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Class

9th

According to SLO Based
Exam System of New Curriculum

BIOLOGY

According to NEW NATIONAL CURRICULUM
for Session 2025-26

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Chairman's Message

Since its inception, **Unique Group of Institutions** has been steadfast in its mission to empower students by providing exceptional opportunities that help turn their aspirations into reality. Driven by an unwavering commitment to nurture young minds, we passionately strive to lay the foundation for successful and meaningful careers. Our guiding philosophy, *"Where Career Meets Success,"* epitomizes our dedication to bridging the gap between ambition and achievement.

Our indefatigable pursuit of educational excellence has inspired us to extend our services into the realm of **Unique Publications**, a visionary initiative aimed at transforming the lives of students across Pakistan. Recognizing the vital need for high-quality, student-centric academic resources, **Unique Notes** have been meticulously crafted by a team of highly skilled, experienced, and devoted educators who possess both subject mastery and a deep understanding of student needs.

At **Unique Group of Institutions**, we believe that every student deserves comprehensive guidance and unwavering support during the formative stages of their academic and professional journey. We walk beside them as mentors and motivators, ensuring they are equipped to excel and secure a future brimming with opportunities, confidence, and success.

Unique Publications is more than just an initiative; it is our pledge to reach every corner of the country, connecting students from bustling cities to the remotest towns with cutting-edge educational material. Through this project, we aspire to democratize education, making world-class learning accessible and inclusive, thus paving the way for a brighter, more empowered Pakistan.

Our vision is clear and resolute: to inspire excellence, foster innovation, and cultivate a generation of well-rounded individuals who will not only achieve personal success but also contribute meaningfully to the nation's progress.

Together, we work toward the ideal of **"Better Education, Better Pakistan"** — a mission that defines us, drives us, and keeps us striving for greater heights.

Abdul Manan Khurram
Chairman UGI





A Word of Thanks

It is a moment of immense pride and satisfaction for me to declare that this book is not merely a helping guide but a testament to the Unique Group of Institutions' (UGI) tenacious commitment to empowering students to perform at their very best. This edition stands as a reflection of the tireless efforts and unparalleled dedication of our esteemed teachers, whose professional expertise, subject mastery, and student-centered approach have truly brought this work to life.

The exceptional dexterity demonstrated by our educators in curating this edition reflects both their individual passion and professional commitment to their respective disciplines. Every effort has been made to ensure that the content is accessible, comprehensive, and aligned with the desired learning objectives, keeping in view the individual learning needs of students. Equal emphasis has been placed on formative and summative evaluations, ensuring that assessment and learning outcomes are both measurable and achievable.

This book has been meticulously designed with a focus on brevity, and precision, while its carefully curated content serves as a true "knowledge booster" for students. Undoubtedly, Unique Notes are the key to success, empowering students to excel academically and achieve their dreams. I deeply appreciate the untiring efforts and profound commitment of our distinguished teachers who have worked diligently to make this vision possible. Their contributions reflect the very essence of excellence, innovation, and purpose-driven education that UGI stands for.

Prof. Amjad Ali Khan
Rector UGI



Foreword

Unique Notes have been meticulously prepared in alignment with the recommendations of the National Education Policy and modern pedagogical requirements, ensuring that they meet the highest standards of contemporary education. The exercises included within this material are carefully designed to foster not only academic excellence but also the mental, personal, and intellectual development of students. Each section has been curated to ignite critical thinking, enhance problem-solving skills, and cultivate a deep understanding of the subjects.

We firmly believe that achieving the dream of educational advancement demands continuous effort, innovation, and an unwavering commitment to excellence. With this realization, we are indefatigably striving to create resources that empower learners and inspire educators. In this pursuit, we warmly invite valuable opinions and constructive suggestions from scholars, esteemed educators, students, parents, and all stakeholders in society. Your feedback is a cornerstone of our progress and will enable us to continually improve and evolve in our mission to deliver the finest educational resources.

Together, let us join our hands and unite our efforts to envision and create a stronger, smarter, and more enlightened future for our students and our nation—a future that shines as a beacon of progress, knowledge, excellence, and inspiration for generations to come.

Prof. Muhammad Abdullah
Additional Director UGI



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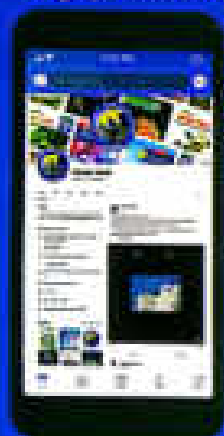
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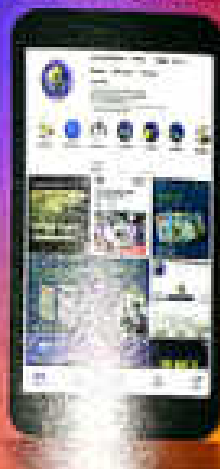


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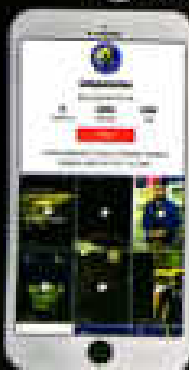


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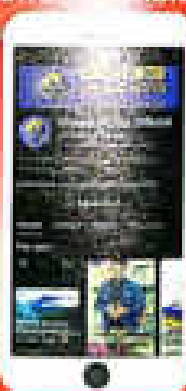
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UNIT 01

THE SCIENCE OF BIOLOGY

Q.1 What is science?

0914013001

Ans. Definition

Science is a process of collecting information about the world around us. Observations are made, experiments are done in order to understand the facts of nature.

Explanation

Much of the time, the first step in collecting information is asking a question. *Why do I feel pain when I touch a hot object?* Making observations, asking questions and trying to find the answers is what science all about. The study of science helps us to answer the how, what, where and why of our surroundings.

Q.2 What is biology?

0914013002

Ans. Definition

Biology is the study of living organisms. It helps us to explain how living things relate to one another and to their surroundings.

Explanation of Word "Biology"

The word biology consists of two Greek words "bios" meaning life and "logos" meaning thought, reasoning and study.

Q.3 Describe the Quranic instructions to reveal the study of life. / Explain the Islamic concept about the origin of life.

0914013003

Ans. Introduction

The Holy Quran is a book for all times to come. It gives us spiritual, moral and practical knowledge. There are many verses in Quran which tell us about the origin of life.

1. Origin of Life in Water

وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ

"We made every living thing from water"

(Sura Ambia 21, Ayat-30)

As we know that living things consists of 60 to 90 percent of water. So all living things have come out of water and thus they have a common origin.

2. Creation of Man

خَلَقَ الْإِنْسَانَ مِنْ صَلْصَالٍ كَالْفَخَّارِ

"He made man from clay like the potter"

(Sura Rahman, Ayat-14)

Creation of man consisted of two steps. The first step was the creation from water. The second step was to mix clay with water to create man. It can be said for all animals as man shares all characteristics of life with other animals.

3. Development

ثُمَّ كُنَّا الْبَشَرِ ثُمَّ عَلَّمْنَاهُ رُحُوتَهُ ثُمَّ عَلَّمْنَاهُ رُحُوتَهُ ثُمَّ عَلَّمْنَاهُ رُحُوتَهُ

"Then fashioned we the drop a clot, then fashioned we the clot a little lump, then fashioned we the little lump bones, then clothed the bones with flesh"

(Sura Al-mominun, Ayat-14)

The sequence of developmental stages is described in Quran many times.

Q.4 Describe major fields and sub fields of biology.

0914013004

Ans. Major Fields of Biology

Biology has three main divisions: Botany, Zoology and Microbiology.



- Botany is the study of plants.
- Zoology is the study of animals.
- Microbiology is the study of micro-organisms e.g., viruses, bacteria etc.

Sub-Fields of Biology



Sub-fields of Biology

Morphology	Anatomy	Physiology	Histology	Cytology
Genetics	Molecular biology	Embryology	Paleontology	Taxonomy
Ecology	Marine biology	Pathology	Immunology	Pharmacology

By dividing biology into a number of sub-fields its study becomes convenient. Some of the sub-fields of biology are:

1. Morphology

Definition

The study of the size, shape, and structure of animals, plants and microorganisms is called morphology. This branch is also called external morphology.

Examples: The morphology of a flowering plant includes the roots, stem, leaves, flowers and fruits. Dental structure in humans is an example of human morphology.

2. Anatomy

Definition

The study of the internal structure of the organisms is called anatomy. Anatomy is also called internal morphology.

Examples: The examples of anatomy include human body parts such as muscles, heart, brain and kidneys etc.

3. Physiology

Definition

The study of the functions of various organs of the organisms is called physiology.

Examples: The examples of physiology are digestion, respiration, excretion, photosynthesis etc.

4. Histology

Definition

The microscopic study of tissues of organisms is called histology.

Example: The example is epithelial tissue that forms a continuous layer covering the entire body surface.

5. Cytology

Definition

The study of the structure and functions of the cell is called cytology. Cell is the basic structural and functional unit of life. Cytology is also called cell biology.

Examples: The study of plant and animal cells.

6. Genetics

Definition

The study of genes and heredity in organisms is called genetics.

Examples: The plants having red flowers produce red flowers. The white cats produce white kittens.

7. Molecular Biology

Definition

Molecular biology is the study of biology at molecular level. It involves study of the structure, function and interaction of biological molecules. e.g. proteins, DNA etc.



Fig. 1.1: Epithelial tissue



8. Embryology

Definition

Embryology is the study of the development of an organism from a fertilized egg e.g. Development of human from zygote (fertilized egg).

9. Paleontology

Definition

It is the study of the history of life on Earth as based on fossils.

Fossils

Fossils are remains of the living things preserved at high temperature and pressure for million of years.



Fig. 1.2: Fossils

Role of Study of Fossils

Study of fossils help us to understand the life of past and process of evolution.

Example: Study of fossils of dinosaurs.

10. Taxonomy

Definition

The classification and naming of organism is called taxonomy.

Example: Humans are mammals. Their scientific name is *Homo sapiens*.

11. Ecology

Definition

The study of the interrelationship of organisms and their environment is called ecology. It is also known as environmental biology.

Examples: The study of ecology of pond, lake, forest and desert etc.

12. Marine Biology

Definition

The study of organisms that live in sea is called marine biology. It deals with physical and chemical parameters of marine water bodies.

Examples: The study of fish, whales, dolphins and porpoises, sponges, crustaceans and molluscs etc.

13. Pathology

Definition

Pathology is the branch of science which deals with the study and diagnosis of diseases.

Examples: The examples of pathology are types of kidney diseases, lung diseases and blood diseases etc.

14. Immunology

Definition

The branch of biology that deals with the study of immunity, is called immunology.

Immunity

The ability of the body to protect itself from foreign substances and cells including infectious microbes is called immunity.

Examples: Immunization is a process by which a person becomes protected against a disease through vaccination. The example of vaccine for diseases are polio, corona and dengue etc.

15. Pharmacology

Definition

The science that deals with the study of drugs, their composition, mode of action and their medical applications is called pharmacology. In pharmacology, a drug is a chemical substance.

Examples: Aspirin is a form of drug often used to treat pain, fever and inflammation. The other examples of drugs are morphine, insulin, penicillin etc.



Q.5 How biology is related with other sciences? Show and explain the link. / Biology is not an isolated branch of science. It has relationship with other sciences. Explain with examples of the linkage of biology with other fields of study.

Ans. Introduction

Biology in one way or other is integrated with other disciplines of science.

- The animals move, walk or run on the principles of physics. There is a similarity between working principles of lever in physics and human limbs.
- The behaviour of atoms and molecules underline and explain the behaviour of living cell. The physical structure of atoms and molecules determine their chemical properties and the roles they play in cells. To understand biology, basic knowledge of chemistry is necessary. So, biology is not an isolated science and is associated with other branches of science.

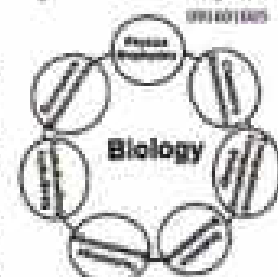


Fig. 1.3: Relationship of biology with other sciences

Relationship of Biology with Other Sciences	
Biophysics	Definition: The study of biological phenomena according to the principles and laws of physics is called biophysics. Example: Biological organisms work on the principles of physics e.g., movement of muscles and bones.
Biochemistry	Definition: The study of chemical constituents found in an organism and chemical reactions taking place in the living organism is called biochemistry. Examples: Living organisms consist of carbon, hydrogen, oxygen, nitrogen, etc. and chemical reactions such as digestion of food, respiration, and photosynthesis takes place in the organisms.
Biostatistics	Definition: Statistics is related to collecting and analyzing various data or facts. Example: The collection of biological data or facts through observations, experiments and analyzing them according to statistical rules for biological study. It is also called biometry.
Computational Biology	Definition: The study of the use of data analysis, mathematical modeling, and computational simulations to understand biological system is called computational biology. Example: The example of computational biology includes the process of locating fragments of DNA on chromosomes. Role of Computational Biology Computational biology has helped to sequence the human genome, created accurate models of the human brain, map the 3D structure of genomes and model of biological system.
Biogeography	Definition: The study of distribution of plants and animals in different geographical regions of the world is called biogeography. Examples: Kangaroo in Australia, Polar Bear in Polar regions.
Biotechnology	Definition: The study of use of different techniques to manipulate the living organisms for the benefit of mankind is called biotechnology. Example: Synthesis of insulin using bacteria.
Bio-economics	Definition: The study of biology from economic point of view is called bio-economics. Examples: Production of wheat, fish, rice and studying their export value etc. are the examples of bio-economics.



Q.6 Describe careers that require a background in biology. / How biology can lead to career of medicine, surgery, fisheries, agriculture, animal husbandry, biotechnology, horticulture, farming and forestry?

Ans. Introduction

After studying the basic courses in biology at secondary and higher secondary level a person has to select a career or profession. Pursuing a career in biology can be immensely rewarding and exciting. There are several applied fields in biology that you can select as a career e.g., medicine, surgery, fisheries, agriculture, animal husbandry, biotechnology, horticulture, farming and forestry etc.

Careers that Require a Background in Biology

Medicine and Surgery	MBBS: MBBS stands for bachelor of medicine and bachelor of surgery. Medicine: Medicine is the diagnosis and treatment of different diseases. Surgery: Surgery is the branch which treats diseases by removal or replacement of the defective parts or organs. Associated Career: After MBBS a student can specialize in various fields of medicine and surgery.
Fisheries	Introduction: The fisheries sector makes a significant contribution to the economy of Pakistan. Associated Careers: Careers associated with it are fish farming, fishery management and related research.
Farming and Agriculture	Introduction: Farming is the growth of crops and animals to provide food, wool and other products. The practice of agriculture is farming while agriculture is the science of improving farming methods. Associated Careers: Careers associated with agriculture are food science, agricultural engineering, agricultural entomology (a person who studies insects) etc.
Animal Husbandry	Introduction: Animal husbandry is the care and breeding of domestic animals. Associated Careers: Associated careers with animal husbandry are veterinary science, animal breeding, animal training etc.
Biotechnology	Introduction: Biotechnology is the use of living organisms or their components to make useful products. Associated Careers: The careers associated with biotechnology are bacteriology, virology, molecular genetics etc.
Horticulture	Introduction: Horticulture means the art of gardening. Associated Careers: The careers involved are plant breeding, horticulture etc.
Forestry	Introduction: It is the science of planting, managing and caring for forests. Associated Careers: The careers related to forestry are forest ecology, environmental engineering etc.

Q.7 Explain that science is a collaborative field.

Ans. Introduction

Scientists from all around the world team up to share ideas and make progress in their research. Some are studying similar things, while others have different knowledge that can help.

Explanation

1) Interdisciplinary Research Collaboration

Introduction

When researchers from different fields work together to create new scientific knowledge, it's called interdisciplinary research collaboration. This is important because they can work on research, find solutions and use what they learn to solve problems and discover new things.



Examples

i) Cognitive Science

For example, cognitive science combines knowledge from neurology, psychology, anthropology, linguistics, environmental engineering, pharmacology and statistics.

ii) Women's Studies

Women's studies combines what we know about gender, history, literature and biology.

iii) Public Health

Public health combines information from medicine, sociology and psychology.

iv) Bioinformatics

Bioinformatics is a combination of biology and information technology. It helps to understand complex biological data.

v) Emerging Careers

The new emerging careers of biology are;

- Bioinformaticians** (apply their computer skills in solving problems in life sciences).
- Biomedical Engineers** (develop new devices and equipments for improving human health).
- Astrobiologist** (study effects of outer spaces on living organisms).
- Cryobiologists** (study of effects of low temperature on living organisms).

2) Collaboration among Scientists

There was a special issue about research collaboration during the COVID era, showing how it was good for both science and society, when we work together across borders, cultures and different fields of study.

One famous example of scientists working together is the International Space Station, where space agencies from Europe, the USA, Russia and Japan all team up.

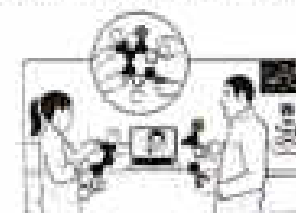


Fig. 1.4: Collaboration in Science

Q.8 Discuss biological method of study and its application. / Define scientific method. Explain various steps involved in biological method.

Ans. Scientific Method

Scientists, including biologists, employ an approach for solving scientific problem that is known as the scientific method. Biological problems are solved by a series of steps of biological method.

Different Steps of Solving a Biological Problem

It has the following steps:

- | | |
|--|-----------------------------------|
| 1. Recognition of a biological problem | 2. Observation and identification |
| 3. Building up hypothesis | 4. Drawing deductions |
| 5. Devising experiments | 6. Inferring results |

1. Recognition of the Biological Problem

Biological problem is a question related to living organisms. This question is either asked by someone or comes in mind of a researcher.



1. Observations

Definition

Observation is a very important step in solving a biological problem. Observations are made by five senses of vision, hearing, smell, taste and touch.

Types of Observations

Observations are of two types:

i) Qualitative Observations

These are based on some quality of characteristics such as colour of blood is red.

ii) Quantitative Observations

These are based on measurable value. Quantitative observations being measurable are invariable and can be expressed in terms of numbers, so are more accurate. For example boiling point of water is 100°C and its freezing point is 0°C .

3. Formulation of Hypothesis

Definition

Hypothesis is a statement that may prove to be the answer of the biological problem under study. Hypothesis is a tentative explanation of the observations that might be true.

Characteristics

A hypothesis should have following characteristics:

- (a) It should be a general statement. (b) It should be tentative idea.
- (c) It should agree with the available observations.
- (d) It should be testable and potentially falsifiable.

4. Deductions

Deductions are the logical consequences of the hypothesis. To draw deductions hypothesis is taken as true. Deductions involve "if" and "then" logic.

5. Experimentation

An act of testing a hypothesis is called experimentation. It is the most important step of biological method. Experiments are performed to prove if hypothesis is true or not. The deductions drawn from the hypothesis are subjected to rigorous testing. Through experimentation, biologist learns which hypothesis is correct.

6. Summarization of the Results

The biologist gathers actual quantitative data from experiments. This data is arranged to draw results.

Q.9 Explain how hypothesis, theory and law are formulated?

aridmnm

Ans. 1) Hypothesis

Definition

A hypothesis is a tentative explanation of observation. It is based on past experience and the available data.

Explanation

A scientific hypothesis makes prediction that can be tested by recording additional observations. In deduction-based science, deduction usually takes the form of predictions about what outcomes of experiments or observations. We should expect if a particular hypothesis is correct. We then test the hypothesis by performing the experiment to see whether or not the results are predicted. This deduction reasoning takes the form of 'if...then' logic.

2. Theory

A scientific theory is tentative explanation of hypothesis. It is much broader in scope than a hypothesis. Compared to any one hypothesis, a theory is generally supported by more evidence.



Explanation

In spite of the body of evidence supporting a widely accepted theory, scientists must sometimes modify or even reject theories when a new research method produce results that do not fit.

3. Law

Definition

The explanation of theory is called law. A theory that has been verified and appears to have wide application may become biological law. It is uniform fact of nature.

Example: Mendel's law of inheritance.

Q.10 Explain biological method with an example of malaria.

aridmnm

Ans. Introduction

Malaria has killed more people than any other disease. The malaria is an example of a biological problem and how such problems can be solved.

Symptoms of Malaria

- i) The patient of malaria feels very chill and cold.
- ii) His temperature rises above normal value of 98.6°F .
- iii) The patient suffers from headache and has feeling of nausea.
- iv) After some time, the person begins to sweat, feels better.
- v) The whole series of events are repeated after every 24, 48 or 72 hours depending upon the species of plasmodium.

1. Cause of Malaria / How biological method is applied to find the cause of malaria?

By adopting the steps of biological method, it was proved that malaria is caused by plasmodium.

Recognition of the Problem

Malaria was a problem since ancient times, but its cause was not known.

Observations

In 19th century, many different causes of malaria were being suggested. By that time, there were four major observations about malaria.

- a) Malaria and marshy areas have some relation.
- b) Quinine is an effective drug for treating malaria.
- c) Drinking the water of marshes does not cause malaria.
- d) Plasmodium is seen in the blood of a malarial patient.

Hypothesis

Based on these observations and other information, following hypothesis was formulated by a French physician Laveran in 1882.

"Plasmodium is the cause of Malaria."

Deduction: Although hypothesis is a tentative idea, to draw deductions it is accepted to be true. One of the deductions from the above hypothesis was:

"If plasmodium is the cause of malaria, then all persons ill with malaria should have plasmodium in their blood".

Experiments

This deduction was tested through experiment. Experiment was designed as:

Blood of 100 patients was examined under microscope. For the purpose of having control group, the blood of 100 healthy persons was also examined under microscope.

Results

The results of experiments showed that almost all malarial patients had plasmodium in their blood. Only 07 out of 100 healthy persons had plasmodium in their blood. Other 93 healthy persons were without any trace of plasmodium in their blood.

In the 07 healthy persons with plasmodium in their blood, plasmodium was in incubation period.



Incubation Period

The incubation period is time between the entry of parasite in the host and the appearance of the symptoms of disease. After few days those 07 healthy persons became ill with malaria.

Results were quite convincing to prove the hypothesis that "plasmodium is the cause of malaria".

Reporting the Results

Results of these experiments were announced worldwide which helped to control malaria.

1. Spread of Malaria / Explain use of biological method to understand the spread of malaria. Biological method helped to find that mosquitoes spread malaria.

Recognition of the Problem

Malaria is a fatal disease since ancient times. After the confirmation that malaria is caused by plasmodium, it was important to find how plasmodium gets into the blood of man.

Observations

This disease was more common in areas near stagnant water ponds where mosquitoes breed. It was found that:

- a) Malaria is associated with marshes.
- b) Drinking water of marshes does not cause malaria.

From these points, it can be concluded that plasmodium was not present in the marshy water. So plasmodium must be carried by something that comes to marshy water. Problem in this study was to find that agent.

a) Work of A.F.A. King

An American scientist A.F.A. King listed 20 observations in 1883 about spread of malaria.

b) Observation of A.F.A. King

Some important observations were:

- a) People who slept outdoors were more likely to get malaria than those who slept indoors.
- b) People who slept under flue nets were less likely to get malaria than those who did not use such nets.
- c) People who slept near smoky fire usually did not get malaria.

Hypothesis

On the basis of these observations King suggested a hypothesis:

"Mosquitoes transmit plasmodium so are involved in the spread of malaria."

Deductions

Following deductions were made considering the hypothesis true.

Deduction-1: "Plasmodium should be present in mosquito".

Deduction-2: "A mosquito can get plasmodium by biting a malarial patient".

Experiments: In order to test the above deductions, many experiments were performed.

Experiments of Ronald Ross: Ross, a British army physician working in India performed an important experiment in 1897.

Experiment No.1

He allowed a female *Anopheles* mosquito to bite a malarial patient. He killed the mosquito some days later and found plasmodium multiplying in mosquito's stomach.

Experiment No.2

Ross used sparrows in his experiments. He allowed female *Culex* mosquitoes to bite the sparrows suffering from malaria.

Experiment No.3

He then allowed these mosquitoes to bite healthy sparrows. After few days these sparrows became ill with malaria.



Experiment on Man

In the end, the hypothesis was tested by direct experimentation on human beings. An Italian biologist allowed an *Anopheles* mosquito to bite a malarial patient. The mosquito was kept for few days and then it was allowed to bite a healthy man. The person later became ill with malaria.

Results: All these experiments confirmed that mosquitoes transmit plasmodium and spread malaria.

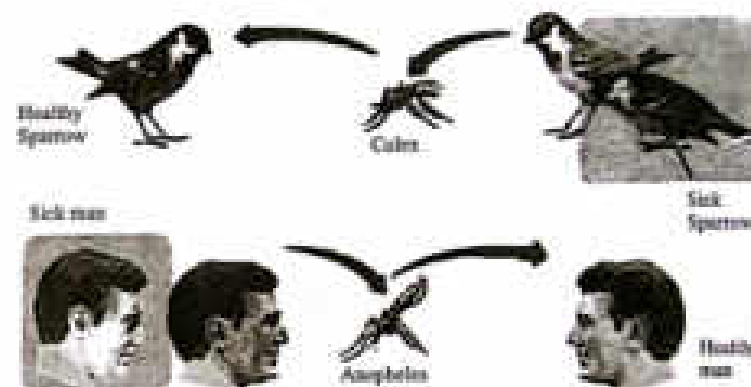


Fig. 1.8: Malaria in man is transmitted by *Anopheles* and in birds by *Culex*

Q.11 How does a female mosquito prevent the blood from clotting in the food canal?

Ans. When a female mosquito pierces the skin with the mouthparts, a small amount of saliva is injected into the wound before drawing blood. The saliva prevents the blood from clotting in the food canal of the mosquito.

Q.12 What is a vector?

Ans. The word vector means transmitter. Any organism which carries a parasite and transfers it from one organism to another is called vector.

Q.13 Describe briefly about dengue fever.

Ans. Dengue Fever

i) Cause

It is caused by a dengue virus and is transmitted by mosquito *Aedes aegypti*, which has zebra like white and black stripes on its body.

ii) Symptoms

Typical case of dengue haemorrhage fever is characterized by high grade fever, bleeding from nose, blood in urine and enlarged liver etc.

iii) Treatment

There is no specific antiviral drug available for the treatment of patients suffering from dengue fever. The second attack can be more serious and dangerous.

iv) Prevention

The best prevention is personal protection from mosquito bite and measures to prevent mosquito breeding.



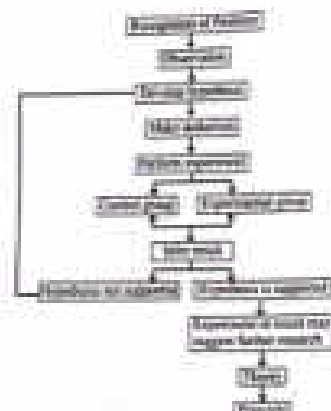


Fig. 1.6 Flow chart of biological method

Q.14 Why is biology important for the welfare of human beings? Give reasons. (01/00/004)

Ans. Biology has been helping mankind in much way in increasing food production, in combating diseases and in protecting and conserving environment. Plant production has been tremendously increased by improving existing varieties and developing new high yield and disease resistant varieties of animals and plants used as food.

Multiple Choice Questions (Exercise)

- The study of functions of various organs of an organisms is: (01/00/001)
 - morphology
 - histology
 - anatomy
 - physiology
- Histology is the microscopic study is: (01/00/004)
 - tissues
 - cells
 - fossils
 - plants
- Paleontology is the study of: (01/00/007)
 - environment
 - development
 - fossils
 - animals
- The other name of environmental biology is: (01/00/008)
 - ecology
 - biotechnology
 - microbiology
 - cell biology
- Microbiology is the study of: (01/00/009)
 - fungi
 - animals
 - plants
 - microorganism
- Which of the following represents the correct sequence of different steps of scientific study? (01/00/010)
 - observation → hypothesis → experiment → deduction → theory
 - observation → deduction → hypothesis → theory → experiment
 - hypothesis → observation → deduction → experiment → theory
 - observation → hypothesis → deduction → experiment → theory
- If a scientist is studying the methods of inserting human insulin gene in bacteria, which branch of biology may this be? (01/00/011)
 - anatomy
 - physiology
 - biotechnology
 - pharmacy
- The starting point of scientific investigation is: (01/00/012)
 - hypothesis
 - theory
 - observation
 - data
- Information that is gathered as a result of an experiment is called: (01/00/013)
 - hypothesis
 - data
 - theory
 - observation



10. Which of following statements best distinguishes hypothesis from theories in science. (01/00/014)

- theories are hypothesis that have been proven true
- theories are based on limited data while hypothesis are based on wide range of data.
- theories are uncertain while hypothesis are certain
- theories are educated guess while hypothesis are widely accepted explanation of natural phenomenon.

11. Malaria is caused by: (01/00/015)

- mosquito
- stagnant water
- swamp
- plasmodium

12. Malarial patient has plasmodium in his blood, what would be the possible

explanation if a healthy person who is not having any malarial symptoms shows plasmodium in his blood? (01/00/016)

- plasmodium are dead
- plasmodium are in incubation period
- plasmodium are not mature
- plasmodium are inactive

13. You are doing a control experiment which: (01/00/017)

- proceeds slowly enough that a scientist can record the results
- may include experimental groups and control groups tested in parallel
- is repeated many times to make sure the results are accurate
- Proceed slowly enough that a scientist can test predictions

14. Which option has correctly matched disease and vector mosquito? (01/00/018)

Malaria in humans	Malaria in birds	Dengue fever
(a) <i>Anopheles</i>	<i>Aedes</i>	<i>Culex</i>
(b) <i>Aedes</i>	<i>Culex</i>	<i>Anopheles</i>
(c) <i>Anopheles</i>	<i>Culex</i>	<i>Aedes</i>
(d) <i>Culex</i>	<i>Anopheles</i>	<i>Aedes</i>

Multiple Choice Questions (Additional)

- Biology is a word of which language? (01/00/019)
 - Latin
 - Arabic
 - Greek
 - English
- The study of plants is called: (01/00/020)
 - Biology
 - Zoology
 - Botany
 - Microbiology
- The study of occurrence and distribution of different species of living organisms in different geographical regions of the world is called: (01/00/021)
 - Histology
 - Microbiology
 - Biogeography
 - Parasitology
- Match anatomy with one of the following: (01/00/022)
 - Physiology
 - Morphology
 - Embryology
 - Genetics
- "We made every living thing from water". This verse is from which sura of Holy Quran? (01/00/023)
 - Al-Bekham
 - Al-Mominun
 - Ar-Rahman
 - Al-Nasr
- Biology is the scientific study of: (01/00/024)
 - Earth
 - Water
 - Life
 - Non-living things
- The branch deals with the study of form and structure of living organisms is called: (01/00/025)
 - Cell biology
 - Physiology
 - Morphology
 - Genetics
- The branch which deals with the study of cell division is called: (01/00/026)
 - Physiology
 - Histology
 - Cell biology
 - Entomology
- The branch deals with the study of the interrelationship of organisms and their environment is called: (01/00/027)
 - Biotechnology
 - Molecular biology
 - Entomology
 - Environmental biology



24. Into how many major divisions biology is divided? (011001018)
 (a) 3 (b) 2
 (c) 4 (d) 5
25. A good hypothesis must be: (011001019)
 (a) Proven right
 (b) Complex
 (c) Testable and potentially falsifiable
 (d) Based on a single observation
26. The new emerging careers of biology include: (011001040)
 (a) Bioinformatics and biomedical engineering
 (b) Biotechnology
 (c) Genetics
 (d) All of above
27. Mr. Nauman was busy in dissecting and analyzing the heart of frog. Probably he is a: (011001041)
 (a) Cell biologist (b) Taxonomist
 (c) Histologist (d) Paleontologist
28. How many people get lung cancer by smoking? This question can be answered through: (011001042)
 (a) Biometry (b) Biophysics
 (c) Bio-economics (d) Biogeography
29. "The number of plants in desert are scarce". This could be the statement of: (011001043)
 (a) Social biologist (b) Taxonomist
 (c) Biogeographer (d) Paleontologist
30. Being a biological research worker, you are studying "Markhor" which branch of biology it will be: (011001044)
 (a) Botany (b) Zoology
 (c) Paleontology (d) Parasitology
31. A well-substantiated explanation of hypothesis is called: (011001045)
 (a) Observation (b) Deduction
 (c) Experimentation (d) Theory
32. Which of the following profession deals with the diagnosis and treatment of diseases in human? (011001046)
 (a) Medicine (b) Surgery
 (c) Biotechnology (d) Farming
33. Study of insects is called: (011001047)
 (a) Immunology (b) Entomology
 (c) Genetics (d) Ecology

34. Five senses are involved in: (011001048)
 (a) Hypothesis (b) Observations
 (c) Deduction (d) Experiment
35. The logical consequences of hypothesis are: (011001049)
 (a) Law (b) Deduction
 (c) Observations (d) Theory
36. Which of the followings is the symptom of malaria? (011001050)
 (a) Chills and cold
 (b) Headache
 (c) Temperature rises and nausea
 (d) All of above
37. Who performed experiments on sparrow? (011001051)
 (a) Ross (b) A. F. A. King
 (c) Laveran (d) None of these
38. Number of steps of biological method are: (011001052)
 (a) Seven (b) Six
 (c) Two (d) Eight
39. The scientific method in which biological problems are solved is termed as: (011001053)
 (a) Physical method
 (b) Biological method
 (c) Chemical method
 (d) Statistical method
40. Deductions are drawn from: (011001054)
 (a) Experiments (b) Hypothesis
 (c) Theory (d) Law
41. In biological method the next step of hypothesis is called: (011001055)
 (a) Deduction (b) Observation
 (c) Result (d) Experiment
42. In mosquito, which one prevents the blood from clotting in her food canal after drawing blood? (011001056)
 (a) Water (b) Saliva
 (c) Platelets (d) Digestive glands
43. Which mosquito transmits dengue fever? (011001057)
 (a) Culex (b) Anopheles
 (c) Aedes (d) Culex and Anopheles
44. Following are the characteristics of a good hypothesis, EXCEPT: (011001058)
 (a) Should be a complex statement
 (b) Should be a tentative idea
 (c) Should be testable
 (d) Should agree with available observation

45. For the first time, who found plasmodium in the blood of malarial patient? (011001059)
 (a) Ronald Ross (b) Laveran
 (c) A.F.A King (d) Mendel
46. Which of the following best describes the logic of the scientific process? (011001060)
 (a) If I generate a testable hypothesis, tests and observations will support it
 (b) If my prediction is correct, it will lead to a testable hypothesis.
 (c) If my observations are accurate, they will support my hypothesis
 (d) If my hypothesis is correct, I can expect certain test result
47. What is the correct experiment to know that plasmodium destroys blood cells? (011001061)
 (a) Examine the blood of a single healthy person
 (b) Examine the blood of a single infected person
 (c) Allow mosquito to bite a healthy person and examine his blood
 (d) Examine the blood of some healthy and also some infected persons
48. People who slept near smoky fire had less chance to suffer from malaria. Why? (011001062)
 (a) Smoke kills plasmodium in their blood
 (b) Fire increases temperature and plasmodia are killed in air
 (c) Mosquito cannot tolerate smoke and are repelled
 (d) Smoke kills plasmodium present in mosquitoes
49. Which one of the following is true about the statement of hypothesis? (011001063)
 (a) Logical
 (b) Possible answer
 (c) Based upon observations
 (d) All of them
50. The actual answer to scientific problem is: (011001064)
 (a) Observation (b) Hypothesis
 (c) Data (d) Conclusion
51. What does MBBS stand for? (011001065)
 (a) Bachelor of Medicine and Bachelor of



- Surgery
 (b) Master of Biology and Biological Studies
 (c) Bachelor of Medical Biological Science
 (d) Master of Biochemical Biological Studies
52. What is the role of horticulturists? (011001066)
 (a) Disease diagnosis
 (b) Plant breeding and cultivation
 (c) Performing surgeries
 (d) Developing medicines
53. The study of how living things interact with each other and their environment is known as: (011001067)
 (a) Physiology (b) Anatomy
 (c) Ecology (d) Genetics
54. What does the field of forensic science involve? (011001068)
 (a) Garden management
 (b) Examination of evidence from crime scenes
 (c) Livestock management
 (d) Drug development
55. What is the study of diseases and their causes called? (011001069)
 (a) Pharmacology (b) Pathology
 (c) Physiology (d) Anatomy
56. Which of the following best describes the field of biotechnology? (011001070)
 (a) Study of diseases
 (b) Study of marine life
 (c) Use of biological processes to develop technologies
 (d) Management of forest resources
57. Which field applies computer technology to biological research? (011001071)
 (a) Biogeography (b) Biostatistics
 (c) Computational biology
 (d) Bioeconomics
58. The scientific method in biology starts with: (011001072)
 (a) Hypothesis
 (b) Recognition of a problem
 (c) Analysis of results
 (d) Deduction



Answer Key

1	d	2	a	3	c	4	a
5	d	6	c	7	c	8	b
9	d	10	a	11	d	12	b
13	b	14	c	15	c	16	c
17	c	18	b	19	c	20	c
21	c	22	c	23	d	24	a
25	c	26	a	27	c	28	a
29	c	30	b	31	d	32	b
33	b	34	b	35	b	36	d
37	a	38	b	39	b	40	b
41	a	42	b	43	c	44	a
45	b	46	c	47	d	48	c
49	c	50	b	51	a	52	b
53	c	54	b	55	b	56	c
57	c	58	b				

Short Answer Questions (Exercise)

Q.1 Define the following branches of biology and give atleast one significance of studying these branches. (05/01/21)

- a. Molecular biology b. Physiology
c. Palaeontology d. Pharmacology
Ans.

a. **Molecular Biology**

Molecular biology is the study of biology at molecular level. It helps to study the structure of DNA, such as how the base pairs are arranged and how the DNA molecule is coiled.

b. **Physiology**

The study of the functions of various organs of the organism is called physiology, e.g., respiration and photosynthesis.

c. **Palaeontology**

The study of fossils is called palaeontology, e.g., fossils of dinosaurs. Study of fossils help us to understand the life of past and process of evolution.

d. **Pharmacology**

The science that deals with the study of drugs and their effects on the human body is called pharmacology. The purpose of pharmacology is to determine the effectiveness and safety of drugs designed to treat, prevent or diagnose diseases.

