contraction of heart which may be normal or abnormal.
4. Carbonic anhydrase.
5. The kind of blood circulation that is concerned with the supply of oxygenated blood from the left ventricle to all body parts and return of oxygenated blood to the right atrium of heart.
6. Interstitial fluid and blood plasma.
7. Afferent blood vessel.

8. Noradrenalin.
9. Hepatic portal vein.
10. A regular sequence of three events (i) auricular systole (ii) ventricular systole and (iii) Joint diastole during the completion of one heart beat.
11. Haemoglobin.
12. The person suffering from haemophilia lacks clotting factors in blood, which result the defective clotting mechanism. In case of injury the person is at a risk of blood loss.

### Short Answer-I

(2 mark each)

13. (i) 'Lubb' the first sound which is low pitched, is caused by the closure of bicuspid and tricuspid valves.  
(ii) 'Dub' the second sound which is high pitched, is caused by the closure or semilunar valves.
14. In a cardiac cycle when both atria and ventricles are in a diastole and are relaxed simultaneously is called a joint diastole.  
Conducting system constitutes : SA node → AV node → Bundle of His → Purkinje fibres.
15. Erythrocytes, lymphocytes, monocytes, neutrophils, eosinophils, basophils and platelets.

### Short Answer-II

(3 marks each)

16. Refer fig. 18.4, page 287 (NCERT Text Book Class XI-Biology)
17. SA node being self excitatory initiate a wave of contraction in the heart.  
SA node — Sino-Atrial Node.
18. Refer fig. 18.2, page 283 (NCERT Text Book Class XI-Biology)/Fig. of support material.
19. Refer content fig. 18.2, page 282 (NCERT Text Book Class XI-Biology)/Points to remember of support material.
20. During one cardiac cycle or one heart beat the volume of blood pumped by the heart is called stroke volume. This is normally 70 mL.  
In one minute the heart beats about 72 times and the amount of blood pumped per minute is called cardiac output. This is usually 4900 mL. or 5 litres.

21. The WBC count of this person may show an increase from the normal range. As pathogens may be present in his body, so the body is producing more WBCs to fight against those pathogens. WBC count is a good tool to assess the presence of infection in a sick person.

### Long Answer

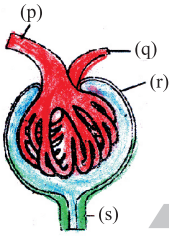
(5 marks each)

22. During her first pregnancy after exposure with blood of her first Rh +ve child, her body prepared antibodies against Rh antigen in her blood. In second pregnancy these Rh antibodies from mother leaked into the blood of foetus (Rh +ve) and destroyed foetus RBCs. It could cause of severe anemia and Jaundice could be fatal to the foetus.

This situation could have been avoided if she had got herself administered anti-Rh antibodies immediately after first delivery to kill Rh antibodies entered in mother's blood from foetus.

23. Refer fig. 18.2, page 283 (NCERT Text Book Class XI-Biology)/Fig. of support material.
24. Refer content 18.3.1., page 283 (NCERT Text Book Class XI-Biology)/Support Material.
25. Refer content 18.3.2., page 284 (NCERT Text Book Class XI-Biology)/Support Material.
26. Refer content 18.3.2., page 281 (NCERT Text Book Class XI-Biology)/Points to remember of support material.
27. 1. (a)  
2. (d)  
3. (d)  
4. (a)  
5. (d)
28. (d)
29. (d)
30. (b)





## Chapter - 19

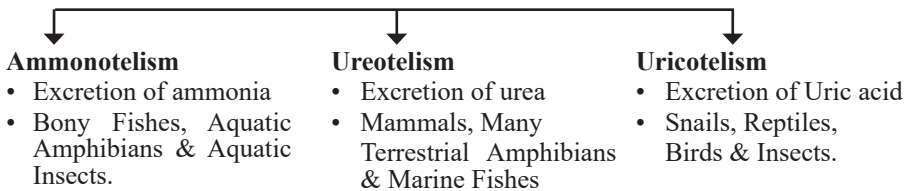
# Excretory products and Their Elimination

### Points To Remember

**Excretory Products :** Ammonia (most harmful) and needs large amount of water for excretion. Urea (less harmful) and Uric acid (least harmful) needs least amount of water for excretion.

#### MODE OF EXCRETION

(On the basis of type of excretory end products)



### Nephrons :

The structural and functional unit of kidneys. Each kidney contains about one million of nephrons.

### Structure of Nephron :

A nephron consists of Glomerulus, Bowman's capsule, PCT (Proximal Convoluted Tubule), JGA (Juxtaglomerular Apparatus), DCT (Distal Convoluted Tubule) and the collecting duct. (Refer fig., 19.3, page 292 (NCERT Text Book of Biology for Class XI))

### Structure of Kidney :

Size 10-12 cm in length, 5-7 cm in width, 2-3 cm thick, average weight about 120-170 g.

- The blood vessels, ureter and nerves enter in the kidney through hilum (a notch).
- The outer layer of kidney is a tough capsule.
- The outer zone of kidney is cortex and the inner is medulla.
- The medulla is divided into few conical masses (medullary pyramids) projecting into calyces.

- The cortex extends between medullary pyramids called columns of Bertini. Refer figure 19.2, page 292 (NCERT—Class XI Biology)

## Glomerular Filtration :

The filtration of blood in glomerulus, about 1100-1200 ml of blood is filtered by the kidney per minute.

## Glomerular Filtration Rate (GFR) :

The amount of filtrate formed by the kidney per minute is called GFR. In a healthy individual it is about, 125 ml/minute, i.e. 180 litres per day.

## Types of Nephrons :

- Juxtamedullary Nephron**—About 15% of total nephrons, Glomeruli are found in inner region of cortex, large in size, long loop of Henle and found deep in medulla, associated with vasa recta control plasma volume when water supply is short.
- Cortical Nephron**—About 85% of total nephron mainly lie in renal cortex, glomeruli found in outer cortex, short loop of Henle, extends very little in medulla. They do not have vasa recta or vasa recta is highly reduced.

## Functions of Tubules :

- PCT**—absorption of all essential nutrients and 70-80% of electrolytes and water, helps to maintain the pH and ionic balance of body fluids by selective secretion of  $H^+$ , ammonia and  $K^+$  into filtrate.
- Henele's Loop**—reabsorption in this segment is minimum, it plays a significant role in maintenance of higher molarity of medullary interstitial fluid.
- DCT**—conditional reabsorption of  $Na^+$  and water takes place here, reabsorption of  $HCO_3^-$  and selective secretion of  $H^+$  and  $K^+$  and ammonia to maintain the pH and sodium-potassium balance in blood.
- Collecting duct**—Large amount of water is absorbed from this region to produce concentrated urine, it plays a role in maintenance of pH and ionic balance of blood by selective secretion of  $H^+$  and  $K^+$  ions.

## Steps of Urine Formation

- 1. Glomerular Filtration**—Blood is filtered by glomerulus through three membranes i.e., endothelium of blood vessel, filtration slits of Bowman's capsule and basement membrane between these two layers. This filtration is called ultrafiltration as all constituents of plasma comes into filtrate except proteins.

**2. Reabsorption**—90% of filtrate is reabsorbed by the renal tubules by active or passive mechanism.

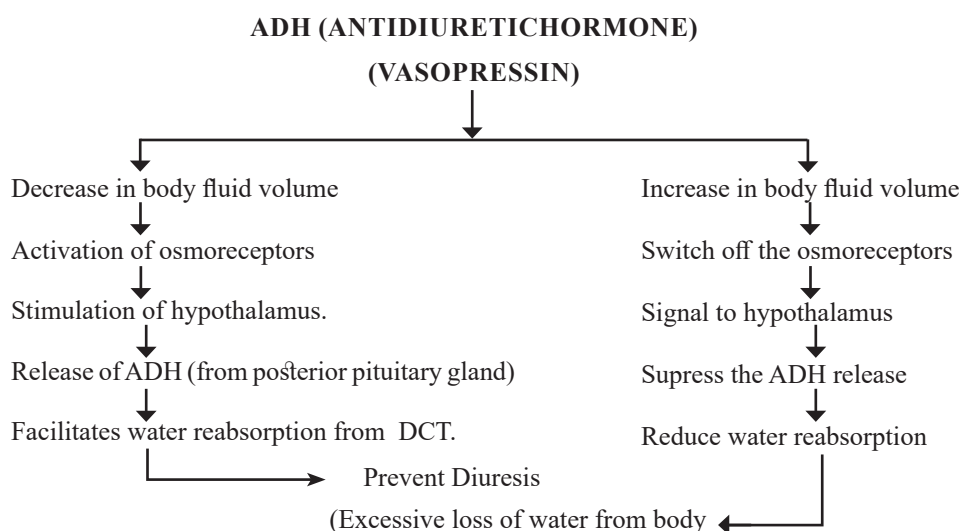
It is evident by the fact that out of 180L of filtrate formed per day only 1.5 L of urine released.

**3. Secretion**—Tubular cells secrete  $H^+$ ,  $K^+$ , ammonia into the urine. It maintains acid-base balance of body fluids.

## Mechanism of concentration of the Filtrate (Countercurrent Mechanism) :

Refer fig 19.6 page 296 (NCERT-Class XI Biology)

- This mechanism is said to be countercurrent mechanism because the out flow (in the ascending limb) runs parallel to and in the opposite direction of the inflow (in the descending limb).
- NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa-recta.
- NaCl is returned to the interstitium by the ascending portion of **vasa recta**.
- Henle's loop and vasarecta as well as the counter current in them help to maintain an increasing osmolality towards the inner medullary interstitium i.e., from 300 mosmol/L in cortex to about 1200 mosmol/L in inner medulla.
- Small amount of urea enter, the thin segment of ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.
- This mechanism helps to maintain a concentration gradient in the medullary tubule interstitium.
- It helps in an easy passage of water from the collecting tubule to concentrate the filtrate i.e. urine.



## Renin Angiotensin System

Fall in GFR

↓ Renin from JG cells

Angiotensinogen → Angiotensin I → Angiotensin II

↓ Acts on

Adrenal Cortex

↓ Secretes aldosterone

Reabsorption of Na<sup>+</sup> and water  
from DCT

↓

Increase in GFR

Atrial natriuretic factor (ANF)

- Increase in blood flow to Atria of heart release of ANF.
- Causes vasodilation and does decrease blood pressure.
- ANF acts as a check on renin-angiotensin mechanism.

## Micturition :

The expulsion of urine from the urinary bladder is called micturition. It is a reflex process but can be controlled voluntarily up to some extent in grown up children and adults.

- The CNS (Central Nervous System) sends the signal which cause the stretching of the urinary bladder when it gets filled with urine.
- In response, the stretch receptors on the walls of the bladder sends signals to the CNS.
- The CNS passes on motor message to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.
- An adult human excretes on an average 1 to 1.5 Litres of urine per day.
- On an average 25-30 gram of urea is excreted out per day.

## Role of other organs in excretion :

- **Lungs**—removes CO<sub>2</sub> (18L/day) and water.
- **Liver**—secretes bilirubin, biliverdin etc. helps to eliminate these substances along. with cholesterol, vitamins, drugs and degraded steroid hormones through digesive wastes.



- **Sweat and sebaceous glands**—These glands of skin help to eliminate small amount of urea, NaCl and lactic acid etc. through sweat while sebaceous glands help to eliminate some substances like steroids, hydrocarbons and waxes through sebum.
- **Saliva**—It can help to eliminate small amount of nitrogenous wastes.

## Disorders of Excretory system :

- **Uremia**—The accumulation of urea in blood due to malfunctioning of kidney.  
**Hemodialysis**—The process of removal of urea from the blood artificially. In this process the blood from an artery is passed into dialysing unit after adding an anticoagulant like heparin. The blood passes through coiled cellophane tube, surrounded by dialysing fluid. The nitrogenous wastes form the concentration gradient and the blood becomes clear. This blood is pumped back to the body through vein after adding anti-heparin to it.
- **Renal calculi**—The formation of insoluble mass of crystallised salts (oxalates or phosphates of calcium).
- **Glomerulonephritis**—Inflammation of glomeruli of kidney.

## Kidney Transplantation

- Kidney transplantation is done in a patient in which both the kidneys fail to work i.e. at total failure of kidney. Kidney transplantation is the ultimate method for treatment of renal failure. In case of kidney transplantation both the damaged kidneys of patient are removed by surgery. And a functional kidney from a healthy donor preferably from close relative is taken and transplanted in the body of patient. After successful transplantation the patient and donor can survive on one kidney.

### Precautions taken for successful transplantation of Kidney :

1. Kidney should be taken from a healthy donor preferably from close relative.
2. Matching of blood group and other factor and compatibility should be done carefully before transplantation.
3. The patient (recipient) has to take some prescribed medicines immunosuppressants through out the life to suppress the immune system.

## Questions

### Very Short Answer Questions

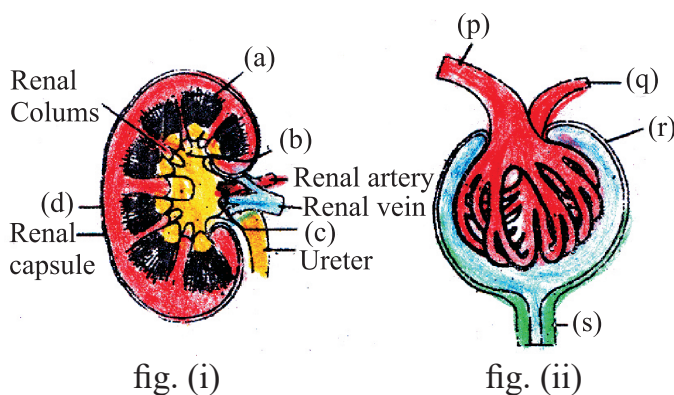
(1 marks each)

1. Which gland secretes sebum ?
2. One part of loop of Henle's is impermeable to water. Name it.
3. Besides water, name any two contents of human sweat.
4. Explain the function of vasa recta.
5. Name two types of nephrons found in human kidney.
6. Define GFR (Glomerular Filtration Rate).
7. The mechanism of concentration of filtrate is also known as counter current mechanism. Justify the statement.
8. What is micturition ?
9. Write the function of hormone 'renin' produced by kidney.
10. Name the excretory product of (i) reptiles (ii) Prawns (iii) Tapeworm (iv) Marine fish (v) Insects (vi) Birds.
11. What is vasa recta ?