Q.2 Can you distinguish between? (05/01/21)

- (a) Anatomy and morphology
(b) Biotechnology and immunology
(c) Genetics and cytology
(d) Marine biology and ecology

Ans.

(a) **Anatomy and morphology**

Anatomy: The study of the internal structure of the organisms is called anatomy. Anatomy is also called internal morphology.

Morphology: The study of the form and external structure of the organisms is called morphology.

(b) **Biotechnology and immunology**

Biotechnology: The study of use of different techniques to manipulate the living organisms for the benefit of mankind is called biotechnology.

Immunology: The ability of the body to protect itself from foreign substances and cells including infectious microbes is called immunity and the study of immunity is called immunology.

(c) **Genetics and cytology**

Genetics: The study of genes and heredity in organisms is called genetics.

Cytology: The study of the structure and

functions of the cell is called cytology. It is also called cell biology. For example, the study of plant and animal cells.

(d) **Marine biology and ecology**

Marine biology: The study of organisms that live in sea is called marine biology. For example the study of fish, whales, dolphins and porpoises, sponges, crustaceans and molluscs etc.

Ecology: The study of the interrelationship of organisms and their environment is called ecology. It is also known as environmental biology. For example the study of ecology of pond, lake, forest, desert etc.

Q.3 Healthy life of a person depends on healthy life choices. How study of biology is going to help you to live a healthy life. (05/01/21)

Ans. The study of biology provides information and remedies to human problems regarding health, food, environment etc.

It plays a significant role in identifying the causes of diseases, how they are transmitted and how they can be controlled.

Q.4 What is the contribution of the following scientists? (05/01/21)

(a) A.F.A. King

Q.5 Observations are mainly of two types i.e., qualitative and quantitative. Sort the following observation according to these two types. (05/01/21)

Colour of cat, Height of giraffe, Weight of mango fruits, Body temperature of birds, Volume of blood in humans, Shape of leaves, Climate of desert, Speed of tiger, Song of a bird.

Ans.

Qualitative Observations

- Colour of cat
- Shape of leaves
- Climate of desert
- Song of a bird

Quantitative Observations

- Height of giraffe
- Weight of mango fruits
- Body temperature of birds
- Volume of blood in humans
- Speed of tiger

Q.6 A Nobel prize winner gave a hypothesis about effects of COVID-19 vaccine. Can it be wrong? Why? Develop deduction from this hypothesis, "Vaccination of COVID-19 can reduce the severity of complications in case of infection." (05/01/21)

Ans. A hypothesis about the effects of COVID-19 vaccine given by a Nobel prize

winner can be wrong because a hypothesis is a tentative explanation of the observations and can often be wrong or fail if it disproves the idea in question.

Deduction: If vaccination against COVID-19 can reduce the severity of complications, then individuals who are vaccinated should experience reduction of symptoms in case of



infection.

Q.7 Why it is impossible to eradicate malaria? 091601079

Ans. Malaria is a disease difficult to control largely due to the highly adaptable nature of the vector and parasites involved.

Q.8 The diagram shows one insect. Answer the following questions related to it. 091601080



i. Why do we use word vector for mosquito?

ii. What is name of organism who transmit malaria disease in man and birds?

iii. What was the main purpose of experiment by Ronald Ross?

Ans. i. Mosquitoes can transmit diverse infectious pathogens and parasites that cause diseases. Therefore, the mosquitoes are so-called disease vectors.

ii. Female *Anopheles* mosquito, transmit malaria in man while *Culex* in birds.

iii. Ronald Ross performed experiments to test

SLO Based Short Answer Questions (Additional)

Q.12 What do you know about agriculture? 091601084

Ans. Agriculture means to cultivate land. It is the growth of crops and animals to provide food, wool and other products.

Careers associated with agriculture are food scientist, agricultural engineer, agricultural entomologist etc.

Q.13 What is animal husbandry? 091601085

Ans. Animal husbandry is the care and breeding of domestic animals.

The careers associated with animal husbandry are vet, animal breeders, animal trainers etc.

Q.14 Define biochemistry. 091601086

Ans. The study of chemical constituents found in an organism and chemical reactions taking place in the living organism is called

the King's hypothesis. "Mosquitoes transmit plasmodium so are involved in the spread of malaria."

Q.9 Why Ross did not allow the infected mosquitoes to bite a healthy person? 091601087

Ans. Ross avoid using healthy human beings for experiments because results can be serious.

Q.10 A student want to investigate the effect of different factors on the activity of salivary amylase. He will design an experiment in order to reach conclusion. What would be the most appropriate first step to initiate? 091601088

Ans. The most appropriate first step to initiate scientific investigation is formulation of hypothesis. Biologist organizes his/her and others' observations into data form and constructs a statement that may prove to be the answer of the biological problem under study. This tentative explanation of observations is called a hypothesis.

Q.11 Hepatitis B virus was found in blood of 10 persons. Only 6 of them were suffering from Hepatitis B disease. Why? 091601089

Ans. The remaining four were not suffering from the disease because virus was in incubation period.

biochemistry.

Example: Living organisms consist of carbon, hydrogen, oxygen, nitrogen etc., and chemical reactions such as digestion of food, respiration and photosynthesis take place in the organism.

Q.15 What do you know about bio-economics? 091601097

Ans. The study of biology from economic point of view is called bio-economics.

Example: Production of wheat, fish, rice and their export value etc., are the examples of bio-economics.

Q.16 Define biogeography. 091601098

Ans. The study of distribution of plants and animals in different geographical regions of the world is called biogeography.

Q.17 Differentiate between zoology and botany. 091601099

Ans. The branch of biology which deals with the study of plants is called botany e.g., mustard, rose. The branch of biology which deals with the study of animals is called zoology e.g., frog.

Q.18 Define the following terms: 091601100

(i) Cell biology (ii) Embryology

Ans. (i) Cell Biology: The study of the structure and functions of the cell is called cell biology.

(ii) Embryology: The study of the developmental stages of an organism from egg to the formation of a new organism is called embryology.

Q.19 What do you know about farming? 091601101

Ans. Farming means to cultivate land. It is the growth of crops and animals to provide food, wool and other products.

Q.24 Show the relationship of biology with other branches of science with the help of diagram. 091601107

Ans.



Relationship of biology with other sciences

Q.25 Define the following: 091601095

(a) Entomology (b) Taxonomy

Ans. (a) Entomology: The branch of biology which deals with the study of insects.

(b) Taxonomy: The branch of biology which deals with the classification and naming of organisms is called taxonomy.

Q.26 Biology is not an isolated branch of science. It has relationship with other branches. Explain with examples the link of biology with a, b & c in the diagram. 091601104

Q.20 What is fisheries? 091601092

Ans. (i) The fisheries sector makes a significant contribution to the economy of Pakistan.

(ii) Careers associated with fisheries are wild life specialist, fishery biologist and improvement of fish production.

Q.21 What is forestry? 091601093

Ans. It is the science of planting, managing and caring for forests.

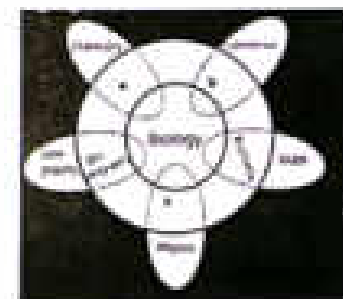
Associated Careers: The careers related to forestry are forest officer, forest ecologist, environmental engineer etc.

Q.22 Define the term fossils. 091601094

Ans. Fossils are remains of the living things preserved by natural process. Fossils help the study of life in the past and process of evolution.

Q.23 What do you know about surgery? 091601096

Ans. Surgery is the branch which treats diseases by removal, or replacement of the defective parts or organs.





Ans.

a) Biochemistry

It deals with the study of the chemistry of different compounds and processes occurring in living organisms. For example the study of basic metabolism of photosynthesis and respiration involves the knowledge of chemistry.

b) Bioeconomics

It deals with the study of organisms from economical point of view. For example the cost value and profit value of the yield of wheat can be calculated through bioeconomics and benefits or losses can be determined.

c) Biophysics: It deals with the study of the principles of physics, which are applicable to biological phenomena. For example there is a similarity between the working principles of lever in physics and limbs of animals in biology.

Q.27 How biology is linked with other sciences?

Ans. The biology is not an isolated science. It is associated with other branches of science. For example:

(i) The animals move, walk or run on the principles of physics.

(ii) There is a similarity between working principle of lever in physics and human limbs.

(iii) The behaviour of atoms and molecules explain the behaviour of living cell, their physical structure determine their chemical properties and the roles they play in cells. To understand biology, basic knowledge of chemistry is necessary.

Q.28 What is the importance of horticulture?

Ans. Horticulture means the art of gardening. It is a branch of agriculture that deals with the science, technology and business of plant cultivation. It includes development of the gardens, cultivation of fruits, vegetables, nuts, flowers, seeds, mushrooms etc.

Q.29 Differentiate between theory and principle.

Ans.

Theory	Principle
Definition If the hypothesis is found to be correct then it	Definition A theory that has been verified and appears to

Associated Careers

The careers involved are plant breeder, horticulturist etc.

Q.29 Define deduction.

Ans. Deductions are the logical consequences of the hypothesis. To draw deductions hypothesis is taken as true. Deductions involve "if" and "then" logic.

Q.30 What ways do you use the scientific method in everyday life?

Ans.

(1) Scientific method is used to locate or identify a problem to solve it.

(2) It describes the problem in detail.

(3) It forms a hypothesis about what the possible cause of the problem might be or what a potential solution could be.

Q.31 What do you know about experiment?

Ans. It is the most important step of biological method. Experiments are performed to prove if hypothesis is true or not. The deductions drawn from the hypothesis are subjected to rigorous testing. Through experimentation, biologists learn which hypothesis is correct.

Q.32 What is hypothesis?

Ans. Hypothesis is a statement that may prove to be the answer of the biological problem under study. Hypothesis is a tentative explanation of the observations that might be true.

Q.33 What are observations?

Ans. Observations are very important step in solving a biological problem. Observations are made by five senses of vision, hearing, smell, taste and touch.

Q.34 Justify mathematics as an integral part of the scientific studies.

Ans. Mathematics is essential to many sciences. The most important function of mathematics in science is the role it plays in the expression of scientific models. Studying mathematics develops reasoning ability.



becomes a theory. It is supported by a number of evidences. A theory can be changed if better evidence is available.

Example: The theory of evolution.

have wide application may become biological principle or law.

Example: Mendel's laws of inheritance

Q.36 Define the following terms:

(a) **Plasmodium** (b) **Incubation Period**

Ans. (a) **Plasmodium:** Plasmodium is a microscopic parasitic protozoan which causes malaria. It completes its sexual phase of life cycle in mosquitoes and asexual phase in the body of human.

(b) **Incubation Period:** The period in between the entry of Plasmodium parasite in human body (host) and appearance of symptoms of malaria (disease) is called incubation period.

Q.37 Write major observations about malaria.

Ans. There were four major observations about malaria.

- Malaria and marshy areas have some relation.
- Quinine is an effective drug for treating malaria.
- Drinking the water of marshes does not cause malaria.
- Plasmodium is seen in the blood of malarial patient.

Q.38 Define the term science.

Ans. The study of the world around us. The study of science helps us to answer the how, what, where and why of our surrounding.

Q.39 What do you know about vector?

Ans. The word vector means transmitter. Any organism which carries a parasite and transfers it from one organism to another is called vector.

Q.40 How malaria is treated?

Ans. • For the treatment of malaria, quinine extracted from the bark of Cinchona plant is used.

• Apart from quinine certain anti-malarial drugs are also used for the treatment.

Q.41 How Ronald Ross proved the deduction, "Plasmodium should be present in mosquito?"

Ans. Ronald Ross performed important experiments in order to test the deductions related to the transmission of plasmodium.

Using Female Anopheles Mosquito

He allowed a female *Anopheles* mosquito to bite a malarial patient. He killed the mosquito some days later and found plasmodium multiplying in stomach of mosquito.

Using Female Culex Mosquito

He allowed female *Culex* mosquito to bite on the sparrows suffering from malaria. He then allowed these mosquitoes to bite the healthy sparrows. The sparrows got malaria.

Results: The experiments of Ross confirmed that mosquitoes transmit plasmodium and so are involved in the spread of malaria.

Q.42 Observations are mainly of two types i.e., qualitative and quantitative. Describe them with the help of examples.

Ans. Qualitative observations are based on some quality or characteristic. These observations are made by using five senses i.e. vision, hearing, smell, taste and touch. For example the freezing point of water is colder than the boiling point.

Quantitative observations are based on measurable value. These observations are made by using instruments. Quantitative observations are more accurate than qualitative ones because they are measurable and can be recorded in terms of numbers. For example the freezing point of water is 0°C and the boiling point is 100 °C.

Q.43 How the malarial parasite enters the body of healthy person?

Ans. Patients suffering from malaria have plasmodium in their blood. When a female *anopheles* mosquito bites a malarial patient it sucks blood from him/her. Thus the plasmodium enters the body of the mosquito.



when the infected mosquito bites a healthy person, it injects plasmodium in his blood.

Q.44 What do you know about the following: i. *Aedes* ii. *Anopheles* (04/01/19)

Ans. i. *Aedes*

Mosquito transmits viruses of dengue fever in humans.

ii. *Anopheles*

Anopheles mosquito transmits plasmodium for malarial fever in humans.

SLO Based Reference Material

Short Answer Questions

Q.45 What is the goal of computational biology in studying genes? (04/01/17)

Ans. Computational biology uses computers to organize and analyze vast amount of genetic information, making it possible to fully understand human chromosomes 22, the first chromosomes to be fully sequenced. This important step in 1999 helped scientists learn more about human DNA.

Q.46 Give the percentage of water in brain, skin and kidney. (04/01/19)

Ans. The brain is composed of 73% water, the skin contains 64% water, and kidneys have 79%.

Q.47 Enlist the common elements present in humans as well as in soil. (04/01/19)

Ans.

Oxygen	Phosphorus	Iron
Carbon	Potassium	Silicon
Hydrogen	Sulphur	Calcium
Nitrogen	Sodium	Magnesium

Q.48 What do you know about mycology? Give the responsibilities of mycologists? (04/01/19)

Ans. Mycology is the study of fungi. Mycologists learn about how fungi grow, their shapes and their roles in nature. They also look at how fungi can be used in food, medicine and industry.

Q.49 How biochemistry help us to understand our body reactions? (04/01/19)

Ans. Biochemistry is the study of the chemical processes and interactions that occur in living systems. Biochemists study the structure and function of biomolecules such as carbohydrates, lipids, proteins and nucleic acids. For example, biochemistry can help understand how enzymes catalyze reactions.

Q.50 What is plasmid? Give its role in biotechnology? (04/01/17)

Ans. Plasmid is a small, circular piece of DNA

that exists separately from the main DNA in bacteria. Scientists use plasmids as tools to add new genes into bacteria for research, like making medicines.

Q.51 Who is the "Father of Immunology" and why? (04/01/19)

Ans. Edward Jenner is known as the "Father of Immunology" because he created the first successful vaccine, which was for smallpox. His work laid the foundation for modern vaccines and the study of how to protect people from infectious diseases.

Q.52 How forensic scientists assist in criminal investigations? (04/01/19)

Ans. Forensic scientists help the police by examining evidence from crime scenes. They study things like hair or fingerprints to identify who was there. They use science to solve crimes and keep people safe.

Q.53 What do you know about Bt Corn? (04/01/19)

Ans. In Pakistan, scientists have used biotechnology to create a special kind of cotton plant called Bt corn. This new type of cotton can protect itself from certain pests without needing many chemical pesticides, which is better for the environment and could help farmers in the future.

Q.54 Give the names of father of different branches of biology. (04/01/19)

Ans.

Branches of Biology	Father
1. Biology	Aristotle
2. Immunology	Edward Jenner
3. Modern botany	Carolus Linnaeus
4. Modern genetics	Gregor Mendel
5. Modern embryology	Karl Ernst Von Baer



Q.55 What are different scientific fields which contributed to develop the MRI machine? (04/01/17)

Ans. The MRI machine, which is really important for medical check ups, was not made only by doctors. Physicians who know about magnetism, engineers who built the machine, biologists and medical experts who understand the human body, and computer scientists who work with the images all helped to make it.

Q.56 How do various experts collaborate to understand global climate change? (04/01/19)

Ans. Understanding global climate change is about more than just temperatures. It involves learning from oceanographers who study the oceans, meteorologists who study the weather, biologists who look at living things and sociologists who understand how people's actions affect the environment. All these experts work together to give us a full picture of how our planet's climate is changing.

Q.57 Why is interdisciplinary collaboration essential in human genome project? (04/01/19)

Ans. This project was a big effort to identify every gene in human DNA. Biologists looked at the DNA structure, while computer scientist handled a lot of data. Chemists studied how molecules interact, and physicians provided special tools for detailed observations. By combining different areas of study, the project gave an understanding of human genetics.

Q.58 What is the role of different scientists in advancing renewable energy technology? (04/01/19)

Ans. Producing clean energy is more than just putting solar panels on roofs. It includes physicist working on the best ways to use sunlight, engineers making systems to store energy, environmental scientists checking how these technologies affect nature, and economists looking at the costs and benefits for people. When these experts work together, they help to build a future that is good for the environment and sustainable for everyone.

Q.59 Scientific methods are based on two key principles. Explain. (04/01/17)

Ans. Scientific methods are based on two key principles. Firstly, everything that happens in nature is caused by natural reasons. Secondly, the fundamental laws of nature are consistent everywhere and at every moment, which is known as the principle of uniformity.

Q.60 What kind of information does a scientific law provide? (04/01/17)

Ans. A scientific law is a universal statement that tells us how things always happen in nature, often written with mathematical expressions. Laws do not explain why things happen, they simply describe what happens. Examples are Newton's law of motion in physics and Mendel's law of inheritance in biology.

SLO Based Reference Material

Long Answer Questions

Q.1 According to the Quranic teachings Allah is the ultimate Creator of every living and non living things. Quote some of the Quranic verses in this regard. (04/01/17)

Ans. Introduction

Allah, the Creator and Sustainer of the whole universe, has guided His creatures in every possible way which can lead them to successful survival. In the same way, He has guided human beings in their search for those basic questions which have puzzled their minds for centuries. For the material guidance and spiritual development of the human intellect, Allah has endowed humanity with the teachings of the Holy Quran.

Quranic Verses

According to the Quranic teachings Allah is the ultimate Creator of every living and non living



thing. Some of the Oymyakon verses in this regard are quoted below:

وَبَدَأَ خَلْقَ الْإِنسَانِ مِن طِينٍ ۝

"And started the creation of man from clay (soil)".

(Surah Al-Saada Ayah: 7)

[illegible]

"And it is He Who sends down water (rain) from the sky, and with it, We bring forth vegetation of all kinds, and out of it We bring forth green stalks, from which We bring forth thick clustered grain. And out of the date palm and its spathe come forth clusters of dates hanging low and near, and gardens of grapes, olives and pomegranates, each similar (in kind) yet different (in variety and taste). Look at their fruits when they begin to bear, and the ripeness thereof. Verily! In these things, there are signs for people who believe."

(Surab Al'Anam'Asah: 69)

وَأَوْحَىٰ إِلَيْنَا أَنَّ أَجْدَدَنَا مِنَ الْعَبَادِ إِبْرَاهِيمَ وَإِسْحَاقَ وَيُوسُفَ ۚ إِنَّهُمْ عَلَيْنَا فَاخِرُونَ ۚ وَأَوْحَىٰ إِلَيْنَا أَنَّ أَكْثَرُ النَّاسِ لَا يَعْلَمُونَ ۚ

"And your Lord inspired to the bee, 'Take for yourself among the mountains, houses, and among the trees and [in] that which they construct. Then eat from all the fruits and follow the ways of your Lord laid down [for you].' There emerges from their bellies a drink, varying in colors, in which there is healing for people. Indeed, in that is a sign for a people who give thought."

(Surah Nahl Asyoh: 68-69)

[illegible]

"And Allah has created every moving creature from water. So, some of them move on their bellies, and some of them move on two legs, and some of them move on four. Allah creates what He wills. Surely, Allah is powerful over everything." (Surah Al-Noor, Ayah: 45)

قَالَ خَالِدٌ، «الْعَلْفَةُ هِيَ الْفُتْلَانِ الْمَطْمَعَةُ بِمَخْطَاةٍ يَتَوَقَّعُهَا الْعَمَلُ لِغِيَرِهِ» قَدْ انْتَهَى خَلْقُهُ الْحَرْبَ وَالْبُدْنَ عَنِ الْخَالِفَيْنِ فِي

Then We developed the drop into a clinging clot (of blood), then developed the clot into a lump (of flesh), then developed the lump into bones, then clothed the bones with flesh, then We brought it into being as a new creation. So Blessed is Allah, the Best of Creators."

(Surah Al-Morning: Ayah: 1-4)

[illegible]

Q.2 Describe the importance of theories and laws in the field of science.

Anal. Theory

References

A theory is a detailed explanation of some aspects of nature that is supported by multiple evidences. It is different from a hypothesis because it has been tested many times and scientists generally agree on it.

Theory as Guiding Principles

Theories serve as guiding principles in science, facilitating research and experimentation, explaining various phenomena, and leading to new hypothesis.

Models of Theory

A scientific theory is based on known facts and accurate predictions and can explain a wide range of phenomena. However, it can be proven wrong. Theories represent scientists' collective understanding and agreement in a particular field of study. They can lead to new inventions and discoveries.

Full-text available

Examples of Theories include Einstein's theory of General Relativity in Physics and Lamarck's Theory of Inheritance of acquired characteristics in biology.

2.1.1.1

Investment Decision

A scientific law is a universal statement that tells us how things always happen in nature, often written with mathematical expressions. Laws do not explain why things happen; they simply describe what happens.

Exercises

Newton's laws of motion in physics and Mendel's laws of inheritance in biology.



UNIT 02

BIODIVERSITY

Q.1 What is biodiversity? Write the importance of biodiversity in the natural ecosystem.

Ans. Definition

Biodiversity is defined as "the variety of living organisms on Earth".

Explanation

The term biodiversity comes from 'biological diversity'. Biodiversity has ecological and economic importance. It provides us with nourishment, housing, fuel, clothing etc.

Importance

i) **Recycling of Nutrients**

The natural biodiversity provides us oxygen, clean water and air. They help carbon cycle and fix nutrients.

ii) **Source of Food, Medicine and Industrial Materials**

Biodiversity provides our food stuff and medicines derived mainly from plants. The industrial materials such as building materials, fibres, dyes, resins, gums, adhesives, rubber and oil etc., are derived directly from plants.

iii) **Others**

They enable the plants to grow. Pests are controlled by organisms such as by insects, birds and fungi. They protect against flooding and regulate climate. They help in pollination and crop production.

Q.2 Describe classification. What are the main aims and objectives of classification?

Ans. Definition of Classification

The grouping of organisms on the basis of similarities and differences is called classification.

Taxonomy

Taxonomy is the branch of biology concerned with identification, naming and classification of organisms.

Systematics

The scientific study of diversity of organisms and their evolutionary relationship is called systematics.

Aims and Objectives

The main aims and objectives of classification are:

- To determine similarities and differences between organisms.
- To arrange organisms on the basis of similarities and differences.
- Identify the organisms to study them systematically.
- To find out evolutionary relationships among organisms.

Q.3 Give an account of history of classification.

Ans. Aristotle

The Greek philosopher Aristotle was the first person who classified the living organisms.

Abu Usman Umer Al-Jahiz

In 700s, Abu Usman Al-Jahiz described 350 species of animals. In the end of 15th century many biologists worked on classification method.

Andrea Caesalpino (1519-1603): He divided plants into fifteen groups and called them genera.



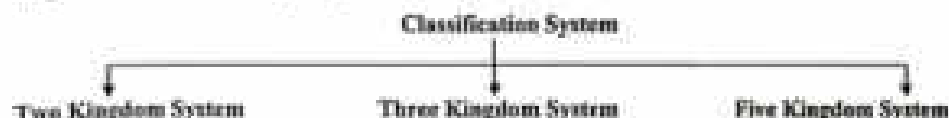
Fig. 1.1: Biodiversity



John Ray (1627-1705): He published important works on the classification of plants.

Tournefort (1656-1708): He introduced the taxa of class and species.

Carolus Linnaeus (1707-1778): He grouped species according to similar physical characteristics. According to earlier classification system, organisms were classified into two kingdoms, then three-kingdom and then five-kingdom system.



1. **Two-Kingdom Classification System**

It is the oldest system and classifies organisms into two kingdoms, the Plantae and Animalia.

i) **Kingdom Plantae**

The kingdom plantae includes the autotrophs. Bacteria, fungi and algae were also included in this kingdom.

ii) **Kingdom Animalia**

The organisms which depend on autotrophs or other heterotrophs are included in the kingdom Animalia.

Many unicellular organisms like *Euglena* have both plant like (presence of chlorophyll) and animal like (heterotrophic mode of nutrition in darkness and lack of cell wall) characteristics. So separate kingdom was introduced for such organisms.

2. **Three-Kingdom Classification System**

The German Scientist Ernst Haeckel proposed a third kingdom Protista to accommodate *Euglena* like organisms and to separate unicellular microscopic organisms from multicellular ones.

3. **Five-Kingdom Classification System**

Work of E-Chatton

In 1937 E-Chatton suggested the terms 'Procariotique' to describe bacteria 'Eucariotique' to describe plant and animal cells.

Work of Robert Whittaker

In 1967 Robert Whittaker introduced five-kingdom classification system. The five kingdoms are: Monera, Protista, Fungi, Plantae and Animalia. In the five kingdom system bacteria and archaea were combined in a single kingdom Monera, because they shared the prokaryotic form of cell structure.

Q.4 Define domain. Describe the three domains system of classification.

Ans. Introduction

In biology, a domain means the largest of all groups in the classification of life. Domain is group of kingdoms or taxonomic category above the kingdom.

Domain System

i) **Introduction**

In 1990, Carl Woese introduced a three domains system of classification. The three domains of life are Archaea, Bacteria and Eukarya.

ii) **Basis of Three Domain System**

Classification into three domains is based on difference in the sequence of nucleotides in the rRNA (ribosomal Ribonucleic acid) of the cell, the cell's membrane lipid structure and its sensitivity to antibiotics.

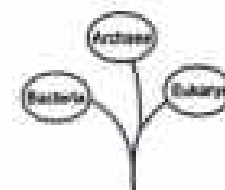


Fig. 1.2: The three domains of life



(ii) Characteristics

1. The Domain Archaea / What are the characteristics of the domain Archaea?

The domain Archaea have the following characteristics:

- Archaea are prokaryotic cells.
- The cell walls of Archaea contain no peptidoglycan.
- The rRNA (ribosomal RNA) are not found in Bacteria and Eukarya.
- Archaea are not sensitive to some antibiotics that affect bacteria. They are sensitive to some antibiotics that affect Eukarya.
- Archaea often live in extreme environment.
- Archaea membrane can withstand higher temperature and stronger acid concentration.
- Archaeal creatures include: Methanogens, Halophiles, Thermocacidophiles.

2. The Domain Bacteria / What are the characteristics of the domain Bacteria?

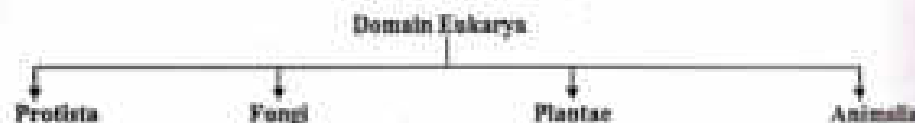
The domain bacteria have the following characteristics:

- Bacteria are prokaryotic cells.
- The cell walls of bacteria contain peptidoglycan.
- They contain rRNA that is unique to bacteria.
- Bacteria are sensitive to traditional antibacterial antibiotics but are resistant to most antibiotics that affect Eukaryotic organisms.

3. The Domain Eukarya / What are the characteristics of the domain Eukarya?

The domain Eukarya (also spelled Eucarya) have the following characteristics:

- Eukarya have eukaryotic cells.
- Not all Eukarya have cells with a cell wall. Their cell wall contains no peptidoglycan.
- Eukarya contains rRNA that is unique to Eukarya.
- Eukarya are resistant to traditional antibacterial antibiotics but are sensitive to most antibiotics that affect eukaryotic cells.



Division of Domain Eukarya / What are the diagnostic characteristics of domain Eukarya?

The domain Eukarya are divided into four kingdoms: Protista, Fungi, Plantae and Animalia.

1. Protista

Characteristics

Protista include eukaryotic organisms with unicellular or colonial organization. These are mostly aquatic.

Types

It is a diverse group of organisms.

It includes:

- Animal like protists called protozoa e.g., *Amoeba*.
- Plant like protists called algae e.g., *Engelma*.
- Fungi like protists e.g., slime molds, water molds etc.

2. Fungi

Characteristics

- Fungi are eukaryotic organisms which have chitin in their cell wall.
- Fungi are sapotrophic decomposers. Mostly fungi are multicellular.
- Some fungi are unicellular (yeast).



Examples: The examples of fungi are black bread mold, yeast, mushroom etc.

3. Plantae

Characteristics

- The members of kingdom plantae are eukaryotic multicellular and autotrophic with chloroplasts containing chlorophyll.
- Their cell wall is made up of cellulose.

Examples: Moss, mustard etc.

4. Animalia

- Animals are multicellular, heterotrophic and eukaryotes.
- They can generally move from place to place. This kingdom includes invertebrates e.g., insects, starfish and vertebrates e.g., fish, frogs and man etc.

Q.5 Describe taxonomic ranks of classification.

Ans. Taxa

The group into which organisms are classified are known as taxonomic categories or taxa (singular 'taxon').

Taxonomic Hierarchy

The taxa form a ladder, called taxonomic hierarchy. There are eight main taxonomic ranks: Kingdom, phylum or division, class, order, family, genus and species. In addition domain is now usually used as a fundamental rank.

The kingdom is the largest taxon or rank. Each kingdom is further divided into smaller taxa in the following way:

- Phylum (Division: for plants and fungi):** A phylum is a group of related classes.
- Class:** A class is a group of related orders.
- Order:** An order is group of related families.
- Family:** A family is a group of related genera.
- Genus:** A genus is a group of related species.
- Species:** A species is a group of similar organisms.



Fig. 1.3: Taxonomic ranks of classification

Examples

Simple Classification of Human and Pea			
Taxa	Human	Taxa	Pea
Kingdom	Animalia	Kingdom	Plantae
Phylum	Chordata	Phylum	Magnoliophyta
Class	Mammalia	Class	Magnoliopsida
Order	Primate	Order	Fabales
Family	Hominidae	Family	Fabaceae
Genus	<i>Homo</i>	Genus	<i>Pisum</i>
Species	<i>Homo sapiens</i>	Species	<i>Pisum sativum</i>

Q.6 Write a brief note on species.

Ans. Definition

Species is a group of similar organisms capable of interbreeding or exchanging genes among themselves and producing fertile offspring.

Explanation

Cross between a male donkey and a female horse produces mule. It is infertile, because of the odd number of chromosomes, they can't reproduce.



Fig. 1.4: Infertile mule



So, it is not a species. Species is the most basic unit of classification, as well as a taxonomic rank.

Q.7 What is binomial nomenclature? Describe aims, principles and importance of binomial nomenclature using local examples. / What is binomial nomenclature? Describe its rules and importance?

Ans. Definition

Binomial nomenclature is the method of giving scientific names to living organisms.

Explanation

(i) **Linnaeus**

Linnaeus introduced a naming system.

(ii) **Latin Names**

He gave each organism a name consisting of two Latin names.

(iii) **Genus**

The first name is genus. The genus name begins with a capital letter.

(iv) **Species**

The second name represents the particular species. The species name begins with a small letter.

(v) **Binomial Nomenclature**

Since each name has two parts so it is called binomial nomenclature e.g., biological name of human being is *Homo sapiens*. Our genus name is *Homo* and species name is *sapiens*.

(vi) A genus may have many species e.g., all cats belong to genus *Felis* including lion.

Importance of Binomial Nomenclature

(i) A common name will vary from country to country just because different countries use different languages.

(ii) There was a need for a universal language such as Latin.

(iii) Even those who speak the same language sometime use different common name for the same organism.

Example: Brinjal is baingan in Urdu, Batatoon in Punjabi, Vaglan in Sindhi.

Examples of Scientific Names

(a) Biological name of Brinjal is *Solanum melongena*.

(b) Potato-*Solanum tuberosum*

(c) Rice - *Oryza sativa*

(iv) A scientific name has the advantage of standing for a single kind of animal, plant or microorganism all over the world.

Q.8 State the complications of classifying viruses.

Ans. Introduction

Viruses show characteristics of both living and non-living things.

Living Characteristics

The living characteristics of viruses are:

1. They occur in different varieties.
2. They have their own genetic material in the form of either RNA or DNA.
3. They reproduce using the material of the host cell they infect.
4. They enter the cells of living organisms and cause diseases.

Non-Living Characteristics

The non-living characteristics of viruses are:

1. They lack cellular structure and enzyme system.
2. They can be crystallized and store in bottle.
3. They do not respire.
4. Viruses behave as non-living, inert infectious particles outside the host.



Reason for the Exclusion of Viruses from All Domains and Kingdoms

Viruses are at the borderline of living and non-living things. So, they are not included in any domain and kingdom under modern classification.

Q.9 Describe briefly about prions and viroids.

Ans. i) Prions are composed of proteins only.

ii) **Viroids** are composed of circular RNA only.

iii) Both causes infectious diseases in certain plants.

iii) Both are acellular particles.

iv) They are not included in any kingdom of classification system.

Multiple Choice Questions (Exercise)

1. Into which kingdom you place a multicellular land organism that performs photosynthesis.

- (a) monera (b) protista
(c) plantae (d) animalia

2. Which kingdom is mismatched with the characteristics?

- (a) fungi-usually saprotrophic
(b) animalia-carnivorous ingestive
(c) protista-various modes of nutrition
(d) plantae-photosynthetic

3. The kingdom to which the algae belongs is:

- (a) animalia (b) protista
(c) plantae (d) fungi

4. Scientific name has advantages of:

- (a) same name applied to different organisms.
(b) same organisms have different name in different areas.
(c) has no scientific basis.
(d) has scientific basis and is universally accepted.

10. Which option is correct regarding the mode of nutrition of following organism?

	Animal	Prokaryote	Fungi	Plant
a)	Heterotrophic	Heterotrophic	Ingestive	Autotrophic
b)	Ingestive	Absorptive	Autotrophic	Heterotrophic
c)	Ingestive	Heterotrophic	Absorptive	Photosynthetic
d)	Absorptive	Autotrophic	Ingestive	Autotrophic



11. Viruses are not included in any domain or classification as:

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- (a) they are poorly understood
- (b) they are too large
- (c) they are of various column
- (d) they are not considered as organism

12. A related groups of genera consists of:

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- (a) a phylum
- (b) a class
- (c) an order
- (d) a family

Multiple Choice Questions (Additional)

15. All prokaryotic organisms are included in kingdom:

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- (a) Protista
- (b) Monera
- (c) Fungi
- (d) Plantae

16. Which kingdom includes eukaryotic, multicellular and absorptive heterotrophs?

091402025

- (a) Monera
- (b) Protista
- (c) Fungi
- (d) None of above

17. Which of the following character is not related to Animalia?

091402026

- (a) Eukaryotic
- (b) Multicellular
- (c) Heterotrophs
- (d) Autotrophs

18. The body of which organism consists only of RNA?

091402027

- (a) Prions
- (b) Viruses
- (c) Viruses
- (d) Algae

19. A species is a group of natural population which can:

091402028

- (a) Interbreed and produce offspring
- (b) Interbreed in nature and produce
- (c) Interbreed and produce fertile offspring
- (d) Interbreed in nature and produce fertile offsprings

20. Scientific name of brinjal is:

091402029

- (a) *Bauhinia cepa*
- (b) *Solanum melongena*
- (c) *Bauhinia robusta*
- (d) *Oryza sativa*

21. All of these are characteristics of Fungi-except:

091402030

- (a) absorptive mode of life
- (b) Multicellular eukaryotes
- (c) Mostly decomposers
- (d) Cell wall is made of cellulose

13. In which of the following the first letter is capitalized in binomial nomenclature?

091402032

- (a) genus
- (b) class
- (c) species
- (d) family

14. If humans and cats belong to the same class, they must belong to the same:

091402033

- (a) phylum
- (b) order
- (c) family
- (d) genus

22. The scientific name of rice is:

091402031

- (a) *Oryza Sativa*
- (b) *Oryza sativa*
- (c) *oryza sativa*
- (d) *ORYZA SATIVA*

23. Select the one which is "NOT" the characteristics of a prion:

091402032

- (a) Composed of protein only
- (b) Can replicate
- (c) Cause disease in sheep.
- (d) Do not contain circular RNA

24. Who suggested the first system of classification of organisms?

091402033

- (a) Al-Jahiz
- (b) Aristotle
- (c) John Ray
- (d) Averroes

25. Which character of viruses make their resemblance with living organism?

091402034

- (a) They can be crystallized
- (b) They can not live outside host body
- (c) They contain DNA or RNA
- (d) All of the above

26. *Euglena* belongs to the kingdom protista because:

091402035

- (a) It is unicellular
- (b) It is eukaryotic
- (c) It has both plant and animal like characters
- (d) It lives in water

27. The correct sequence of hierarchy from small to large units is:

091402036

- (a) Genus → family → order → class
- (b) Family → order → class → genus
- (c) Genus → family → class → order
- (d) Species → family → genus → order

28. The kingdom which contains eukaryotic autotrophic organism is:

091402037

- (a) Protista
- (b) Fungi
- (c) Monera
- (d) None of them

29. Which of the following kingdoms possesses the simplest organism?

091402038

- (a) Fungi
- (b) Monera
- (c) Protista
- (d) Plantae

30. What is binomial nomenclature?

091402039

- (a) Classifying organisms on seven levels
- (b) Naming system developed by Aristotle
- (c) Grouping animals based on their habitat
- (d) Naming system in which each organism is given two-part name

31. Which one is the correct way of writing scientific name of an organism?

091402040

- (a) *Canis lupus*
- (b) *Saccharum*
- (c) Giant's gazelle
- (d) *Escherichia coli*

32. Which one is the basic unit of classification?

091402041

- (a) Genus
- (b) Species
- (c) Family
- (d) Order

33. Which is composed of only protein?

091402042

- (a) Viruses
- (b) Prions
- (c) Viroids
- (d) Both 'b' and 'c'

34. Which one is acellular?

091402043

- (a) Bacteria
- (b) Fungi
- (c) Cyanobacteria
- (d) Viruses

35. Cell wall of fungi is made up of:

091402044

- (a) Cellulose
- (b) Amino acid
- (c) Chitin
- (d) Both 'a' and 'b'

36. The kingdom protista includes:

091402045

- (a) Unicellular and simple multicellular organisms with prominent nucleus
- (b) True multicellular organisms with no prominent nucleus
- (c) True multicellular organisms with prominent nucleus
- (d) Unicellular organisms with no prominent nucleus

37. In which kingdom, would you classify unicellular eukaryotes?

091402046

- (a) Fungi and Plantae
- (b) Fungi and Monera
- (c) Only Protista
- (d) Only Fungi

38. A certain organism is multicellular, adapted for photosynthesis and has multicellular sex organs. To which kingdom does it belong?

091402047

- (a) Animalia
- (b) Fungi
- (c) Plantae
- (d) Protista

39. The branch of biology which deals with classification is:

091402048

- (a) Taxonomy
- (b) Systematic
- (c) Botany
- (d) Genetics

40. The scientific name of human being is:

091402049

- (a) *Homo sapiens*
- (b) *Pisum sativum*
- (c) *Amanita muscaria*
- (d) *E. coli*

41. The kingdom of bacteria is:

091402050

- (a) Fungi
- (b) Monera
- (c) Protista
- (d) Plantae

42. What does biodiversity refer to:

091402051

- (a) The variety of living organisms in an area
- (b) The quantity of water bodies in a region
- (c) The speed at which species evolve
- (d) The number of cells in an organism

43. Who is considered the father of modern taxonomy?

091402052

- (a) Albert Einstein
- (b) Gregor Mendel
- (c) Charles Darwin
- (d) Carl Linnaeus

44. Which is not one of the three broad domains of living organisms?

091402053

- (a) Bacteria
- (b) Archaea
- (c) Fungi
- (d) Eukarya

45. Which of the following is NOT a taxonomic rank?

091402054

- (a) Kingdom
- (b) Phylum
- (c) Class
- (d) scientific name

46. The two-kingdom classification system divided into which of the following?

091402055

- (a) Animalia and Fungi
- (b) Plantae and Monera
- (c) Animalia and Plantae
- (d) Archaea and Bacteria

47. Which of the following kingdoms contains their DNA float freely within the cell?

091402056

- (a) Protista
- (b) Eubacteria
- (c) Fungi
- (d) Plantae



Answer Key

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

Short Answer Questions (Exercise)

Q.1 Why are the following scientists famous for?

- (a) Aristotle
(b) Carolus Linnaeus
(c) Carl Woese

Ans. a) Aristotle

The Greek Philosopher Aristotle was the first person who classified the living organisms.

b) Carolus Linnaeus

He grouped species according to similar physical characteristics. According to earlier classification system, organisms were classified into two kingdoms, then three kingdom and then five-kingdom system. He also introduced binomial nomenclature.

c) Carl Woese

In 1990 Carl Woese introduced a three domain system of classification. The three domains of life are:

- i) Archaea ii) Bacteria iii) Eukarya

Q.2 Define.

- (a) Biodiversity (b) Classification
(c) Taxonomy (d) Systematics
(e) Domain (f) Taxa
(g) Species

Ans. a) Biodiversity

Biodiversity is defined as 'the variety of living organisms on Earth.

b) Classification

The grouping of organisms is called classification.

c) Taxonomy

Taxonomy is the branch of biology concerned with identification, naming and classification of organisms.

d) Systematics

The scientific study of diversity of organisms and their evolutionary relationship is called systematics.

e) Domain

In 1990 Carl Woese introduced a three domains system of classification. The three domains of life are Archaea, Bacteria and Eukarya.

f) Taxa

The group into which organisms are classified are known as taxonomic categories or taxa (singular 'taxon'). The taxa form a ladder, called taxonomic hierarchy. There are eight main taxonomic ranks: Kingdom, phylum or division, class, order, family, genus and species.

g) Species

Species is a group of similar organism capable of interbreeding or exchanging genes among themselves and producing fertile offspring.

Q.3 What is domain? Name three domains of life.

Ans. In biology, a domain means the largest

of all groups in the classification of life. Domain is a group of kingdoms or taxonomic category below the kingdom. The three domains of life are Archaea, Bacteria and Eukarya.

Q.4 What are basis of classification of life into domains?

Ans. Basis of Three Domain System

Classification into three domains is based on difference in the sequence of nucleotides in the rRNA (ribosomal ribonucleic acid) of the cell, the cell's membrane lipid structure and its sensitivity to antibiotics.

Q.5 Can you differentiate between:

- (a) Bacteria and Protists (b) Fungi and Plants
(c) Plants and Animals

Ans. (a) Bacteria and Protists

Bacteria	Protists
(i) Prokaryotic organisms.	(i) Eukaryotic organisms
(ii) They are unicellular, filamentous or colonial and are relatively simple in structure.	(ii) Unicellular or simple multi-cellular and mostly aquatic.
(iii) Examples: Bacteria and Cyanobacteria	(iii) Examples: Amoeba, Euglena, and Slime molds.

(b) Fungi and Plants

Fungi	Plants
(i) Eukaryotic organisms.	(i) Eukaryotic organisms.
(ii) Mostly multi-cellular and some fungi are unicellular.	(ii) Multi-cellular
(iii) Fungi may be saprotrophic decomposers.	(iii) Plants are autotrophic with chloroplasts containing chlorophyll.
(iv) Fungi have chitin in their cell walls.	(iv) Plants cell wall is made of cellulose.
(v) Fungi have absorptive mode of nutrition.	(v) Plants have photosynthetic mode of nutrition.
(vi) Examples, black bread mold, yeast, mushroom etc.	(vi) Examples, moss, mustard.



(c) Plants and Animals

Plants	Animals
(i) Eukaryotic multi-cellular.	(i) Eukaryotic multi-cellular.
(ii) Autotrophic with chloroplast containing chlorophyll.	(ii) Heterotrophic and lack chlorophyll.
(iii) They have cellulose in cell walls.	(iii) Animals lack cell wall.
(iv) They cannot move.	(iv) They can move from place to place.
(v) Examples, moss, mustard.	(v) Examples: (a) Invertebrates e.g., insects, star fish. (b) Vertebrates e.g., fish, frogs.

Q.6 Answer the following with supportive reasons.

Ans. (a) Which is the simplest domain?

(b) Which is the complex domain?

(c) Are most bacteria harmful?

(d) Which domains can flourish or survive in most adverse conditions?

Ans. a) Archaea domain is the simplest one. This domain is comprised organisms that are prokaryotic or cells without nuclei. They are single celled and reproduce asexually.

b) Domain Eukarya is the complex one. It consists of all eukaryotic organisms or those with the largest, most complex cells and the most advanced compartmentalization.

c) Most bacteria are harmless, but certain types can make you sick. These bacteria are a type of pathogen. Pathogens are microorganisms that can cause diseases.

(d) Archaea can be found in every ecosystem and environment on Earth. They can survive and thrive in extreme environments.

The archaean cytoplasmic membrane contains unique lipids that cannot easily be degraded, are temperature and mechanically resistant and highly salt tolerant.



Q.7 Compare two kingdom, three kingdom, and five kingdom classification system.

Two Kingdom Classification System	Three Kingdom Classification System	Five Kingdom Classification System
(i) It includes two Kingdoms: Plantae and Animalia. (ii) Bacteria and Cyanobacteria were placed in plant kingdom. (iii) Unicellular or simple multicellular eukaryotes wrongly placed in kingdom Plantae and Animalia. (iv) Fungi are wrongly placed in kingdom plantae.	(i) It includes three kingdoms: Plantae, Animalia, Protista. (ii) <i>Euglena</i> was placed in kingdom Protista. (iii) Multicellular microscopic organisms were separated from unicellular microscopic organisms. (iv) Fungi were placed in kingdom Plantae.	(i) It includes five kingdoms: Monera, Protista, Fungi, Plantae and Animalia. (ii) Bacteria and cyanobacteria are placed in kingdom Monera. (iii) Unicellular or simple multicellular eukaryotes placed in kingdom Protista. (iv) Fungi are placed in kingdom Fungi.

Q.8 Compare the three domain system of classification.

Ans. i) The Domain Archaea

The domain Archaea have the following characteristics:

- Archaea are prokaryotic cells.
- The cell walls of Archaea contain no peptidoglycan.
- The rRNA (ribosomal RNA) are not found in Bacteria and Eukarya.

ii) The Domain Bacteria

The domain bacteria have the following characteristics:

- Bacteria are prokaryotic cells.
- The cell walls of bacteria contain peptidoglycan.
- They contain rRNA that is unique to bacteria.

iii) The Domain Eukarya

The domain Eukarya has the following characteristics:

Q.10 Write the names of kingdoms mentioned as i, ii, iii, iv and v in the following flow chart according to five kingdom classification system.

- Eukarya have eukaryotic cells.
- Not all Eukarya have cells with a cell wall. Their cell wall contains no peptidoglycan.
- Eukarya contains rRNA that is unique to Eukarya.

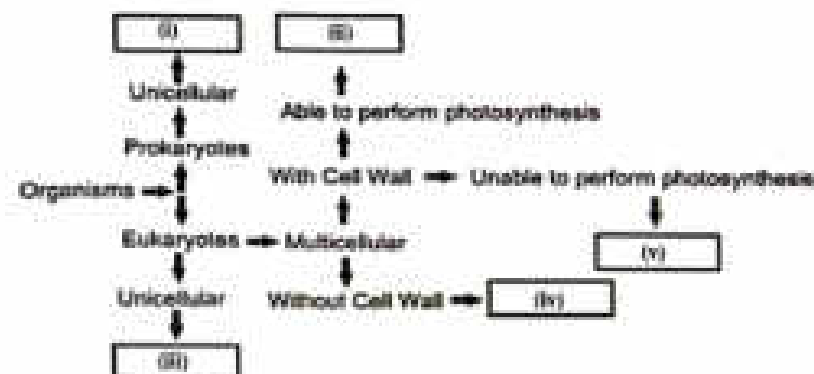
Q.9 Why mule is not regarded as a species?

Ans. Definition

Species is a group of similar individuals capable of interbreeding among themselves and producing fertile offspring.

Explanation

Cross between a male donkey and a female horse produces mule. It is infertile because of the odd number of chromosomes, they can't reproduce. So, it is not species. Species is the most basic unit of classification as well as a taxonomic rank.



Ans. (i) Monera (ii) Plantae (iii) Protista (iv) Animalia (v) Fungi

SLO Based Short Answer Questions (Additional)

Q.11 Define acellular.

Ans. Acellular means non-cellular, a living entity without cells e.g., prions, viroids.

Q.12 Define binomial nomenclature.

Ans. Binomial nomenclature is the method of giving scientific names to living organisms. Since each name has two parts so it is called binomial nomenclature e.g., biological name of human being is *Homo sapiens*. Our genus name is *Homo* and species name is *sapiens*.

Q.13 Define biodiversity. Describe briefly the meaning of biodiversity.

Ans. Biodiversity is the variety of the living organisms present in an ecosystem. It is the richness and variety of living organisms on Earth.

Q.14 Define the following terms:

(a) Autotrophs (b) Heterotrophs

(c) Saprotrophs

Ans. (a) Autotrophs

The organisms that are capable of producing their own food are called autotrophs (photosynthetic mode of nutrition) e.g., green plants, cyanobacteria, and algae.

(a) Heterotrophs

Organisms which eat other things as food are called heterotrophs (ingestive mode of nutrition) e.g., animals, animal like protists, etc.

(b) Saprotrophs

The organisms that depend on dead, decaying matter are called saprotrophs (absorptive mode of nutrition) e.g., fungi, bacteria. These are decomposers.

Q.15 Define prokaryotes and eukaryotes.

Ans. Prokaryotes

The organisms which lack nucleus in their cells are called prokaryotes e.g., bacteria.

Eukaryotes

The organisms which have true nucleus in their cells e.g., plant cells.

Q.16 Describe aims of classification.

Ans. Aims of Classification

The main aims and objectives of classification are:

- To determine similarities and differences between organisms.
- To arrange organisms on the basis of similarities and differences.
- Identify the organisms to study them systematically.
- To find out evolutionary relationship among organisms.

Q.17 Which kingdom does *Euglena* belong to? Give reason for its placement. Enlist any three characteristics of that kingdom.

Ans. *Euglena* belongs to kingdom Protista.

**Reason for Placement**

It is a unicellular organism. *Euglena* has both plant-like (presence of chlorophyll) and animal-like (heterotrophic mode of nutrition in darkness and lack of cell wall) characters. Due to this it is placed in the kingdom Protista.

Characteristics

i) Kingdom Protista includes eukaryotic

organisms with a unicellular or simple multicellular structure.

ii) Most organisms belonging to this kingdom are aquatic.

iii) It includes animal like protists called protozoa e.g., *Amoeba*. Plant like protists called algae e.g., *Euglena*. Fungi like protists e.g., slime molds.

SLO Based Reference Material Short Answer Questions

Q.18 How does classification help scientists to understand the evolutionary relationship between organisms? (01/03/24)

Ans. The classification reflects shared ancestry. Organisms with similar traits likely share a common evolutionary history. For example, pigeons and parrots indicates their shared origin from a common bird ancestor. Classification helps us to construct phylogenetic trees, which depict the evolutionary history of species. These trees show how species are related through common ancestors.

Q.19 How classification is vital for the researchers? (01/03/24)

Ans. Classification is an essential tool for researchers to select model organisms that are representative of a larger group for experimental research. This allows researchers to apply their findings from one organism to others. For example both mice and humans belong to the class Mammalia. This shared classification group enables researchers to select mice as model organisms in medical research, including drug testing.

Q.20 Differentiate between Methanogenic, Extremophilic and Non-extreme Archaeobacteria along with suitable examples of each. (01/03/24)

Ans. Methanogenic archaeobacteria

They cannot survive in oxygen and produce methane from hydrogen and carbon dioxide.

Example: *Methanobrevibacter smithii*

Extremophilic Archaeobacteria

They thrive in extreme conditions such as high temperatures, high salt concentrations, (e.g., Dead Sea), and extreme pH levels.

Example: *Picrophilus torridus*

Non-extreme Archaeobacteria

They live in common environments like soil and sea. They were previously thought to only exist in extreme places.

Example: *Nitrososphaera viennensis*

Q.21 How does cell wall composition helps to differentiate Eubacteria and Archaea?

Ans. Archaea (Archaeobacteria) (01/03/24)

The cell walls of archaeobacteria differ significantly from those of eubacteria, lacking peptidoglycan and instead made up of a combination of proteins, glycoproteins, and polysaccharides.

Eubacteria (Bacteria)

They have cell walls typically made of peptidoglycan, and their genetic material mostly consists of single circular DNA.

Q.22 Write the scientific names of red panda and mountain lion? (01/03/24)

Ans. Scientific name of red panda is *Ailurus fulgens* and of mountain lion is *Puma concolor*.

Q.23 What kind of parasites are viruses? (01/03/24)

Ans. Viruses are acellular structures that are obligate intracellular parasites which are inactive outside the host cell. They depend on the host cell to replicate and metabolize. Once inside the host cell, they become active and take over the host's cellular machinery, such as



cellular organelles and enzymes, to make new viruses.

Q.24 What is ICTV? Give its contribution. (01/03/24)

Ans. A committee was created, called the International Committee on Taxonomy of

Viruses (ICTV), and was given the task of developing a single, universal taxonomic scheme for all the viruses infecting animals, fungi, bacteria and archaea.

SLO Based Reference Material Long Answer Questions

Q.1 Write taxonomic hierarchy of some of the common animals and plants. (01/03/24)

Ans.

	Mustard	Oak	Man
Kingdom	Plantae	Plantae	Animalia
Phylum	Tracheophyta	Angiospermophyta	Chordata
Class	Magnoliopsida	Dicotyledonae	Mammalia
Order	Brassicales	Fagales	Primates
Family	Brassicaceae	Fagaceae	Hominidae
Genus	<i>Brassica</i>	<i>Quercus</i>	<i>Homo</i>
Species	<i>Brassica campestris</i>	<i>Quercus robur</i>	<i>Homo sapiens</i>

Q.2 Write a note on six kingdom system of classification. (01/03/24)

Ans. Six Kingdom System

In 1977, Carl Woese proposed a six kingdom system. The "six kingdoms" approach expands the traditional five-kingdom system by splitting the Monera kingdom into Eubacteria and Archaeobacteria kingdoms. The members of kingdom Eubacteria typically have cell wall of peptidoglycan, while Archaeobacteria have diverse cell wall compositions and unique genetic and metabolic properties, often suited for extreme environments. This system classifies life into six main kingdoms: Animalia, Plantae, Fungi, Protista, eubacteria (Bacteria), and Archaeobacteria (Archaea), offering a more detailed classification of organisms.



THE CELL

Q.1 What do you know about cell and its discovery? Differentiate between animal and plant cells with the help of suitable diagrams.

BY NEHA KUMAR

Ans. Cell

Irrespective of size and shape all life forms are made up of units called cells. The functions performed by the living organisms are also performed at the cell level. So cell is the basic unit of structure and function of all living organisms.

Discovery of Cell and Nucleus

In 1665, Robert Hooke discovered cell when he examined a thin slice of cork tissue under a compound microscope. He observed cells as empty chambers with thick outer coverings. However, the quality of microscope lenses improved greatly in the nineteenth century which lead to the discovery of cell nucleus in 1833 by Robert Brown and many cytoplasmic organelles in coming years.

Difference between Animal and Plant cells

An Animal cell: Eukaryotic cell has membrane bound nucleus and organelles. Animal cells have no cell wall and chloroplast.

A Plant Cell: Plant cells are different from animal cells in having cell wall, single large vacuole and plastids.

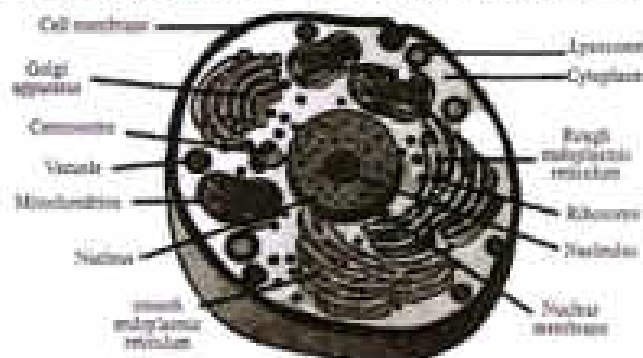


Fig. 3.1: Animal cell

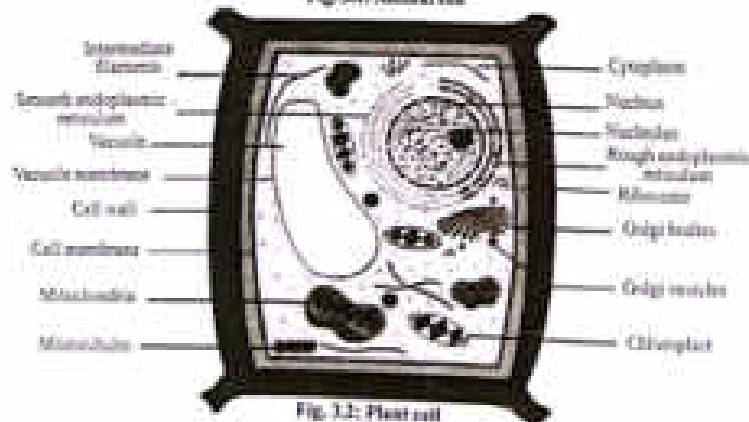


Fig. 3.2: Plant cell



Q.2 Write a note on cell wall. (OR) How the cell wall is important in the lifestyle of plants?

BY NEHA KUMAR

Ans. Introduction

The cell wall surrounds the plasma membrane of plant cells. It is rigid, inert covering secreted and deposited outside the cell membrane. It consists of three layers namely middle lamella, primary wall and secondary wall.

(i) **Middle Lamella:** Middle lamella is made up of magnesium and calcium salts of pectin. It is sticky in nature that holds the neighbouring cell walls together.

(ii) **Primary Wall:** Primary wall contains cellulose fibers arranged in a criss-cross fashion. It is thin and flexible.

(iii) **Secondary Wall:** Some plant cells like xylem vessels form secondary wall inside the primary wall. It is very thick and rigid structure due to presence of lignin which cements the cellulose fibers together.



Fig. 3.3: Plant cell wall

Plasmodesmata

Cell wall bears tiny pores through which neighbouring cells form cytoplasmic connections called plasmodesmata.

Chemical composition

(i) **Cell Wall of Algae:** Algae have cellulose in their cell wall.

(ii) **Cell Wall of Fungi:** Fungal cell wall is made up of chitin.

(iii) **Cell Wall of Prokaryotes:** Prokaryotes also possess cell wall made up of peptidoglycan(murein). Cell wall is absent in animals and animal like protists (protozoa).

Functions

(i) Cell wall supports the structure of individual cells and the plant as a whole.

(ii) It protects and gives shape to the cell.

(iii) Plant cells can develop turgor due to presence of cell wall.

Q.3 Explain the structural model of cell membrane and give the roles of cell membrane.

BY NEHA KUMAR

Ans. Introduction

Cell membrane is a thin sheet like covering of the cell.

Chemical Composition

Chemically it is composed of proteins 60-80%, phospholipids 20-40 % and traces of carbohydrates.

Structure

(i) The structure of cell membrane is explained according to **fluid mosaic model**.

(ii) It postulates that cell membrane consists of a double layer of phospholipids in which proteins are incorporated in a mosaic fashion.

(iii) In fact, protein molecules float like icebergs in a sea like fluid of phospholipids.

(iv) Cell membranes of eukaryotes also contain cholesterol.

(v) It prevents stiffening of cell membrane.

(vi) Cholesterol is required for the fusion of secretory vesicles with membrane.

(vii) Carbohydrates are either linked with proteins or lipids.

Functions

(i) Cell membrane acts as barrier and gatekeeper for the cell.



Fig. 3.4: Fluid mosaic model of cell membrane



- (ii) It is semipermeable so some molecules can move across the lipid bilayer but others are blocked.
- (iii) It maintains fluid environment inside the cell.
- (iv) Cell membrane acts as a barrier between the cell and its environment. It regulates the exchange of materials between cell and its environment.

Q.4: Write a note on cytoplasm.

Ans. Introduction

Between the cell membrane and nucleus of the cell is an aqueous substance called cytoplasm. It is about 90% water having many dissolved and suspended materials.

Functions

- (i) It is the site for many biochemical processes.
- (ii) It stores food granules and waste materials.
- (iii) It is home for a variety of cell organelles.

Q.5: Write a note on endoplasmic reticulum.

Ans. Introduction

It is a system of membranes present throughout the cytoplasm of eukaryotic cells. Flattened sacs of the endoplasmic reticulum are called cisternae which form a network of interconnected channels.

Forms of Endoplasmic Reticulum

There are two forms of endoplasmic reticulum.

- (i) **Rough Endoplasmic Reticulum (RER)** are covered with ribosomes.
- (ii) If ribosomes are absent it is **Smooth Endoplasmic Reticulum (SER)**.

Functions

- (i) A complex network of endoplasmic reticulum provides mechanical support to the cell.
- (ii) They are also involved in transport of substances within the cell.
- (iii) Due to attached ribosomes RER have role in the synthesis of some proteins.
- (iv) SER synthesizes lipids including steroids.
- (v) SER also detoxify harmful substances.
- (vi) In muscle cells SER have important role in contraction process.

Q.6: Write down the structure and function of ribosomes.

Ans. Need of Ribosomes

Proteins make up to about 55% dry weight of a cell. A cell thus needs protein synthesis at high rate. This role is performed by the ribosomes.

Definition: Ribosomes are tiny granular structures found both in prokaryotic and eukaryotic cells.

Structure: They are not bound by any membrane. They are composed of roughly equal amount of proteins and ribosomal RNA (rRNA).

Size: The prokaryotic ribosomes, however, are smaller in size.

Location: A large number of ribosomes are scattered in the cytoplasm. In eukaryotes many ribosomes are also attached on the surface of RER.

Parts: Each ribosome consists of two subunits, one small and one large. These two subunits join when ribosome has to perform its function.

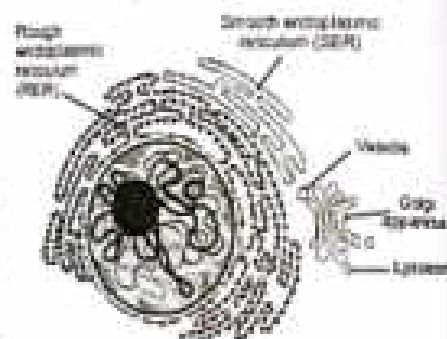


Fig. 3.5: Structure of Rough and Smooth Endoplasmic Reticulum



Fig. 3.6: Function of ribosomes



Fig. 3.7: Subunits of ribosome

Q.7: Write a note on Golgi apparatus.

Ans. Introduction

Golgi apparatus was discovered by Camillo Golgi in 1898. It is present in all eukaryotic cells. Like endoplasmic reticulum, Golgi apparatus is also collection of flattened sacs called cisternae. However, in Golgi apparatus many cisternae are stacked over each other. They are constantly formed at one end and breakup into vesicles at the other end.

Functions

- (i) Golgi apparatus store and modify materials into finished form before packing into vesicles. Some of these vesicles settle in cytoplasm as organelles like lysosomes. Others fuse with the cell membrane to release out packed material as cell secretion.
- (ii) Products of glands like enzymes, hormones, mucus etc. are secreted in cellulose fibres which arrange themselves to form cell wall.

Q.8: Write a note on lysosomes.

Ans. Introduction

They are single membrane bound small sac like structures. They contain a variety of digestive enzymes. The enzymes contained in lysosomes are synthesized on RER and then transported to Golgi apparatus. Lysosomes then bud off from Golgi apparatus with their processed enzymes.

Functions

- (i) **Intracellular Digestion**

One important role of lysosome is intracellular digestion. In this process lysosomes digest materials taken up by the cell from outside as food vacuole. When lysosome fuses with the food vacuole, the lysosomal enzymes act on complex food substances and convert them into simple form.

- (ii) **Autophagy**

They also engulf and digest unwanted cell organelles. This process is termed as autophagy.



Fig. 3.8: Structure of Golgi apparatus



Fig. 3.9: Structure of Lysosome

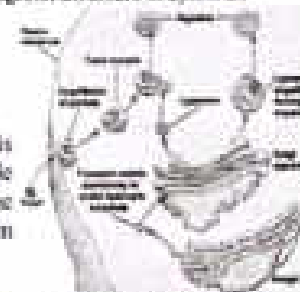


Fig. 3.10: Formation and function of lysosomes



Q.9: Write a note on mitochondria.

Ans. Need of Mitochondria

Energy is an important theme in biology. All systems, from cells to ecosystems require energy to do work. Cells get energy by the breakdown of organic food in a process called respiration. If it requires oxygen, it is called aerobic respiration. It takes place in mitochondria.

Location

Mitochondria are found in all aerobic eukaryotic cells.