### Short Answer Questions-I

(2 marks each)

12. Mark the odd ones in each of the following—
  - (a) Renal pelvis, medullary pyramid, renal cortex, ureter.
  - (b) Afferent arteriole, Henle's loop, vasa recta, efferent arteriole.
  - (c) Glomerular filtration, antidiuretic hormone, hypertonic urine, collecting duct.
  - (d) Proximal convoluted tubule, distal convoluted tubule, Henle's loop renal corpuscle.
13. In the following diagram of longitudinal section of kidney (Fig.-1) identify and label a, b, c and d respectively.

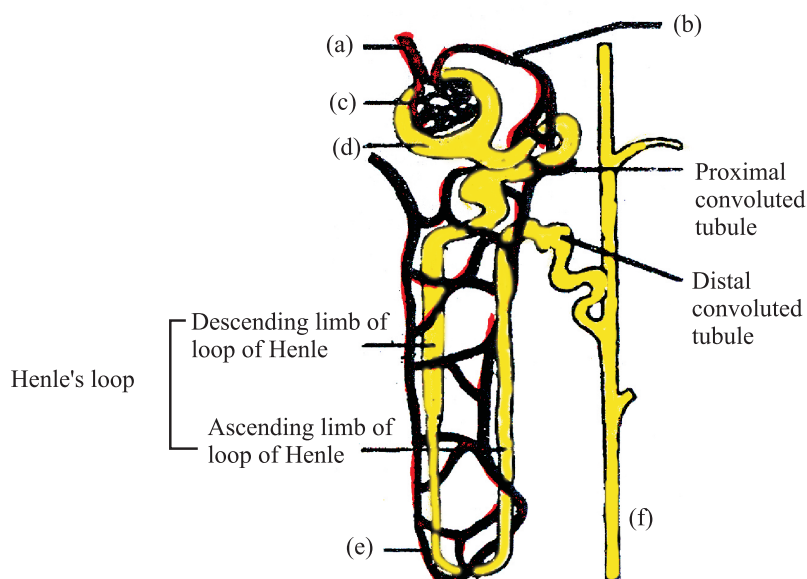


14. In the diagram (Fig.-2) showing malpighian body (renal corpuscle) identify and label p, q, r, s.
15. Name two metabolic disorder which can be diagnosed by analysis of urine.

### Short Answer Questions-II

(3 marks each)

16. In the following diagram (Fig.-3) showing structure of a nephron label a, b, c, d, e and f.



17. Describe the hormonal feed back circuit in controlling the renal functions.
18. Give three points of difference between renin and Renin.
19. What are ammonotelic, ureotelic and uricotelic animals ? Give an example of each type of these.
20. Why is urine formation less during summers ?

### Long Answer Questions

(5 marks each)

21. Draw a labelled diagram of human urinary system and write one function of each adrenal gland, ureter, urinary bladder, kidney and urethra.
22. Describe how urine is formed in the nephron through filtration reabsorption and secretion.

OR

Explain the steps involved in the process of urine formation.

23. Distinguish between (i) Uricotelism and Ureotelism (ii) Sebum and sweat (iii) Proximal and distal convoluted tubules (iv) Ascending and descending limbs of Henle's loop (v) Cortical and Medullary nephrons.
24. Explain the process of reabsorption and secretion of major substances at different parts of nephron with the help of schematic diagram.

### Case Based

25. For the regulation of glomerular filtration rate (GFR) the kidneys have a built-in mechanism. One such efficient mechanism is known as renin-angiotensinogen system and is carried out by the distal convoluted tubule and the afferent arteriole at the location of their contacts. Fall in GFR can stimulate the JG cells to release renin which can stimulate the glomerular blood flow and thereby the GFR back to normal. An increase in blood flow in the atria of the heart can cause the release of the Atrial natriuretic factor (ANF). This causes vasodilation of blood vessels and thereby decreases the blood pressure. ANF mechanism, therefore, acts as a check on renin-angiotensin mechanism.

1. Why is GFR called ultrafiltration?

- (a) As it is very efficient
- (b) As it is using ultraviolet rays of filtration
- (c) As all constituent of plasma come into filtrate except proteins
- (d) All of the above

2. Where is JGA located?

- (a) Below renal corpuscle
- (b) At Henle's loop
- (c) At the contact region between distal convoluted tubule and afferent arteriole.
- (d) Below glomerulus

3. Give the causes of the release of ANF.
- (a) Decrease in blood flow to the atria of the heart
  - (b) Increase in blood flow to the atria of the heart
  - (c) Decrease in blood flow to the ventricle of the heart
  - (d) Increase in blood flow to the ventricle of the heart
4. Which mechanism can act as a check on renin-angiotensin mechanism?
- (a) Self-check and control
  - (b) Atrial natriuretic factor
  - (c) Parasympathetic system
  - (d) Vasopressin factor
5. What do JG cells release to control GFR?
- (a) Renin
  - (b) Rennin
  - (c) Angiotensin
  - (d) Antidiuretic hormone

**Assertion reasoning type questions:**

**DIRECTIONS :** In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
  - (b) If both (A) and (R) true, but (R) is not the correct explanation of (A)
  - (c) If (A) is true but (R) is false
  - (d) If both (A) and (R) are false
26. **Assertion :** In cortical nephrons vasa recta is absent or highly reduced.

**Reason :** Cortical nephrons are mainly concerned with the concentration of urine.



27. **Assertion :** Comparative to uric acid urea is a more toxic excretory substance.

**Reason :** Birds and insects are uricotelic animals.

28. **Assertion :** Vasopressin increases the water permeability of the distal convoluted tubule.

**Reason :** In absence of ADH, water reabsorption is considerably reduced.

## Answers

### Very Short Answer

(1 mark each)

1. Sebaceous glands (wax-glands)
2. Ascending limb.
3. Sodium chloride, lactic acid, glucose (any two).
4. It helps to retain reabsorbed ions and urea in the interstitial fluid of the medulla, to maintain its high osmotic pressure.
5. (i) Juxta medullary nephron (ii) Cortical nephron
6. The amount of filtrate formed by the kidney per minute.
7. In the ascending limb, the outflow runs parallel to and in the opposite direction of the inflow in the descending limb.
8. The act of passing out urine from urinary bladder.
9. Renin is used to convert angiotensinogen to angiotensin.
10. (i) Uric acid (ii) Ammonia (iii) Ammonia (iv) Urea (v) Uric Acid (vi) Uric acid.
11. Capillary network running parallel to loop of Henle is known as Vasa recta.

### Short Answer-I

(2 marks each)

12. (a) Ureter (b) Henle's loop (c) Glomerular filtration (d) Renal Corpuscle.

13. Refer fig. 19.2, page 292 (NCERT Class XI-Biology)
14. Refer fig. 19.4 page 293 (NQERT class XI-Biology)
15. Glycosuria, Ketonuria

### Short Answer-II

(3 marks each)

16. Refer fig. 19.3, page 292, (NCERT class XI-Biology)
17. Refer content 19.5, page 297 (NCERT class XI-Biology).

18.	Rennin	Renin
	(i) It is a proteolytic enzyme.	(i) It is a hormone that acts as an enzyme.
	(ii) It helps in the digestion of milk protein.	(ii) It converts the protein angiotensinogen into angiotensin
	(iii) It is secreted as an inactive form Prorennin which is activated to rennin by HCl.	(iii) It is secreted as rennin.
	(iv) Its secretion is stimulated by food.	(iv) Its secretion is stimulated by a reduction of $\text{Na}^+$ level in tissue fluid.

19. Refer content given in the beginning of the chapters of NCERT Text Book page 290 class XI-Biology or Points to remember of this support material.
20. Due to sweating in summers blood volume is decreased. ADH is secreted from hypothalamus which increase reabsorption from D.C. tubules thus amount of urine is decreased.

### Long Answer

(5 mark each)

21. Refer fig. 19.1, page 291 and content 19.1 (NCERT Text Book page Class XII-Biology)
22. Refer content points to remember of this support material.
23. Refer the content given in the chapter or NCERT Text Book Class-XI Biology at pages 290, 298 (19.7), 292 and 293 respectively./Points to remember of this chapter of support material.

24. Refer content 19.3 and content fig. 19.5 at page 294-295 (NCERT Text Book Class XI-Biology).

25. 1. (c)

2. (c)

3. (c)

4. (b)

5. (a)

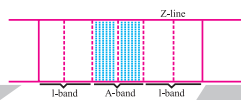
26. (c)

27. (b)

28. (b)







## Chapter - 20

# Locomotion and Movement

### Points To Remember

**Arthritis** : an inflammatory joint disease characterised by inflammation of joints.

**Coccyx** : tail bone formed by fusion of four coccygeal vertebrae in man.

**Dicondylic Skull** : A Skull with two occipital condyles.

**Endo Skeleton** : A skeleton present inside the body.

**Fascicle** : Bundles of muscle fibres held together by connective tissue.

**Fascia** : Collagenous connective tissue layer that surrounds muscle bundles.

**Floating ribs** : The ribs that remain free anteriorly, **(last 2 pairs)**

**False ribs** : 8th, 9th and 10th pair of ribs not directly joins the sternum but to seventh pair of ribs, hence called pseudoribs.

**Myoglobin** : A red colored pigment present in sarcoplasm of muscle.

**Sarcomere** : A portion of myofibril between two successive 'Z' lines.

**Sarcolema** : The plasma membrane of a muscle.

**Gout** : Inflammation of joints due to accumulation of uric acid crystal.

**Suture** : immovable joints between skull bones.

**Synovial joints** : Freely movable joints between limb bones.

**Patella** : A sesamoid bone acting as kneecap.

**Intervertebral disc** : Fibro cartilaginous pad present between the vertebrae that act as shock absorbers.

**Tendon**—Connective tissue made of yellow fibrous tissue which connect muscle to bone. It is not flexible.

**Ligament**—Connective tissue made of white fibrous tissue which joins two bones. It is flexible.

LMM : Light meromyosin

HMM : Heavy meromyosin

**Types of Movement :**

1. **Amoeboid movement** : These movements takes place in phagocytes where leucocytes and macrophages migrate through tissue. It is affected by pseudopodia formed by the streaming of protoplasm (as in amoeba)
2. **Ciliary movement** : These movement occurs in internal organs which are lined by ciliary epithelium.
3. **Muscular Movement** : This movements involve the muscle fibers, which have the ability to contract and relax.

**Properties of Muscle** : (i) Excitability                      (ii) Contractility  
(iii) Extensibility                      (iv) Elasticity

## Types of Muscles :

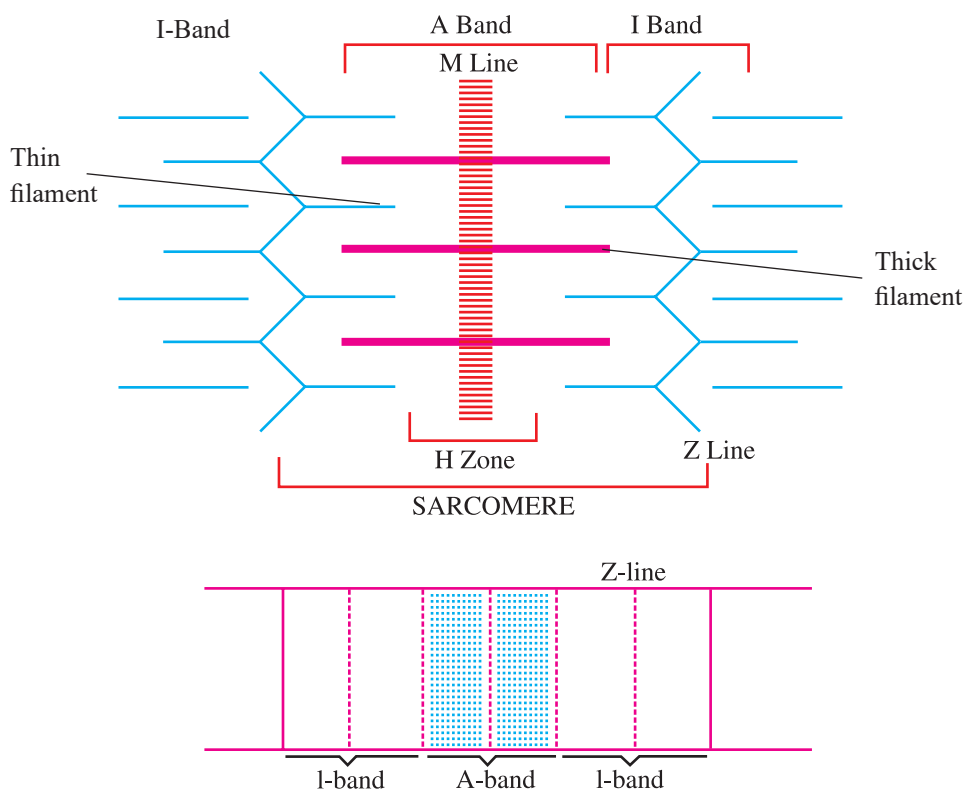
- (a) **Skeletal muscles or striated muscles**—These involved in locomotion and change of body postures. These are also known as voluntary muscles.
- (b) **Visceral muscles or smooth muscles**—These are located in inner wall of hollow visceral organ, smooth in appearance and their activity are not under control of voluntary nervous system. They are called involuntary muscles.
- (c) **Cardiac muscles**—The muscles of heart, involuntary in nature, striated and branched, These are uninucleated.

Characteristic	Skeletal Muscle	Smooth Muscle	Cardiac Muscle
<b>Location</b>	Muscles attached with skeletal components	muscles found in the inner walls of hollow visceral organs	Muscles found only in heart.
<b>Appearance</b>	Striated having light and dark bands. Multi-nucleated	unstriated, smooth in appearance with tapering ends. Uninucleated	Striated in appearance and branched, uninucleated
<b>Control</b>	They are controlled by our will hence called voluntary muscles.	They are not under the control of our will hence called involuntary muscles.	not under the direct control of nervous system.