Structure

Mitochondria are double membrane bound structures. The outer membrane is smooth and inner membrane forms finger like projections called cristae. They increase the surface area for the respiration. The fluid inside the mitochondrion is called matrix. Mitochondria have their own DNA and ribosomes. They can multiply within the cell at their own.

Function

They produce energy in the form of ATP that is why they are called power house of cell.

Q.10: Write a note on plastids. / Give the types of plastids and enlist the role of each type.

Ans. Introduction

Plastids are double membrane bound organelles. They are found in plants and algae.

Types

There are three types of plastids i.e., chloroplast, chromoplast and leucoplast.

(1) Chloroplast

Structure

(i) **Shape:** Chloroplast usually oval in structure.

(ii) **Chloroplast's envelope:** Two membranes of chloroplast form chloroplast's envelope.

(iii) **DNA and Ribosomes:** They have their own DNA and ribosomes. They can multiply within the cell at their own.

(iv) **Thylakoids:** They have a system of membranes containing chlorophylls and other photosynthetic pigments. This system consists of hollow coin like membranous structures called thylakoids.

(v) **Granum:** Many thylakoids stack to form granum. Some thylakoids of adjacent grana fuse to form intergrana.

(vi) **Stroma:** The fluid part of chloroplast is called stroma.

Functions

Chloroplasts synthesize food by photosynthesis process. It takes place in two phases;

a. **Light-dependent phase:** which takes place in thylakoid membranes.

b. **Light-independent phase:** which takes place in stroma.

(2) Chromoplast

Introduction

Chromoplasts are coloured other than green. They may be red, pink, yellow, blue, purple etc.

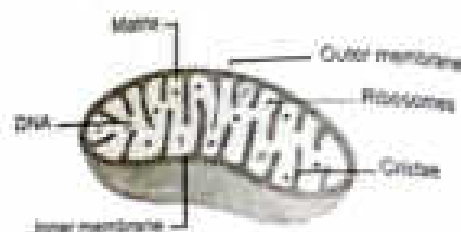


Fig. 3.11: Structure of mitochondria



Fig. 3.12: Structure of chloroplast



Location and Function

(i) They are found in flower petals to attract insects.

(ii) Insects help in pollination.

(iii) They are also present in the wall of ripened fruits where they attract birds and other animals which help in seed dispersal.

(3) Leucoplasts

Introduction

Leucoplasts are non-pigmented plastids.

Functions

(i) They are food storing organelles usually found in roots, bulbs and stem tubers.

(ii) They store carbohydrates, proteins or lipids.

Q.11: Write a note on vacuole.

Ans. Introduction

A vacuole is a membrane bound fluid filled sac.

(a) Vacuole in an Animal Cell

Animal cell may have many small vacuoles which exist temporarily. They contain water and food substances. Some freshwater organisms like amoeba and sponges have contractile vacuoles which collect and pump out extra water and other wastes. Some cells ingest food by forming food vacuoles which is then digested into simple molecules. Food vacuoles also store food.

(b) Vacuole in a Plant Cell.

Introduction

Plant cells have a large central vacuole. It is formed by joining small vacuoles.

Tonoplast: The membrane of plant vacuole is called tonoplast.

Cell Sap: It contains liquid called cell sap. Cell sap has dissolved materials like mineral salts, sugars, and amino acids. It also provides support and helps in growth.

Functions

The primary role of the central vacuole in a plant cell is to maintain turgor pressure within the plant cell. Turgor pressure occurs when the fluid content of a cell pushes the cell membrane against the cell wall in order to provide shape to the plant cell.

Q.12: Write a note on centrioles, (centrioles)

Ans. Introduction

Centrioles are hollow open ended cylinder like structures. They are found in animal cell. They exist in pairs near the nuclear envelope. Each centriole consists of nine triplets of microtubules.

Functions

(i) At the start of cell division centrioles duplicate and two pairs move to the opposite poles, thus help in the formation of spindle apparatus.

(ii) They are also involved in the formation of cilia and flagella.



Fig. 3.13: Structure and types of vacuole in animal cell



Fig. 3.14: Pair of centrioles

00100001

Q.13: Write a note on cytoskeleton.

Ans. Introduction

Cell has a system of a variety of fibrous proteins throughout the cytoplasm. These proteins collectively form cytoskeleton.

Types

Three types of cytoskeletal fibers are identified in the cell. These include; microtubules, microfilaments and intermediate filaments.

(i) **Microtubules**

Microtubules are made up of tubulin protein they are unbranched hollow tube like structure. Microtubules give rise to spindle fibers, cilia and flagella.

(ii) **Microfilaments**

Microfilaments are very thin protein fibers. They consist of contractile proteins mainly actin. They are responsible for the streaming movements of the cytoplasm. The overall cell movement is also regulated by the microfilaments.

(iii) **Intermediate filaments**

Intermediate filaments are composed of a variety of proteins including keratin and vimentin. They form a branching network in the cell. They maintain the cell structure. In tissues, they fit cell with each other.

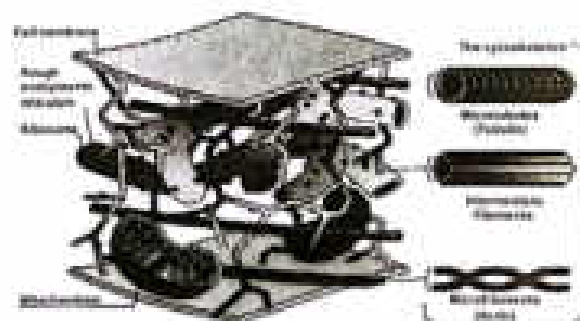


Fig. 3.15: (a): Structure and types of cytoskeleton

Q.14: Write about cilia and flagella.

Ans. Cilia

Some eukaryotic cells have extensions that look somewhat like hair. These structures are called cilia.

Flagella

Some cells have whip like extensions called flagella.

Structure of Cilia and Flagella

Cilia and flagella consist of nine pairs of microtubules which surround a single central pair of microtubules.

Functions

Cilia and flagella are connected to the basal body. The basal body serves to anchor a cilium or flagellum to the cell. The function of cilia and flagella is movement.



Fig. 3.15: (b): Cilia and Flagella

Q.15: Write a note on nucleus.

Ans. Introduction

Cell activities like metabolism, growth and reproduction need to be well regulated. In eukaryotic cell this role is served by the nucleus. Nucleus acts as control centre of the cell because it contains hereditary material DNA.

Structure

(i) **Nuclear Envelope:** Nucleus is surrounded by two membranes which collectively form the nuclear envelope.

(ii) **Nuclear Pores:** Nuclear envelope bears nuclear pores at points where both membranes fuse with each other. Through nuclear pores nucleus communicates with the cytoplasm. Some nutrients and proteins enter the nucleus through these pores and ribosomes and mRNA leave the nucleus.

(iii) **Nucleoplasm:** Nucleus contains a fluid called nucleoplasm.

(iv) **Nucleolus:** Nucleolus is a round darkly stained area in the nucleus. Ribosomes are assembled at this point. Here ribosomal RNA (rRNA) is formed which combines with proteins to form ribosomes. It disappears for some time during cell division.

(v) **Chromatin:** Hereditary material in the nucleus is actually in the form of chromatin. Chromatin consists of DNA fibres coiled on histone proteins.

(vi) **Chromosomes:** During cell division chromatin fibres condense into more tightly coiled threads known as chromosomes. Each species has its own unique chromosomal set different from other species.

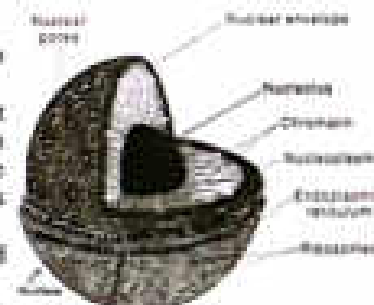


Fig. 3.16: Structure of nucleus

Q.16: Describe the structural advantages of animal and plant cell.

Ans. Introduction

The cells of living organisms have basic similarities in structure due to common origin, however, they differ in many respects. Cell wall makes a major difference in plant and animal cell. The presence of cell wall in plant cell and absence in animal cell is reflected in their life styles.

Advantages of Animal and Plant cells

Plant Cell advantages/disadvantages	Animal Cell advantages/disadvantages
Due to cell wall adjoining plant cells are cemented with each other. Supportive structure of plant as a whole is thus formed by cell wall.	The supportive structure of an animal as a whole is not dependent on a cell wall but rather on the collective arrangement and organization of tissues, organs, and skeletal systems present in the animal's body.
Transport channels in plants, xylem and phloem, are also formed because of presence of cell walls.	In animal cells, since they lack a cell wall, the transport of fluids, nutrients, and gases occurs through different structures and mechanisms.



The rigid wall helps plant cell to withstand high osmotic stress and store water.	Animal cells cannot withstand high osmotic pressure and cannot store larger volumes of water.
Plant cell can become turgid which allows plant parts to maintain structure and stay upright.	Animal cell cannot become turgid to provide support to the body.
Plants cannot move from place to place because of rigidity provided by the cell wall.	Lack of cell walls which makes them very flexible. Animal cells can move. Animals can move to suitable environmental conditions, find shelter and better feeding and opportunities for reproduction.
Due to rigid structure plant cell cannot reproduce at a faster rate.	It also helps animal cell to divide and reproduce at faster rate.

Q.17: State the relationship between structure and function of epidermal cells, mesophyll cells, red blood cells, neurons, muscles, and liver cells.

Ans. Introduction

In multicellular organisms, cells are specialized to perform their specific roles. Daughter cells formed by mitosis process undergo changes in a process called differentiation. They alter in structure, metabolic activities and physiological responses. As a result, they become specialized for their role in the body. Some examples of the specialized cells are given below.

(1) Epidermal Cells

Introduction

Epidermal cells of plants form protective covering of root, stem and leaves. They are flat cells which pack tightly to form a continuous outer layer of plant body.

Function

Epidermal cells having some additional role are modified accordingly. For example, root hair cells which absorb water and minerals from the soil and guard cells of leaves which regulate the opening and closing of stomata.

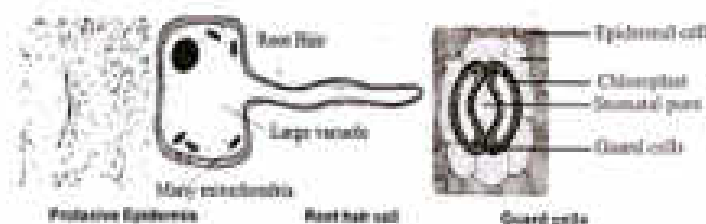


Fig. 3.17: Epidermal cells

(2) Mesophyll Cells

Introduction

Mesophyll cells are photosynthetic cells of plants. They are present in plant leaves. They contain a large number of chloroplasts.

Function

Chlorophyll and other photosynthetic pigments are anchored in the thylakoid membranes of chloroplasts. These pigments absorb light energy and use it to produce food in photosynthesis process.



Fig. 3.18: Mesophyll cells



(3) Red Blood Cells

Introduction

Red blood cells (RBCs) are haemoglobin filled cells to transport oxygen in the body.

Structure

They are biconcave disc shaped cells. This shape provides more surface area to absorb and release oxygen. Nucleus, mitochondria, endoplasmic reticulum etc. are absent. It helps to accommodate more haemoglobin. These cells are very flexible so they can easily pass through blood capillaries.

Average Age

The average age of RBCs is 120 days.

(4) Neurons

Introduction

Neurons are the cells of nervous system. They are responsible for coordination in the animal bodies. To accomplish this job their structure is very unique.

Function

A neuron has a cell body and two types of cytoplasmic fibres. One of them are dendrites which conduct nerve impulses to the cell body. Others are axons which conduct messages away from the cell body. The dendrites and axons make it possible for neurons to communicate with far away cells of the body.

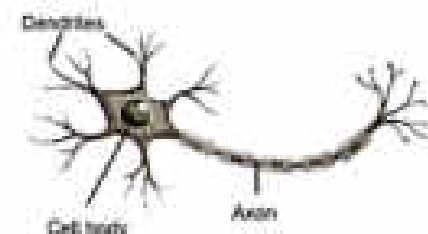


Fig. 3.20: Neuron

(5) Muscle Cells

Introduction

Muscle cells have ability to contract and relax.

Functions

(i) Locomotion, breathing movements, blood pumping by the heart, change in size of eye pupil, peristaltic contraction of the gut, speech movements of tongue, lips etc. are result of the muscle contraction.

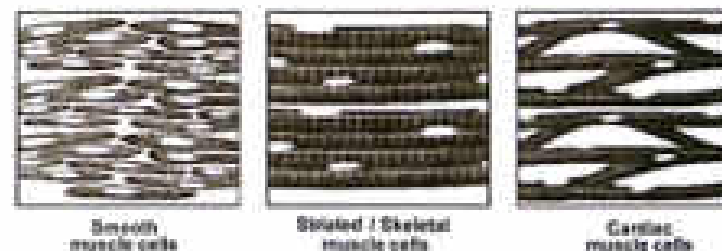


Fig. 3.21: Types of muscles

(ii) To produce contractions muscle cells have elongated shape and are filled with actin and its associated contractile proteins.



(K) Liver Cells

Introduction

Liver cells are almost round in shape and have prominent nucleus and abundance of cytoplasmic organelles. They are metabolically most active cells of the body.

Functions

Their few important roles are:

- Storage of glycogen, iron and some vitamins.
- Detoxification of toxic substances.
- Production of clotting proteins of blood.
- Recycling of old red blood cells.

Q.18: What is division of labour? Give examples. WB00002

Ans. Introduction

Within a cell different organelles perform their assigned roles. Mitochondria act as powerhouse of the cell as they produce energy for the cell. Ribosomes remain engaged in protein synthesis. Chloroplasts harvest light energy to manufacture organic food. For the normal survival and functioning of a cell its organelles must do their specified jobs. The performance of given function by different organelles is the division of labour.

Examples

(i) Division of Labour within Unicellular Organisms

Cell is the unit of life, so a cell can perform all basic functions of life. A cell can respire, take and utilize nutrients, grow in size, reproduce, show movements etc. In unicellular organisms, a single cell lives as an organism and performs all these life processes independently.

(ii) Division of Labour within Multicellular Organisms

Introduction: A huge number of cells assemble a body of multicellular organism. In multicellular organism it is not possible for billions or trillions cells to perform all life tasks independently. So cells arrange in groups to perform some given roles.

Tissue: A group of cells performing same function is called tissue.

Cell from Zygote: The cell originating from same zygote change their cell lines and differentiate into unique structures suitable for their roles.

Muscle Cells: Muscle cells are elongated to make the body parts move by their contractions.

Neurons: Neurons form thin cytoplasmic fibers to conduct messages in the body. Muscle cells and neurons cannot exchange their function.

RBCs and Bone Cells: RBCs transport oxygen and bone tissue provides mechanical support.

Mesophyll Cells and Phloem: In plants mesophyll cells prepare food by photosynthesis process and phloem cells transport this food to all parts of the plant body.

Q.19: Write a note on stem cells. WB000018

Ans. Introduction

Around 220 types of cells are identified in human body. These cells vary in their size, shape and role. However, all these types of cells have a common origin. They all develop from a single cell the zygote. A cell which gives rise to cells of other types is called the stem cell. The zygote is very basic stem cell which has ability to produce all kinds of cells of an organism.

Explanation

(a) Sexually Reproducing Organisms

In sexually reproducing organisms, life starts from zygote. As the development progresses, different cell lines are formed. Each cell line has its own stem cell. Brain, liver, and other body tissues are products of stem cells.

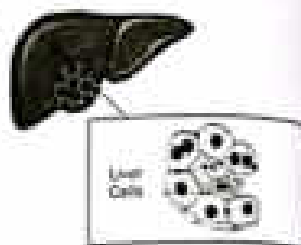


Fig. 3.22: Liver and liver cells



(b) Stem Cells are Un-specialized

Stem cells by themselves are not differentiated and are un-specialized. Each daughter cell produced by division of a stem cell has capacity to remain un-specialized stem cell or differentiate into mature cell of some tissue. So stem cells divide, renew themselves and daughter cells differentiate into distinct cell type.

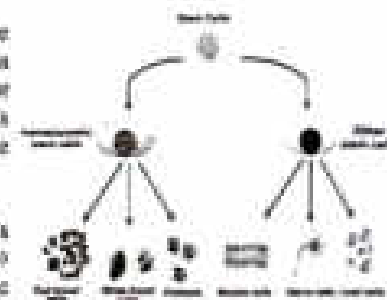


Fig. 3.23: Stem cells and formation of specialized cells

Q.20: If a cell is rich in SER, list the roles in which this cell will be more efficient. WB000009

Ans. The main functions of the smooth endoplasmic reticulum include:

- Manufacturing products like lipids and hormones.
- It also helps in detoxification by processing toxins in the liver.
- It also regulates calcium ions for muscle contraction.

Q.21: Give the significance of muscles in the life of animals. WB000021

Ans. Muscle tissue produces the body and organs movement. Muscle cells are known as myocytes or muscle fibres. They have the ability to decrease their length which in turn produces muscle contraction. Muscle cells are organized in bundles.

Q.22: Justify how the cells of leaf have a variety of specialized structure and function. WB000022

Ans. Following examples clearly tell us that cells of leaf have a variety of specialised structures and functions.

(1) Palisade Mesophyll

Cells are long and packed tightly at the upper part of the leaf. They are good at absorbing sunlight, which help in photosynthesis.

(2) Spongy Cells

Spongy cells are shaped differently with irregular forms and air spaces. They help in gas exchange, which is also important for photosynthesis.

(3) Epidermis

Epidermis is the outer most single layer of cells covering the leaf surface. A waxy substance called cutin which forms the cuticle covers the upper epidermis. The function of epidermis is to protect the tissues and to prevent loss of water.

(4) Stomata

On the lower epidermis tiny pores are present called stomata. Each stoma is enclosed by two guard cells having chloroplasts. The guard cells control the opening and closing of stoma. Exchange of oxygen and carbon dioxide and evaporation of water vapours takes place through stomata.

(5) Xylem

Xylem vessels present in the leaves are dead cells. Through xylem cells transportation of water from root to leaves takes place.

(6) Phloem

The phloem cells carry the prepared food from the leaf to other parts of the plant.

Q.23: Describe the role of the cell membrane in maintaining equilibrium while exchanging in matter? WB000013

Ans. The cell regulates or maintains homeostasis through selective permeability. This means that the cell membrane only allows certain things into and out of the cell, allowing the cell to maintain stable conditions that are different from the environment. In general, oxygen, food and water are allowed to enter, waste products are allowed to leave and harmful substances are kept out.



Multiple Choice Questions (Exercise)

- A network of channels extending from cell membrane to nuclear membrane is called: (09160024)
(a) centriole (b) endoplasmic reticulum
(c) ribosomes (d) centrosome
- The site of enzyme synthesis in cells is: (09160025)
(a) lysosome (b) smooth endoplasmic reticulum
(c) Golgi bodies (d) ribosomes
- What are the functions of mitochondria? (09160026)
(a) lipid synthesis (b) protein synthesis
(c) photosynthesis (d) cellular respiration
- A red blood cell and a plant root hair cell both have: (09160027)
(a) cellulose cell wall (b) haemoglobin
(c) large surface area (d) nucleus
- The diagrams show cells from different types of tissues (not drawn on scale). Which type of cell contracts when it is stimulated? (09160028)



- Plastids of different types are correctly represented by: (09160029)

	Photosynthetic	Pigmented	Food storage	Colour variety
(a)	Chloroplasts	Leucoplasts	Chromoplasts	Chloroplasts
(b)	Chromoplasts	Chloroplasts and Chromoplasts	Chromoplasts and Leucoplasts	Chromoplasts
(c)	Leucoplasts and chloroplasts	Chromoplasts and Leucoplasts	Leucoplasts	Chloroplasts
(d)	Chloroplasts	Chloroplasts and Chromoplasts	Leucoplasts	Chromoplasts

- Which of the following statement correctly represents ribosomes? (09160030)
(a) They are present only in eukaryotic cell.
(b) They are produced in the nucleus then migrate to the cytoplasm where they synthesize proteins.

- Which of the following cell organelle does not contain DNA? (09160031)
(a) nucleus (b) lysosomes
(c) chloroplast (d) mitochondria
- Phospholipids are required for cell membrane formation are synthesized in: (09160032)
(a) mitochondria (b) cytoplasm
(c) endoplasmic reticulum (d) smooth endoplasmic reticulum
- Cytoskeleton is an important component of eukaryotic cells. Which of the following statement correctly describes cytoskeleton? (09160033)
(a) All the cytoskeletal structures are made up of same protein.
(b) There is no contractile protein in cytoskeletal component.
(c) Cytoskeleton provides mechanical support and has role in cell division.
(d) The entire cytoskeleton is present around the cell membrane.
- The shape of normal red blood cells is: (09160034)
(a) oval (b) crescent
(c) biconcave (d) biconcave

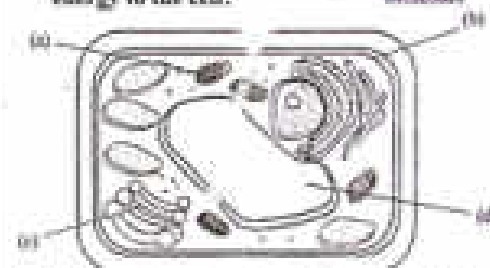
- They are covered by single membrane.
(d) All ribosomes are attached to the inner surface of RER.



Multiple Choice Questions (Additional)

- Cell walls are found in these organisms, except for: (09160035)
(a) plants (b) animals
(c) bacteria (d) fungi
- Ribosomes are constructed in the: (09160036)
(a) endoplasmic reticulum (b) nucleoid
(c) nucleolus (d) nuclear pore
- The chloroplast functions in: (09160037)
(a) ATP synthesis (b) protein synthesis
(c) photosynthesis (d) DNA replication
- Which plastid is primarily involved in the storage of food molecules in plant
(a) chromoplasts (b) chloroplasts (09160038)
(c) leucoplasts (d) lysosomes
- The stacked membranous structure in the chloroplast is: (09160039)
(a) thylakoids (b) stroma
(c) granum (d) intergranum
- The membranous structure in the chloroplast is: (09160040)
(a) thylakoids (b) stroma
(c) granum (d) intergranum
- The type of plastids present in fruits are: (09160041)
(a) chloroplasts (b) chromoplasts
(c) leucoplasts (d) all of the above
- The type of plastids present in roots are: (09160042)
(a) chloroplasts (b) chromoplasts
(c) leucoplasts (d) all of the above
- Single membrane bounded organelles having strong digestive enzymes are: (09160043)
(a) ribosomes (b) lysosomes
(c) chromosomes (d) nucleosomes
- The organelle which provides energy to the cell: (09160044)
(a) Golgi apparatus (b) ribosome
(c) mitochondria (d) nucleus
- Inside the nucleus, granular material is called: (09160045)
(a) cytoplasm (b) protoplasm
(c) nucleoplasm (d) cell sap

- The organelle involved in protein synthesis: (09160046)
(a) ribosome (b) vacuole
(c) Golgi apparatus (d) plastids
- Cell wall is present in the cells of: (09160047)
(a) fungi only
(b) plants only
(c) plants and prokaryotes only
(d) all of the above
- Which organelles are covered with a double membrane? (09160048)
(a) ribosomes (b) vacuoles
(c) centrioles (d) mitochondria
- The diagram shows a plant cell which of the labelled structure is responsible for energy to the cell? (09160049)



- Which structure is exclusive to plant cells? (09160050)
(a) centriole (b) lysosome
(c) chloroplast (d) nucleus
- What is the primary role of centrioles in animal cells? (09160051)
(a) energy production
(b) protein synthesis
(c) cell division
(d) photosynthesis
- Which organelle plays a significant role in lipid synthesis and detoxification processes in the cell? (09160052)
(a) Chloroplast
(b) Mitochondria
(c) Endoplasmic reticulum
(d) Golgi Apparatus



30. The biconcave disc shape of red blood cells is advantageous for: (01/10/2016)

- Oxygen transport
- carbon dioxide storage
- nucleus protection
- muscle contractions

31. Liver cells, hepatocytes, are well-suited for various functions due to their: (01/10/2016)

- Hexagonal shape
- central nucleus
- irregular structure
- haemoglobin content

32. What is cell specialization? (01/10/2016)

- The process of cells dividing and multiplying

(b) The process where a cell changes to perform a unique function

(c) The process of creating new cells in a multicellular organism

(d) The process of cell fusion in the body

33. Which of the following organisms is a prokaryote? (01/10/2016)

- Baccha*
- mushroom
- Escherichia coli*
- human

34. What is the primary pigment responsible for capturing sunlight in chloroplasts? (01/10/2016)

- melanin
- chlorophyll
- haemoglobin
- carotene

Answer Key

1.	(b)	2.	(d)	3.	(d)	4.	(c)	5.	(b)
6.	(b)	7.	(d)	8.	(c)	9.	(d)	10.	(d)
11.	(b)	12.	(b)	13.	(c)	14.	(c)	15.	(c)
16.	(c)	17.	(a)	18.	(b)	19.	(c)	20.	(b)
21.	(c)	22.	(c)	23.	(a)	24.	(d)	25.	(d)
26.	(a)	27.	(c)	28.	(c)	29.	(c)	30.	(a)
31.	(a)	32.	(b)	33.	(c)	34.	(b)		

Short Answer Questions (Exercise)

Q.1: Why mitochondria are known as powerhouse of the cell? (01/10/2016)

Ans. Mitochondria produce energy in the form of ATP that is why they are called powerhouse of cell.

Q.2: What makes red blood cells more suitable for the transport of oxygen? (01/10/2016)

Ans. Red blood cells have a noticeable biconcave disc shape which means they are curved inward on both sides. This shape gives them more surface area and carry oxygen and carbon dioxide more efficiently.

Q.3: Give the modifications of epidermal cells for: (01/10/2016)

(a) Exchange of gases

(b) Absorption of water and minerals.

Ans. (a) There are special epidermal cells on leaves called guard cells. These cells surround small opening called stomata and help to control gas exchange and transpiration from the plants.

(b) In roots, certain epidermal cells extend into long "root hairs" that vastly increase the surface area for water and nutrient absorption from the soil.

Q.4: Following diagram shows a plant cell: (01/10/2016)



Keeping in view the parts labeled 1 to 4, answer the following questions:

(a) Give the number indicating the structure which controls the cell activities.

Ans. 4

(b) Name a biochemical process taking place in part 2.

Ans. Glycolysis an important step in making energy for the cell.



(c) What will happen to cell if part 1 is removed and part 3 is overfilled with water?

Ans. If the part 1 (cell wall) is removed from the cell and its part 3 (vacuole) is overfilled with water, the cell will likely to burst due to lack of structural support and high internal pressure.

Q.5: The diagram below represents a nucleus. (01/10/2016)



(a) Name the structure labeled E and F.

Ans. E = Nucleolus F = Nuclear pore

(b) Give the function of F.

Ans. Nucleus communicates with the cytoplasm through nuclear pore. Some nutrients and proteins enter the nucleus through these pores and ribosomes and mRNA leave the nucleus.

Q.8: Select the structures which are present in all cells of all kingdoms. Write one function of each selected structure. Cell membrane; Nucleus; Chromosomes; Cytoplasm; Ribosomes; RER; SER; Golgi apparatus; Lysosome; Mitochondria; Centriole; Cilia; Flagella; Cell wall; Cytoskeleton; Vacuole; Plastids. (01/10/2016)

Ans. Following structures are present in all cells of all kingdoms.

Structures present in all cells	Functions
1. Cell membrane	It stops the cell contents from escaping and also controls the substances which are allowed to enter or leave the cell.
2. Chromosome	It contains DNA which is the genetic material of the cell.
3. Cytoplasm	It contains all the organelles. Many biochemical reactions take place in it.
4. Ribosomes	Ribosomes are the sites of protein synthesis.

Q.9: Which cells in animals and plants do not have a nucleus? How do these cells perform their functions without nucleus? (01/10/2016)

Ans. Sieve tube cells in plants and red blood cells in human are exceptional living cells that do not possess nucleus. In sieve tube cells the nucleus of companion cells controls their functional activities. Losing the nucleus enables the red blood cell to contain more

(c) Which cytoplasmic organelles are formed by ER?

Ans. Ribosomes are assembled/ formed by ER.

(d) What happens to ER during cell division?

Ans. During cell division, ER (nucleolus) disappears.

Q.6: Cell shape is related to cell function. Give three examples to support your answer. (01/10/2016)

Ans. Function of each cell is associated with the shape of cell. Such as:

- Amoeba and the white blood cells can change their shape as they move about.
- Sperm cells have, whip-like tails called flagella for locomotion.
- Nerve cells are long and thin, so they can transmit messages over great distance.

Q.7: Plasma membrane has two main components according to fluid mosaic model. Which component represents fluid and which component represents mosaic? (01/10/2016)

Ans. Lipid bilayer represents fluid and protein component represents mosaic.

oxygen to carry haemoglobin, thus enabling more oxygen to be transported in the blood and boosting our metabolism.

Q.10: Unripe oranges are green in colour. After ripening their colour changes. Suggest which organelles, number changed in them during ripening? (01/10/2016)

Ans. Unripe fruits are green because of chlorophyll in their cells. As they ripen, the



chloroplast) breaks down and is replaced by orange carotenoids and red anthocyanins. During opening, chloroplasts change into chromoplasts.

SLO Based Short Answer Questions (Additional)

Q.12: What is chloroplast? medium

Ans. Chloroplast is a type of a plastid found by a double membrane. It is found in plant cells. Chloroplasts are the sites of photosynthesis in eukaryotes. They contain chlorophyll, the green pigment necessary for photosynthesis.

Q.13: What are Golgi apparatus? medium

Ans. It was discovered by Italian scientist Camillo Golgi in 1898. Golgi apparatus is also known as Golgi bodies or Golgi complex.

Structure

The electron microscope has revealed that a Golgi apparatus is a stack of flattened sacs formed of membranes. Most cells contain 10 to 20 sets of these flattened membranes. In cells, the inner face of the stack is directed toward the endoplasmic reticulum and the outer face of the stack is directed towards the plasma membrane. Vesicles are seen at the edges of the stack.

Q.14: What are leucoplasts? medium

Ans. Leucoplasts are colourless. These are found in the underground parts of the plant, e.g., roots, tubers. Leucoplasts store food.

Q.15: Define lysosomes. Give their function. medium

Ans. Lysosomes are roughly spherical structures bounded by a single membrane.

Structure

Lysosomes contain various active hydrolytic enzymes which breakdown proteins, nucleic acids, lipids and carbohydrates.

Q.16: What is mitochondrion? medium

Ans. Mitochondria are spherical, rod-like or elongated tiny organelles.

Structure

Under EM, a mitochondrion is a double membrane structure. The outer membrane is smooth. The inner membrane is folded to form

Q.11: Which organelles are abundant in the salivary gland cell? Explain. medium

Ans. Cells that engage in a great deal of secretory activity have abundant number of Golgi-bodies.

crina. Cristae provide a much greater area. Mitochondrial cristae is called matrix.

Q.17: What do you know about nucleus? medium

Ans. It is located in central region in animal cells. Nucleus consists of a double nuclear membrane, nucleoplasm, nucleolus and chromatin.

Structure

(i) Nuclear envelope: The surface of the nucleus is bounded by a double nuclear membrane called nuclear envelope. The nuclear membrane has many pores.

(ii) Nucleoplasm: The fluid inside the nucleus is called nucleoplasm.

(iii) Nucleolus: The darkly stained region in the nucleus is called nucleolus.

(iv) Chromosomes: The thread like structures in the nucleus are called chromosomes.

(v) Chemical composition of chromosomes: Chemically chromosomes consist of deoxyribonucleic acid (DNA) and protein.

(vi) Centrioles: The centrioles is a structure in cytoplasm.

Q.18: Write down the names of parts labeled A, B and C in the following diagram of the chloroplast on your answer book. medium



Ans. A = Grana
B = Inner membrane
C = Thylakoid



Q.19: Name the types of plastids. medium

Ans. (i) Chloroplast (ii) Chromoplast (iii) Leucoplast

Q.20: Draw a labeled diagram of a general prokaryotic cell. medium

Ans.



Q.21: Write a short note on nervous tissues. medium

Ans.

The structural and functional unit of nervous system is nerve cell or neurone.

Structure

Each neurone consists of cell body having a nucleus. And a number of thin extensions. One type of extension called dendrite generally carries signals toward the cell body, another type, the axon usually transmits signals away

from the cell body. To carry messages, the neurones are thin and long.

Q.22: What is muscle tissue and name its types. medium

Ans. Muscle tissue consists of bundles of long cells called muscle fibres. The cells of these tissues have ability to contract.

Types of muscle tissues:

- (i) Skeletal muscle
- (ii) Smooth muscle
- (iii) Cardiac muscle

Q.23: The following diagram is the internal structure of mitochondria, label the parts A, B and C. medium



Ans. A = Cristae
B = Matrix
C = Inner membrane

SLO Based Reference Material Short Answer Questions

Q.24: What do you know about the number of cells and bacteria in an adult body? medium

Ans. An adult body consists of an estimated 10 trillion to 100 trillion cells. Microbiologists

Q.25: Differentiate between prokaryotic cells and eukaryotic cells. medium

Ans.

Prokaryotic Cells	Eukaryotic Cells
The name "Prokaryotes" comes from Greek words meaning "before nucleus".	Eukaryotic cells get their name from Greek words meaning "true nucleus".
They do not have a true nucleus instead their DNA is in an area called the nucleoid.	These cells have a true nucleus, keeping their DNA inside the nuclear membrane.
They do not have membrane bound organelles like the endoplasmic reticulum and mitochondria.	They have membrane bound organelles.
They are usually smaller than the other types of cells.	They are larger than the prokaryotic cells.
Examples: Bacteria and archaea.	Examples: All animal and plant cells.



BIOLOGY

Q.26: Differentiate between anucleate and multinucleate cells.

Ans.

Anucleate	Multinucleate
Cells which do not have nucleus are termed as anucleate.	Cells which have multiple nuclei and are called multinucleate.
Examples: Mature red blood cells in humans.	Examples: Skeletal muscle cells or some fungi.

Q.27: What do you know about highly active cells and less active cells?

Ans. The number of mitochondria in cells varies based on their activity level. Highly active cells such as liver cells have over a 1000 mitochondria while less active cells like those in the sarcolemma contain a small number of them.

Q.28: What do you know about the followings?

(i) Accessory Pigments

(ii) Types of Leucoplasts

Ans. (i) Along with chlorophyll, other photosynthetic pigments called accessory pigments are present in the chloroplasts, including carotenoids and xanthophylls.

(ii) There are three types of leucoplasts.

(a) amyloplasts (store starch)

(b) elaioplasts (store oils)

(c) Proteinoplasts (store proteins)

Q.29: How would you justify that structure and function are closely tied to each other?

SLO Based Reference Material (Long Answer Questions)

Q.1: Answer the questions related to the functions of an organelle, shown in figure.

I. Identify the organelle A.

Ans. Lysosome

II. Label the steps C, D and E.

Ans. C - lysosome engulfing damaged organelle

D - Digestion of food vacuole

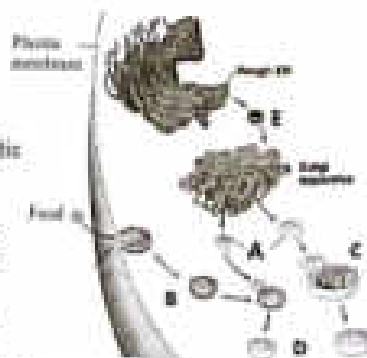
E - Transport vesicle (containing active hydrolytic enzymes)

iii. Enlist the functions of organelle A.

Ans. 1. Lysosomes contain various active hydrolytic enzymes which breakdown nucleic acids, lipids and carbohydrates.

2. Lysosomes digest engulfed nutrients of food vacuole.

3. Lysosomes serve as a recycling center for damaged organelles.



UNIT 04

CELL CYCLE

Q.1: What is the cell division? Describe the importance of cell division.

09100001

Ans. Introduction

According to the cell theory, new cells originate by division in the pre-existing cell. The cell which divides is called parent cell and the new cell formed as a result of division is called daughter cell.

Importance

(i) The process of cell division is needed for development, growth, healing and for sexual and asexual reproduction.

(ii) Cell not only increase in number but also manage to transfer genetic characteristics to the next generations.

(iii) During cell cycle, cells grow in size, form new molecules and organelles, replicate their chromosomes and divide by equally distributing genetic material in the daughter cell.

Q.2: What is cell cycle? Describe its phases in detail.

09100002

Ans. Definition

The cell cycle is the sequence of events which involves growth of newly formed cell, replicates its genome and divides into two daughter cells ultimately.

Phases: It consists of two main phases; interphase and mitotic phase.

(i) Interphase

Interphase is the period in cell cycle between two consecutive divisions.

Sub-phases: It is divided into G₁ (Gap 1), S (Synthesis), and G₂ (Gap 2).

Explanation

G₁ phase

(i) It starts with the production of new cell.

(ii) Cell grows in size, increases the number of its organelles, forms needed proteins and other substances.

(iii) During this phase cell prepares itself for the next phase of cell cycle (S phase).

(iv) It forms enzymes and nucleotides of DNA required for replication process.

S phase: (i) It is the synthesis phase of DNA.

(ii) The cell replicates its entire genetic material to form in two copies. That is why each chromosome has two chromatids during cell division, one for each of the daughter cell.

(iii) These chromatids are attached with one centromere and are called sister chromatids.

G₂ phase

(i) During this phase cell prepares for mitotic phase.

(ii) Cell forms proteins especially those required for the formation of spindle fibers.

(iii) Also cell accumulates energy to complete the division process.

(iv) More mitochondria are formed.

G₀ phase(i) During G₁, cell may exit the cell cycle and enter in G₀ phase.

(ii) In G₀ cell stops to divide.



Fig. 4.1: Cell cycle



(iii) Some cells e.g., neurons, once mature never divide again. They remain in G_0 forever. Cell of liver, kidneys etc. enter G_0 temporarily. When needed they re-enter the cell cycle and start to divide again. Many epithelial cells divide continuously. They never enter in G_0 phase.

(2) Mitotic phase (M phase): During this phase cell divides into daughter cell.

Q.3: What is Cancer? Differentiate between benign and malignant tumours.

Introduction

Cancer is a disease of cell cycle. Unlike normal cells of the body, cancer cells do not have a proper functioning cell cycle control system and therefore divide excessively. This excessive growth can result in an abnormal mass of cells called tumour.

Benign Tumour: Not all tumours are cancerous however, a benign tumour is an abnormal mass of essential normal cells. They always remain at their original site in the body.

Malignant Tumour: A malignant tumour is cancerous. It is capable of spreading into neighbouring tissues and often to other distant parts of the body. The spread of cancer cells beyond their original site is called metastasis.

Q.4: How would you describe spindle apparatus?

Ans. Introduction

Cytoskeleton of the eukaryotic cell forms spindle apparatus during the cell division. Major component of the cytoskeleton are microtubules. The spindle apparatus separates chromatid or chromosomes during cell division and move them to opposite poles. In this way hereditary material of the parent cell is equally distributed into daughter cell.

Explanation

(i) Spindle Apparatus in Animal cells

A pair of centrioles is situated near the nucleus of animal cell. They duplicate and another pair is formed. Both pairs migrate to opposite poles. They also give rise to spindle fibres. Spindle apparatus is formed around the nucleus, but as soon as nuclear envelope disintegrates, spindle fibres penetrate into the region of nucleus. They later on attach to the centromere of chromosome and pull them to their poles.

(ii) Spindle Apparatus in Plant cells

There are no centrioles in plant cell, the spindle apparatus of plant cell is formed without centrioles.

Q.5: Define mitosis. Explain the phases of mitosis with the help of diagram.

Ans. The cell division in which parent cell produces two daughter cells with the same number of chromosomes as in the parent cell. Mitosis is a continuous and very fast process which takes less than an hour, but to study easily it is divided into karyokinesis and cytokinesis.

(i) Karyokinesis

It is division of the nucleus, which form two nuclei in a dividing cell. It is further divided into: prophase, metaphase, anaphase and telophase.

(i) Prophase

(a) Duplication of Chromatin Fibres: During interphase hereditary material is found in the form of very thin threads called chromatin. If a cell is going to divide, all of its chromatin fibres duplicate during S phase of interphase.

(b) Condensation of Chromatin: Prophase is the longest phase of cell division. At the start of prophase chromatin fibres coil up and condense into chromosomes. Due to duplication all



Fig. 4.2: Spindle apparatus



chromosome consists of two chromatids. The chromatids of each chromosome are attached to each other at centromere.

(c) Disappearance of Nucleolus and Nuclear Membrane: Nucleolus disappears as its DNA is packed into chromosomes. At the end of prophase nuclear membrane splits into vesicles which disperse in the cytoplasm. Spindle apparatus is formed.

(ii) Metaphase

Chromosomes are aligned at the equator of spindles. Two spindle fibers, one from each pole, are attached at the centromere of chromosomes.

(iii) Anaphase

Spindle fibres pull the centromeres which split and chromatids are separated from each other. Individual chromatids are pulled until they reach their respective poles.

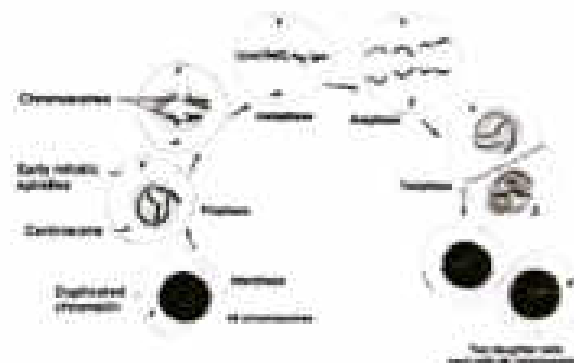


Fig. 4.3: Mitosis

(iv) Telophase

Chromatids reach at their poles. They uncoil and lengthen to form chromatin fibres again. The spindle apparatus disintegrates. Nuclear membrane is formed around chromatin at each pole. Nucleoli reappear in both nuclei.

(2) Cytokinesis

Introduction

It is division of the cytoplasm which results in the formation of two daughter cells. It starts while telophase is in progress. The pattern of cytokinesis is different in animal and plant cell.

Cytokinesis in Animal Cells

Cell membrane in animal cell begins to invaginate in the equator region. As a result, a cleavage furrow is formed which continues to grow inward. Cell membranes in the furrow finally join up and separate the two daughter cells.

Cytokinesis in Plant Cells

In plant cell spindle fibres in the equator region form a structure called phragmoplast. Golgi apparatus forms vesicles which appear in the centre of phragmoplast initially and then grow at equatorial plane. The content in these vesicles form middle lamella and primary walls of daughter cells. Later on some cells form secondary walls.



Fig. 4.4: Cytokinesis in animal cell

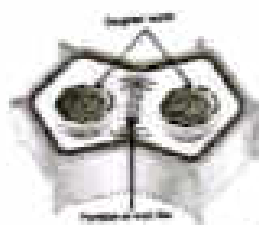


Fig. 4.6: Cytokinesis in plant cell

Q.6: What is the significance of mitosis in your life?

Ans. Introduction

The main function of mitosis is to maintain the number of chromosomes and genetic material in all cells of an organism. Following is the significance of the mitosis.

Genetic Stability

Mitosis produces two daughter cells with the same number of chromosomes as in parent cell. Before the start of cell division, DNA of the parental chromosomes replicates to form two exact copies. Daughter cells thus will have same genetic information.

Development and Growth

Life of sexually reproducing multicellular organisms start from a single cell, the zygote. The continuous cell division process leads to the development of adult form. The organisms also grow in size by increasing cell number. Thus the development and growth of multicellular organisms depends on mitosis.

Cell Replacement and Wound Healing

The replacement of worn out cells involves mitosis. The epithelial cells of skin, digestive tract and respiratory tract die off regularly. They are replaced by identical cells produced by mitosis. Damage, repair and wound healing depends on the process of mitosis.

Regeneration: Some animals have ability to form whole part of the body if it is removed accidentally. This is called regeneration. For example; sea star can regenerate arm, earthworms can regenerate head, and salamander can regenerate its limb. The production of new cells to form missing part involves mitosis.



Fig. 4.6: Regeneration of arm in Sea star

Asexual reproduction

(i) Introduction

Mitosis is the basis of asexual reproduction. This reproduction involves only one parent. All asexually produced offspring are genetically identical to their parent organism. The vegetative propagation is very common in plants. It involves new generations from root, stem or leaf of parent plant.

(ii) Explanation

Potato, onion, garlic, ginger, grasses etc. reproduce asexually. Many animal species like sponges, planaria and hydra undergo asexual reproduction.

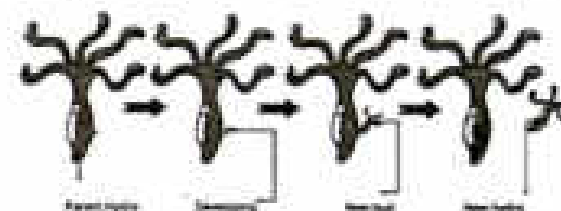


Fig. 4.7: Budding in Hydra

Cloning and Tissue Culture

Mitosis has made it possible for scientists to produce a very large number of identical copies of the living organisms in artificial environment. This process is called cloning or tissue culture if small mass of tissue cells is used.



Fig. 4.8: Cloning by (a) Tissue culture (b) Vegetative propagation in potato

Q.7: Describe meiosis in an animal cell. Explain your answer with the help of labelled diagram.

OR ANSWER

Ans. Introduction

It is a type of cell division which give rise to four daughter cells each having half the number of chromosome of the parent cell. It takes place only in cells involved in sexual reproduction. Such parent cells are usually diploid which by this reduction division produce haploid daughter cells.

Diploid (2n) and Haploid (n)

Cells which have two sets of chromosomes are called diploid (2n) and cells with half the number of chromosomes are called haploid (n). Chromosomes in a diploid cell are in homologous pair. Haploid cells carry one member of each homologous pair.

Phases of meiosis

Meiosis is a continuous process but for convenience is divided into interphase-I, meiosis-I, interphase II and meiosis II.

Interphase-I

Before the onset of division process, cell forms a copy of its genome by replication process. That is why chromosomes appear with two chromatids during division process.

Meiosis-I

It is the reduction division which for daughter cells reduces the number of chromosomes to half. Firstly, karyokinesis forms two haploid nuclei which is followed by cytokinesis.

Karyokinesis in Meiosis-I

It is further divided into prophase-I, metaphase-I, anaphase-I and telophase-I.

Prophase I

(i) Synapsis and Bivalent

It is the longest phase of meiosis. Chromosomes begin to appear as thicker fibres due to coiling of chromatin. Homologous chromosomes line up point to point against each other and form



pairs. Their centromeres are in the same position. This pairing process of homologous chromosomes is called **synapsis**. Each pair is called **bivalent**.

(ii) Chiasmata and Crossing Over

The non-sister chromatids of homologous chromosomes join each other at some points along their length. Such points are called **chiasmata**. Each chiasma is a site for the exchange of some genetic material between chromatids. The exchange of segments of non-sister chromatids during prophase-I is called **crossing over**.

(iii) Sister and Non-sister Chromatids

Sister chromatids are two exactly similar copies attached by a centromere while the chromatids of two homologous chromosomes are non-sister chromatids.

(iv) Condensation of Chromosomes

To the end of prophase I, chromosomes are fully condensed and paired chromosomes repel each other. However, they are still attached at chiasmata.

(v) Disappearance of Nucleoli and Nuclear Envelope

Nucleoli and nuclear envelope disappear. Spindle apparatus is formed.

Metaphase-I

Bivalents are arranged at the equatorial plate. Spindle fibres are attached to the centromere of chromosome. One member of a homologous pair receives a spindle fibre from one pole and the other member from the opposite pole.

Anaphase-I

Spindle fibres pull on the homologous chromosomes. Separated chromosomes of each pair move to the opposite poles. Each pole receives haploid set of chromosomes.

Telophase-I

Once at their pole, chromosomes uncoil into chromatin. A nuclear envelope is formed at each pole around the haploid set.

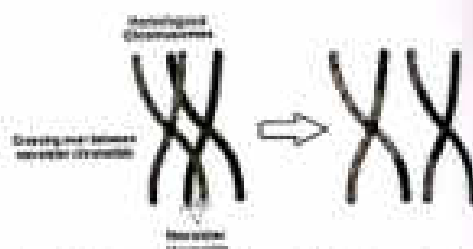


Fig. 4.8: Crossing over in non-sister chromatids

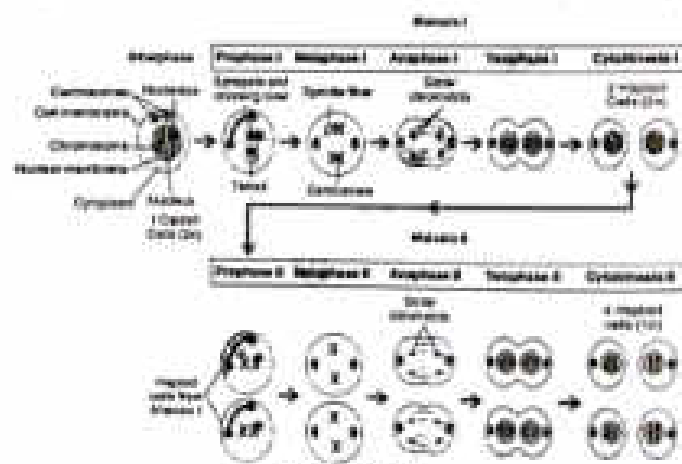


Fig. 4.10: Meiosis



CYTOKINESIS

Cytokinesis occurs by cleavage in animal cell by forming cell wall in plant cell. Although each daughter cell is haploid with half the number of chromosomes, their chromosomes are composed of two chromatids. Due to crossing over, these chromatids are not genetically identical. They must be separated in second meiosis.

Two haploid daughter cells thus formed enter in interphase II.

Interphase-II

This phase varies in length but there is no further DNA replication during this phase.

Meiosis-II

It is similar to mitosis and is divided into prophase II, metaphase II, anaphase II and telophase-II.

Prophase-II

Chromatin coils again so chromosomes appear as thick fibres. Spindle apparatus is organized. Nucleoli disappear and nuclear envelope disintegrates.

Metaphase-II

Chromosomes line up separately around the equator of the spindles. Spindle fibres are attached to the centromere of chromosome. Like mitosis here each chromosome is attached by a fibre from both poles.

Anaphase-II

Centromeres divide and spindle fibres pull the chromatids to the opposite poles.

Telophase-II

Chromatids reach at their poles and uncoil. The spindle apparatus disappears. Nuclear envelopes are formed around chromatin at each pole.

Cytokinesis

Cleavage furrow in animal cells and cell wall formation in plant cells gives four daughter cells at the end of meiosis process. All cells formed by meiosis process are haploid as they have half the number of parental chromosomes. Also they have changed genetic makeup because of crossing over between homologous chromosomes during meiosis I.

Q-8: Describe the significance of meiosis. *answ*

Ans. (a) Maintenance of Chromosomes

(i) During the life cycle of sexually reproducing organisms, diploid germ cells undergo meiosis to produce haploid daughter cells which act as gametes.

(ii) Fusion of such haploid gametes thus maintains chromosome number specific for each species.

(iii) Humans have 46 chromosomes in their somatic cells.

(iv) The haploid gametes (eggs and sperms) formed by meiosis have 23 chromosomes.

(v) In fertilization process a sperm having 23 chromosomes fuses with an egg also having 23 chromosomes.

(vi) The original chromosome number of 46 is restored in the zygote.

(vii) In plants meiosis takes place during spore formation.

(b) Genetic Variations

Variations are the differences among the members of same species. They are necessary for the survival of species in always changing environment. It is because of meiosis that new combinations of genes appear in gametes and then in



Fig. 4.11: Fertilization of sperm and egg cell to form zygote



Fig. 4.12: Variation in Butterfly patterns



regions. Crossing over and independently formed combinations of chromosomes in gametes are two important events of meiosis. Both crossing over and chromosomal combination provide basis of variations.

Q.09: Write the difference between mitosis and meiosis.

Ans.

Comparison of mitosis and meiosis	
Mitosis	Meiosis
It occurs in somatic cells.	It occurs in germ line cells.
Cell divides only once.	Cell divides twice.
It produces two daughter cells.	Four daughter cells are produced.
Daughter cells produced are diploid.	All daughter cells are haploid.
Daughter cells become part of somatic body.	Daughter cells form gametes.
All chromosomes remain independent of each other.	Homologous chromosomes pair with each other.
No chiasmata formation.	Chiasmata are formed.
There is no crossing over during mitosis process.	Crossing over takes place during meiosis-I.
Daughter cells are genetically alike.	Daughter cells are genetically different from each other and parent cell.
In most cases daughter cells can divide again.	Gametes produced by meiosis cannot divide any more.

Multiple Choice Questions (Exercise)

- A bivalent consists of:
 - Two chromatids and one centromere
 - Four chromatids and two centromeres
 - Four chromatids and four centromeres
 - Two chromatids and two centromeres
- During cell division spindle fibres attach a chromosome at:
 - Centromere
 - Telomere
 - upper arm of chromosome
 - lower arm of chromosome
- Some student of SSC observed a thin cross section from root tip of onion plant under the microscope. They found dividing cells at different stages of their life cycle. One of the students found a cell at late prophase and counted 28 chromosomes in it. The number of chromosomes in daughter cells should be:
 - 14
 - 28
 - 56
 - 07
- Crossing over results in genetic recombination. It occurs between:
 - Two chromatids of the same chromosome
 - Two chromatids of any two non-homologous chromosomes
 - Two chromatids of opposite gametes
 - Two chromatids of homologous chromosomes
- The spindle apparatus of plants differs from that of animals in not having:
 - microtubules
 - square of spindle
 - asteroid
 - centromere
- Substance and energy required for the replication of DNA is accumulated in the cell during:
 - G₁
 - G₂
 - S phase
 - M phase

7. All of the following events takes place both in mitosis and meiosis except:

- Condensation of chromatin to form chromosomes
- Formation of spindle apparatus
- Nuclear envelop and nucleolus disappear
- Chromosomes pair for crossing over

8. The cell shown in this diagram is passing through:



- Prophase I of meiosis
- prophase of mitosis
- Telophase of meiosis I
- anaphase of meiosis II

9. The longest phase of meiosis is:

- Interphase I
- prophase I
- interphase II
- prophase II

10. What causes the number of chromosomes to reduce to half when a cell divides by meiosis?

- replication of DNA during interphase I
- separation of homologous chromosomes during meiosis I
- separation of sister chromatids of all the chromosomes during meiosis I
- crossing over during teliosis I

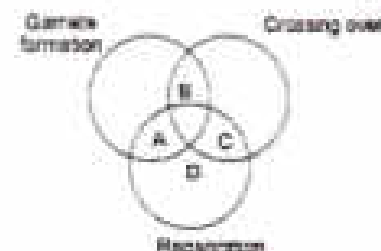
11. Which of the following cell is at metaphase I stage?



12. This diagram is showing different stages of crossing over. Which stage contains chiasma?



13. Which processes involve meiosis?



14. Diagram shows replication of chromosomes:



What is the total number of chromosomes in this diagram?

- 2
- 3
- 4
- 6

15. Chromosomal number of fruit fly is 8. The gametes of fruit fly contain:

- 2 chromosomes
- 4 chromosomes
- 8 chromosomes
- 16 chromosomes



Multiple choice Questions (Additional)

16. The period of cell cycle between two consecutive divisions is termed as: (01104022)
(a) Prophase (b) Metaphase
(c) Telophase (d) Interphase
17. Which of the following phases of mitosis is essentially the opposite of prophase in terms of nuclear change? (01104025)
(a) Telophase (b) Interphase
(c) Metaphase (d) Anaphase
18. When do homologous chromosomes pair up? (01104027)
(a) Only in mitosis
(b) Only in meiosis I
(c) Only in meiosis II
(d) In both mitosis and meiosis
19. The arm of the chromosomes are called: (01104023)
(a) Chromatin (b) Chromatids
(c) Diploids (d) Centromere
20. Cytokinesis is: (01104029)
(a) Division of nucleus
(b) Mitosis
(c) Division of cytoplasm
(d) Division of centromere
21. In which stage of cell cycle, the cell stops dividing: (01104030)
(a) G₁ phase (b) S phase
(c) G₂ phase (d) G₀ phase
22. Chiasmata formation takes place during the prophase I. Find out how many chiasmata are there in this diagram? (01104031)
- 
- (a) 1 (b) 2
(c) 3 (d) 5
23. In which stage of the cell cycle each chromosome is duplicated and so it consists of two chromatids? (01104032)
(a) G₁ (b) S
(c) M (d) G₂
24. During which phase of cell cycle, spindle fibres are formed? (01104033)
(a) G₂ (b) Interphase
(c) Prophase (d) Metaphase
25. In which stage of the cell cycle, the cell is preparing enzyme for chromosome replication? (01104034)
(a) G₁ (b) G₂
(c) S (d) M
26. Which of the following stage of cell division is very different for animal and plant cells? (01104035)
(a) Telophase (b) Metaphase
(c) Anaphase (d) Cytokinesis
27. Cytokinesis in a plant cell is characterized by: (01104036)
(a) The equal division of homologous chromosomes
(b) A pinching off of the cell membrane to divide the cell
(c) The formation of a cell plate in the cytoplasm
(d) The movement of the chromosomes from the metaphase plate
28. Which event distinguishes meiosis from mitosis? (01104037)
(a) Condensation of chromosomes
(b) Loss of the nuclear membrane
(c) Formation of metaphase plate
(d) Pairing of homologous chromosomes
29. In which stage of the cell cycle most cells spend their lives? (01104038)
(a) Prophase (b) Metaphase
(c) Interphase (d) Telophase
30. Which of the following distinguishes meiosis from mitosis? (01104039)
(a) The chromosome number is reduced
(b) Chromosomes undergo crossing over
(c) Daughter cells are genetically different from the parent cell
(d) All of the above
31. Find the correct statement. (01104040)
(a) Homologous chromosomes form pairs during mitosis.
(b) Chromosomes do not duplicate in the interphase preceding meiosis-I.
(c) Homologous chromosomes form pairs during meiosis but not in mitosis.
(d) Spindles are not required during meiosis.



32. What reason would you suggest for the fact that the total DNA content of each daughter cell is reduced during meiosis? (01104041)
(a) Chromosomes do not replicate during the interphase before meiosis I.
(b) Chromosomes do not duplicate between meiosis I and II.
(c) Half of the chromosomes from each gamete are broken.
(d) Sister chromatids separate during anaphase of meiosis I.
33. The longest phase is: (01104042)
(a) Mitotic phase (b) Meiosis
(c) Cell cycle (d) Interphase
34. Type of spindle fibre which attaches the chromosomes is called: (01104043)
(a) Kinetochore (b) Non-kinetochore
(c) Both a and b (d) Centromere
35. During crossing over, genetic material is exchanged between: (01104044)
(a) Sister chromatids of homologous chromosomes
(b) Non-sister chromatids of homologous chromosomes
(c) Sister chromatids of non-homologous chromosomes
36. Which of the following is correct for mitosis? (01104045)
(a) Removal of chromosomes
(b) Chromosomes number remains same
(c) Reduction of chromosomes
(d) Increase in number of chromosomes
37. In which phase of meiosis do homologous chromosomes separate? (01104046)
(a) anaphase I (b) anaphase II
(c) metaphase I (d) metaphase II
38. Tumours are produced as a result of errors in: (01104047)
(a) Meiosis
(b) Mitosis
(c) Binary Fission
(d) Multiple Fission
39. Which of the following does not occur in Prophase-I? (01104048)
(a) Synapsis and chiasma formation
(b) Crossing over
(c) Condensation of chromosome
(d) Separation of a homologous pair
40. Which of the following is correct about the examples of haploid and diploid cells in man? (01104049)

	Example of Haploid Cell	Example of Diploid Cell
(a)	Nerve cell	Skin cell
(b)	Sperm cell	Skin cell
(c)	Sperm cell	Egg cell
(d)	Nerve cell	Egg cell

41. Which of the following is unique to mitosis and not a part of meiosis? (01104050)
(a) Homologous chromosomes pair forming bivalents.
(b) Homologous chromosomes cross over
(c) chromosomes pairs are broken during anaphase
(d) chromatids separate during anaphase
42. The cell cycle describes: (01104051)
(a) how cells die
(b) how cells consume energy
(c) the life cycle of a cell
(d) cell movement
43. During which phase of the cell cycle does DNA replication occur? (01104052)
(a) G₁ (b) G₂
(c) S (d) metaphase
44. In which stage of mitosis do chromosomes align in the middle of the cell? (01104053)
(a) prophase (b) metaphase
(c) anaphase (d) telophase
45. Which cellular process is responsible for tissue repair? (01104054)
(a) meiosis (b) cytokinesis
(c) mitosis (d) replication



46. During cytokinesis, in animal cells, the cell membrane pinches inwards to form: (09/10/2021)

- (a) centrosomes (b) cell plate
(c) cleavage furrow (d) chromosomes

47. What type of cell division is responsible for sexual reproduction? (09/10/2021)

- (a) mitosis (b) meiosis
(c) binary fission (d) budding

48. How many phases are present in both meiosis I and meiosis II? (09/10/2021)

- (a) 2 (b) 3
(c) 4 (d) 5

Answer Key

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

Short Answer Questions (Exercise)

Q.1: Explain spindle apparatus in detail. (09/10/2021)

Ans. The two centrosomes give rise to microtubules by joining the tubulin proteins present in the cytoplasm. The microtubules thus formed are called spindle fibres and the complete set of the spindle fibres is known as mitotic spindle or spindle apparatus.

Q.2: What is the significance of crossing over? (09/10/2021)

Ans. Variations are the differences among the members of same species. They are necessary for the survival of species in always changing environment. It is because of meiosis that new combinations of genes appear in gametes and then in zygote. Crossing over and independently formed combinations of chromosomes in gametes are two important events of meiosis. Both crossing over and chromosomal combination provide basis of variations.

Q.3: Enlist the events taking place during G₁ phase. (09/10/2021)

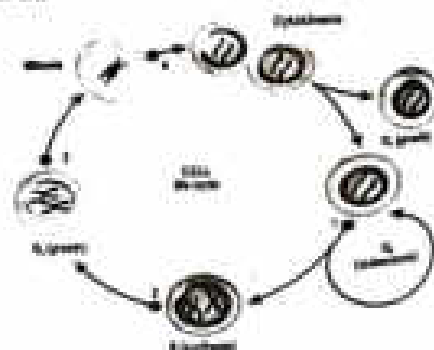
Ans. (i) This phase starts with the production of new cell.

(ii) Cell grows in size, increases the number of its organelles, forms needed proteins and other substances.

(iii) During this phase cell prepares itself for the next phase of cell cycle (S-phase).

(iv) It forms enzymes and nucleotides of DNA required for replication process.

Q.4: Cell cycle below shows the formation of two daughter cells, cell A and cell B. Cell A continues in the cell cycle while cell B exits in G₀.



What will be the difference in materials they synthesize after the production of cell A and cell B? (09/10/2021)

Ans. Cell A: Cell A will involve in growth of newly formed cell, replicates its genome and divides into two daughter cells, ultimately.

Cell B: Cell B will cease synthesizing materials required for cell division and may focus on synthesizing proteins and molecules necessary for its specialized functions and

activities. Cell B exit the cell cycle and enter in G₀.

Q.5: Why do epithelial cells of skin divide continuously? (09/10/2021)

Ans. Epithelial cells of skin divide continuously to replace old or damaged cells that are constantly shed from the surface of the skin, ensuring the maintenance of the skin barrier and promote wound healing.

Q.6: Give difference between meiosis I and meiosis II. (09/10/2021)

Ans.

	Meiosis - I	Meiosis - II
1	The number of cells is doubled but the number of chromosome is not.	It is like mitosis, the number of chromosomes does not get reduced.
2	Homologous chromosomes separate.	Sister chromatids separate.
3	Two haploid daughter cells produce.	Meiosis-II produces four haploid daughter cells.
4	Genetic recombination (crossing over) only occurs in meiosis - I.	No crossing over in meiosis - II.
5	Interphase before meiosis - I.	Resting phase between meiosis - I and II is called Interkinesis.

Q.7: In rapidly dividing cells which phase of cell cycle is reduced? Explain. (09/10/2021)

Ans. Cell cycle consists of two major phases i.e. interphase and mitotic phase (M phase). Most of the cell cycle is spent in interphase. In rapidly dividing cells interphase of cell cycle is reduced.

Q.8: What is the difference between cytokinesis of a plant cell and an animal cell? (09/10/2021)

Ans.

Cytokinesis in Animal Cells:

In animal cells this separation is achieved by pinching of the cell membrane in the middle forming a cleavage furrow.

(ii) **Cytokinesis in Plant Cells:** In plant cells, vesicles derived from Golgi apparatus move to the equator and fuse to form phragmoplast. Phragmoplast grows outward and fuse with the cell membrane and parental cell wall. The contents of the phragmoplast form middle lamella and primary walls of daughter cells. Later on same cells form secondary walls.

Q.9: Both skin cells and cancerous cells divide rapidly. Why cancerous cells are harmful but skin cells are not? (09/10/2021)

Ans. Skin cells are produced normally by mitosis while cancerous cells are harmful because they divide uncontrollably due to genetic mutations, that disrupt normal regulatory mechanism, leading to formation of tumors. In contrast, skin cells divide rapidly, but in controlled manner without causing harm.

Q.10: How haploid organisms produce gametes? (09/10/2021)

Ans. In haploid organisms (male honey bees) produce gametes by mitosis. In the honey bees, males (drones) develop from unfertilized eggs. The queen bee, though carrying male gametes from male has the ability to lay eggs that have not been fertilized. The sperms she receives from a drone bee are stored in a pouch closed off by a valve. The eggs may be fertilized or may not be fertilized from the stored sperms. The haploid egg develops into haploid offspring.



Q.11: Down's syndrome is due to extra copy of chromosome number 21. That is why down's syndrome people have 47 chromosomes. Why their chromosome number is high? medium

Ans. It is one of the consequences of autosomal non-disjunction in man, during

which 21st pair of chromosome fails to segregate, resulting in gamete with 24 chromosomes.

When this gamete, fertilises normal gamete the new individual will have 47 chromosomes.

Short Answer Questions (Additional)

Q.12:

(i) Can you distinguish between:

- Mitosis and meiosis.
- Chromatin and chromosome.
- Chromosome and chromatids.
- Centromeres and centrioles.
- Cytokinesis and karyokinesis.
- Centromeres and kinetochores.
- Haploid and diploid number of chromosomes.

Ans. (a) Mitosis and meiosis.

Mitosis	Meiosis
• It takes place in somatic cells.	• It takes place in germ line cells of sex organs.
• It consists of one division.	• It consists of two divisions.
• Crossing over does not take place during prophase.	• Crossing over takes place during prophase I.
• Centromere divides at metaphase.	• Centromere does not divide at metaphase I.
• Individual duplicated chromosomes align at the metaphase plate during metaphase.	• Paired homologous chromosomes align at metaphase plate during metaphase I.
• Daughter chromosome move to opposite poles during anaphase.	• Homologous chromosomes with two sister chromatids, separate and move to opposite poles during anaphase I.
• Two diploid daughter cells are formed.	• Four haploid daughter cells are formed.
• The daughter cells are genetically identical to each other and to the parent cell.	• The daughter cells are not genetically identical to each other and to the parent cell.
• The number of chromosomes remains constant.	• The number of chromosomes becomes half in meiosis.
• Mitotic products are usually capable of undergoing additional mitotic divisions.	• Meiotic products cannot undergo further divisions.

(ii) Chromatin and Chromosome

Chromatin	Chromosome
In the beginning of prophase, the chromosomes are not visible as they are in the form of fine thread like structures called chromatin.	During prophase, the chromatin begins to shorten, thicken and coil by a process called condensation. It results in the appearance of chromosomes.

(iii) Chromosome and Chromatids

Chromosome	Chromatids
The chromatin begins to shorten, thicken and coil by a process called condensation. It results in the appearance of chromosomes. It consists of two chromatids. Two chromatids of a chromosome is joined by centromere.	Unseparated replica of a chromosome is called chromatids.



(iv) Centromeres and Centrioles

Centromeres	Centrioles
The centromere is a constrictor in chromosome.	A pair of centrioles located near the anterior surface of the nucleus. It consist of triplet of microtubules arranged to form a hollow cylinder.

(v) Cytokinesis and Karyokinesis

Cytokinesis	Karyokinesis
The process of cytoplasmic division is called cytokinesis.	The process of nuclear division is called karyokinesis.

(vi) Centromeres and Kinetochores

Centromeres	Kinetochores
The centromere is a constrictor in chromosome.	Kinetochores are proteins that act as attachment site for spindle fibres.

(vii) Haploid and Diploid Number of Chromosomes

Diploid Number of Chromosomes	Haploid Number of Chromosomes
- Diploid means cells have full number of chromosomes e.g., - Somatic cells are diploid (2n) - Diploid number of chromosomes in man is 46.	- Haploid means cells having half number of chromosomes e.g., - Germ line cells are haploid (n) - The haploid number of chromosomes in man is 23.