## Structure of myofibril :

- Each myofibril consist of alternate dark and light band.
- Dark band—contain myosin protein and is called A-band or Anisotropic band.
- Light band—Contain actin protein and is called I Band or Isotropic band.
- I Band is bisected by an elastic fiber called 'Z' line. Actin filament (thin filament) are firmly attached to the 'Z' lines.
- Myosin filament (thick filament) in the 'A' Band are also held together in the middle of T Band by thin fibrous membrane called 'M' line.
- The portion between two successive 'Z' lines is considered as functional unit of contraction and is called a sarcomere.

## Structure of Actin and Myosin Filament



1. **Actin filament** : An actin filament is made of two 'F' actins which are helically wound to each other. Two filaments of tropo myosin protein also run close to 'F' actins throughout its length. A complex protein Troponin is distributed at regular intervals on tropomyosin which mask the actin binding site for myosin.
2. **Myosin filament** : Each myosin filament is a polymer of meromyosin. Each meromyosin has two components—a globular head with a short arm and a tail. Head is made of heavy meromyosin while tail is made of light meromyosin. The head with its short arm project outward at regular distance and angle from each other and is known as cross arm. The head has an active site for actin and binding site for ATP.

## Red muscle fibres :

- These are red in colour due to presence of high content of myoglobin.
- These contain plenty of mitochondria.
- Sarcoplasmic reticulum is less in these fibres.
- Show slow but sustained contractions for longer periods.

## White muscle fibres

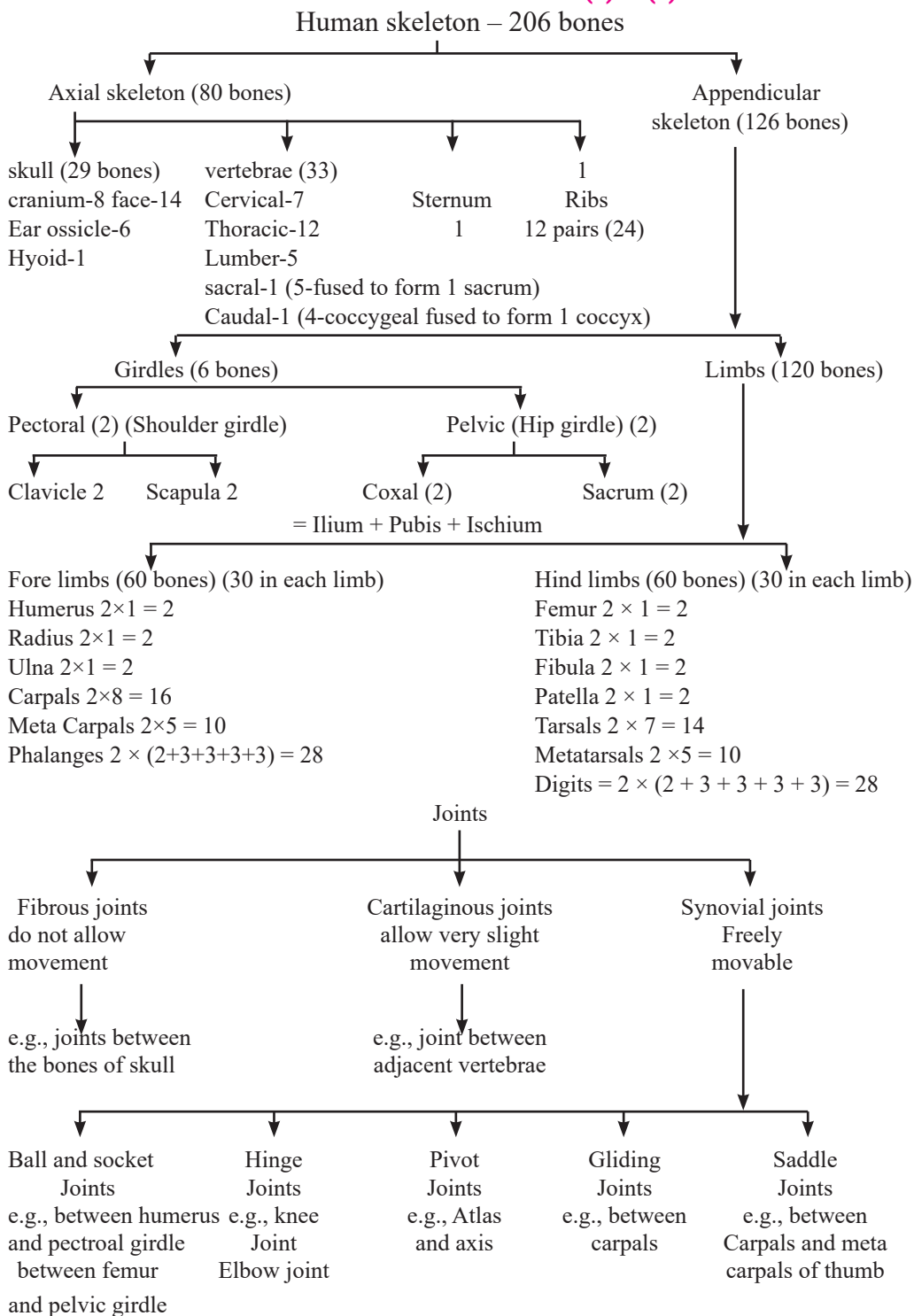
- These are pale or whitish due to presence of less content of myoglobin.
- These contain fewer mitochondria
- Sarcoplasmic reticulum is more/high
- During strenuous exercise, lactic acid accumulates in large quantity so muscle fatigues

## Mechanism or Muscle contraction : Sliding filament theory

The contraction of muscle fiber takes place by the sliding of actin (thin filament) on myosin (thick filament)

- Muscle contraction is initiated by a signal sent by the CNS via a motor neuron.
- Impulse from motor nerve stimulates a muscle fiber at neuro muscular junctions.
- Neurotransmitter releases here which generates an action potential in sarcolemma.
- This causes release of  $\text{Ca}^{++}$  into sarcoplasm. These  $\text{Ca}^{++}$  binds with troponin, thereby remove masking of active site.
- Myosin head binds to exposed active site on actin to form a cross bridge, utilising energy from ATP hydrolysis.
- This pulls the actin filament towards the centre of 'A' band.
- 'Z' lines also pulled inward thereby causing a shortening of sarcomere i.e. contraction.
- I band get reduced, whereas the 'A' band retain the length.
- During relaxation, the cross bridge between the actin and myosin break.  $\text{Ca}^{++}$  pumped back to sarcoplasmic cisternae. Actin filament slide out of 'A' band and length of I band increase. This returns the muscle to its original state.

## Vertebral formulae of man $C_7T_{12}L_5S_{(5)}C_{(4)} = 33$



## Questions

### Very Short Answer Questions

(1 mark each)

1. What is the total number of bones present in left pectoral girdle and left arm respectively in human beings?
2. Why do skeletal muscle show striation?
3. Why are 11th and 12th pair of ribs called floating ribs ?
4. Name the proteins making up dark and light bands of myofibrils.
5. Write the name of chemical that causes fatigue in the muscles.
6. What lubricate the freely movable joints at the shoulder ?
7. Name the longest bone of human body.
8. Give the name of first vertebra.
9. Define a sarcomere.
10. Name the cup shaped bone that constitutes the knee cap.
11. Which muscle fibre work during long flight of eagle ?
12. Name the cavity in the girdle into which the head of femur fits ?

### Short Answer Questions-I

(2 marks each)

13. Write any two difference between cardiac muscle and skeletal muscle.
14. Distinguish between red fibre and white fibre.
15. Name the two types of girdles found in human body and write their role.
16. State the role of calcium ions and ATP in muscle contraction.
17. Name the bones of fore limb (hand) of human body. Give their number in each limb.

## Short Answer Questions-II

(3 marks each)

18. What makes the synovial joints freely movable ? List any four types of synovial joints.
19. Name the category of bones forming the ribcage. How are these articulated to each other to form the cage ?
20. How are actin and myosin filament arranged in a muscle fibre ?
21. Mention the factor which is responsible for the following :
  - (i) Tetany
  - (ii) Gout
  - (iii) Osteoporosis

## Long Answer Questions

(5 mark each)

22. Explain the important steps of sliding filament theory of muscle contraction.

## Case Based

23. The muscle fiber is a syncytium. A characteristics features of the muscle fiber is the presence of a large number of parallelly arranged filaments in the sarcoplasm called myofilaments or myofibril each myofibril has alternate dark and light bands on it. Visceral muscles are located in the inner walls of hollow visceral organs of the body. They do not have any striation and are smooth in appearance. Many cardiac muscle cells assemble in a branching pattern to form cardiac muscle.
1. Why is muscle fiber called a syncytium?
    - (a) As it is aseptate
    - (b) As it has more than one nuclei
    - (c) As it has more than one sarcoplasm
    - (d) As it has dark and light bands
  2. Give a characteristic feature of muscle fiber.
    - (a) Presence of myofilaments
    - (b) Absence of myofilaments
    - (c) Presence of branching pattern
    - (d) Spindle shaped appearance

3. Name some visceral organs of the human body.
- (a) Femur, legs, arms
  - (b) Oesophagus
  - (c) Stomach
  - (d) Both (b) & (c)
4. Which type of muscle are located in the inner walls of hollow visceral organs?
- (a) Skeletal muscles
  - (b) Smooth muscles
  - (c) Cardiac muscles
  - (d) Smooth muscles & cardiac muscles
5. Skeletal muscles and smooth muscles are .....
- (a) Involuntary and voluntary respectively
  - (b) Voluntary and involuntary respectively
  - (c) Both involuntary
  - (d) Both voluntary

**Assertion reasoning type questions:**

**DIRECTIONS :** In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

- (a) If both (A) and (R) are correct and (R) is the correct explanation of (A)
  - (b) If both (A) and (R) true, but (R) is not the correct explanation of (A)
  - (c) If (A) is true but (R) is false
  - (d) If both (A) and (R) are false
24. **Assertion :** Fatigue is the inability of muscles to relax.
- Reason :** It is due to lactic acid accumulation by repeated contractions.
25. **Assertion :** Rapid spasm in the muscle is termed as tetany.
- Reason :** Tetany is caused by an increase in the blood calcium level.



26. **Assertion :** Radius is shorter than the ulna.

**Reason :** It has a large olecranon process.

27. **Assertion :** First seven pairs of ribs are called true ribs.

**Reason :** These ribs are not connected ventrally to the sternum.

28. **Assertion :** Inflammation of a skeletal joint may immobilize the movement of joints.

**Reason :** Uric acid crystals in the joint cavity and ossification of articular cartilage leads to this condition.

## Answers

### Very Short Answers

(1 mark each)

1. Left pectoral girdle has 2 bones (1 clavicle and 1 scapula). Left Arm has 30 bones.
2. Due to distribution pattern of actin and myosin protein.
3. These ribs are not ventrally attached to sternum
4. Actin and myosin
5. Lactic acid
6. Synovial fluid
7. Femur
8. Atlas
9. A portion of myofibril between two successive 'Z' lines.
10. Knee cap
11. Red muscle fibre
12. Acetabulum

### Short Answers-I

(2 marks each)

13. Refer NCERT Text book Class XI Page 303
14. Refer Points to remember
15. Pectoral and Pelvic girdle bones help in articulation of the upper and lower limbs respectively with the axial skeleton.
16. Calcium ( $\text{Ca}^{++}$ ) ions binds with troponin, thereby remove masking sites. ATP hydrolysis gives energy to Myosin head to bind with active site of actin.
17. Refer Points to remember

### Short Answers-II

(3 marks each)

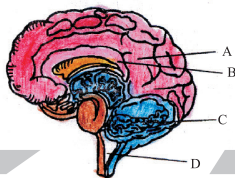
18. Refer NCERT Text book Page 312. Class XI
19. Refer NCERT Text book Page 310. Class XI
20. Refer NCERT Text book Page 305. Class XI
21. Refer NCERT Text book Page 312. Class XI

### Long Answer

(5 marks each)

22. Refer Points to remember
23.
  1. (b)
  2. (a)
  3. (d)
  4. (b)
  5. (b)
24. (a)
25. (c)
26. (b)
27. (c)
28. (a)





## Chapter - 21

# Neural Control and Coordination

### Points To Remember

**Coordination** : Process through which two or more organs interact and complement the functions of one another surrounding the brain.

**Action potential** : A sudden change in the electrical charges in the plasma membrane of a nerve fibre.

**Aqueous humour** : The thin watery fluid that occupy space between lens and cornea in eye.

**Blind spot** : A spot on retina which is free from rods and cones and lack the ability for vision.

**Cerebrospinal fluid** : An alkaline fluid present in between inner two layer of meninges, surrounding the brain and spinal cord.

**Cerebellum** : A part of hind brain that controls the balance and posture of the body.

**Cochlea** : A spirally coiled part of internal ear which is responsible for hearing.

**Corpus callosum** : A curved thick bundle of nerve fibres that joins two cerebral hemisphere.

**Depolarisation** : A condition when polarity of the plasma membrane of nerve fibre is reversed.

**Endolymph** : The fluid filled within membranous labyrinth.

**Eustachian Tube** : A tube which connect ear cavity with the pharynx.

**Fovea** : An area of highest vision on the retina which contain only cones.

**Meninges** : Three sheets of covering of connective tissue wrapping the brain.

**Grey Matter** : This shows many convolutions which increase the amount of vital nerve tissue.

**Medula oblongata** : Posterior most part of the brain which is continuous with spinal cord and control respiration, heart rate,swallowing,vomiting.

**Pons :** Thick bundles of fibres on the ventral side of brain below cerebellum.

**Foramen magnum :** A big aperture in the skull posteriorly through which spinal cord emerges out.

**Spinal cord :** A tubular structure connected with medulla oblongata of brain and situated in the neural canal of the vertebral column, covered by meninges.

**Synaptic cleft :** A narrow fluid filled space which separates two membranes of the two neurons at the synapse.

**Synaptic vesicles :** These are membrane bound vesicles in the axoplasm of the axon terminal and these store neurotransmitter.

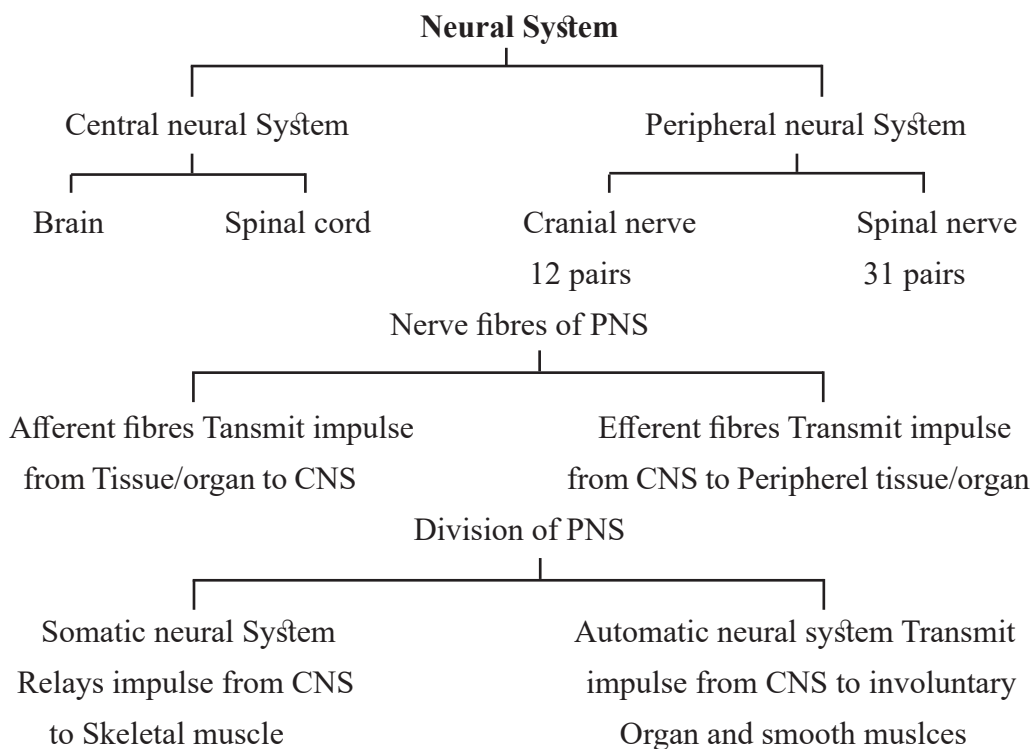
**Neurotransmitter :** These are chemicals stored in synaptic vesicles, diffuse to reach the membrane of next neuron for its stimulation.

**Synapse :** A physiological junction between axon of one neuron and dendrite of next neuron.

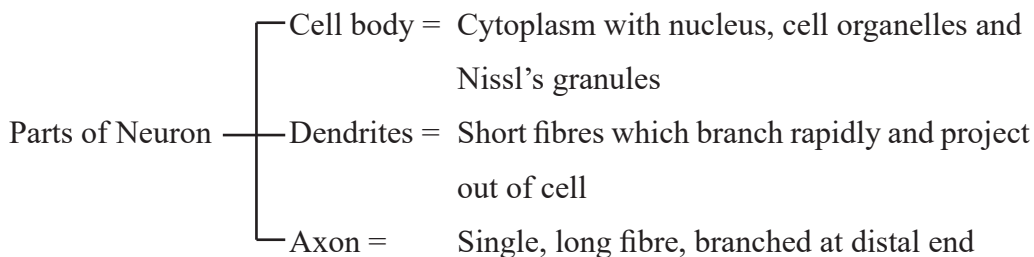
CNS—Central neural system

PNS—Peripheral neural system

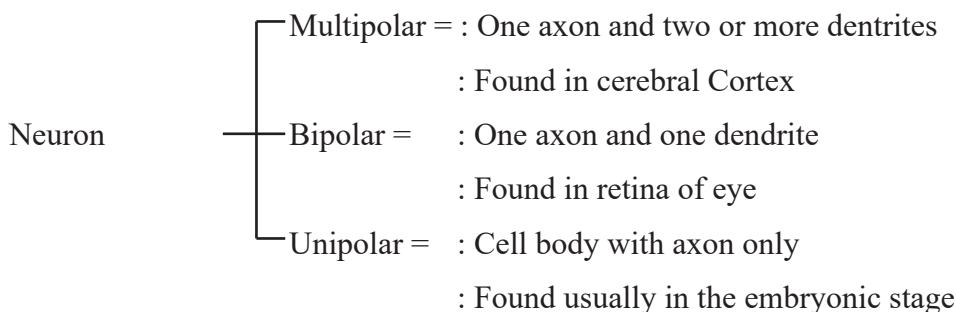
ANS—Autonomic neural system



**Visceral Nervous System :** whole complex of nerves, fibres, ganglia and plexuses by which impulses travel from CNS to the viscera and from viscera to CNS



(Refer fig. 21.1, page 317, NCERT - Biology, Class-XI)



## Conduction of Nerve Impulse

### Polarization : Resting potential

- Before stimulation axoplasm contain –vely high concentration of  $K^+$  and low concentration of  $Na^+$  Inner surface is –vely charged.
- Fluid outside axon – low concentration of  $K^+$  and high concentration of  $Na^+$ . Outside the membrane is + vely charged.
- Most membrane channels are closed.

### Depolarization: Action potential

- Stimulation of nerve.
- Permeability of membrane to  $Na^+$  increases.
- $Na^+$  channels opens allowing  $Na^+$  to diffuse into the cell quickly.
- As a result inside become +ve and outside -ve.

### Repolarization : Normalising

- $K^+$  gates open in order to allow  $K^+$  to diffuse out of the axon. This restores the membrane. (+ve outside -ve inside)



## Transmission of Impulses at Synapse

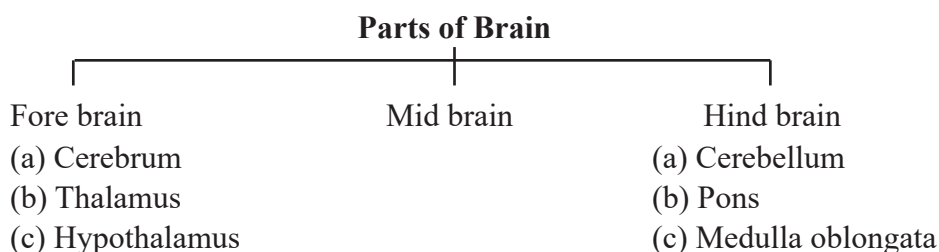
- (i) **At electrical synapses :** Here the membrane of pre and post-synaptic neuron are in very close proximity. Electric current can flow directly from one neuron into other across these synapses, like impulse conduction along a single axon.
- (ii) **At chemical synapses :** Here the membrane of pre and post-synaptic neuron are separated by fluid filled space called synaptic cleft. Neurotransmitter are involved here.

When an impulse arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards membrane and they fuse with the plasma membrane and release their neurotransmitter in the synaptic cleft. These chemicals bind to specific receptors, present on the post-synaptic membrane. Their binding opens ion channels and allow the entry of ion which generate new potential in post synaptic neuron.

**Human brain :** Human brain is the major portion of central neural system. Which is well protected by the skull.

The brain is surrounded by three cranial meninges—

- (i) Dura mater—outer layer
- (ii) Arachnoid—middle layer
- (iii) Pia mater—Inner layer—remain in contact with brain



## Functions of parts of brain :

**Cerebrum :** Centre of intelligence, memory and imagination, reasoning, judgement, expression of will power.

**Thalamus :** Acts as relay centre to receive and transmit general sensation of pain, touch and temperature.

**Hypothalamus :** Centre for regulation of body temperature, urge for eating and drinking.

**Midbrain :** Responsible to coordinate visual reflexes and auditory reflexes.

**Cerebellum :** Maintains posture and equilibrium of the body as well as coordinates and regulates voluntary movement.

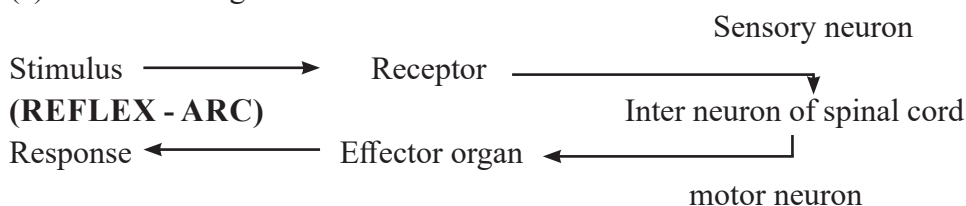
**Pons :** Relays impulses between medulla oblongata and cerebral hemisphere and between the hemisphere of cerebrum and cerebellum. It also helps to regulate breathing.

**Medulla oblongata :** Centre that controls heart beat, breathing, swallowing, salivation, sneezing, vomiting and coughing.

**Reflex action :** It is spontaneous, autonomic and mechanical response to a stimulus that occurs at the level of spinal cord, without involvement of brain.

**Reflex arc :** The flow of nerve along the specific during reflex action. It consists of—

- (a) A receptor
- (b) An Afferent neuron (sensory neuron)
- (c) An inter neuron
- (d) An efferent neuron (motor neuron)
- (e) An effector organ



### Organ of Sight-Eye

Layer	Component	Function
1. External layer	Sclera	Protects and maintain shape of the eye ball
	Cornea	Outermost transparent portion of eye which allows light to enter
2. Middle layer	Choroid	Absorb light and prevent light from being reflected within the eye ball.
	Ciliary body	Holds lens, regulate shape of the lens.
	Iris	Control amount of light entering.
3. Inner layer	Retina	Vision in dim light, colour vision, vision in bright light. Sends the image to brain through optical nerves.

(Refer-Fig. 21.6, Page 323 NCERT-Biology, Class XI)



## Organ of Hearing–Ear

Portion of the ear	Component	Function
1. External ear	<ul style="list-style-type: none"><li>Pinna</li><li>External auditory canal</li></ul>	Collect sound waves Direct sound waves towards ear drum, ear wax prevents the entry of foreign bodies.
2. Middle ear	<ul style="list-style-type: none"><li>Tympanic membrane</li><li>Ear ossicles</li><li>Eustachian tube</li></ul>	Acts as resonator that reproduces the vibration of sound. Transmit sound waves to internal ear. Helps in equalising the pressure on either side of ear drum.
3. Internal ear	<ul style="list-style-type: none"><li>Cochlea</li><li>Vestibular apparatus</li></ul>	Hearing organ. Balancing of body.

(Refer Fig. 21.7, page 325-NCERT-Biology, Class XI)

## Organ to smell – Nose (Factor Organ)

### NOSE

#### Olfactory Epithelium

Olfactory Receptors – Receives sense of smell (air/chemicals)  
(mucus coated)



Olfactory Neurons



Olfactor bulbs (limbic system of brain)

#### Organ to Taste – Tongue (Gustatory Organ)

### TONGUE

Papillae



Taste buds



Gustatory Nerves



Brain (integrates the differential inputs from taste buds).



## Questions

### Very Short Answer Questions

(1 mark each)

1. Name the fluid present in membranous labyrinth.
2. Name the area of retina where only cones are densely packed.
3. Name the inner most meninges of the brain.
4. To which part of the brain communication and memory are associated ?
5. Name the bundle of fibres that connect two cerebral hemisphere in human being.
6. Name the photo pigment present in the rod cells.
7. Why do impulses flow only in one direction ?
8. Where is hypothalamus located in the brain ?
9. Which cells are responsible for scotopic vision ?

### Short Answer Questions-I

(2 marks each)

10. Distinguish between electrical synapses and chemical synapses.
11. What is iris ? Give the function of iris.
12. What is organ of corti ? Where is it located ?
13. Differentiate between cerebrum and cerebellum.
14. What is synapse ? Name its two types.
15. Fill in the blanks in the different columns A to D :

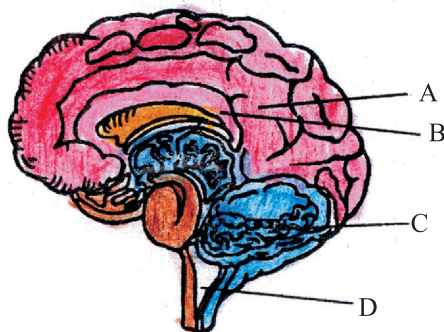
Part/Organ	Function
Pinna	.....(A).....
.....(B).....	Equalise the pressure on either side of ear drum.
Cone cells	.....(C).....
.....(D).....	regulate amount of light to pass into the eye.

16. Why are grey matter and white matter contained in human nervous system named so ?

## Short Answer Questions-II

(3 marks each)

17. Observe the diagram given right and answer the following questions :



- (i) Label the parts A, B, C & D.
  - (ii) Give the function of C and D.
  - (iii) Name the layers which wrap this organ.
18. What is a synapse ? How does the nerve impulse cross the chemical synapse ?
19. Give the function of the following :
- (i) Cerebrum
  - (ii) Hypothalamus
  - (iii) Mid brain
20. What is meant by reflex action ? Name the components of a reflex arc in correct sequence from receptor upto effector. Support your answer by a diagram.
21. Draw a diagram of V.S. of human eye and label the following :  
Iris, Retina, Cornea, Blind spot, Ciliary body and Vitreous chamber.

## Long Answer Questions

(5 mark each)

22. Describe in detail, how conduction of nerve impulse takes place through a nerve fibre.

## Case Study based questions :

23. Read the following and answer any four questions from 23 (i) to 23 (v) given below :

Ajinomoto, the most popular ingredients commonly used in Chinese dishes as a taste enhancer is otherwise known as mono sodium glutamate (MGS). Excessive consumption of Ajinomoto can cause various harmful effects such as hypertension, effect on Brain and nerves, nausea, headache, sleeping

disorders and cancer. As glutamate can serve as a neurotransmitter, high intake of MSG can adversely affect the brain and nerves. In our body neurotransmitters are involved in carrying nerve impulses across a chemical synapse. Common neurotransmitters are epinephrine, adrenaline, acetylcholine, dopamine and GABA. When an impulse arrives at the axon terminal, it stimulates the movement of synaptic vesicles towards the presynaptic membrane, where they fuse and release their neurotransmitters in the synaptic cleft. Now these neurotransmitters bind to their specific receptors present on the postsynaptic membrane, which opens ion channels. Thus signal is transmitted across the synapse. In electrical synapse signal can flow directly from one neuron to another.