Q.13: How does meiosis contribute to genetic recombination? medium

Ans. The chromosomes undergo crossing over during meiosis. The daughter cells i.e., gametes have genetic variations. When gametes fuse and form zygote. It is genetically different from both parents. Thus, meiosis provides variations in next generation.

Q.14: Differentiate between benign and malignant tumours, why does it occur? medium

Ans. I. Benign Tumours: Not all tumours are cancerous however, a benign tumour is an abnormal mass of essential normal cells. They always remain at their original site in the body.
II. Malignant Tumour: A malignant tumour is cancerous. It is capable of spreading into neighbouring tissues and often to other parts of the body.

Q.15: What is G₀ Phase? medium

Ans. Cells that have stopped dividing are in G₀ phase. In multicellular eukaryotes, cells enter G₀ phase from G₁.

Examples

- Some cells of liver and kidneys enter the G₀ phase temporarily.
- Neurons remain in G₀ phase for indefinite period.
- Other cells, such as epithelial cells do not enter G₀ phase.

Q.16: Describe G₂ Phase. medium

Ans. It is last sub-phase before cell division. In this phase increased protein synthesis occurs for the production of spindle fibres.

Q.17: What is M-Phase? medium

Ans. In this phase the cell is divided into two daughter cells. This phase is called mitosis.



SLO based Reference Material

Short Answer Questions

Q.18: (a) In the given figure, identify the phase and type of cell division. b) State the events taking place in this phase of cell division. (c) What is kinetochore? Write its role.



Ans. (a) The type of cell division in the given figure is "Mitosis" and the phase of mitosis shown in the figure is "Anaphase".
(b) i. In anaphase spindle fibres contract.
ii. Sister chromatid of each chromosome separate from each other and move to the opposite poles. Now they are called chromosomes. Finally, same number of

chromosomes as parent cell reach the respective poles.

(c) The kinetochore is a protein complex that plays a critical role in the attachment of spindle fibres to the centromere during cell division.

Q.19: What do you know about germ-line cells? Where are they produced?

Ans. In animals, cells that produce gametes are referred to as germ-line cells. They are produced in the testes of males and the ovaries of females of humans where meiosis occurs.

Q.20: Why are genetically unique cells produced at the end of meiosis?

Ans. Meiosis also differs from mitosis in that it involves a process known as recombination, during which chromosomes exchange segments with one another. As a result, the gametes produced during meiosis are genetically unique.

SLO based Reference Material

Long Answer Question

Q.1: Describe comparison between mitosis in animal cell and plant cell.

Ans.

Animal Cell	Plant Cell
• Centriole is present and divides into two during early prophase.	• Centriole is absent.
• Centriole and spindle fibres form mitotic apparatus.	• Only spindle fibres form mitotic apparatus.
• Cytokinesis occurs by pinching of the cell membrane in the middle forming a cleavage furrow.	• Cytokinesis occurs by the phragmoplast, which separates the two cells.
• Cell division occurs in all tissues of the body.	• Cell division occurs only in meristematic cells of plants.



UNIT 05

TISSUES, ORGANS AND ORGAN SYSTEMS

Q.1: Give an account of levels of biological organization.

Ans. Introduction

Cell organelles are the parts that make up a cell, like the nucleus, ribosomes and the mitochondria. Each individual organelle has a specific role to play, and when combined, multiple organelles will form a single cell.

Tissues

The cells in complex multicellular organisms like human beings are organized into tissues i.e., groups of similar cells that work together on a specific task.

Organs and Organ System

Organs are structures made up of two or more tissues organized to carry out a particular function, and groups of organs with related functions make up different organ systems.

Relation of Structure to Function

At each level of organization cells, tissues, organs, and organ systems—structure is closely related to function. For instance, the cells in the small intestine that absorb nutrients look very different from the muscle cells needed for body movement. The structure of the heart reflects its job of pumping blood throughout the body, while the structure of the lungs maximizes the efficiency with which they can exchange gases.

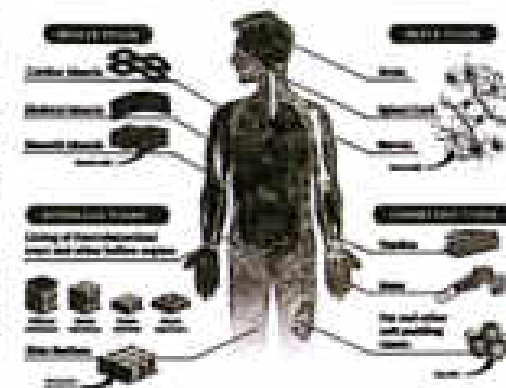


Fig. 5.1: Types of tissues in humans

The Levels of Organization and their explanation

Level of Organization	Explanation	Example
 Atomic Level	Atoms are defined as the smallest unit of an element that still maintains the property of that element.	Carbon, Hydrogen, Oxygen
 Molecular Level	Atoms combine to form molecules which can have entirely different properties than the atoms they contain.	Water, DNA, Carbohydrates
 Organelle Level	Monomers assemble in a specific way to form organelles. Organelles are sub-cellular structures.	Nucleus, ribosomes



 Cellular Level	Cells are the smallest unit of life. Cells are enclosed by a membrane or cell wall and in multicellular organisms often perform specific functions.	Muscle cell, Skin cell, Neuron
 Tissue Level	Tissues are groups of cells with similar functions.	Muscle, Epithelial, Connective
 Organ Level	Organs are two or more types of tissues that work together to complete a specific task.	Heart, Liver, Stomach
 Organ System Level	An organ system is a group of organs that perform related functions.	Digestive System, Circulatory System
 Organism Level	An organism has several organ systems that function together.	Human

Explanation

(1) Organs

Definition

Organs, such as the heart, the lungs, the stomach, the kidneys, the skin, and the liver, are made up of two or more types of tissues organized to serve a particular function.

Example

The heart pumps blood, the lungs bring in oxygen and eliminate carbon dioxide, and the skin provides a barrier to protect internal structures from the external environment.

Types of the Tissues in Organs

Most organs contain all four types of tissues. The layered walls of the stomach provide a good example of how tissues form an organ.

Epithelial Tissue

The inside of the stomach is lined by epithelial cells which secrete mucus, hydrochloric acid and pepsin enzyme.

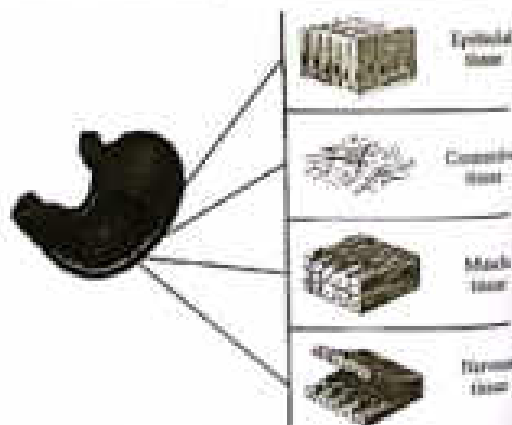


Fig. 5.3: Stomach as an organ



Connective Tissue

Around the epithelial layer are layers of connective tissue and smooth muscle, along with glands, blood vessels, and neurons.

- The smooth muscle contracts to move food through the gut.
- Connective tissues support the tissues of the mucosa and connect it to the muscular layer.
- The blood supply of the submucosa provides nutrients to the wall of the stomach.
- Nervous tissue in the submucosa controls smooth muscle contraction and secretion of digestive substances.

(2) Organ System

Definition

Organs are grouped into organ systems, in which they work together to carry out a particular function for the organism.

Examples

- The heart and the blood vessels make up the cardiovascular system. They work together to circulate the blood, bringing oxygen and nutrients to cells throughout the body and carrying away carbon dioxide and metabolic wastes.
- Respiratory system, brings oxygen into the body and gets rid of carbon dioxide. It includes the nose, mouth, pharynx, larynx, trachea, and lungs.

(3) Working of Organ Systems

Introduction

Just as the organs in an organ system work together to accomplish their task, the different organ systems also cooperate to keep the body running.

Example

The respiratory system and the circulatory system work closely together to deliver oxygen to cells and get rid of the carbon dioxide that these cells produce. The circulatory system picks up oxygen in the lungs and drops it off in the tissues, then performs the reverse function for carbon dioxide. The lungs expel the carbon dioxide and bring in new oxygen containing air. Only when both systems are working together can oxygen and carbon dioxide be successfully exchanged between cells and environment.



Fig. 5.2: Respiratory system

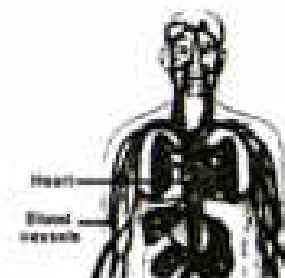


Fig. 5.4: Circulatory system

Q.2: How different organ systems of human work to maintain homeostasis?

01/01/2020

Ans. Homeostasis

Definition

The tendency to maintain a stable, relatively constant internal environment is called homeostasis. The body maintains homeostasis for many factors for example, temperature, the



concentration of various ions, pH and the concentration of glucose. If these values get too high or low, you can end up getting very sick.

Explanation

Homeostasis is maintained at many levels, not just the level of the whole body as it is for temperature. For instance, the stomach maintain a pH that's different from that of surrounding organs, and each individual cell maintains ion concentrations different from those of the surrounding tissue fluid. Maintaining homeostasis at each level is key to maintain the body's overall function.

(a) Maintaining Homeostasis

Biological systems like those of your body are constantly being pushed away from their balance points. For instance, when you exercise, your muscles increase heat production, pushing your body temperature upward. Similarly, when you drink a glass of fruit juice, your blood glucose goes up. Homeostasis is the ability of your body to detect and oppose these changes and work to maintain balance points.

(b) Homeostatic Responses in Temperature Regulation

(i) Introduction

If you get either too hot or too cold, sensors in the periphery and the brain tell the temperature regulation centre of your brain in a region called the hypothalamus that your temperature has strayed from its set point.

(ii) Example

For instance, if you've been exercising hard, your body temperature can rise above its set point, and you'll need to activate mechanisms that cool you down. Blood flow to your skin increases to speed up heat loss into your surroundings, and you might also start sweating so the evaporation of sweat from your skin can help you cool off. Heavy breathing can also increase heat loss.

(iii) Mechanism of Working

First, high temperature will be detected by sensors—primarily nerve cells with endings in your skin and brain—and relayed to a temperature-regulatory control centre in your brain. The control centre will process the information and activate effectors—such as the sweat glands—whose job is to oppose the stimulus by bringing body temperature down via sweating.

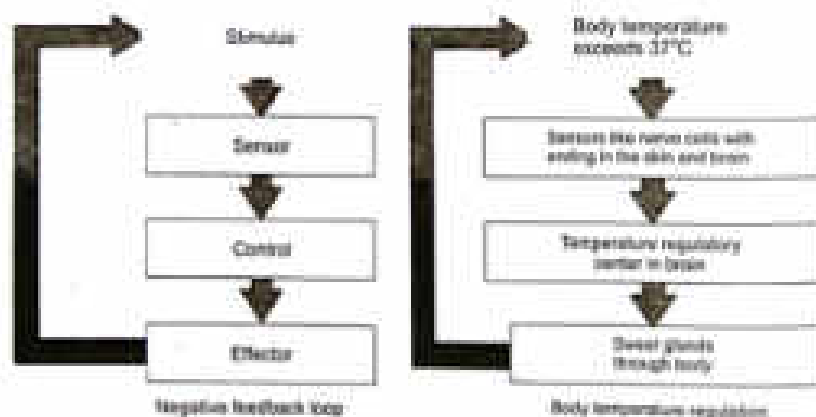


Fig. 5.5: Homeostatic response in temperature regulation



Q.3: Describe major organ systems of the human body and their role in homeostasis. ANSWER

Major organ systems of the human body and homeostasis			
Organ system	Function	Organs, tissues, and structures involved	Role in Homeostasis
Cardiovascular	Transports oxygen, nutrients, and other substances to the cells and transports wastes, carbon dioxide, and other substances away from the cells	Heart, blood, and blood vessels	Help stabilize levels of gases and wastes, body temperature and pH
Lymphatic	Defends against infection and disease and transfers lymph between tissues and the blood stream	Lymph, lymph nodes, and lymph vessels	Maintain tissue fluid homeostasis
Digestive	Processes foods and absorbs nutrients, minerals, vitamins, and water	Mouth, salivary glands, oesophagus, stomach, liver, gallbladder, exocrine pancreas, small intestine, and large intestine	Maintains levels of nutrients in blood
Endocrine	Provides communication within the body via hormones and directs long-term change in other organ systems to maintain homeostasis	Pituitary, pineal, thyroid, parathyroid, endocrine pancreas, adrenals, testes, and ovaries	Maintains balance of many blood components like glucose, water, calcium etc.
Integumentary	Provides protection from injury and fluid loss and provides physical defence against infection by microorganisms	Skin, hair, and nails	Involved in temperature regulation
Muscular	Provides movement and support	Skeletal, cardiac, and smooth muscles	Helps in temperature regulation by heat production
Nervous	Collects, transfers, and processes information and directs short-term change in other organ systems	Brain, spinal cord, nerves, and sensory organs—eyes, ears, tongue, skin, and nose	Maintains homeostasis by rapidly controlling body functions
Respiratory	Delivers air to sites where gas exchange can occur	Mouth, nose, pharynx, larynx, trachea, bronchi, lungs, and diaphragm	Controlling the balance of oxygen and carbon dioxide in the body
Skeletal	Supports and protects soft tissues of the body; provides movement at joints; produces blood cells; and stores	Bones, cartilage, joints, tendons, and ligaments	By regulating the level of calcium and other minerals in the blood (storing or



	minerals		releasing them from bones)
Urinary	Removes excess water, salts, and waste products from the blood and body and controls pH	Kidneys, ureters, urinary bladder, and urethra	By regulating levels of water, salts, H^+ and wastes in blood
Immune	Defends against microbial pathogens-disease-causing agents-and other diseases	Leukocytes, tonsils, adenoids, thymus, and spleen	By removing pathogens, fighting infections and helping in healing

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Q.4: Describe briefly about plant tissues.

Ans. Introduction

Plants are autotrophic multicellular eukaryotes with tissue systems. Plant tissues are composed of cells that are similar and perform a specific function. Different tissues combine to form organs. Each organ itself is also specific for a particular function together making up the tissue systems.

Types

Plant tissues differentiate into three main types:

- Dermal Tissues:** Dermal tissue (epidermal tissues) covers and protects the plant.
- Ground Tissues:** The ground tissue serves as a site for photosynthesis, provide support, and helps to store water and sugars.
- Vascular Tissues:** The vascular tissue transports water, minerals, and sugars to different parts of the plant.

Q.5: Describe plant organs and organ system. 08160804

Ans. Plant Organs

Plant tissues form organs (such as leaves, stems, or roots), each of which perform a specific set of functions. Leaves perform photosynthesis. Stems support the plant and transport substances.

Plant Organs System

Organs often work together to form organ systems.

Vascular plants have two distinct organ systems: a shoot system, and a root system.

The Shoot System

The shoot system consists of two portions: the vegetative (non-reproductive) parts of the plant, such as the leaves and the stems, and the reproductive parts of the plant, which include flowers and fruits. The shoot system generally grows above ground, where it absorbs the light needed for photosynthesis.

The Root System

The root system, which is usually underground anchors the plant into the ground, absorbs water and minerals, and serves as a storage site for food.

Q.6: Justify how the cells of leaf have a variety of specialized structure and function?

Ans. Introduction

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Leaves are thin, flat organs responsible for photosynthesis in the plants. It develops laterally at the node. It is an important part of the shoot system as it performs photosynthesis and transpiration

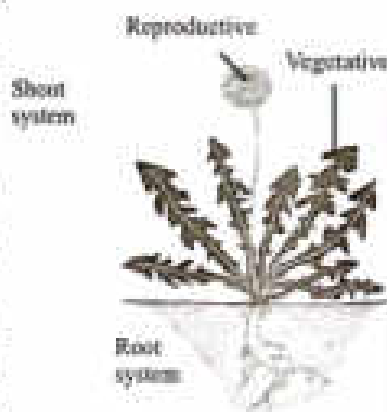


Fig. 3.6: Plant organ systems



Leaf cells need water, carbon dioxide and light for photosynthesis and oxygen for respiration. Leaves transfer the synthesized food to other parts of the plant. So, there are varieties of functions and accordingly there are varieties of cells, in the leaf. Each type of cell performs a special function.

Structure

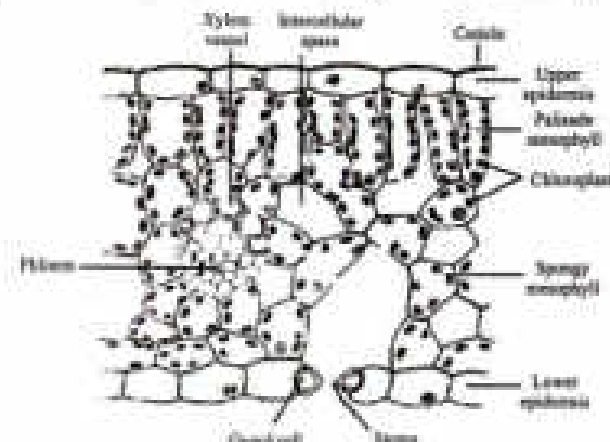


Fig. 3.7: Transverse section of a leaf

(i) Epidermis

Epidermis is the outermost layer. It is a single layer of cells, covering the leaf surface. It is of two types, upper epidermis and lower epidermis.

(ii) Cutin

A waxy substance called cutin, which forms the cuticle, covers the upper epidermis. The function of the epidermis is to protect the tissues and to prevent loss of water.

(iii) Stomata and Guard Cells

On the lower epidermis tiny pores are present called stomata. Each stoma is enclosed by two guard cells, having chloroplasts. The guard cells control the opening and closing of stoma. Exchange of oxygen and carbon dioxide with the environment and evaporation of water vapour takes place through stomata.

(iv) Mesophyll

Definition

Between the two-epidermal layers lies the group of cells called mesophyll.

Types of Mesophyll

There are two types i.e., palisade mesophyll and the spongy mesophyll.

(a) Palisade Mesophyll: The palisade mesophyll consists of two or three layers of cylindrical cells. These cells contain many chloroplasts.

(b) Spongy Mesophyll: The spongy mesophyll consists of loosely arranged irregular shaped cells having chloroplast. Large intercellular spaces are present among these cells. This arrangement facilitates diffusion of gases.

(v) Xylem Vessels

Xylem vessels present in the leaves are long and dead cells. Through xylem cells transportation of water from root to leaves takes place.

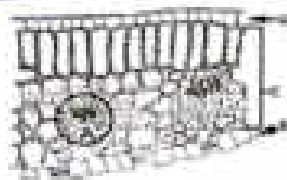


(vi) Phloem Cells

The phloem cells carry the prepared food from the leaf to other parts of the plant.

Multiple Choice Questions (Exercise)

1. The diagram shows cells in part of the leaf of a green plant. Which region contains cells which are responsible for the process of transport?



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2. The table shows three functions of cells which row is correct?

	Absorption	Support	Transport
(a)	Red blood cell	Muscle cells	Root hair cell
(b)	Root hair cell	Xylem vessel	Red blood cell
(c)	Muscle cell	Red blood cell	Xylem vessel
(d)	Xylem vessel	Root hair cell	Muscle cell

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3. What are the functions of xylem and phloem in green plants?

	Xylem	Phloem
(a)	Support and transport of sugars	Transport of water
(b)	Transport of sugars	Support and transport of water
(c)	Support and transport of water	Transport of sugars
(d)	Transport of water	Support and transport of sugars

4. If tissue level is not developed in the level of organization, which next level will not form?

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- (a) Molecular level
(b) atomic level
(c) organ level
(d) organelle level

5. Following diagram shows level of organization in a rat. Which row is the organ level?

09160004



6. Which of the following lists the levels of body organization from smallest to largest?

09160004

- (a) Organism, organ system, organ, tissue, cell
(b) tissue, cell, organ, organ system, organism
(c) organ, organ system, organism, tissue, cell
(d) cell, tissue, organ, organ system, organism

7. This statement about homeostasis is incorrect:

09160004

- (a) because of this, the fluctuations of the internal environment are of extremely narrow range as compared to that of the external environment
(b) There is one system regulating the homeostatic activities
(c) homeostatic mechanisms keep the internal environment constant despite wide changes in the external environment
(d) homeostasis is necessary for the survival of cells.

8. Which of the following statements best describes homeostasis?

09160004

- (a) keeping the body in a fixed and unaltered state.
(b) dynamic equilibrium
(c) maintaining a near-constant internal environment
(d) altering the external environment to accommodate the body's needs.

9. Organisms have the ability to change and modify their internal conditions according to the environment through:

09160004

- (a) osmoregulation
(b) excretion
(c) thermoregulation
(d) all of the above

10. You can observe spongy mesophyll and xylem in the section of leaf. These are part of the same:

09160004

- (a) cell and organism
(b) organ and organism
(c) cell and tissue
(d) tissue and organ

11. The diagram shows a sample of material taken from an organism.



Multiple Choice Questions (Additional)

16. Biological organization means:

09160004

- (a) study of different organisms
(b) study of different branches of biology
(c) study of all the subjects of science
(d) study of biology at different levels.

17. The level of organization which is represented by the heart of frog is:

09160004

- (a) organ
(b) tissue
(c) organism
(d) organelle

18. What is the primary function of the root system in plants?

09160004

- (a) photosynthesis
(b) gas exchange
(c) absorbing water
(d) reproduction

- Which level of organization does the sample show?

09160004

- (a) cell
(b) organ
(c) organ system
(d) tissue

12. Which structure is not an organ?

09160004

- (a) artery
(b) flower
(c) spinal cord
(d) xylem

13. Which description of xylem is correct?

09160004

- (a) a cell used for absorption
(b) an organ system used for conduction
(c) a tissue used for transport
(d) an organ used for transport

14. Which structure is at a different level of organization from the other three?

09160004

- (a) kidney
(b) liver
(c) neuron
(d) lung

15. The diagram shows tissues from section of leaf. Which type of cells will perform photosynthesis?

09160004



- (a) 1 and 4

- (b) 2 and 5

- (c) 2 and 3

- (d) 3 and 6



22. Which tissue transports water in plants?

- (a) xylem (b) Phloem
(c) Epidermal (d) Mesophyll

23. What is the main function of the nervous system?

- (a) Digesting food
(b) circulating blood
(c) controlling and coordinating

(d) plastids

24. What is homeostasis?

- (a) A type of hormone
(b) Digestive process
(c) the body's way of maintaining a stable internal environment
(d) A respiratory function

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Answer Key

1.	(a)	2.	(b)	3.	(c)	4.	(c)	5.	(c)
6.	(d)	7.	(b)	8.	(c)	9.	(d)	10.	(c)
11.	(a)	12.	(d)	13.	(c)	14.	(c)	15.	(b)
16.	(d)	17.	(a)	18.	(c)	19.	(c)	20.	(b)
21.	(c)	22.	(a)	23.	(c)	24.	(c)		

Short Answer Questions (Exercise)

Q.1: Can you differentiate between

- (a) Organ and organelle (b) Animal and plant tissues
(c) Xylem and phloem (d) Epithelial and muscular tissue
(e) Nervous and connective tissue (f) Epidermal and ground tissue
(g) Root and shoot system (h) Vegetative and reproductive part

Ans. (a) Organ and organelle

Organ: Organs are two or more types of tissues that work together to complete a specific task.

Example: Heart, liver, stomach.

Organelle: Biomolecules assemble in a specific way to form organelle. Organelles are subcellular structures.

Example: nucleus, ribosomes.

(b) Animal and Plant tissues

Animal Tissues	Plant Tissues
Tissue organization towards mobility of animals.	Tissue organization is targeted toward stationary habit of plants.
Organization is complex.	Organization is simple.
Most of the tissues are living.	Many of the tissues are dead. For example, cork.
Growth is not limited to areas.	Growth is confined to certain areas.
More maintenance energy required.	Less maintenance energy required.
After reaching maturity stage animals do not show further growth.	Plant grow continuously throughout life.

(c) Xylem and Phloem

Xylem	Phloem
Xylem is responsible for conduction of water and mineral salts and to provide support and strength.	Phloem conducts prepared food from leaves to stem and roots.
Xylem consists of tracheids and vessel elements.	Phloem consists of sieve tube elements and companion cells.



(d) Epithelial and Muscular Tissues

Epithelial Tissues	Muscular Tissues
Epithelial tissue is also called epithelium. It consists of tightly packed cells that form a continuous layer or sheet covering the entire body surface and lining most of the inner cavities.	Muscular tissue is composed of bundles of long cells called muscle fibres. These fibres are contractile, held together by connective tissue.
The cells in this type of tissue are very closely packed together.	Muscle fibres contain actin filaments and myosin filaments. The filaments cause the movement of the body and body parts.
This tissue has many types on the basis of the shape of cells as well as the number of cell layers. (a) squamous epithelium (b) cuboidal epithelium (c) columnar epithelium (d) ciliated columnar epithelium (e) stratified squamous epithelium	All the vertebrates have three types of muscular tissue: (a) skeletal muscle (b) smooth muscle (c) cardiac muscles

(e) Nervous and Connective tissues

Nervous tissues	Connective tissues
This tissue is mainly composed of nerve cells or neurons which are specialized to conduct messages in the form of nerve impulses.	As the name shows connective tissues serves a "connecting function".
They are found in nerves, spinal cord and brain.	They are found around the ends of bones, in external ear, nose, trachea etc. i.e. cartilage and around kidneys, under skin, in abdomen etc. i.e. adipose tissue.
They are responsible for communication among body parts.	It supports and binds other tissues. Unlike epithelial tissue, connective tissue has cells scattered throughout an extra cellular matrix.

(f) Epidermal and Ground tissues

Epidermal tissues	Ground tissues
Epidermal tissues are composed of a single layer of cells and they cover plant body.	They are simple tissues made up of parenchyma cells and are spherical in shape.
On stems and leaves, they secrete cutin which prevents evaporation.	In the leaves, they have sites of photosynthesis and in other parts, they are the sites for respiration and protein synthesis.
Epidermal tissues also have some specialized cells that perform specific functions. For example (i) root hairs (ii) stomata	Most parenchyma cells have ability to divide and differentiate into other types of cells and they do so during repairing an injury.
They act as a barrier between the internal plant tissues and the environment.	They have thin primary cell walls and have large vacuoles for storage of food.

(g) Root and Shoot system

Shoot system	Root system
The shoot system consists of two portions: the vegetative (non-reproductive) parts of the plant, such as the leaves and the stems, and the reproductive parts of the plant, which include	The root system, which is usually underground anchors the plant into the ground, absorbs water and minerals, and serves as a storage site for food.



flowers and fruits. The shoot system generally grows above ground, where it absorbs the light needed for photosynthesis.

(b) Vegetative and Reproductive Parts

Vegetative Parts	Reproductive Parts
It includes roots, stems, branches and leaves.	It includes flowers which produce fruits and seeds.
These do not take part in sexual reproduction.	They take part in sexual reproduction.

Q.2: How different tissues form stomach? (01/04/2017)

Ans. (i) Stomach is an organ specialized for the digestion of proteins and storing food.

(ii) Stomach has:

(a) Epithelial (glandular) tissues which secrete the gastric juice.

(b) Muscular tissues which perform contractions of stomach walls for grinding of food, mixing enzyme with food and moving food to posterior end.

Q.3: Why respiratory and cardiovascular systems work together? (01/04/2017)

Ans. Working of Organ system

(a) The respiratory system and the circulatory system work closely together to deliver oxygen to cells and get rid of the carbon dioxide that these cells produce. The circulatory system picks up oxygen in the lungs and drops it off in

the tissues, then performs the reverse function for carbon dioxide. The lungs expel the carbon dioxide and bring in new oxygen containing air. Only when both systems are working together can oxygen and carbon dioxide be successfully exchanged between cells and environment.

Q.4: How temperature is regulated in our body? (01/04/2017)

Ans. First, high temperature will be detected by sensors—primarily nerve cells with endings in your skin and brain and relayed to a temperature-regulatory control centre in your brain. The control centre will process the information and activate effectors—such as the sweat glands—whose job it is to oppose the stimulus by bringing body temperature down.

Short Answer Questions (Additional)

Q.5: Following are the example of different levels of organization. Sort them in tabular form according to levels of organization. (01/04/2017)

Root system, Neuron, Protein, Nitrogen, Cat, Epidermis, Brain, Carbon dioxide, Zinc, Cilia, Rose plant, Xylem, Leaf, Guard cell.

Ans.

Level of organization	Examples
Atomic level	Zinc, nitrogen
Molecular level	Carbon dioxide, protein
Organelle level	Cilia
Cellular level	Neuron, Guard cell
Tissue level	Xylem, epidermis
Organ level	Brain, leaf
Organ system level	Root system
Organism level	Rose plant, cat

Q.6: Enlist the levels higher than the organism level. (01/04/2017)

Ans. Following are the levels higher than the organism level.

(i) Population level: The group of similar individuals in an area is called a population.

(ii) Community level: Two or more populations of different organisms living together make a community.

(iii) Ecosystem: The community and the non-living components of an area make an ecosystem.

(iv) Biosphere: All the ecosystems of the planet earth are collectively called the biosphere.

Q.7: What is organ system? Give examples. (01/04/2017)

Ans. In higher multicellular organisms, particularly in animals, different organs performing related functions are organized together in the form of an organ system. For example, digestive system carries out process of digestion. It consists of oral cavity, stomach, small intestine, large intestine, liver and pancreas.

SLO based Reference Material

(Short Answer Questions)

Q.11: What do you know about homeostasis? Enlist its advantages. (01/04/2017)

Ans. Homeostasis, derived from Greek words meaning "similar" and "steady" is the process by which living organisms maintain a stable internal environment despite changes in the external surroundings. Homeostasis helps to maintain three main components of the body:

(i) Water and salt concentration

(ii) Temperature

(iii) Nitrogenous waste.

Q.12: What are parenchyma cells? Give examples. (01/04/2017)

Ans. The cells of ground tissue are called parenchyma cells. In a leaf, mesophyll cells are a special version of parenchyma cells that have adapted over time for their specific role within the leaf structure.

Q.13: How would you differentiate between palisade and spongy mesophyll? (01/04/2017)

Ans. Mesophyll Tissue

The tissue that lies below the epidermis is known as mesophyll tissue. It is a

Q.8: Define organelles with examples. (01/04/2017)

Ans. An enormous number of biomolecules become associated in a particular way and form organelles. The organelles are actually sub-cellular structures, e.g. mitochondria, ribosomes etc.

Q.9: What is tissue level? Give one example. (01/04/2017)

Ans. A group of similar or different types of cells performing same function e.g. xylem and phloem in plants, are composed of different cells while nervous tissues are composed of same type of cells.

Q.10: Write down the chemical composition and function of gastric juice. (01/04/2017)

Ans. Gastric juice consist up of mucus, hydrochloric acid, and pepsin enzyme that help in digestion of food.

specialized type of ground tissue found within the leaves of plants. This tissue is organized into two regions:

Palisade Mesophyll

Palisade mesophyll is composed of tightly packed columnar cells organized in one or more layers and is abundantly rich in chloroplasts. These cells carry out most of the leaf's photosynthesis, the conversion of sunlight into chemical energy in the form of glucose.

Spongy Mesophyll

Spongy mesophyll is situated beneath the palisade mesophyll. It contains loosely arranged, irregular-shaped cells with air spaces between them. These air spaces allow carbon dioxide to diffuse more efficiently into the mesophyll cells and enable the quick removal of oxygen from these cells, thereby facilitating gaseous exchange. Although spongy mesophyll cells also contain chloroplasts and contribute to photosynthesis, their primary function is to

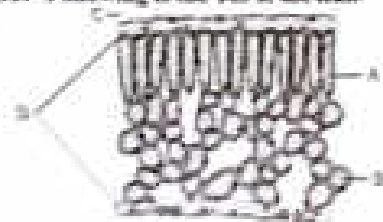


support the exchange of gases necessary for photosynthesis and respiration within the leaf.

Q.14: A cell works as an open system. Comment on it.

Ans. A cell works as an open system i.e. it takes in substances needed for its metabolic activities through its cell membrane. It takes up food, oxygen, water and salts for survival, growth and division, and energy for metabolic processes. Products and by-products are formed in metabolism. Cell either utilizes the products or transports them to other cells. The by-products are either stored or are excreted out of cell.

Q.15: Following is the T.S of the leaf.



SLO Based Reference Material

Long Answer Questions

Q.1: Describe the contribution of various cells for the healthy functioning of human body.

Ans. (i) The nerve tissues carry messages to different parts of the body. Due to these nerves there is a coordination among different parts of the body.

(ii) The muscular tissues perform vital roles in human body. Smooth muscles form the contractile portion of the walls of digestive tract, urinary bladder and blood vessels. These are responsible for the movement of those material which are present in these muscular organs. The striped muscles form flesh of the body. These muscles are also attached with the skeleton so responsible for the movements of human body like walking, running and jumping etc. The cardiac muscles form the walls of heart. The heart beat is due to these muscles.

(iii) Blood is the liquid connective tissue. The blood cells perform many important functions in human body. WBC's are called police force of body because they destroy germs and protect the body from diseases. They also remove damaged and decaying cells from the place of cut. They also cause dilation of blood vessels and prevent blood clotting. The function of blood platelets is clotting of blood when blood vessels are injured. The RBCs carry oxygen to all parts of the body.

(iv) Skin performs many important functions in human body. It helps to maintain the body temperature. Skin produces vitamin 'D' when sun shines on it early in the morning. It protects the body from outer effects. The skin is also an organ of sensation e.g. heat, cold, touch, pain etc.

(v) Bones are hard structures which are made up of connective tissues. Bones perform three important functions in human body.

(a) They give support to soft part of the body.

(i) Where the process of photosynthesis takes place?

(ii) What is needed by leaf for photosynthesis?

(iii) Where the guard cells of leaf are located? What is its function?

Ans. (i) The process of photosynthesis takes place at A (palisade mesophyll) and B (spongy mesophyll).

(ii) Leaf needs water and CO_2 to prepare food during photosynthesis in the presence of sunlight and chlorophyll.

(iii) Guard cells are present in the lower epidermis of leaf. They help in transpiration and exchange of gases.



(b) Without bones the human will become a heap of flesh. Bones are responsible for the movement of human beings.

(c) Bones also protect many organs e.g. Skull protects the brain.

Q.2: What are emergent properties in biology? How do emergent properties manifest when going from organelles to cells?