- (i) Identify the harmful effects of excessive consumption of ajinomoto :
  - (a) Hypertension
  - (b) Headache
  - (c) Effects nerves
  - (d) All of them
- (ii) Ajinomoto serves as a \_\_\_\_\_ neurotransmitter :
  - (a) Glutamate
  - (b) GABA
  - (c) Dopamine
  - (d) Acetyl choline
- (iii) Interaction between neurons occurs commonly across junctions called :
  - (a) Action potential
  - (b) Synapse
  - (c) Axon terminal
  - (d) Juxtaposition
- (iv) Receptor site for neurotransmitters are present on :
  - (a) Presynaptic membrane
  - (b) Tips of axons
  - (c) Postsynaptic membrane
  - (d) Membranes of synaptic vesicles



- (v) **Assertion :** Transmission of nerve impulse across a synapse is accomplished by neurotransmitters.

**Reason :** Transmission across a chemical synapse usually requires neurotransmitters because there is a small space, synaptic cleft that separates one neuron from another.

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false
- (d) Both the assertion and reason are false

#### **Assertion and Reason type Questions :**

In each of the following questions, two statements are given, one is Assertion and other is Reason. Mark the correct answer as :

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false
- (d) Both the assertion and reason are false
24. **Assertion :** The space between the cornea and the lens is called the vitreous chamber.
- Reason :** The space between the lens and retina is called the aqueous chamber.
25. **Assertion :** The Eustachian tube helps in equalizing the pressure on either side of the ear drum.
- Reason :** The Eustachian tube connects the middle ear cavity with the pharynx.

## Answers

### Very Short Answers

(1 mark each)

1. Endolymph
2. Fovea
3. Pia mater
4. Cerebrum
5. Corpus callosum
6. Rhodopsin
7. Because each synapse allows impulse to cross it in a single direction.
8. At the base of thalamus.
9. Rods

### Short Answers-I

(2 marks each)

10. Refer NCERT text book, Class XI Page no. 319.
11. Refer NCERT Text book, Class XI Page no. 323.
12. Refer NCERT Text book, Class XI Page no. 326.
13. Refer NCERT Text book, Class XI Page no. 321.
14. Junction between two nerves      Chemical synapse and electrical synapse
15. (A) To collect sound waves      (B) Eustachian tube  
(C) Colour vision      (D) Iris
16. Refer NCERT book, Page no. 321.

### Short Answers-II

(3 marks each)

17. (i) A : Cerebrum      C : Cerebellum  
B : Corpus callosum      D : Medulla oblongata  
(ii) C : Balancing of body and maintain posture  
D : Vomiting, coughing, breathing, salivation or any other correct answer (anyone).  
(iii) Pia mater, arachnoid and dura mater.

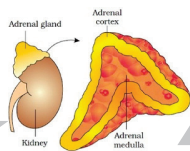
18. Refer NCERT Text book, Class XI Page no. 319.
19. Refer NCERT Text book, Class XI Page no. 321.
20. Refer NCERT Text book, Class XI Page no. 322.
21. Refer NCERT Text book, Class XI Page no. 323.

### Long Answer

(5 marks)

22. Refer NCERT Text book, Class XI Page no. 317 and 318.
23. (i) (d) All of them  
(ii) (a) Glutamate  
(iii) (b) synapse  
(iv) (c) post synaptic membrane  
(v) (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion
24. (d) Both the assertion and reason are false
25. (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.





## Chapter - 22

# Chemical Coordination and Integration

### Points To Remember

**Endocrine glands :** These are ductless glands which secrete hormones directly into the blood stream.

**Hormones :** Non-nutrient chemicals synthesised in trace amount by Endocrine glands that act as intracellular messengers and are specific in their action which are transported by blood from site of production to site of action.

### Hypothalamus :

- It is basal part of diencephalon.
- Has neurosecretory cells called nuclei which produce hormones to regulate the synthesis and secretion of pituitary gland hormones.
- Two types of hormones released are :

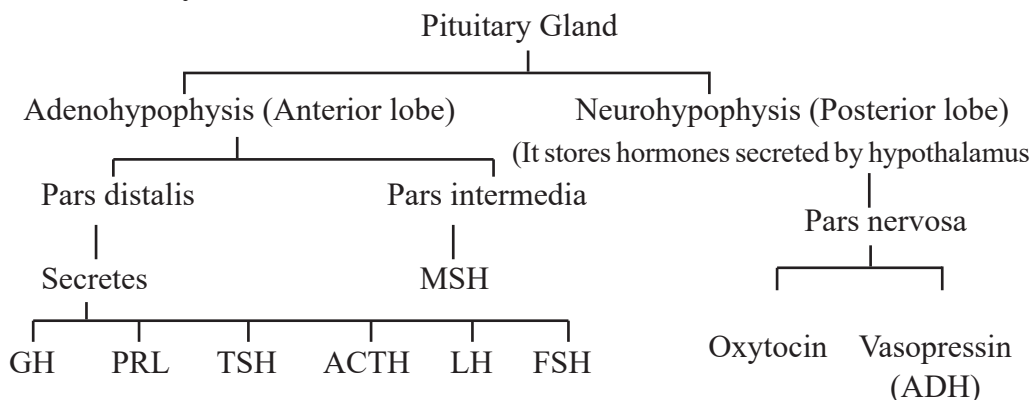
**Releasing hormones :** Stimulate secretion of pituitary hormones, *e.g.*, *Gonadotrophin* releasing hormone stimulates pituitary gland to synthesise gonadotrophins.

**Inhibiting hormones :** Inhibit secretions of pituitary hormones, *e.g.*, Somatostatin inhibits secretion of growth hormone.

### Pituitary Gland :

- Located in bony cavity called as sella tursica.
- Attached to hypothalamus by a stalk.
- Divided anatomically into : Adenohypophysis (Anterior lobe) and Neurohypophysis (Posterior lobe).
- Hormones released from hypothalamic neurons reach anterior pituitary through portal system and through neurons in Posterior pituitary.
- Posterior pituitary is under neural control of hypothalamus.

## 1. Pituitary Gland



### Adenohypophysis : (Anterior lobe of Pituitary)

- **Growth hormone (GH)** : Oversecretion leads to gigantism and low secretion causes dwarfism and Proper secretion leads to proper growth of body.
- **Prolactin (PRL)** : Growth of mammary gland and formation of milk in them.
- **Thyroid stimulating hormone (TSH)** : Stimulates synthesis and secretion of thyroid hormones from thyroid gland.
- **Adrenocorticotrophic hormone (ACTH)** : Stimulates synthesis and secretion of steroid hormones called glucocorticoids from adrenal cortex.
- **Luteinizing hormone (LH)** : Synthesis and secretion of hormones called androgens in males, and helps in ovulation and maintenance of corpus luteum in females.
- **Follicle stimulating hormone (FSH)** : Regulate spermatogenesis in males, and growth and development of ovarian follicles in females.

### Neurohypo physis (Posterior lobe of Pituitary)

- **Oxytocin** helps in contraction of uterus during child birth and milk ejection from mammary gland in females.
- **Vasopressin** : Acts on kidney and stimulates reabsorption of water and electrolytes by distal tubules to reduce water loss through urine. It is also called as Anti Diuretic Hormone (ADH).

### Diabetes insipidus : Impairment of synthesis of ADH

- (i) Diminished ability of kidney to conserve water.
- (ii) Water loss and dehydration.
- (iii) Can be overcome by taking more water.



## Excessive Secretion of Growth Hormone

- **Acromegaly** : It is a condition when the pituitary gland makes too much growth hormone. It is due to a tumour in pituitary gland. Person suffering from acromegaly (acro means tip and megaly means enlargement) may gradually develop a long face with protruding lower jaw, enlarged nose and wider spacing between teeth and enlarged hands and feet.

### 2. Pineal Gland :

- Located on dorsal side of forebrain.
- Secretes Melatonin to regulation 24-hours rhythm, sleep-wake cycle, menstrual cycle, pigmentation etc.

### 3. Thyroid Gland :

- Has two lobes on either side of trachea interconnected by isthmus (connective tissue).
- Composed of follicles and stromal tissues.
- Follicular cells synthesise thyroxine ( $T_4$ ) and tri-iodothyronine ( $T_3$ ).
- Iodine is necessary for normal functioning of thyroid.
- **Goitre (Hypothyroidism)** : Enlargement of thyroid gland; Hypothyroidism may lead to mental retardation and stunted growth (cretinism) Deaf-mutism in the baby if it occurs during pregnancy.
- **Hyperthyroidism** : Occurs due to cancer or due to development of nodules in thyroid glands, affects body physiology as abnormal high levels of thyroid hormones is synthesised. Basic metabolic rate increase.
- **Exophthalmic goitre** : It is a form of hyperthyroidism, characterised by enlargement of thyroid gland, protrusion of eye balls and increased BMR
- Thyroid hormone controls carbohydrates, proteins & fats metabolism.
- Also secretes a protein hormone called Thyrocalcitonin (TCT) which regulates blood calcium level.

### 4. Parathyroid Gland :

- Present on back side of thyroid gland. Each lobe of thyroid gland has its one pair.
- Secrete peptide hormone called parathyroid hormone (PTH) which increases calcium levels in blood so called **hypercalcemic** hormone.
- PTH stimulates bone resorption, and reabsorption of calcium from blood and reabsorption of calcium by renal tubules, thus increasing blood  $Ca^{++}$  level.

## 5. Thymus Gland

- Located on dorsal side of heart and aorta.
- Secrete peptide hormones called Thymosins which play role in differentiation of T-lymphocytes (help in cell mediated immunity.)
- Thymosins also produce antibodies and provide humoral immunity.
- Immunity of old people usually becomes weak as thymus gets degenerated with age.

## 6. Adrenal Gland

- Located at anterior part of each kidney.
- Has centrally located adrenal medulla and at periphery in adrenal cortex.
- Adrenal medulla secretes adrenaline (epinephrine) and nor adrenaline (norepinephrine), commonly called as catecholamines or emergency hormones or hormones of fight or flight.
- These hormones increase heart beat, rate of respiration, breakdown of glycogen thus increase blood glucose level, breakdown of lipids and protein, alertness, raising of hairs, sweating etc.
- Adrenal Cortex-(3 layers) :
  - Zona reticularis (inner layer)
  - Zona fasciculata (middle layer)
  - Zona glomerulosa (outer layer)

### ● Adrenal cortex secretes :

#### 1. Androgenic steroids : (Secreted by Zona reticularis)

- Secreted in small amounts.
- Play role in growth of axial pubic and facial hair during puberty.

#### 2. Glucocorticoids : (Secreted by fasciculata)

- Involved in carbohydrate metabolism.
- Stimulates gluconeogenesis, lipolysis and proteolysis.
- e.g., Cortisol which is also involved in cardio-vascular and kidney functions.
- It also suppresses immune response and stimulates RBC production.

#### 3. Mineralocorticoids : (Secreted Zona glomerulosa)

- Regulate balance of water and electrolytes in body.
- e.g., Aldosterone which also helps in reabsorption of  $\text{Na}^+$  and water excretion of  $\text{K}^+$  and phosphates ions from renal tubules.

- When adrenal cortex is damaged, it does not produce enough cortisols (which regulate body's reaction to stressful situations) and aldosterone.
- It result in **Addison's disease**. Symptons of addison's disease are weak muscles, extreme fatigue, increased skin pigmentation, weight loss, sores in mouth and depression.

## Two major causes :

1. Primary adrenal insufficiency where our immune system mistakes adrenal for an antigen and tries to damage it.
2. Secondary adrenal insufficiency-when pituitary gland can't produce ACTH
7. **Pancreas** : It is called composite/dual gland. As it acts as Exocrine and endocrine gland i.e. has both exocrine and endocrine function.
  - Contains about 1-2 million islets of Langerhans which has glucagon secreting  $\alpha$ -cells and insulin secreting  $\beta$ -cell.
  - **Glucagon** : Peptide hormone, stimulates glycogenolysis by acting on liver cells. Also, stimulates gluconeogenesis. Hence called hyperglycemic hormone.
  - **Insulin** : Peptide hormone, acts on hepatocytes and adipocytes to enhance cellular glucose uptake, stimulates conversion of glucose to glycogen (glycogenesis), so decrease blood glucose level. Hence called hypoglycemic hormone.
  - Deficiency of insulin causes diabetes mellitus in which loss of glucose occurs through urine. Excessive hunger and thirst (polydipsia) are other symptoms of Diabetes.
  - Insulin and glucagon are antagonistic hormones i.e. play opposite role.

**Glycogenolysis** : Breaking of glycogen into glucose.

**Gluconeogenesis** : Formation of glucose from substances other than glycogen.

**Glycogenesis** : Conversion of glucose into glycogen.

## 8. Testis :

- A pair of testis composed of seminiferous tubules and interstitial cells is present in the scrotal sac of males.
- Leydig cells (interstitial cells) produce androgens (mainly testosterone) which regulate development and maturation of male accessory sex organs, formation of secondary sex characters and play stimulatory role in spermatogenesis.

Male sexual behaviour (libido) is influenced by androgens.

**Ovary :** A pair of ovaries which produce one ovum in each menstrual cycle are present in abdomen in females.

- Ovary composed of ovarian follicles and stromal tissue.
- Estrogen synthesised by growing ovarian follicles helps in stimulation of growth of female secondary sex organs, female behaviour, mammary gland development and female secondary sex characters.
- Ruptured follicle form corpus luteum which secretes progesterone. Progesterone supports pregnancy and stimulates alveoli formation and milk secretion in mammary glands.

### **Hormones secreted by tissues which are not endocrine glands :**

- (a) **Heart :** Atrial wall secretes Atrial Natriuretic factor (ANF) which decreases blood pressure by dilation of the blood vessels.
- (b) **Kidney :** Juxtaglomerular cells secrete erythropoietin which stimulates erythropoiesis (RBC formation).
- (c) **Gastro-intestinal tract :** It secretes four peptide hormones.
  - **Gastrin :** Acts on gastric glands and stimulates secretion of hydrochloric acid and pepsinogen.
  - **Secretin :** Acts on pancreas and stimulates secretion of water and bicarbonate ion.
  - **Cholecystokinin (CCK) :** Act on pancreas and gall bladder to stimulate secretion of pancreatic juice and bile juice respectively.

**Gastric inhibitory peptide (GIP) :** Inhibits gastric secretion and motility.

**Mechanism of hormone action :** By hormone receptors of two kinds, *i.e.*,

#### **(a) Located on membrane of target cell**

- These are membrane bound receptors.
- Form hormone receptor complex.



Leads to biochemical changes in tissue.



Release of second messengers like (cyclic AMP,  $IP_3$ ,  $Ca^{2+}$  etc.) which regulate cellular metabolism.

**(b) Located inside the target cell**

- These are intra cellular receptors.
- Hormones (steroid hormones iodothyronines etc.) interact with them and cause physiological and developmental effects of regulating gene expression.

## Questions

### Very Short Answer Questions

**(1 mark each)**

1. Which two system Coordinate and regulate physiological functions of our body ?
2. What is the role of melanocyte stimulating hormone ?
3. Name the hormones which act antagonistically in order to regulate calcium levels in the blood.
4. Give the names of any one glucocorticoid and one mineralocorticoid.
5. How does atrial natriuretic factor decreases blood pressure ?
6. Which structure is formed from ruptured follicle in females ? What is its role ?
7. Immunity of old persons becomes very week. Give reason.

### Short Answer Questions-I

**(2 marks each)**

8. What happens if a person suffers from prolonged hyperglycemia ?
9. What are the two modes through which the hypothalamus causes the release of hormones by pituitary gland ?
10. Androgen regulated the development, maturation and other important functions in human male. List them.
11. Mr. Akshay notices that his shoe size has progressively increased. He also observes that shape of his face has gradually changing with protruding lower jaw. What can be the cause for all changes. Name the disorder.

## Short Answer Questions-II

(3 marks each)

12. Define hormone and classify them on basis of their chemical nature.
13. How do oxytocin, progesterone and estrogen differ from each other ?
14. What are the disorders caused and the effects produced due to malfunctioning/ improper secretion from thyroid gland ?
15. Name the disease/disorder caused by :
  - (a) Excessive secretion of Thyroid hormone in adults.
  - (b) Insufficient amount of insulin secreted by pancreas.
  - (c) Damage of adrenal cortex.

## Long Answer Questions

(5 mark each)

16. 'The master gland regulates a number of physiological functions in our body.' Give reasons and explain.

## Answers

## Very Short Answers

(1 mark each)

1. Nervous system and endocrine system.
2. Acts on melanocytes and regulates pigmentation of skin.
3. Thyrocalcitonin (TCT) and parathyroid hormone (PTH).
4. Glucocorticoid—Cortisol; Mineralocorticoid—aldosterone.
5. By dilation of the blood vessels.
6. Corpus luteum which secretes progesterone.
7. Thymus gland degenerates with age.

## Short Answer Questions-I

(2 marks each)

8. Gets affected by diabetes mellitus which causes loss of glucose through urine and formation of harmful ketone bodies.

9. Through hypothalamic neurons control anterior pituitary gland. Through neural regulation controls posterior pituitary gland.
10. Refer Points to Remember.
11. Increased secretion of growth hormone Acromegaly

### Short Answers Questions-II

(3 marks each)

12. Refer Points to Remember and page no. 338, NCERT, Text Book of Biology for class XI.
13. Oxytocin causes milk ejection and contraction of uterus at time of child birth.  
Progesterone—causes milk secretion and maintains pregnancy.  
Estrogen : Refer Points to Remember.
14. Refer Points to Remember.
15. (a) Exophthalmic goitre  
(b) Diabetes  
(c) Addison's disease

### Long Answers Questions-II

(3 mark each)

16. Explain the role of pituitary gland + Refer Points to Remember.

#### Case Study based question :

17. Read the following and answer any four questions from 17 (i) to 17 (v) given below :

Xenoestrogens are found in a variety of everyday items. Its sources are plastic, pesticides, insecticides, beauty products etc. Many of us don't think twice about the make up we wear, container we use to pack a lunch. Unfortunately this may be altering the way our body works naturally because they all contain endocrine disruptors called Xenoestrogens. Xenoestrogens are a subcategory of endocrine disruptor that specifically has estrogen like effects. Estrogen is a natural hormone synthesized by the growing ovarian

follicles in females. It helps in the growth of female secondary sex organs and female secondary sex characters. It is also important for bone growth and reproduction in men and women. When xenoestrogen enter the body they increase the total amount of estrogen in the body resulting in a phenomenon called estrogen dominance. As they are not biodegradable they are stored in our fat cells. This leads to breast cancer, prostate cancer, obesity, infertility, miscarriages and diabetes.

- (i) Xenoestrogen mimics the action of \_\_\_\_\_ and its excess causes \_\_\_\_\_.  
(a) Progesterone, bone and prostate cancer  
(b) Estrogen, breast and prostate cancer  
(c) Cortisol, brain and blood cancer  
(d) Thyrocalcitonin, bone and lung cancer
- (ii) Estrogen is secreted mainly by :  
(a) GI tract  
(b) Pancreas  
(c) Growing ovarian follicles  
(d) Thymus
- (iii) Select the function/functions performed by estrogen in females :  
(a) Growth of female secondary sex organs  
(b) Bone growth  
(c) Female secondary sex-characters  
(d) All of these
- (iv) What measures, as an individual you would take to reduce your exposure to these harmful exoestrogens?  
(a) Eat local and organic food  
(b) Use beauty products made from natural ingredients



- (c) Do not use plastic lunch box and water bottles
- (d) All of these
- (v) **Assertion :** Estrogen belongs to the class of steroid hormones.  
**Reason :** Cholesterol is the precursor used in synthesizing estrogen hormone.
  - (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
  - (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  - (c) Assertion is true but reason is false
  - (d) Both the assertion and reason are false

**Assertion and Reason type Questions :**

**(1 mark each)**

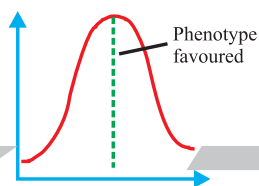
In each of the following questions, two statements are given, one is Assertion and other is Reason. Mark the correct answer as :

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
  - (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  - (c) Assertion is true but reason is false
  - (d) Both the assertion and reason are false
18. **Assertion :** Hormone thyrocalcitonion has antagonistic effect to that of parathyroid hormone (PTH).  
**Reason :** Thyrocalcitonin decreases the blood calcium level while parathyroid hormone increases blood calcium level.
19. **Assertion :** Immunity of old person becomes weak.  
**Reason :** Thymus degenerates in old individuals.

**Answers :**

17. (i) (b) Estrogen, breast and prostate cancer  
(ii) (c) Growing ovarian follicles  
(iii) (d) All of these  
(iv) (d) All of these  
(v) (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion
18. (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
19. (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.





# Practice Paper

## Solved Sample Paper

**Subject : BIOLOGY (044) (Theory)**

**Class : XI**

**Time : 3 Hrs.]**

**[MM : 70**

### INSTRUCTION :

- (i) All questions are compulsory.
- (ii) The question paper has 4 sections. Section–A, Section–B, Section–C, Section–D.
- (iii) Section-A contains 14 questions of 1 mark each (including 4 Reasoning-Assertion questions) and two case-based question of 4 marks each.
- (iv) Section-B contains 9 questions of two marks each.
- (v) Section-C contains 5 questions of 3 marks each.
- (vi) Section-D contains 3 questions of 5 marks each.
- (vii) There is no overall choice. However, internal choice have been provided in some questions. A students has to attempt only one of the alternatives in such questions.
- (viii) Wherever necessary, neat and properly labelled diagrams should be drawn.

### SECTION 'A'

- 1. Mention the number of obligate taxonomic categories.
- 2. What term is given to the arrangement of leaves on the stem?
- 3. Where do you find Malphigian tubules?
- 4. What is symplast?

5. Name the molecule which is the terminal acceptor of electrons in cellular respiration.
6. Give two examples of anaerobes.
7. Why is Oxytocin called "birth hormone"?
8. In which organelle does Krebs's cycle occur in the living cells?
9. Name the mineral element that forms the core constituent of the ring structure of chlorophyll.
10. Give two examples of fruits having sclereids.
11. **Assertion :** In Lily flower, Perianth is a term used when calyx and corolla are not distinct.

**Reason :** Calyx and Corolla are the reproductive parts of a flower.

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
  - (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  - (c) Assertion is true but reason is false.
  - (d) Both the assertion & reason are false.
12. **Assertion :** Tendons attach one bone to another bone.

**Reason :** Ligaments attach skeletal muscles to bones.

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
  - (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
  - (c) Assertion is true but reason is false.
  - (d) Both the assertion & reason are false.
13. **Assertion :** Metabolism refers to the sum total of chemical reactions, (catabolism + anabolism) that occur within living organisms.

**Reason :** Metabolic reactions occur simultaneously inside living organisms.

- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.

- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion & reason are false.
14. **Assertion :** The enzyme Nitrogenase is a Mo-Fe protein and catalyses the conversion of atmospheric nitrogen into ammonia.
- Reason :** The enzyme nitrogenase is highly sensitive to the molecular oxygen.
- (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.
- (b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.
- (c) Assertion is true but reason is false.
- (d) Both the assertion & reason are false.
15. Read the following and answer any four questions from 15 (i) to 15 (v) given below :

Lipids are water insoluble. They could be simple fatty acids, which has a carboxyl group attached to a 'R' group. Fatty acids could be saturated (having only single bonds) or unsaturated (with one or more double or triple bonds). Another simple lipid is Glycerol, which is Trihydroxy propane. Simple lipids are made up of both Glycerol and Fatty acids, in which three molecules of fatty acids are esterified with one molecule of glycerol (Triglycerides). They are also called Fats and oils depending upon their melting point. Oils have lower melting points which depend upon the chain length and degree of unsaturation. Fatty acids could be essential or non-essential. Fatty acids like alpha-linolenic acid (Omega-3 fatty acid) and Linolenic acid (Omega-6 fatty acid), which our body requires for good health but cannot be prepared by it and must be taken from diet are called essential Fatty acids.

- (i) Triglycerides are formed by joining of :
- (a) One Glycerol and three fatty acids through ester bonds.
- (b) Three Glycerol and one fatty acid through peptide bonds.

- (c) One Glycerol and three fatty acids through ether bonds.
  - (d) Three Glycerol and one fatty acid through phosphodiester bonds.
- (ii) The melting point of fatty acids depends upon chain length and\_\_\_\_\_
- (a) Shape of fatty acids
  - (b) Degree of unsaturation
  - (c) Charge on alpha carbon
  - (d) All the three
- (iii) Find the incorrect statement about the biological functions of lipids:
- (a) Storage form of fuel
  - (b) Acts as carrier for absorption of fat soluble vitamins
  - (c) Structural component of membranes
  - (d) Exhibit catalytic activity
- (iv) Liquid form of triglycerides at ordinary temperature is called :
- (a) Solids
  - (b) Oils
  - (c) Fats
  - (d) None of these
- (v) **Assertion :** Omega-3 fatty acid comes under the category of essential fatty acid.

**Reason :** This is because our body requires them but cannot synthesise them for good health. They need to be taken in the form of our diet.

16. Read the following and answer any four questions from 16 (i) to 16 (v) given below :

Eyes are the organs of sight. They are located in sockets of skull called orbits. They are covered by three walls layers. External layer is called Sclera, its anterior portion forms cornea. Middle layer is choroid, in the anterior part it becomes thick to form a ciliary body. Ciliary body continues

forward to form a pigmented structure called iris. The eyeball contains a crystalline biconvex lens, which is held in place by the ligaments of the ciliary body. In front of the lens, the aperture surrounded by the iris is called pupil. The diameter of the pupil is regulated by the muscles of iris. The innermost layer is the retina which contains ganglion cells, bipolar cells and photoreceptor cells. There are two types of photoreceptors, namely rods and cones.

- (i) The transparent lens in the human eye held in its place by :
  - (a) Ligaments attached to the ciliary body
  - (b) Ligaments of iris
  - (c) Smooth muscles of iris
  - (d) Smooth muscles of ciliary body
- (ii) Coloured portion of eye which decides our eye colour and controls the amount of light reaching the retina is called :
  - (a) Cornea
  - (b) Pupil
  - (c) Retina
  - (d) Iris
- (iii) The eye lens is :
  - (a) Concave
  - (b) Convex
  - (c) Biconcave
  - (d) Biconvex
- (iv) The innermost and the most delicate layer of the eyeball where the photoreceptors are located is :
  - (a) Choroid
  - (b) Sclera
  - (c) Cornea
  - (d) Retina

- (v) A corneal transplant is never rejected in humans because :
- (a) It consists of enucleated cells
  - (b) It is a non-living layer
  - (c) It has no blood supply
  - (d) Its cells are least penetrable by bacteria

### SECTION 'B'

17. Identify and name the following types of root modifications :
- (i) Roots performing the function of photosynthesis
  - (ii) Roots come above the surface of the soil to absorb air
  - (iii) The pillar-like roots developed from lateral branches for providing mechanical support
  - (iv) Roots coming out of the lower nodes of the stem and provide support to the plant.
18. Draw a well labelled diagram of a sarcomere.
19. Match the following :
- | Column – I       | Column–II                               |
|------------------|---|
| (i) Pineal gland | (a) regulates metabolism                |
| (ii) 3 Hormone   | (b) regulates skin colour               |
| (iii) MSH        | (c) regulates diurnal (24 hours) rhythm |
| (iv) Insulin     | (d) regulates blood sugar level         |
20. (a) Why are bryophytes called amphibians of the plant kingdom?  
(b) Why is the plant body of an alga called a thallus?