Ans. Emergent properties in biology refer to new abilities or functions that arise when moving from simpler to more complex levels of biological organization. These properties are not predictable or explainable in the simpler levels but become apparent as these levels combine and interact to form complex levels. Emergent properties can be seen as a gain in functionalities at different levels of biological organization, such as:

Sub-cellular Organelles

Like the mitochondria and ribosomes perform specific functions within a cell. Each organelle has its own properties and functions, but it cannot survive or function independently, an emergent property present in a cell but not in its individual organelle.

Take muscle cells, for example, where the collaborative actions of different organelles enable the cell to contract. Mitochondria, essential for energy production, provide the necessary power for this process. Ribosomes are tasked with creating specific proteins that are crucial for contraction. Moreover, the endoplasmic reticulum plays a primary role in managing calcium storage and release, a critical element required to contract muscle fibers. Through the combined functions of these organelles, muscle cells are equipped to perform the complex task of contraction, illustrating how the cell operates as the basic unit of life with emergent properties that arise from the collective operation of its sub-cellular structures.

This idea of working together goes beyond just cells. It includes how groups of cells come together to make tissues that have a common role. While each cell has its own function, it cannot do the tissue's job by itself. For example, while muscle cells can contract on their own, when they are part of muscle tissue, like in the esophagus, they work in a coordinated way to create wave-like contractions called peristalsis. This movement is crucial for pushing food from the esophagus to the stomach.

This shows emergent properties at work again, where the collective action of cells in tissue achieves something that individual cells cannot, further illustrating the incredible complexity and collaboration in biological systems.



UNIT 06

MOLECULAR BIOLOGY

Q.1: What is biochemistry? How can we differentiate molecular biology from it? (05/10/2022)

Ans. Biochemistry

Definition

Biochemistry is the study of different chemical compounds and the chemical processes taking place within the living organisms.

Important Role of Biochemistry

Biochemistry is related to both biology and chemistry. Therefore, biochemistry solves the problems faced by living organisms by using the knowledge and techniques of chemistry.

Molecular Biology

Sometimes biochemistry and molecular biology are taken as same but molecular biology is the specialized branch of biochemistry that is mainly concern with the interaction of bio-molecules within the cells and biochemical processes like DNA replication, transcription and translation.

Importance of Biochemistry

(i) Study of biochemistry is greatly helpful to explore the cell biology and anatomy as all the structures of the living organisms (cells, tissues and organs etc.) have specific biochemical organization.

(ii) Similarly, knowledge of biochemistry is essential to study the physiology of organism because life processes such as photosynthesis, respiration, digestion, inheritance, are explained in biochemical terms.

Q.2: What are bioelements? Write about its types. (01/10/2022)

Ans. Bioelements

Bodies of living organisms are composed of protoplasm, which is made of certain elements called bioelements. Out of 92 naturally occurring elements of earth, 16 of these are bioelements.

Classification of Bioelements

On the basis of their proportions in the living organisms, bioelements are further classified into major and minor bioelements.

(i) **Major Bioelements**

Definition

Six most common bioelements constitute 99% of protoplasm so called major bioelements.

Examples

Oxygen, Carbon, Hydrogen, Nitrogen, Calcium and Phosphorus.

(ii) **Minor Bioelements**

Remaining ten bioelements constitute only 1% of the biomolecules so called minor bioelements.

Examples

Potassium, Sulphur, Chlorine, Sodium, Magnesium, Iron, Copper, Manganese, Zinc and Iodine. The proportions of these bioelements are given in the fig. 6.1.

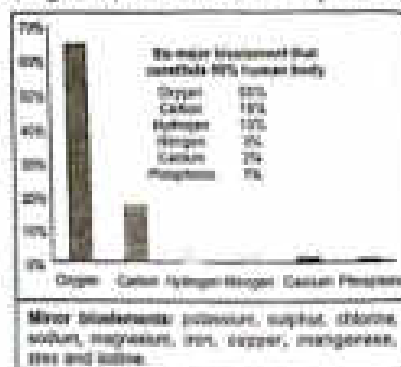


Fig. 6.1: Proportions of bioelements in human body



Q.3: Define biological molecules. Explain in detail major organic biomolecules, their location in the cell and roles. (09/10/2022)

Ans. Definition

Molecules produced and utilized in the metabolic processes within the living organisms are called biological molecules.

Importance

Bio-molecules are the building blocks of life and perform important functions in living organisms like growth, development, energy production, reproduction. Different bioelements combine with each other to form biomolecules.

Nature: Biomolecules may be inorganic (water and salts) and organic (carbohydrates, lipids, proteins and nucleic acids).

Complex Organic Molecules

Complex organic biomolecules are polymers of their building blocks called monomers. Major organic biomolecules, their locations inside the cell and main roles are given in table

Biomolecules, their location in the cell and roles		
Biomolecules	Location in cell	Main roles
Carbohydrates e.g. Glucose, lactose, starch	Cell wall, cell membrane, smooth endoplasmic reticulum, Golgi bodies	Used as food, energy source, components of plant and fungi cell walls, cell surface markers, component of DNA and RNA as 5-carbon sugar
Proteins e.g. Haemoglobin, actin, myosin, hormones, enzymes, antibodies	Cytoplasm, Rough Endoplasmic reticulum, Golgi bodies.	Energy source, components of cell membrane, gaseous transport, chemical messengers, speed up chemical reactions, immunity, component of chromosomes
Lipids e.g. Fats, Phospholipids, waxes, oils, vitamin D	Cell membrane, smooth endoplasmic reticulum	Provide cells with long-term energy, component of cell membranes.
DNA	Nucleus (Chromosomes)	Component of chromosomes store and pass on genetic information
RNA (mRNA, tRNA, rRNA)	Nucleolus, cytoplasm	Tools for translation, protein synthesis.

Q.4: What are proteins? Describe their chemical composition, structure, sources and importance. (01/10/2022)

Ans. Introduction

Proteins are main structural and functional components of the cell which make up around 35% of the dry weight of cell. They are present in all types of cells and contribute in the variety of cell functioning. Proteins are synthesized in the cells by ribosomes.

Chemical Composition of Proteins

Proteins molecules mainly composed of C, H, O, N and sometimes P, S, Fe etc. Chemically proteins are polypeptide chains which are polymers of amino acids.

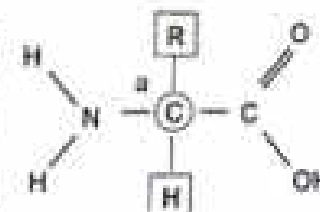


Fig. 4.2: General structure of an amino acid



Building Blocks / Monomers of Protein

Amino acids are the building blocks or monomers of proteins. There are about 20-25 different types of amino acids commonly found in proteins. Each amino acid contains a central carbon atom called α (alpha) carbon. Four different groups are attached to α -carbon, including a hydrogen atom (-H), an amino group ($-\text{NH}_2$), a carboxyl group ($-\text{COOH}$) and an alkyl group labelled as -R. Each amino acid has a different R group which determines its chemical properties.

Structure of Protein

- Structure of protein may consist of a single polypeptide or more than one polypeptides.
- Number of amino acids and polypeptide chain varies in different proteins.
- Bond between two amino acids is called peptide bond as shown in figure 6.3.
- The structure of proteins is classified as primary, secondary, tertiary and in some case quaternary.

(v) These structures are based on the level of complexity of the folding of a polypeptide chain.

(vi) A linear polypeptide with a specific number, type and sequence of amino acids is called primary structure.

(vii) After synthesis a protein does not remain in its primary structure. Polypeptide folds upon itself due to additional bonds to form some higher structural level (secondary, tertiary or quaternary) to perform its specific role. Shape of the protein (fitness or globular) also depends upon the structural level in the protein.

Importance

- Proteins are very important molecules in our cells.
- Each protein within the body has a specific function.
- They are involved in the formation of many structures of body.
- They play many important roles with in body.

Energy Value

One gram of protein has 4 kcal of energy. A list of important proteins and their roles is given in table.

Examples and Functions of Proteins	
Examples	Functions
Cell membrane protein	Many proteins in plasma act as channel and carrier proteins. Some proteins at the surface of cell act as antigen.
Enzymes	Most of the enzymes are protein which control biochemical reactions.
Hormones	Protein hormones act as chemical messengers and regulate different functions in body e.g. growth, reproduction, digestion, glucose level etc.
Antibodies	Antibody proteins produced by WBCs provide immunity against germs.
Haemoglobin	RBCs have red pigment haemoglobin protein that is involved in the



Fig. 6.3: Polypeptide chain and peptide bond



Fig. 6.4: Structure of Protein



	transport of oxygen and carbon dioxide in the body via blood.
Fibrinogen	Blood plasma contains a blood clotting protein to stop bleeding at injuries.
Actin and Myosin	These proteins are present in muscle cells. These are involved in contraction and relaxation of muscles during movement.
Collagen	It is major component in structure of skin, bones, cartilage, muscles, tendons and ligaments. It provides support and strength.
Keratin	It is the component of hair, nails, feathers, horns and beaks to make them hard and protective.
Histone	It is attached to DNA to form chromosome.

Sources of Proteins

(i) Proteins may be obtained from plants, fungi and animals.

(ii) Plant seeds are most common source of proteins like beans, lentils, peas, nuts.

(iii) Animal products are sources of high protein contents e.g. milk, beef, mutton, poultry meat, egg, fish, sea food.

(iv) Some proteins are obtained from mushrooms.



Fig. 6.5: Sources of proteins

Q.5: What are lipids? Describe their chemical composition, structure, role and sources.

Ans. Introduction

A group of different types of organic compounds which are all hydrophobic in nature, collectively called lipids. Hence, lipids are a heterogeneous group of organic compounds which are insoluble in water but soluble in organic solvent such as alcohol, ether etc. Lipids are non-polar compounds.

Lipids in Living Organisms

Lipids found in living organisms include fats, oils, waxes and steroids.

Chemical Composition

Molecules of lipids are composed of C, H and O like carbohydrates.

Energy Value

One gram of lipids contain double amount of energy than carbohydrates because they have relatively more carbon-hydrogen ratio than carbohydrates.

Structure of Lipids

Lipids which are mainly made up of fatty acids and glycerol (an Alcohol) are called Acyl glycerides.

Types of Lipids

Fatty acids may be saturated or unsaturated.

(i) **Saturated Fatty Acids**

Saturated fatty acids have all C-C single bonds and are solid at room temperature e.g. cheese,

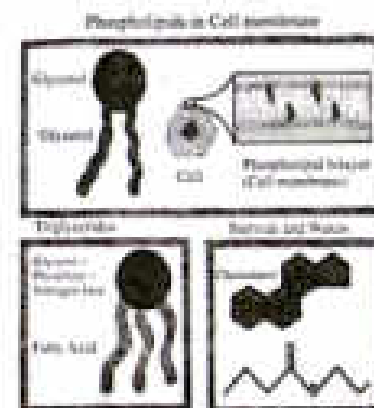


Fig. 6.6: Structure of different types of lipids



butter, ghee etc.

(ii) **Unsaturated Fatty Acids**

Unsaturated fatty acids have double or triple C-C bonds and are liquid at room temperature e.g. soybean oil, mustard oil, olive oil etc.

(iii) **Types of Acyl Glycerides**

Most common types of acyl glycerides are tri-acyl glycerides which contains one glycerol and three fatty acids.



(iv) **Complex Lipids**

Some lipids are even more complex and have phosphate, nitrogen base along with glycerol and fatty acids e.g. phospholipids and waxes.

(v) **Steroids**

Some lipids may not have fatty acids in their formula rather they have three ring structure called steroids e.g. cholesterol, vitamin D.

Functions of Lipids

Lipids are very useful biological molecules and have many important roles in cells and as a whole in bodies of living organisms.

1. Phospholipids and cholesterol are components of plasma membrane structure.

2. Lipids act as energy stores in fat cells, liver and in blood. One gram of lipids provides 9.1 kcal of energy which is double than carbohydrates or proteins.

3. Many lipids act as important steroid hormones e.g. testosterone, Aldosterone etc.

4. Some lipids act as insulators against atmospheric heat and cold.

5. Waxes are used by insects for constructing their hives.

6. Waxy cuticle of leaves act as protective and waterproof layer to avoid water loss.

7. Some vitamins are lipid in nature e.g. vitamin A, D, E and K. Vitamin D is derived from cholesterol.

Sources of Lipids

(i) Variety of foods are rich sources of lipids.

(ii) Foods containing large amounts of saturated fat include red meat, butter, cheese, ghee, fish liver oil etc.

(iii) Some oils are obtained from plant seeds like sunflower oil, soybean oil, peanut oil, coconut and palm oil are also rich in unsaturated fats.

(iv) Wax is obtained from comb of many insects.

Q.6: What are carbohydrates? Describe their structure, sources and functions.

Ans. **Introduction**

Carbohydrates are the important biological molecules present in all parts of cell. Carbohydrates are also called as sugars or saccharides due to their sweet taste. Word saccharide is derived from Greek word "Sakcharon" meaning sugar.



Fig. 6.7: Sources of lipids



Most Common Carbohydrates

Most common and simple carbohydrate, glucose is naturally produced in the green plants by the process of photosynthesis using CO_2 from air and H_2O from soil.



Energy Value

Plants use sunlight energy for food synthesis. This energy is stored as chemical energy in the bonds of glucose molecules and 4 kcal per gram of energy is released when glucose is broken down in the cell. Plants use glucose molecules to form complex molecules like starch and cellulose.

Structure of Carbohydrates

Carbohydrates are the compounds of carbon, hydrogen and oxygen with a ratio of 1:2:1 respectively. Literal meaning of word carbohydrate is "hydrates of carbon". This name is given because number of carbon atoms are equal to the number of water molecules in the chemical formula of carbohydrates.

Thus, generalized formula of carbohydrates is $\text{C}_x(\text{H}_2\text{O})_y$, where X is number of carbon atoms and Y is number of water molecules. For example, formula of most common sugar glucose is $\text{C}_6(\text{H}_2\text{O})_6$ or $\text{C}_6\text{H}_{12}\text{O}_6$.

Functions of Carbohydrates

Carbohydrates play following structural and functional roles in living organisms.

1. Carbohydrates are major source of usable and stored energy in the cells of living organisms.

2. Carbohydrates are structural material for cell wall of Plants (cellulose), Fungi (chitin) and Bacteria (Peptidoglycan).

3. Cellulose present in the cell wall of plant fruit, vegetables, bran and whole grains is not digestible hence act as fiber or roughage in the human diet. It helps in the movement of food efficiently through the digestive tract and effective in avoiding constipation.

4. Cellulose fiber absorbs away toxic chemicals which might be present in food. It is used in paper industry. It also helps in lowering blood cholesterol and regulates blood pressure.

5. Sucrose is used as common table sugar and used as natural sweetener.

6. Extra glucose in plants is stored as starch in their root, stem, fruits or seeds used as animal and human food.

7. Extra blood glucose is stored in animal muscles and liver cells as glycogen which serves as energy bank. It can be converted back to glucose when needed for energy.

8. Chitin makes exoskeleton of arthropods.

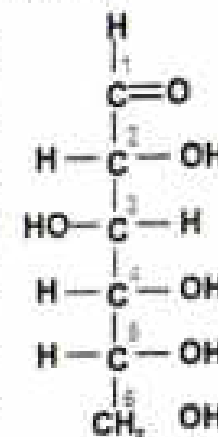


Fig. 6.8: Structure of Glucose



Sources of Carbohydrates: Carbohydrates are the most abundant class of organic biomolecules. They have various sources.

1. Monosaccharides such as glucose, fructose and galactose are obtained from fruits, vegetables and cereals. They are also present in honey.
2. Disaccharide such as sucrose is obtained in sugarcane, sugar beet and fruits. Maltose is found in cereals. Lactose is milk sugar and found in dairy products.
3. Cellulose is obtained from plants e.g. cotton is pure cellulose.
4. Starch is present in cereals, wheat, barley, rice, maize, potato, sweet potato etc.

Q.7: Describe the classification of carbohydrates in detail.

Ans. Introduction

Carbohydrates are classified on the basis of number of monomers i.e. saccharide units in the molecule. Carbohydrates are generally classified into three groups.

(I) Monosaccharides

Introduction

Monosaccharides are the simplest form of carbohydrates which are primarily produced during photosynthesis. They are white crystalline solids and are soluble in water. They are sweet in taste.

Name of Monosaccharides

Number of carbon atoms in different monosaccharides may range from 3 to 7. Monosaccharides are named on the basis of number of carbon atoms in their structure e.g.

Trioses (3C), tetroses (4C), pentoses (5C), hexoses (6C) etc.

Most Common Monosaccharides

Most common monosaccharides are pentoses and hexose. For example, ribose is a pentose ($C_5H_{10}O_5$), found in the nucleotides of nucleic acids. Glucose ($C_6H_{12}O_6$) is a familiar hexose. Monosaccharides are not further hydrolysed.

Structure: If monosaccharides (mostly pentoses and hexoses) are in crystalline form they are found as open chain structure but when they are dissolved in water they are converted into ring structure.

(2) Disaccharides / What are different types of disaccharides? How are they produced? Mention their sources.

Introduction

Carbohydrates, which release two monosaccharides on their hydrolysis are called disaccharides because disaccharide are formed due to bonding of two monosaccharides. They are also white crystalline solids. They are comparatively less soluble in water and are less sweet in taste.

Molecular Formula

The molecular formula of disaccharide is $C_{12}H_{22}O_{11}$.

Examples

Examples of disaccharides are sucrose, maltose and lactose.



Fig. 6.7: Sources of carbohydrates

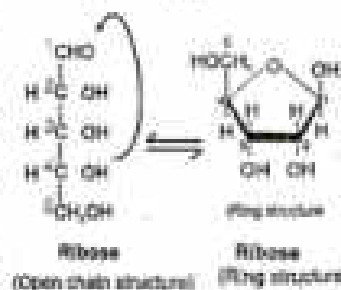


Fig. 6.18: Open Chain and ring structure of Pentose (ribose)



(i) Sucrose

Sucrose is the most familiar disaccharide, commonly used sweetener and known as cane sugar. The sucrose is formed by the condensation of glucose and fructose releasing a water molecule.



(ii) Maltose

(a) Formation

Maltose is also produced during hydrolysis of starch and glycogen, as an intermediate disaccharide. It is slightly sweet, very soluble in water. The maltose is formed by the condensation of two glucose molecules releasing a water molecule.



(b) Maltose – Malt sugar

Maltose is called malt sugar, because it is produced during the brewing the beer and related drinks by alcoholic fermentation of malted barley.

(iii) Lactose

(a) Formation

Lactose is a naturally found in milk and milk products. The lactose is formed by the condensation of galactose and glucose.



(b) Lactose Common Sugar

Lactose is the only common sugar obtained from animals. Milk of all mammals is composed of 2.8% lactose. Lactose can be prepared from whey which is a byproduct of the cheese making process.

(3) Polysaccharides

Introduction

Polysaccharides is largest group of carbohydrates. They are complex carbohydrates and polymers of more than ten monosaccharides.

Sources

They are produced in the cells of plants and animals to store extra carbohydrate food and energy e.g. starch, glycogen. They are storage molecule of carbohydrates.

Nature

Polysaccharides are not sweet in taste rather usually tasteless. They yield many monosaccharide units upon complete hydrolysis for energy use.

Role

Polysaccharides are also structural components of cell walls in the cells of plant (cellulose), fungi (chitin) and bacteria (peptidoglycan).

Q.8: Write a note on nucleic acids.

ANSWER

Ans. Introduction

Nucleic acids are the most important organic biomolecules which store and transfer hereditary information from one generation to next.



Nuclein and Nucleic acid

Swiss physician Friedrich Miescher isolated a whitish material from nucleus of human pus cells. He named this material as nuclein as it was isolated from nucleus. Later on, on the basis of its acidic properties, nuclein was called nucleic acid.

Types of Nucleic Acid

There are two main types of nucleic acids.

(i) Deoxyribonucleic Acid (DNA)

(ii) Ribonucleic Acid (RNA)

Both types of nucleic acids (DNA and RNA) are made up of many units called nucleotides.

Structure of Nucleotide

(A) Components of Nucleotide

Each nucleotide is made up of three components.

(i) Pentose (5C Sugar)

(ii) Nitrogen containing ring structure called **nitrogen base**, which is attached at the first carbon of pentose sugar.

(iii) **Phosphate group** acid attached with fifth carbon of pentose sugar.

(B) Types of Pentose Sugar

The pentose sugar in nucleic acid is of further two types:

(a) Deoxyribose in DNA

(b) Ribose in RNA.

(C) Types of Nitrogen Bases

The nitrogen bases in nucleic acid are also of two main types

(a) Purines

Which are nitrogen containing double ring structures i.e. Adenine and Guanine.

(b) Pyrimidines

Which are nitrogen containing single ring structure i.e.

Cytosine, Thymine and Uracil.

(D) Types of Nucleotide

Names of the nucleotides are given on the basis of the type of pentose sugar and nitrogen base they have. The DNA molecules consists of four different types of nucleotides called deoxyribonucleotides.

Each deoxyribonucleotide can have any one of the nitrogen base from Adenine, Cytosine, Guanine and Thymine.

The RNA molecules also consists of four types of nucleotides called ribonucleotides. Each ribonucleotide can have any one of the nitrogen base from Adenine, Cytosine, Guanine and Uracil. So DNA nucleotides can have Thymine while RNA nucleotides can have Uracil as nitrogen base.

Q.9: Describe the structure of DNA.

Ans. Introduction

DNA molecule is a polynucleotide as it is made up of many deoxyribonucleotides. Each acid nucleotide binds through its phosphate at the 3rd carbon of pentose sugar of previous nucleotide.

Structure of DNA was explained by two scientists, James Watson and Francis Crick.

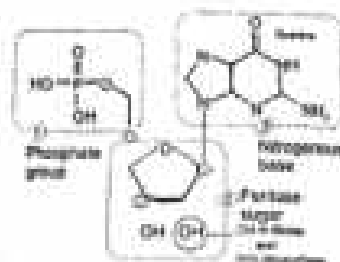


Fig. 6.11: Structure of nucleotide

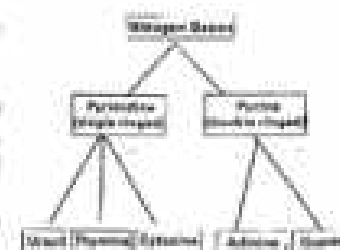


Fig. 6.12: Types of Nitrogen bases

Main points

The main points of Watson and Crick Model of DNA are:

1. Double helix

(i) The DNA molecule is a double stranded like a ladder and both strands are coiled around each other like a helix.

(ii) Both strands of DNA molecule are antiparallel (oppositely oriented to each other).

2. Sugar Phosphate Backbone

(i) The back bone (upright) of molecule are composed of sugar and phosphate part of nucleotide while bases form the rungs.

(ii) The amount of adenine and thymine is always equal and amount of cytosine and guanine is always equal in DNA molecule.

3. Base Pairing

(i) Base pairing between the both strands is highly specific.

(ii) Adenine of one strand always pairs with thymine of other strand while cytosine of one strand always pairs with guanine of other strand.

(iii) Due to this base pairing principle, the sequence of nucleotides in one strand is complementary to the sequence of nucleotides in the other strand.

4. Hydrogen Bonding

(i) Both strands of DNA are held by weak hydrogen bonds. There are two hydrogen bonds between adenine and thymine and three hydrogen bonds between cytosine and guanine.

(ii) The diameter of double helix of DNA is thoroughly uniform and is about 2 nm.

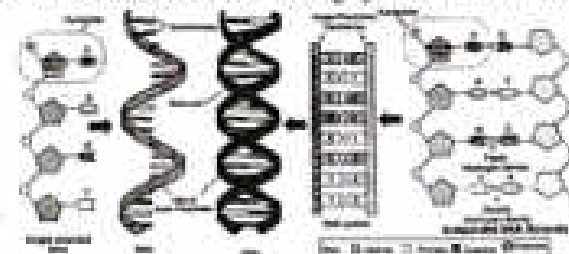


Fig. 6.13: Structure of RNA and Watson and Crick model for structure of DNA

Q.10: Give an account of gene on chromosomes.

Ans. Heredity

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Heredity is the transmission of characters from one generation to the next and it is important for the continuity of all life forms.

Transfer of Heredity Instructions: Although offsprings and parents may have different appearance but, they have a basic resemblance in many characters that run from generation to generation. For the continuity of life forms, each generation transfer the hereditary instructions to the next generation.

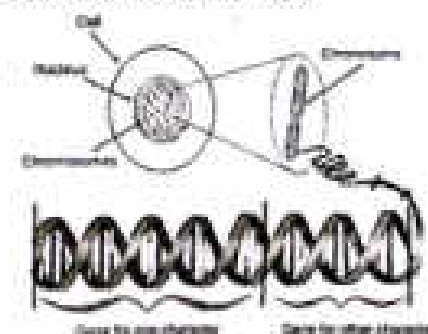


Fig. 6.14: DNA, chromatin and condensed chromosome structure



These hereditary instructions are in the form of huge DNA molecules and are transferred from one generation to next.

Chemical Composition of Chromatin: In a non-dividing cell, hereditary material (DNA) is found in nucleus in the form of fine fibres called chromatin. Chromatin is composed of DNA and a protein called histone.

Nucleosomes: Coiling of DNA around histone form bead like structures called nucleosomes.

Units of Heredity: The Genes

(a) **Chromosome:** During cell division, chromatin fibres condense and further fold to form thread like structures called chromosomes.

(b) **Genes:** Small piece of huge DNA molecule in the chromosome is called gene. Genes actually store and control the hereditary information. Each chromosome is made up of large number of genes.

(c) **Genome**

The total number of genes found in the complete set of chromosomes of an organism is called genome of that organism.

Gametes Act as Vehicle for Transfer of Hereditary Information (genes) to Next Generation

During sexual reproduction, gametes or spores are produced by meiosis. Male and female gametes (sperm and egg) contain chromosomes (set of genes) of parent generation. At fertilisation, male and female gametes fuse to form zygote, thus genes of both parents are transferred to zygote. Zygote develops into the offspring which are the next generation. Thus, genes are transferred from one generation to next through gametes or spores. So, therefore, DNA (genes) in the chromosomes carry the hereditary information from one generation to next.

Q.11: Write a note on structure of ribonucleic acid (RNA).

(10 Marks)

Ans.

(i) **Single Stranded Nucleic Acid:** The RNA is a polynucleotide helical chain like DNA but it is single stranded nucleic acid.

(ii) **Ribose Sugar:** In RNA, pentose sugar ribose is present instead of deoxyribose.

(iii) **Uracil Nucleotide:** RNA molecule also differs from DNA in having uracil nucleotide instead of thymine nucleotide.

(iv) **Nitrogen Base:** Nitrogen bases of RNA molecule are weakling because they are not bonded to nitrogen bases of other (complementary) strand like DNA.

(v) **Sequence of Nucleotides:** Sequence of nucleotides in RNA is synthesised by using the sequence of nucleotides in DNA by the process of transcription.

Q.12: Describe the function of RNA in converting hereditary information into useful proteins.

(10 Marks)

Ans. Introduction

After synthesis in the nucleus, RNA is transported to cytoplasm. RNA is an intermediate molecule for controlling the heredity. The primary function of RNA is to synthesise proteins by the process of translation. All three types of RNA are involved in translation of genetic information into various proteins necessary for cellular processes.

Types and Functions of RNA

There are three types of RNA:

(i) **Messenger RNA (mRNA):** It carries message of DNA from nucleus to cytoplasm for protein synthesis in called mRNA.

(ii) **Transfer RNA (tRNA):** It transfer amino acids to ribosomes during protein synthesis hence called tRNA.



(iii) **Ribosomal RNA (rRNA):** It is the component of ribosome therefore called rRNA. It synthesise with ribosomal protein to form units of ribosomes, which are factory of proteins.

Q.13: Describe the central dogma stating the role of gene in protein synthesis. (OR) Describe the role of gene in protein synthesis.

Ans. Introduction

(10 Marks)

DNA (genes) contain information needed for the synthesis of proteins. The flow of biological information, from DNA to RNA and from RNA to protein is known as the "central dogma of molecular biology" or "central dogma of life".

Protein Synthesis

Proteins are the main structural and functional molecules of living organisms. Correct primary structure of any protein is primarily determined by DNA. Protein synthesis takes place in two sequential steps i.e. transcription and translation.

Gene Expression

Together transcription and translation are known as gene expression.

1. Transcription

Transcription is the first step to gene expression that involves the formation of RNA molecule from DNA. Both DNA strands of a gene unwind from each other. Only one strand of DNA is copied. Nucleotide sequence of one DNA strand (coding strand) is copied in the form of mRNA. After the gene is copied to mRNA, both strands of DNA are again coiled together into its normal double stranded shape.

2. Translation

The mRNA synthesized in the nucleus of the cell moves into the cytoplasm where it binds to the ribosome. The mRNA message (codes) is translated by ribosomes which link amino acids to form polypeptide chain with specific sequence of amino acids. Different types of tRNAs, transfer amino acids to ribosome as per sequence of codes in mRNA.

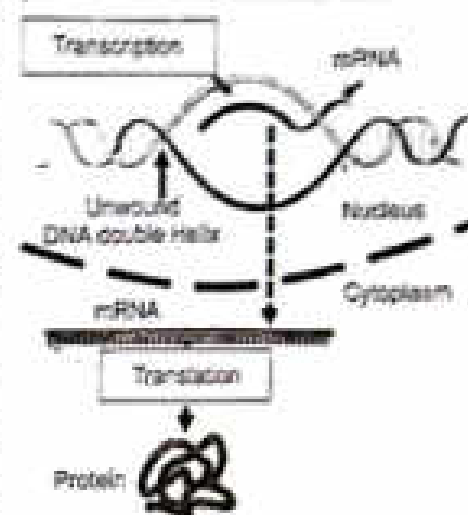


Fig. 6.15: Transcription and Translation

Multiple Choice Questions (Exercise)

1. Which of the following is major bio-element? (10 Marks)

- (a) sodium (b) magnesium
(c) phosphorus (d) iron

2. Peptide bond is formed between two: (10 Marks)

- (a) monosaccharides (b) amino acids
(c) nucleotides (d) fatty acids

3. During translation, sequence of amino acids in the protein is decided on the basis of sequence of nucleotides in: (10 Marks)

- (a) tRNA (b) rRNA
(c) mRNA (d) DNA

4. Different amino acids differ from each other on the basis of their _____ group: (10 Marks)

- (a) alkyl (b) carboxylic
(c) amino (d) phosphate



5. Both strands of DNA are held together by hydrogen bonding, double hydrogen bonds are present between: (01100018)

(a) adenine and thymine
(b) cytosine and guanine
(c) cytosine and thymine
(d) adenine and guanine

6. Transcription takes place in the: (01100019)

(a) cytoplasm
(b) nucleus
(c) ribosomes
(d) rough endoplasmic reticulum

7. All the nucleotides of RNA differ from the nucleotides of DNA in having different: (01100020)

(a) nitrogen base
(b) pentose sugar, nitrogen base
(c) phosphate group
(d) carboxylic group

8. Diameter of DNA is thoroughly uniform and is about: (01100021)

(a) 3 nm (b) 2.4 nm
(c) 2 nm (d) 1.1 nm

9. Which of the disaccharide is also called transport sugar? (01100022)

(a) sucrose (b) maltose
(c) fructose (d) lactose

10. Vitamin D belongs to: (01100023)

(a) carbohydrates (b) lipids
(c) protein (d) RNA

Multiple Choice Questions (Additional)

11. Which one of these bio-elements is highest percentage in the human body? (01100024)

(a) hydrogen (b) oxygen
(c) carbon (d) nitrogen

12. Which of these major bio-elements is present in lowest percentage in human body? (01100025)

(a) oxygen (b) phosphorus
(c) calcium (d) nitrogen

13. How much nitrogen is present in making body mass of a living organism? (01100026)

(a) 10% (b) 3%
(c) 1% (d) 18%

14. As a bio-element, the percentage of carbon is: (01100027)

(a) 18% (b) 10%
(c) 2% (d) 3%

15. As a bio-element, the percentage of calcium is: (01100028)

(a) 01% (b) 02%
(c) 03% (d) 04%

16. As a bio-element, the percentage of hydrogen: (01100029)

(a) 18% (b) 10%
(c) 03% (d) 02%

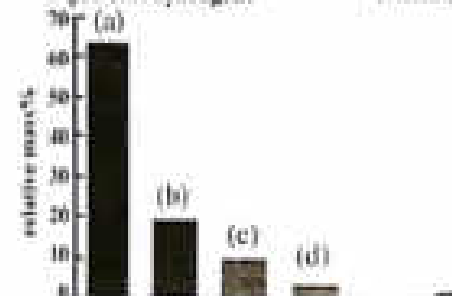
17. The number of elements that occur in nature are: (01100030)

(a) 200 (b) 192
(c) 92 (d) 100

18. The element that makes 65% of the total mass of living organisms: (01100031)

(a) hydrogen (b) carbon
(c) oxygen (d) nitrogen

19. The following graph shows percentage composition of bio-elements by mass of a human being. Which labeled part represents hydrogen? (01100032)



20. The given diagram shows the distribution of bio-elements in the human body: (01100033)



The elements represented by I, II and III are:

	I	II	III
(a)	Oxygen	Carbon	Hydrogen
(b)	Carbon	Oxygen	Hydrogen
(c)	Hydrogen	Carbon	Oxygen
(d)	Carbon	Hydrogen	Oxygen

21. The table shows the bioelements present in each of four substance. Which substance should be proteins? (01100034)

Substances	Carbon	Hydrogen	Nitrogen	Oxygen
(a)	✓	✓	✓	×
(b)	✓	✓	×	✓
(c)	✓	✓	✓	✓
(d)	✓	×	✓	✓

22. Which of the following substance could be lipid? (01100035)

Substances	Amino Acid	Glucose	Fatty Acid	Glycerol
(a)	✓	×	×	×
(b)	×	×	✓	✓
(c)	×	✓	×	×
(d)	✓	✓	×	×

23. The type of RNA that brings amino acids to the ribosome is: (01100036)

(a) mRNA (b) tRNA
(c) rRNA (d) snRNA

24. The amount of energy obtained from one gram of fat is: (01100037)

(a) 5 Kcal/g (b) 9 Kcal/g
(c) 13 Kcal/g (d) 17 Kcal/g

25. Genes are short segments of: (01100038)

(a) proteins (b) carbohydrates
(c) DNA (d) lipids

26. In DNA, the "rungs" of the ladder are formed by pairs of: (01100039)

(a) phosphate groups
(b) sugar molecules
(c) nitrogenous bases
(d) nucleotides

27. The round structure formed when DNA coils around the histone protein is: (01100040)

(a) eucromatin (b) chiasma
(c) nucleosome (d) chromatin

28. The central dogma is best represented by: (01100041)

(a) DNA → RNA → Protein
(b) DNA → RNA + Protein
(c) DNA → RNA → Protein
(d) Protein → DNA → RNA

29. Which of the following statements regarding genes is false? (01100042)

(a) Genes are located on chromosomes
(b) Genes consist of a long sequence of DNA
(c) A gene contains information for the production of a protein
(d) Each cell contains a single copy of every gene



30. Chromosomes carry units of inheritance called as: (01100441)
 (a) chromatin (b) DNA
 (c) Genes (d) Alleles
31. Genes contain instructions for the synthesis of: (01100441)
 (a) fat (b) carbohydrates
 (c) vitamins (d) proteins
32. Chromatin is made up of: (01100441)
 (a) DNA (b) Protein
 (c) DNA + protein (d) RNA
33. Polynucleotide strands present in DNA molecule are: (01100441)
 (a) 2 (b) 3
 (c) 4 (d) 5
34. Outside backbone of double helix is made up of: (01100441)
 (a) sugar
 (b) phosphate
 (c) sugar-phosphate
 (d) nitrogenous bases
35. Inside of double helix consists of: (01100441)
 (a) nitrogenous bases (b) sugar
 (c) sugar-phosphate (d) phosphate
36. Backbone of DNA molecule is: (01100441)
 (a) phosphate
 (b) Deoxyribose
 (c) nitrogenous bases
 (d) phosphate + deoxyribose
37. This is a heredity material: (01100441)
 (a) DNA (b) RNA
 (c) tRNA (d) rRNA
38. Central dogma means working of: (01100441)
 (a) genes (b) chromosomes
 (c) DNA (d) All
39. Synthesis of mRNA molecule from a DNA template is known as: (00100441)
 (a) transcription
 (b) translation
 (c) replication
 (d) genetic recombination

40. Which of the following is not a molecule studied in molecular biology? (01100441)
 (a) DNA (b) RNA
 (c) Protein (d) Xenon
41. Which protein provides structure to hair and nail? (01100441)
 (a) collagen (b) keratin
 (c) haemoglobin (d) myoglobin
42. Which is not a function of carbohydrates? (01100441)
 (a) providing energy
 (b) serving as building blocks for complex carbohydrates
 (c) forming the primary structure of cell membranes
 (d) breaking down into glucose
43. Cellulose differs from starch and glycogen due to its: (01100441)
 (a) glucose units
 (b) bond arrangement
 (c) sweet taste
 (d) solubility in water
44. Lipids are insoluble in water because they: (01100441)
 (a) have a high affinity for water
 (b) are primarily made up of hydrocarbons
 (c) are non-polar compounds
 (d) attract water molecules
45. The hydrophilic component of a phospholipid is the: (01100441)
 (a) fatty acid tail
 (b) hydrocarbon tail
 (c) glycerol backbone
 (d) phosphate group
46. Which part of the amino acid structure varies from one amino acid to another? (01100441)
 (a) amino group
 (b) carboxylic acid group
 (c) hydrogen atom
 (d) R group



Answer Key

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

Short Answer Questions (Exercise)

Q.1: Compare ratios of bio-elements.