Or

Draw a well labelled diagram of sporophyte and gametophyte of Funaria.

21. Why do plant cells get plasmolysed when placed in hypertonic solution?
22. Give one word scientific term for the following :
- (a) Blood filled cavity in Arthropods
  - (b) Excretory organs of an annelid



- (c) Stinging cells of Cnidaria
  - (d) Individual animals bearing organs of both sexes.
23. Define R.Q? What is its value for fats?
24. Name the three common nitrogenous waste materials in vertebrates. Which of these is the most toxic?
25. (a) Why are xylem and phloem called complex tissues?
- (b) Distinguish between xylem and phloem on the basis of their function.

### SECTION 'C'

26. (a) In botanical gardens and tea gardens, gardeners trim the plants regularly so that they remain bushy. Does this practice have any scientific explanation?
- (b) Define Vernalization?
27. (a) Tabulate four major differences between Monera and Protista.
- (b) Name a composite organism, which is a pollution indicator and made up of an algal and a fungal component.
28. Describe the three types of coelom found in various living organisms with the help of well labelled diagrams. Also mention one example of each category.
29. How do neutral solutes move across the plasma membrane? Can the polar molecules also move across it in the same way? If not, then how are these transported across the membrane.

Or

What is a centromere? How the position of the centromere forms the basis of classification of chromosomes. Support your answer with a diagram showing the position of centromere on the different types of chromosomes.

30. Tabulate six differences between dicot stem and monocot stem.

### SECTION 'D'

31. Explain the five phases of Prophase – I of Meiosis–I.

Or

Why mitosis is called equational division? Give a short account of its four phases.

32. Describe the process of digestion of proteins in the human alimentary canal.

Or

Give reason for the following :

- (a) There is a slight gap between auricular systole and ventricular systole.
  - (b) Left ventricle has a thicker wall than right ventricle
  - (c) SA node is called a pacemaker of the heart.
33. (a) Explain non-cyclic photophosphorylation. Why is it called so?
- (b) Give two difference between cyclic and non-cyclic photophosphorylation.

Or

Describe the C<sub>4</sub> pathway with the help of a suitable diagram. Give two examples of plants showing this cycle.

## SOLUTIONS :

### SECTION 'A'

- |    |   |   |
|----|---|---|
| 1. | 7   | 1 |
| 2. | Phyllotaxy  | 1 |
| 3. | At the junction of midgut & hindgut of the alimentary canal of cockroach.               | 1 |
| 4. | Entry of water into the cells through cell membrane, intercellularly via plasmodesmata. | 1 |
| 5. | Oxygen  | 1 |
| 6. | Yeast & bacteria  | 1 |
| 7. | As it helps in contraction of the uterus during childbirth.                             | 1 |
| 8. | Mitochondria  | 1 |
| 9. | Magnesium   | 1 |
| 10 | Nuts, guava, sapota, pear (any two)   | 1 |

11. C
12. d
13. b
14. b
15. (i) a (ii) b (iii) d (iv) b (v) a (any four) 1+1+1+1
16. (i) a (ii) d (iii) d (iv) d (v) c (any four) 1+1+1+1

### SECTION 'B'

17. (i) Storage/Assimilatory roots (ii) Pneumatophores (iii) Prop roots  
(iv) Stilt roots (0.5 marks each).
18. Refer to NCERT Biology class XI page no. 305 fig. 20.2 diagram  
0.5 mark; 3 correct labelling. 0.5 mark each
19. (i) (c) (ii) (a) (iii) (b) (iv) (d) 0.5 mark each
20. (a) As Bryophytes can live in soil but are dependent on water for sexual reproduction. 1  
(b) Algal plantbodies do not have a well differentiated body, showing root, stem or leaf. 1

Or

- Refer to NCERT Biology class XI page no. 34 fig. 3.2 (c) diagram 0.5 mark; 3 correct labelling. 1.5 mark
21. As water comes out of the cell, which is exosmosis. This causes a decrease in the volume of the cell. 1+1
  22. (a) Haemocoel; (b) Nephridia; (c) Cnidoblasts; (d) Hermaphrodites  
0.5 mark each
  23. Ratio of the volume of CO<sub>2</sub> evolved to the volume of O<sub>2</sub> consumed in respiration. R.Q. for fats is less than 1. 1+1
  24. Ammonia, urea and uric acid. Ammonia is most toxic. 0.5 mark each
  25. (a) These tissues are made up of more than one type of cells.  
(b) Xylem helps to conduct water and minerals from roots to other parts of the plant. Phloem helps to transport food from leaves to other parts of the plants. 1+1

## SECTION 'C'

26. (a) This is decapitation, which causes removal of APICAL Dominance, and results in the growth of lateral buds. As auxin from the tip of the shoot is removed with decapitation.

(b) Plants for which flowering is either quantitatively or qualitatively dependent on exposure to low temperature. 1+1+1

27.

S.No.	Monera	Protista
1.	It includes unicellular prokaryotes	It includes unicellular eukaryotes
2.	Membrane bound cell organelles absent	Membrane bound cell organelles present
3.	Shows fermentation and aerobic respiration	Respiration is aerobic and is dependent on mitochondria
4.	Classified into archaeobacteria, Eubacteria and PPLO Example : Nostoc	Classified into Chrysophytes, Dinoflagellates, Euglenoids, Slime moulds and Protozoans. Example : Euglena

(b) Lichens 2+1

28. Acoelomates: Body cavity absent e.g, Platyhelminthes.

Pseudocoelomates : No true coelom as mesoderm is scattered in pouches between ectoderm and endoderm e.g, Aschelminthes.

Coelomates : Have true body cavity, which is lined by mesoderm e.g, Annelids, Arthropods. for diag. refer to NCERT Biology class XI page No. 48 fig. 4.3 1+1+1

29. Neutral solutes movement : through passive diffusion, without energy expenditure. 1

Polar molecules movement, across the membrane is different. It's Facilitated Diffusion. 1

Which can be through symport, antiport or uniport method. 1

Or

Centromere : Primary constriction in every chromosome. 0.5

Classification : Metacentric : middle centromere; 0.5

Sub-metacentric : centromere near to one end of chromosome 0.5

Acrocentric : centromere situated close to the end of chromosome 0.5

Telocentric : Has terminal centromere 0.5

for diagram refer to NCERT Biology class XI page 139 fig. 8.12 0.5

30.

S.No.	Dicot stem	Monocot stem
1.	It is differentiated into epidermis, cortex, endodermis, pericycle and stellar system.	There is no such differentiation
2.	Hypodermal ring is collenchymatous	Hypodermal ring is sclerenchymatous
3.	Vascular bundles are arranged in a ring	Vascular bundles are scattered
4.	Open vascular bundle	Closed vascular bundle
5.	Bundle sheath absent	Bundle sheath present
6.	Phloem parenchyma is present	Phloem parenchyma is absent

Or Write any other appropriate point.

0.5 × 6=3

### SECTION 'D'

31. Meiosis -I Prophase-I

1+1+1+1+1

Leptotene: condensation of chromosomes.

Zygotene: synapsis between homologous chromosomes.

Pachytene : crossing over between non sister chromatids.

Diplotene : dissolution of synaptonemal complex.

Diakinesis : full condensation and terminalization of chiasmata.

Or

Mitosis is equational, as daughter cells receive equal no. of chromosomes, as were present in the parent cell. Its four phases are – prophase, anaphase, metaphase and telophase.

For brief description refer to NCERT Biology class XI page no. 164-166 or points to remember of Cell cycle and cell division of support material.

1+1+1+1+1



32. For process of digestion of protein refer to NCERT Biology class XI page no. 263 & 264 or points to remember of Digestion and absorption of support material.

Or

- (i) To prevent backflow of blood in auricles, by the closure of bicuspid and tricuspid valves. 1.5
  - (ii) So as to pump the blood further around the body, and against high pressure, compared with the right ventricle. 1.5
  - (iii) SA node being self-excitatory, initiate a wave of contraction in the heart. 2
33. (a) Non cyclic photophosphorylation : Two photosystems are working in a zigzag way looking like Z shaped, PSII connected to PSI via an electron transport system. (Z SCHEME). It results in the formation of ATP & NADPH + H<sup>+</sup>.  
It's non cyclic as electrons are not returning back to PSII, one they reach PSI. 3
- (b) Refer to NCERT Biology class XI page no. 212 2

Or

Description refer to NCERT Biology class XI page no. 218 and diagram on page no. 219 fig. 13.9. Two examples maize and sorghum or any two correct examples. 2+2+1

\*\*\*\*\*

## **PRACTICE PAPER - 1 (Unsolved)**

### **BIOLOGY (044) (THEORY)**

#### **CLASS : XI**

**Time : 3 Hours**

**Max. Marks : 70**

#### ***General Instructions:***

- (i) All questions are compulsory.
- (ii) The question paper has four sections. Section–A, Section–B, Section–C, Section–D. There are 33 questions in the question paper.
- (iii) Section-A has 14 questions of 1 mark each and 02 case-based question. Section-B has 9 questions of 2 marks each. Section C has 5 questions of 3 marks each and Section-D has 3 questions of 5 marks each.
- (iv) There is no overall choice. However, internal choice have been provided in some questions. A students has to attempt only one of the alternatives in such questions.
- (v) Wherever necessary, neat and properly labelled diagrams should be drawn.

#### **SECTION 'A'**

##### **(1 mark questions)**

- 1. Why is the respiratory pathway also known as an amphibolic pathway?
- 2. Which types of secondary metabolite is (a) lemongrass oil, (b) morphine
- 3. To which order *Triticum sativum* belongs to?
- 4. Where are unmyelinated nerve fibres found?
- 5. Give an example of a flower having false septum.
- 6. How is fascicular and interfascicular cambium different?
- 7. What do you understand by the term polysomes?
- 8. Name the group of organism which have stiff cellulosic plates and possess two flagella.
- 9. Give reason for the cause of acromegaly
- 10. What is the function of kinetochores?

## ASSERTION REASONING

The following question consists of 2 statements - Assertion (A) and Reason (R). Answer the question by selecting the appropriate option below :

11. **Assertion (A)** : Plasmodesmata are the connections between two adjacent cells.

**Reason (R)** : Plasmodesmata are part of the symplastic system.

- (a) Both the assertion and reason are true and the reason is the correct explanation of the assertion.
  - (b) Both the assertion and reason are true but the reason is not a correct explanation of the assertion.
  - (c) The assertion is true but the reason is false
  - (d) Both the assertion and reason are false
  - (e) The assertion is false but the reason is true
12. **Assertion (A)** : Most of the cartilage in vertebrate embryos are replaced by bones in adults.

**Reason (R)** : Cartilage is solid and pliable and resists compression.

- (a) Both A and R are true and the reason is a correct explanation of the assertion.
  - (b) The assertion is true but the reason is false
  - (c) Both the assertion and reason are false
  - (d) The assertion is false but the reason is true
13. **Assertion (A)** : ABO grouping is based on the presence or absence of two surface antigens.

**Reason (R)** : Rh antigen is the part of ABO blood grouping.

- (a) Both the assertion and reason are true but the reason is not a correct explanation of the assertion
- (b) The assertion is true but the reason is false
- (c) Both the assertion and reason are false
- (d) The assertion is false but the reason is true



14. **Assertion (A)** : The fimbriae are elongated tubular structures made of a special protein.

**Reason (R)** : The pili are small bristles like fibres sprouting out of the cell.

- (a) Both A and R are true and the reason is a correct explanation of the assertion
- (b) The assertion is true but the reason is false
- (c) Both the assertion and reason are false
- (d) The assertion is false but the reason is true

### CASE BASED QUESTIONS :

Read the following and answer any four questions from (i) to (v) given below :

15. There are two types of nitrogenous bases - Purines (Adenine and Guanine), and Pyrimidines (Cytosine, Uracil and Thymine). Cytosine is common for both DNA and RNA and Thymine is present in DNA. Uracil is present in RNA at the place of thymine. A nitrogenous base is linked to the pentose sugar through a N-glycosidic linkage to form a nucleoside, such as adenosine or deoxyadenosine, guanosine or deoxyguanosine, cytidine or deoxycytidine and uridine or deoxythymidine. When a phosphate group is linked to 5'-OH of a nucleoside through phosphodiester linkage, a corresponding nucleotide (or deoxynucleotide depending upon the type of sugar present) is formed. Two nucleotides are linked through 3'-5' phosphodiester linkage to form a dinucleotide. More nucleotides can be joined in such a manner to form a polynucleotide chain. A polymer thus formed has at one end a free phosphate moiety at 5'-end of ribose sugar, which is referred to as 5'-end of polynucleotide chain. Similarly, at the other end of the polymer the ribose has a free 3'-OH group which is referred to as 3'-end of the polynucleotide chain. The backbone in a polynucleotide chain is formed due to sugar and phosphates. The nitrogenous bases, linked to the sugar moiety project from the backbone.

- (i) DNA is different from RNA in terms of
  - (a) It is single stranded
  - (b) It has thymine instead of uracil
  - (c) Phosphate group is present at 5' end of the polynucleotide chain
  - (d) Guanine is a purine
- (ii) In RNA, there is free -OH group at
  - (a) 3' end
  - (b) 5' end
  - (c) Both at 3' end and 5' end
  - (d) In the middle of chain
- (iii) When a nitrogenous base is linked to pentose sugar then the suffix is added to deoxyribonucleotide, so the cytosine is written as
  - (a) Dooxycitotide
  - (b) Deoxycytidine
  - (c) Deoxycytisine
  - (d) Deoxycytotide
- (iv) The bond between pentose sugar and a base such as adenine is called
  - (a) Gycosine linkage
  - (b) Ester linkage
  - (c) A-glycosidic linkage
  - (d) N-glycosidic linkage
- (v) Adenine pairs with guanine with
  - (a) Single bond
  - (b) Double bond
  - (c) Triple bond
  - (d) Does not form any bond

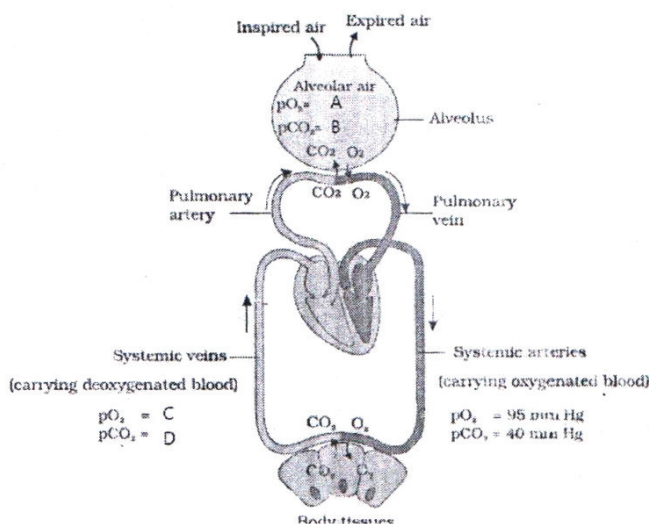
16. In some herbaceous plants with beautiful yellow flowers such as garden *nasturtium* which is also known as *Tropaeolum*, one can see water droplets oozing out of the special pores present in the leaves early in the morning. When sun rays get a little stronger in cold winters, the water droplets also vanish. This phenomenon can only be seen if there is high humidity and plants are well watered. It is believed that this occurs due to root pressure present in such plants. Along with water, many minerals and salts are also excreted by the plants. This is also considered as one of the excretory methods adapted by the plants.
- (i) Name the phenomenon due to which garden *nasturtium* loses water in the form of water droplets?
- (ii) The special pores are called
- (a) Stomata
  - (b) Hydathodes
  - (c) Vein endings
  - (d) Xylem stoma
- (iii) Why is such a phenomenon not seen in taller plants?
- (iv) Which phenomenon is responsible for the ascent of sap in taller plants?
- (v) How is the function of stomata different from the phenomenon explained above?

## SECTION 'B'

### 2 MARKS QUESTIONS

17. 'Meiosis is considered an important step in evolution of any species. Justify.
18. Write four components of blood.
19. What is the difference between plasmodium of protozoa and plasmodium of slime moulds?
20. (a) Why are bryophytes considered as amphibians of the plant kingdom?  
(b) How is polyp and medusa different?

21. Explain the mechanism of vision in human beings.
22. Draw the fluid mosaic model of cell membrane given by Singer and Nicolson.
23. Differentiate between  
Endarch and exarch condition  
Conjoint and radial vascular bundle
24. In the given figure give the concentration of oxygen and carbon dioxide for A and B in alveoli and in the systemic vein.



Or

- (a) Name the hormones secreted by
  - (i) Adrenal medulla
  - (ii) Middle lobe of pituitary
- (b) What does the T wave represent in ECG?
25. What are the two major functions of the large intestine in digestion and absorption of food substances?

### 3 MARKS QUESTIONS

26. Explain C3 cycle.
27. (a) Which group is considered as imperfect in kingdom fungi and why? Write difference between basidiomycetes and ascomycetes.  
(b) Name any two disease caused by bacteria.
28. (a) 'Calcium ions play a significant role in contraction of muscles during walking'. Explain.  
(b) What is gout?
29. (a) Name an element which is required by plants for activation of various enzymes such as carboxylase.  
(b) What do you understand by the term apical dominance?  
(c) Which plant growth regular helps to increase the absorbing surface of roots in plants?

Or

- (a) What is mineral toxicity? Give examples.  
(b) Give an example each of short- and long-day plants.  
(c) Give any two reasons for seed dormancy.
30. (a) What is an algal partner and fungal partner of lichen called as? What role do they play to establish a symbiotic relationship?  
(b) Give an example of ssRNA virus

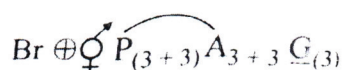
### 5 MARKS QUESTIONS

31. Write complex wise steps of electron flow till formation of ATP in ETS.

Or

- (a) How is C3 cycle different from C4 cycle in terms of  
(i) Cell which contains RuBisCo

- (ii) Carbon-di-oxide fixation in high light conditions
  - (iii) Ambient temperature
  - (b) How is transpiration beneficial and an evil for plants?
32. Identify and explain the given floral formula



Or

- (a) Draw the diagram of digestive system of cockroach and label the following parts
    - (i) Organ for excretion
    - (ii) Organ which secretes digestive juices
    - (iii) Organ which opens into anus
    - (iv) Organ used for storing food
    - (v) Organ which helps in grinding food
    - (vi) Organ which is also called as mesenteron
  - (b) Name the organs/location where the following tissues are found
    - (i) smooth muscle
    - (ii) cuboidal epithelium
    - (iii) tissue with hard and non-pliable ground substance rich in calcium salts
    - (iv) tissue in which collagen fibres are present in rows between many parallel bundles of fibres.
33. (a) What is the role of tubular secretion in maintaining ionic balance in our body?

- (b) What is uricotelism? Give an example.
- (c) Mention the role of sebaceous glands in excretion.

Or

- (a) Complete the following :

(i) Dipeptides  $\xrightarrow{\textcircled{a}}$  Amino acids

(ii) Maltose  $\xrightarrow{\text{Maltase}}$   $\textcircled{b}$  + Glucose

(iii)  $\textcircled{c}$   $\xrightarrow{\text{Lactase}}$  Glucose + Galactose

(iv) Sucrose  $\xrightarrow{\text{Sucrase}}$  Glucose +  $\textcircled{d}$

- (b) What is the difference between angina and heart failure?
- (c) Which part of the brain controls (i) respiratory rhythm, (ii) moderates respiratory rate.

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## **PRACTICE PAPER - 2 (Unsolved)**

### **BIOLOGY (044) (THEORY)**

#### **CLASS : XI**

**Time : 3 Hours**

**Max. Marks : 70**

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#### ***General Instructions:***

- (i) All questions are compulsory.
- (ii) The question paper has four sections. Section–A, Section–B, Section–C, Section–D. There are 33 questions in the question paper.
- (iii) Section-A has 14 questions of 1 mark each and 02 case-based question. Section-B has 9 questions of 2 marks each. Section C has 5 questions of 3 marks each and Section-D has 3 questions of 5 marks each.
- (iv) There is no overall choice. However, internal choice have been provided in some questions. A students has to attempt only one of the alternatives in such questions. Wherever necessary, neat and properly labelled diagrams should be drawn.

#### **SECTION 'A'**

- 1. How many molecules of ATP are required for synthesis of one molecule of glucose in C3 and C4 pathways?
- 2. Where do you observe trichomes?
- 3. Name the scientist who wrote the book 'Systema Naturae'.
- 4. Which Ascomyceles has been used extensively in biochemical and genetic work?
- 5. Name the arthropods that is a (i) living fossil, (ii) Gregarious pest.
- 6. What is mesoglea? Where is it found?
- 7. Why do plants have different types of phyllotaxy?
- 8. In a pea plant, aestivation in corolla is known as vexillary. Give reason.
- 9. Write the name of most abundant enzyme in the world.



10. To which bone ribs are attached to ?

Follow the following instruction for the question no. 11 to 14.

Choose the option as given below :

- (a) Both assertion and reason are correct
- (b) The assertion is incorrect, but the reason is correct
- (c) Both assertion and reason are incorrect
- (d) The assertion is correct, but the reason is incorrect

11. **Assertion :** Cyanobacteria are used to increase the fertility of the soil.

**Reason :** Cyanobacteria have specialized cells called heterocyst.

Or

**Assertion :** All insects show indirect development.

**Reason :** Development through larval stage is called indirect development.

12. **Assertion :** Malonate is an inhibitor of Succinic dehydrogenase.

**Reason :** Inhibitor closely resemble the substrate in the molecular structure and inhibit the enzyme activity.

13. **Assertion :** Emphysema is a chronic disorder in which alveolar wall gets damaged.

**Reason :** The dust produced in stone grinding causes severe lung damage in people working there.

14. **Assertion :** Progesterone supports pregnancy and stimulates alveoli formation and milk secretion in mammary glands.

**Reason :** Ruptured graafian follicles forms corpus luteum which secretes progesterone.

15. Read the following and answer any four questions from (i) to (v) given below :

Plants respond to the light by absorbing it and photosynthesizing the food, but plant can respond to the light in some other ways also which help in

adjusting the plant in environmental conditions. Growing of shoot towards light and flowering in plant when sufficient duration of light is available are a few of such types of responses. Light sensing in plants involves special protein called phytochromes which are molecules of a protein bound to a light-absorbing organic molecule, called the chromophore. When phytochromes absorb light, they change shape, become active and can change the activity of other proteins in the cell.

- (i) A plant can respond towards sunlight by
  - (a) Photosynthesis
  - (b) Flowering
  - (c) Growth of shoot towards light
  - (d) All of the above
- (ii) The response of the plant by flowering when sufficient duration of light and dark period is available, it is called as
  - (a) Phototropism
  - (b) Photoperiodism
  - (c) Vernalisation
  - (d) Differentiation
- (iii) The hormone responsible for phototropism is
  - (a) Abscissic acid
  - (b) Ethylene
  - (c) Gibberellic acid
  - (d) Auxin
- (iv) If a duration of sunlight is interrupted by exposure of dark period in a short-day plant, then
  - (a) Then plant will not show flowering
  - (b) The plant will show flowering
  - (c) The seeds of this plant will not germinate
  - (d) The growth of the plant will be adversely get affected

(v) Assertion : Auxin promotes cell elongation, causing the plant to grow more on the shady side and bend in the direction of the light source.

Reason : More auxin is transported down the shady side, and less auxin is transported down the illuminated side.

(a) Both assertion and reason are true, and the reason is the correct explanation of the assertion

(b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion

(c) Assertion is true but reason is false

(d) Both assertion and reason are false

16. Oxygen saturation is an essential element in the management and understanding of patient care. Oxygen saturation measures binding of haemoglobin to oxygen in comparison to how much haemoglobin remains unbound. Haemoglobin molecule can bind to four molecules of oxygen at a time and transport it to the tissues and cells. Due to the critical nature of tissue oxygen consumption in the body, it is essential to be able to monitor current oxygen saturation. A blood-oxygen saturation reading indicates the percentage of haemoglobin molecules in the arterial blood which are saturated with oxygen. The reading may be referred to as SaO<sub>2</sub>. Reading vary from 0 to 100%. Normal readings in a healthy adult, however, range from 94% to 100%. A pulse oximeter can measure oxygen saturation. It is a non-invasive device placed over a person's finger. It measures light wavelengths to determine the ratio of the current levels of oxygenated haemoglobin to deoxygenated haemoglobin. The use of pulse oximetry has become a standard of care in medicine. As such, medical practitioners must understand the functions and limitations of pulse oximetry.

(i) The following factor facilitates the binding of oxygen to haemoglobin

(a) Low pCO<sub>2</sub>

(b) Low O<sub>2</sub>

(c) High H<sup>+</sup>

(d) Higher temperature

(ii) How much oxygen is delivered by every 100 ml of oxygenated blood to the tissues, under normal physiological conditions

- (a) 50 ml
- (b) 20 ml
- (c) 10 ml
- (d) 5 ml

(iii) About 97% of oxygen is transported by RBCs in the blood. How does the remaining 3% of oxygen of oxygen transported?

- (a) It does not get transported
- (b) It gets transported as oxyhaemoglobin
- (c) It is carried out in plasma in dissolved form
- (d) Its transport is decided by carbamino haemoglobin

(iv) The percentage of CO<sub>2</sub> carried out in dissolve state through plasma is

- (a) 7
- (b) 20-25
- (c) 70
- (d) 2.5

(v) Read two statements

**Statement I :** Volume of air remaining in lungs even after forceful expiration is called residual volume

**Statement II :** Vital capacity of a person can be increase through breathing exercise.

Choose from below the correct alternative :

- (a) Only statement is true
- (b) Both statements I and II are true
- (c) Statement I is true but statement II is false
- (d) Statement I is false but statement II is true

## SECTION 'B'

17. Viruses and viroids differ in structure and the diseases they cause. How?
18. Why growth and reproduction can not be taken as defining property of all living organisms?
19. What is casparian strips? Write its significance in plants.
20. What is the function of ciliated epithelium? Where do we find this epithelium?
21. How is adhering junction different from gap junction?
22. A primary root grows from 5 cm to 19 cm in a week. Calculate the absolute growth and relative growth over the given period.

Or

Where are auxins generally produced in a plant? Name any one naturally occurring plant auxin and one synthetic auxin.

23. Differentiate between apocarpous and syncarpous ovary.
24. Mention the specific term used for the following :
  - (i) Cluster of ribosomes found in cytoplasm
  - (ii) Extensive infolding to the inner membrane of mitochondria
  - (iii) Stacks of closely packed thylakoids
  - (iv) Stalked particles on the inner membrane of mitochondria
25. What will be the DNA content of a cell at G<sub>1</sub>, after S and G<sub>2</sub> phase, if the DNA content after M phase is 2C?

## SECTION 'C'

26. The gametophytes of bryophytes and pteridophytes are different from that of gymnosperms. How?
27. Differentiate between dicot and monocot stems.
28. When and why does photorespiration take place in plants? How does this process result in a loss to the plants?
29. Draw a diagram showing schematic plan of blood circulation in human.

30. How are actin and myosin fibres arranged in a muscle fibre? Explain with the help of a diagram.

Or

What is synapse? How does the nerve impulse cross the chemical synapse?

### SECTION 'D'

31. Draw a neatly labelled structure of internal ear of a human.

Or

Describe how urine is formed in the nephron through filtration, reabsorption and secretion.

32. What is glycolysis? Where does glycolysis takes place in a cell? Give schematic representation of glycolysis.

Or

Give the schematic representation of overall view of TCA cycle.

33. What is cell cycle? Explain the events occurring in this cycle.

Or

- (i) Explain peptide bond, glycosidic bond and phosphodiester bond.
- (ii) Explain competitive inhibition along with an example.

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