Ans. Bioelements

Bodies of living organisms are composed of protoplasm, which is made of certain elements called bioelements. Out of 92 naturally occurring elements of earth, 16 of these bioelements.

Classification of Bioelements

On the basis of their proportions in the living organisms, bio-elements are further classified into major and minor bio-elements.

(i) Major Bio-elements

Definition

Six most common bioelements constitute

99% of protoplasm so called major bioelements.

Examples

Oxygen, Carbon, Hydrogen, Nitrogen, Calcium and Phosphorus.

(ii) Minor Bioelements

Remaining ten bioelements constitute only 1% of the biomolecules so called minor bioelements.

Examples

Potassium, Sulphur, Chlorine, sodium, magnesium, Iron, Copper, Manganese, Zinc and Iodine.

Q.2: Compare the energy level of carbohydrates, Proteins and lipids.

Ans.

Protein	Lipids	Carbohydrates
(1) One gram of protein has 4 Kcal of energy	One gram of lipids provides 9.1 Kcal energy which is double than carbohydrates or proteins.	4 Kcal per gram of energy is released when glucose is broken down in the cell.
(2) Proteins can also be used for gaining energy.	Lipids act as energy storage in fat cells, liver and in blood.	Carbohydrates are major source of useable and stored energy in the cells of living organisms.

Q.3: How biochemistry is important for study of physiology, cell biology and anatomy?

Ans. Biochemistry is the study of different chemical compounds and the chemical processes taking place within the living organisms.

Important Role of Biochemistry

Biochemistry is related to both biology and chemistry. Therefore, biochemistry solves the problems faced by living organisms by using the knowledge and techniques of chemistry. Similarly, knowledge of biochemistry is essential to study the



physiology, cell biology and anatomy of organisms because life processes such as photosynthesis, respiration, digestion, inheritance are explained in biochemical terms.

Q.4: Define gene (a localized region of DNA that codes for a protein). (05/000001)

Ans. Small piece of huge DNA molecule in the chromosome is called gene.

Genes actually store and control the hereditary information. Each chromosome is made up of large number of genes.

Q.5: Name structural and energy producing nature of carbohydrates. (05/000001)

Ans. Extra glucose in plants is stored as starch in their root, stem, fruits or seeds used as animal and human food. Extra blood glucose is stored in animal muscles and liver cells as glycogen which serves as energy bank. It can be converted back to glucose when energy needed. Carbohydrates can serve as structural

components in cells and tissues, such as cellulose in plant cell walls and chitin in the exoskeleton of arthropods. They are a primary source of energy and can be broken down into glucose during cellular respiration, providing fuel for metabolic processes and ATP production.

Q.6: What are different plant sources of proteins? (05/000001)

Ans. Plant seeds are most common sources of protein like beans, lentils, peas, nuts.

Q.7: How primary structure of protein is important? (05/000001)

Ans. The significance of the unique sequence or order of amino acids known as the protein's primary structure, is that it dictates the 3-D conformation the folded protein will have. This conformation, in turn, will determine the function of the protein.

Short Answer Questions (Additional)

Q.8: Explain the composition of chromatin material. (05/000001)

Ans. In a non-dividing cell, hereditary material (DNA) is found in nucleus in the form of thin fibres called chromatin. Chromatin is composed of DNA and a protein called histones. Coiling of DNA around histones form bead like structure called nucleosomes.

Q.9: Explain how genes control inheritance of characters. (05/000001)

Ans. For the continuity of life forms, each generation transfer the hereditary instructions to the next generation. During sexual reproduction, gametes or spores are produced by meiosis. Male and female genetic sperm and egg contain chromosomes (set of genes) of parent generation. At fertilization, male and female gametes fuse to form zygote. Thus genes of both parents are transferred to zygote. Zygote develops into the offspring which are the next generation. Thus, genes are transferred from one generation to next, through gametes

or spores.

So therefore, DNA (genes) in the chromosomes carry the hereditary information from one generation to next.

Q.10: What are bio-elements? (05/000001)

Ans. The elements which take part in making the body mass of a living organism are called bio-elements. These are 16 in number. There are two types of bio-elements.

(i) Major elements

Six elements making 99% mass of living organisms are called major elements. These are C, H, O, Ca, N and P.

(ii) Trace elements

Other ten elements making 1% mass of living organisms are called trace elements. These are K, S, Cl, Na, Mg, Fe, Cu, Mo, Zn and I.

Q.11: Give the names and symbols of the bio-elements which make 99% of the total mass of an organism. (05/000001)

Ans. Following six bio-elements make 99%



of total mass of an organism. These are known as major elements:

- (i) Oxygen (O) (ii) Carbon (C)
- (iii) Hydrogen (H) (iv) Nitrogen (N)
- (v) Calcium (Ca) (vi) Phosphorus (P)

Q.12: Write down the %age composition (by mass) of bio-elements found in the protoplasm of living organisms. (05/000001)

Ans. Percentage composition (by mass) of bio-elements in the protoplasm of living organism given below:

- i) Oxygen 65% ii) Carbon 18%
- iii) Hydrogen 10% iv) Nitrogen 3%
- v) Calcium 2% vi) Phosphorus 1%
- vii) Others 1%

Q.13: Differentiate between transcription and translation. (05/000001)

Ans.

Transcription	Translation
It is a process in which specific sequence of DNA nucleotides is copied in the form of messenger RNA (mRNA). It takes place in the nucleus.	The mRNA carries the sequence of its nucleotides to ribosomes. Ribosomes read this sequence and join specific amino acids, according to it proteins are synthesized. It takes place in the cytoplasm.

SLO based Reference Material

Short Answer questions

Q.14: What do you know about the following? (05/000001)

- (i) Oligosaccharides
- (ii) Peptide bond and polypeptides
- (iii) Phosphodiester bond
- (iv) Nitrogenous bases in DNA

Ans. (i) **Oligosaccharides:** Oligosaccharides are a type of carbohydrate that falls between monosaccharides and polysaccharides in terms of number of monomers. The most common oligosaccharides are disaccharides.

(ii) **Peptide Bond and Polypeptides:** When amino acids link together, they form a bond known as a peptide bond. This bond is created through a dehydration synthesis reaction where a water molecule is removed. Chains of amino acids linked by peptide bonds are termed as polypeptides.

(iii) **Phosphodiester Bond:** The covalent bond between the two nucleotides in DNA and RNA is named as phosphodiester bond.

(iv) **Nitrogenous Bases in DNA:** There are bases in DNA, Adenine (A), Thymine (T), Cytosine (C) and Guanine (G).

Nucleotides in DNA join together by covalent bonds between the phosphate group

of one nucleotide and the sugar molecule of the next nucleotide. These bonds form a "backbone" of sugar-phosphate.

Q.15: How does the structure of fatty acids determine whether a fat is saturated or unsaturated? (05/000001)

Ans. Fatty acids in triglycerides can be either saturated or unsaturated. A fatty acid is considered saturated if there are no double bonds between carbon atoms of its chain.

On the other hand, an unsaturated fatty acid has one or more double bonds, formed by the removal of hydrogen atoms from the carbon skeleton.

Q.16: Name two types of proteins that provide structure in the human body. (05/000001)

Ans. Keratin in hair and nails and Collagen in tissues provide structure to various parts of the body.

Q.17: How does molecular biology relate to the understanding of DNA and genetic information? (05/000001)

Ans. Molecular biology looks at the molecule related to genetic information, particularly DNA. It seeks to understand how DNA is made copied and used providing



insight into heredity, genetic variations and the basis of life.

Q.18: Why are lipids insoluble in water?

Ans. Lipids are organic compounds made up of carbon, hydrogen and oxygen. They have

little or no affinity for water (hydrophobic in nature) due to the presence of mostly hydrocarbons. That is why they are insoluble in water but soluble in organic solvents such as alcohol.

SL.O Based Reference Material

Long Answer Questions

Q.1: Classify biomolecules based on location and function. Explain the significance of each biomolecule in cellular processes.

Ans.

Biomolecules	Location within the Cell	Main Role
Carbohydrates	Cytoplasm and attached to cell surfaces	Act as a primary energy source, some have structural roles.
Lipids	Mainly in cell membranes and membranes of organelles	Form the cell membrane and thereby act as a barrier, store energy.
Proteins	Throughout the cell	Act as enzymes to speed up chemical reactions, provide structural support, transport substances and aid in body defense.
DNA (Deoxyribonucleic Acid)	Primarily in the cell nucleus	Stores genetic information, guides development, growth, and reproduction and directs the synthesis of proteins.
RNA (Ribonucleic Acid)	Both the cell nucleus and cytoplasm	Facilitates protein synthesis and acts as an enzyme (ribozyme).

Q.2: How would you give comparison between DNA and RNA?

Ans.	DNA	RNA
Sugar	 Deoxyribose	 Ribose
Nucleotides bases	Adenine (A), Guanine (G), Cytosine (C), Thymine (T)	Adenine (A), Guanine (G), Cytosine (C), Uracil (U)
Form	 Double stranded	 Generally single stranded
Functions	Stores RNA and protein encoding information; transfers information to daughter cells.	Carries protein encoding information; helps to make proteins.



UNIT
07

METABOLISM

Q.1: What do you know about chemical and biochemical reactions?

Ans. Chemical Reaction

Chemical reaction is a process in which one or more substances, the reactants, are converted to one or more different substances, the products. Chemical reactions are happening every where on earth in non-living environment as well as inside the living organisms.

Bio-chemical Reaction

Those chemical reactions which are taking place in living organisms are called biochemical reactions. The life of living organisms is sustained due to these biochemical reactions.

Q.2: Describe metabolism and its types.

Ans. Metabolism

The word metabolism means "to change". The sum of all the chemical reactions going on within each cell of living organisms for the maintenance and sustainability of life is known as metabolism.

Types: Metabolism is divided into two types, i.e. catabolism and anabolism.

(i) Catabolic Reactions

Definition

Biochemical reactions which break down complex molecules into simpler molecules, are called catabolic reactions or catabolism. Energy is released during this process.

Examples

- Digestion is the catabolic process in which larger and complex food molecules are broken down into smaller and simpler molecules.
- Cellular respiration is also a catabolic process where glucose molecules are broken down to CO_2 and H_2O by a series of reactions in all body cells.

(ii) Anabolic Reactions

Definition

Reactions which build complex molecules from simpler molecules are called anabolic reactions or anabolism. Energy is utilized during this process.

Examples

- Photosynthesis is an anabolic process where simple molecule like CO_2 and H_2O are converted to larger molecule glucose.
- Condensation of glucose molecules to form glycogen in muscle and liver cells is also anabolic reaction.

Q.3: What are enzymes and its types?

Ans. Introduction

Vital biochemical reactions taking place in the body must occur quickly and precisely for a cell to perform and survive. These metabolic reactions in living organisms are sped up by specific proteins in the body called biological catalysts or enzymes. "Enzymes are biologically active globular proteins made by living cells, which tremendously speed up the biochemical reactions". Each cell synthesizes its own enzymes and the type of enzymes produced in each cell are specific which is determined by the genes active in that cell.

Explanation

Substrates

Enzymes act on specific molecules in the cell called substrates. The substrates are the



molecules entering into chemical reactions.

Product

After binding to the specific enzyme, substrates undergo chemical changes resulting in a new bonding arrangement between the molecules. The substrates modified by enzymes are called products.

Types of Enzymes

(1) **Intracellular Enzymes:** The enzymes, which stay inside the cells to speed up the reactions, are called intracellular enzymes (e.g., the enzymes of glycolysis working in the cytoplasm).

(2) **Extracellular Enzymes:** Often the enzymes made inside the cells are allowed to go out of the cell to do their work outside. These enzymes are called extracellular enzymes (e.g., pepsin enzyme working in the stomach cavity). Fungi and bacteria release extracellular enzymes to digest their food.

Enzymology: Study of structure, type and role of enzymes is called enzymology.

Q.4: Describe the characteristics and specification of enzymes.

ORIGIN

Ans. Enzymes have following characteristics.

1. Enzymes are Globular Proteins

All enzymes are made up of chains of amino acids folded to form 3D protein molecules called globular proteins. Few enzymes are RNA in nature called ribozymes.

2. Enzymes Increase Rate of Reaction

Reaction may initiate without involvement of enzymes, but it will be extremely slow and may take months or years to complete the reactions. The enzymes speed up the reactions millions of times faster as compared to non-enzymatic reaction. It is important to know that enzymes only speed up a reaction and do not start a chemical reaction.

3. Enzymes are Required in Small Quantity

Structure of enzymes may slightly change during reaction but they regain their actual shape, so they remain unchanged at the end of the reaction. That is why they can be used repeatedly. Thus, a very small quantity of an enzyme is capable of catalysing a huge amount of substrate.

4. Enzymes are Specific

Enzymes are usually very specific so catalyse only one type of reaction and it will not act on a different substrates. For example, amylase will only act on starch and not on proteins or fats.

5. Enzymes Require Co-factor

Introduction

Many enzymes require an additional non-protein component for their proper functioning called cofactor. Cofactor usually act as bridge between protein part of enzyme and its substrate or may provide chemical energy to enzyme.

Types of Co-factors

There are three types of cofactors.

(i) Activator

Some enzymes require detachable inorganic ions (metal ions) as cofactor called activator such as Zn^{2+} , Fe^{2+} , Cu^{2+} and chlorides etc. For example, activity of salivary amylase is increased in the presence of chloride ions.

(ii) Prosthetic Group

If the cofactor is an organic molecule tightly and permanently attached to the enzyme it is known as prosthetic group. For example, Flavin Adenine Dinucleotide (FAD), Haem group etc.

(iii) Coenzyme

If the cofactor is detachable organic molecule it is called coenzyme. Examples of co-enzymes are NAD (nicotinamide adenine dinucleotide), coenzyme A and vitamin A and C etc.

6. Regulation of Enzyme Production and Activity

Synthesis of enzymes within the cells and can be increased or decreased by a cell according to



requirements. Enzyme activity can be regulated by inhibitors or activators within or from out of cell.

2. Enzymes Make Metabolic Pathway

Many enzymes work together in a specific sequence to make metabolic pathways. Metabolic pathway is a series of connected chemical reactions where multiple intermediate molecules are produced before conversion of an initial substrate into final product.

8. Energy of Activation

Minimum amount of extra energy required to activate the molecule to react or start the reaction is called energy of activation. Enzymes lower the activation energy so that these reactions can take place at body temperature. Enzymes lower the activation energy by changing the shape and charge of the substrate. Enzyme may provide entirely different mechanism of reaction to lower the activation energy.

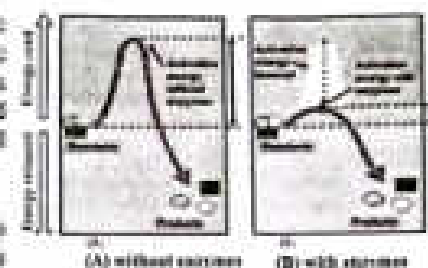


Fig. 1.1: Energy of activation

Enzymes lower the activation energy by changing the shape and charge of the substrate. Enzyme may provide entirely different mechanism of reaction to lower the activation energy.

Q.5: Describe the mechanism of enzyme action.

ORIGIN

Ans. Introduction

Most enzymes are far larger protein molecules than the substrates they act on. Specific part on the globular surface of enzyme where substrate binds and actually take part in reaction is called the active site. The active site is usually a very small portion of the enzyme which is a charge bearing cavity having a specific shape. Active site has two portions, binding site and catalytic site.

Mechanism of Enzyme Action

Specific substrate molecule temporarily binds to the active site of enzyme to form Enzyme Substrate (ES) complex. Once the ES complex has formed, enzyme catalyses the reaction to convert the substrate into product, thus converting the ES complex to Enzyme Product (EP) Complex. Finally, EP complex breaks up into products and enzyme. The enzyme molecule remains unchanged at the end of the reaction and is available again if needed for same reaction again.

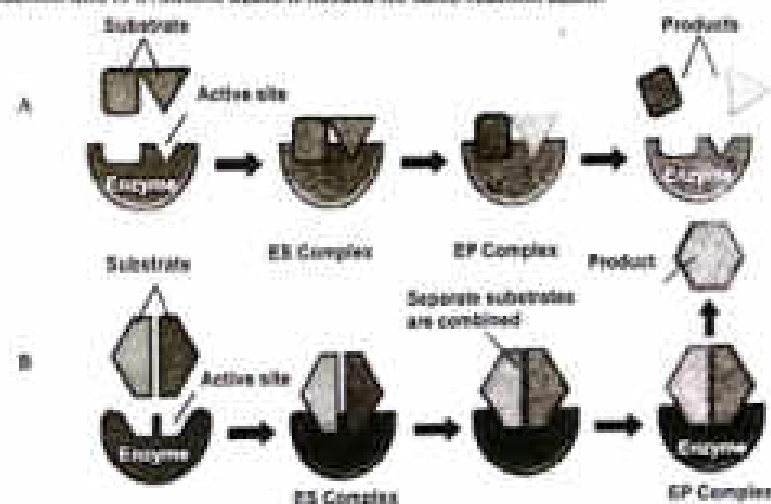


Fig. 1.2: Mechanism of enzyme action (a) Breakdown (b) Synthesis



Q.6: Describe factors affecting enzyme activity. (OR) What happens to enzymes when you increase or decrease: (a) temperature (b) pH (c) substrate concentration?

Ans. Several environmental factors affect the rate at which enzymatic reactions proceed.

(a) Temperature

The rate of reaction increases with increase in temperature but up to a specific limit. Each enzyme works best at a specific temperature called optimum temperature.

Optimum Temperature for Human Enzymes

Different enzymes have different optimum temperatures e.g., optimum temperature for human enzymes is 36°C to 38°C . Any increase or decrease in temperature affect the rate of enzymatic reaction.

Effect of High and Low Temperature

At very high temperature atoms of the enzyme molecule gain kinetic energy and start vibrating vigorously so, globular structure and active site of enzyme is damaged and it is called denatured. At very low temperature enzyme remain inactive due to fall in available activation energy. They will regain their catalytic activity when normal temperatures are restored.

(b) Optimum pH

pH of medium affect the enzyme functioning. Each enzyme performs best at a specific pH, which is called optimum pH. Slight change in pH of the reacting medium below or above the optimum pH reduce the rate of reaction. Extreme changes in pH denature the enzyme. For example, pepsin and trypsin are both protein digesting enzymes. Pepsin performs best in acidic medium in stomach at 2.00 pH whereas trypsin performs best in alkaline medium in small intestine at 8.00 pH.

(c) Substrate Concentration

In the presence of enough enzyme molecules at the reaction site, the rate of reaction is directly proportional to the substrate available. So, rate of enzymatic reaction increases with the increase in substrate concentration up to a certain limit.

Saturation of Active Sites

After that, a point is reached when further increase in substrate concentration will have no effect on the rate of enzymatic reaction. It is due to the presence of extra substrate molecules in the medium which have occupied all the active sites of the available enzyme molecules, this condition is called saturation of active site.

Inhibitors and Activators

Inhibitors are molecules produced in the cell or enter into the cell from outside and stop the enzymatic reactions while activators are molecules that increase the rate of enzymatic reaction.

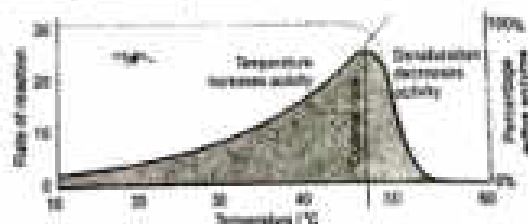


Fig. 7.3: Effect of temperature on rate of enzyme activity

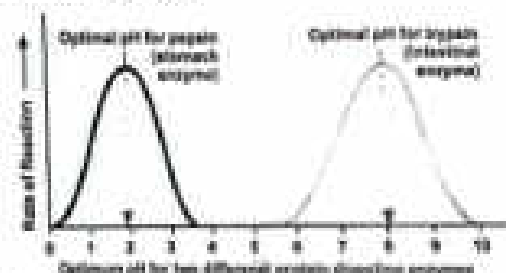


Fig. 7.4: Effect of pH on rate of enzyme controlled reaction

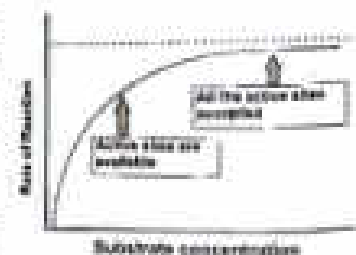


Fig. 7.5: Effect of Enzyme and substrate concentration on the rate of enzyme action



Q.7: Describe enzyme inhibition and its types.

Ans. Enzyme Inhibition

Sometimes enzymes are not able to perform their role due to the presence and interference of some chemicals at the reaction site, this phenomenon is called enzyme inhibition. The chemical substance which react with enzyme in place of substrate but does not convert to products thus inhibiting the enzyme action is called inhibitor. Inhibitors may block or damage active site temporarily or permanently. Generally, enzyme activity may be temporarily inhibited by accumulated products within the cell to regulate the rate of reaction.

Factors for Enzyme Inhibition

External factors responsible for enzyme inhibition are poisons, cyanide, antibiotics, some drugs or accumulated products etc.

Types of Enzyme Inhibition

Enzyme inhibition may be of two major types:

(I) Competitive Inhibition

If enzymes are inhibited due to presence of molecules which occupy the active site due to their similarity in structure and shape to substrate is called competitive inhibition. Such inhibitors are neither converted to products nor they allow the actual substrate to bind hence reaction does not proceed. Competitive inhibition is temporary and can be reversed if the concentration of actual substrate is increased than the concentration of inhibitor molecules.

(II) Non-competitive Inhibition

The structure and shape of these inhibitors do not resemble the substrate molecules so they do not occupy the active site. They may attach to enzyme surface at a point other than active site called allosteric site. They alter the globular shape of enzyme and damage the active site of enzyme. Thus, actual substrate will not be able to bind to active site and reaction stops.

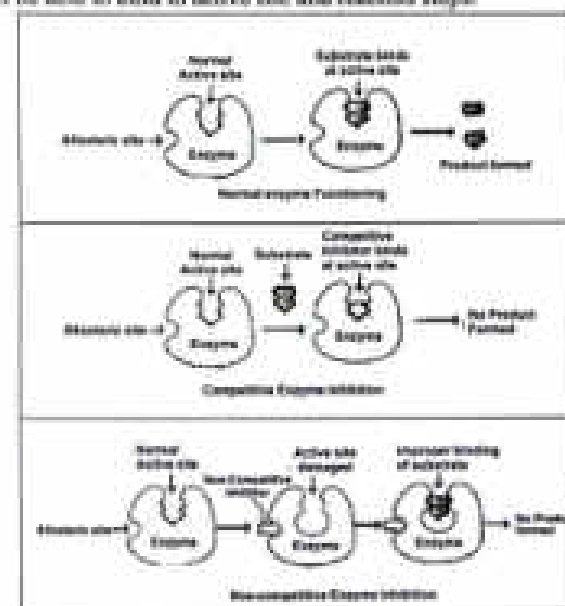


Fig. 7.6: Competitive and non-competitive inhibition of enzyme



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Q.11 Describe the uses and structure of ATP.

Ann. Need of Energy

Life of the living organisms is possible only if constant supply of energy is available in its cells. All the life processes like movement, development, reproduction, thermoregulation, active transport, etc. depend on the availability of energy. The living organisms use and store energy at the cellular level in the form of adenosine triphosphate (ATP).

ATP: The Cell's Energy Currency

ATP is commonly called the "energy currency" of cell because it is an energy rich compound that can store and release energy and can be used much like money. When organic molecules (glucose, amino acids etc.) are broken down in the cells, energy is released that can be captured and stored in ATP molecules. The energy remains stored in the ATP until it is needed. When energy is needed by the cells, ATP molecule is hydrolysed to release energy.

ATP = ADP Cycle

ATP can be converted to ADP and inorganic phosphate by hydrolysis. The third phosphate group separates from ATP and remains in the cell in inorganic form. ADP and phosphate can be converted back to ATP by condensation. The ability of ATP to store and release energy is because of its unique structure.

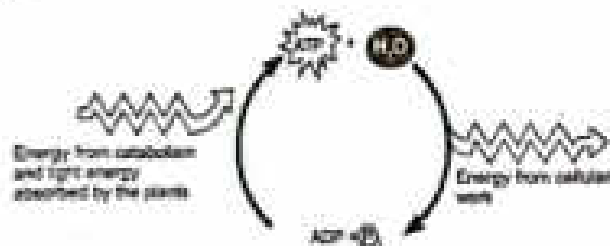


Fig. 2.1c. ATP-ADP Cycle

Structure of ATP Molecule

ATP molecule consists of three components:

1. Adenine (double ringed Nitrogen Base)
2. Ribose (Five Carbon Sugar)
3. Three Phosphate Groups (PO_4) linked in a chain called a triphosphate group.

References

Adenine nitrogen base binds to ribose sugar and becomes adenosine.

Adenine + Ribose Sugar $\rightarrow$ Adenosine (nucleoside)

AMP: First phosphate group binds with adenine to form adenosine monophosphate (AMP).

ADP: Second phosphate group binds with AMP to form adenosine diphosphate (ADP)

ATP: Third phosphate group binds with ADP to form adenosine triphosphate (ATP). Thus all three phosphate groups are serially bonded in a linear chain with adenosine to form ATP!

Adenine + Ribose Sugar + 3 Phosphate groups $\rightarrow$ Adenosine triphosphate (nucleotide)

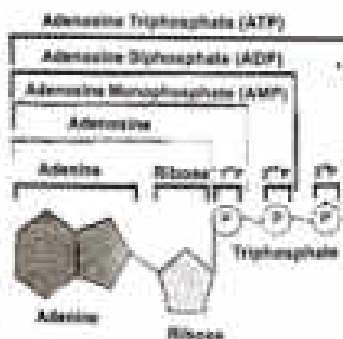


Fig. 7A: Structure of ATP (high energy bonds indicated by wavy lines)



High Energy Bands

The covalent bonds between phosphate groups are called "high energy" or "energy-rich" bonds. The two bonds linking the phosphate group together are represented by a specific sign of wavy lines. The energy stored in these bonds may be used by the cells to carry out their functions.

Q.5: Define photosynthesis. Discuss it with its chemical equation.

Ans. Photosynthesis: Photosynthesis is an important biochemical process taking place in plants, algae and cyanobacteria. During this process plants absorb light energy in the presence of chlorophyll and use carbon dioxide and water to make glucose. Oxygen is produced as a by-product during photosynthesis.

Chemical Equation



Nearly all life forms depend on photosynthesis for food directly or indirectly. Photosynthesis involves a series of coordinated reactions. The above equation shows summary of photosynthesis process.

Q.18: Describe mechanism of photosynthesis.

Ans. (ii) Light Reactions

Photosynthesis occurs in two phases called as light dependent and light independent reactions. In the first phase, light energy is absorbed and then used to produce energy rich molecules ATP and NADPH. These reactions take place in chloroplasts. These reactions occur only in the presence of light so are called light dependent reactions.

on Dark Reactions

During the second phase carbon dioxide is reduced by NADPH to form glucose molecule. This reduction requires energy which is provided by ATP. These reactions do not use light directly; hence they are known as light independent reactions.

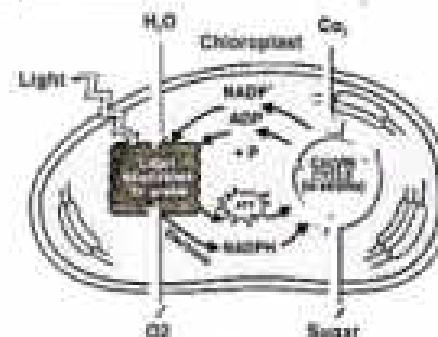


Fig. 10. The magnitude of the relative error.

Exclusion criteria

(1) Light Dependent Reactions of Photosynthesis / Describe and sketch the light reactions of photosynthesis.

The reactions, which depend upon light energy, are called light dependent reactions of photosynthesis. These reactions take place in thylakoid membranes where photosynthetic pigments are arranged into clusters called photosystems. There are two types of photosystems: Photosystem I and Photosystem II. Process of light dependent reactions starts from photosystem II.



1. Chlorophyll *a* or photosystem II absorbs light and a pair of electrons is emitted from it which are accepted by a molecule called primary electron acceptor.

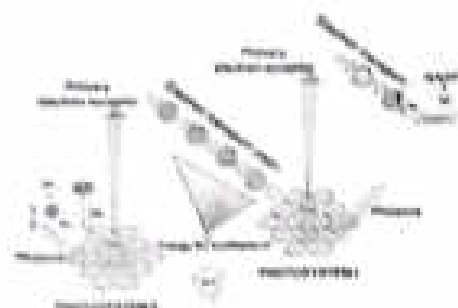


Fig. 7.10: Light dependent reactions of photosynthesis

2. At the same time, water molecule also splits into oxygen atoms, two hydrogen ions (H^+) and two electrons. Splitting of water takes place to compensate the electron loss of light affected chlorophyll of photosystem II and is called photolysis of water.
3. Oxygen is released out of leaf through stomata.
4. Electron pair from primary electron acceptor passes through a chain of molecules called electron transport chain (ETC). Electrons passing through ETC, gradually release energy which is used for ATP synthesis.
5. Light also acts on photosystem I which also gives out an electron pair. These electrons and two H^+ of water reduce $NADP^+$ to $NADPH$.

(2) Light Independent Reactions of Photosynthesis/ Describe and sketch dark reactions of photosynthesis.

Once the light reactions produce ATP and NADPH, a photosynthetic cell can fix carbon dioxide to synthesise sugar molecules. These reactions does not depend directly on light that is why it is called dark reactions or light independent reactions. It takes place in stroma of chloroplast.

The sequence of reactions in this phase was first described by Melvin Calvin and his colleagues so is known as **Calvin cycle** as well.

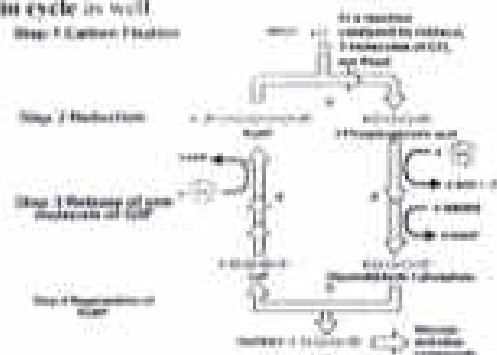


Fig. 7.11: Calvin cycle

1. Carbon dioxide combines with an already existing 3-carbon molecule: Ribulosebiphosphate ($RuBP$) to form a 6-carbon intermediate molecule.
2. This 6-carbon molecule is unstable and splits into two 3-carbon molecules ($3PGA$).



3. Now these 3-carbon molecules are reduced to 3-carbon sugar molecule (G3P) by NADPH using energy of ATP.
4. These 3-carbon sugar molecules are used to synthesise glucose and also to regenerate original 3-carbon molecule for next Calvin cycle.

Q.11: Briefly describe limiting factors of photosynthesis. / Explain the factors affecting rate of photosynthesis.

Ans. Rate of photosynthesis can be affected by following environmental factors called a limiting factor of photosynthesis.

1. More light intensity and duration of light (photoperiod) increase the process of photosynthesis.
2. Carbon dioxide is one of the raw material (substrate) for photosynthetic reaction. More CO_2 concentration increase the rate of photosynthesis but only up to a specific point.
3. Rate of photosynthesis is highest at $25^\circ C$ called optimum temperature for photosynthesis. Temperature below or above the optimum affect the rate of photosynthesis.

Q.12: Define respiration. Describe its types and importance.

Ans. The process by which energy is produced from food is called respiration. Respiration is a chemical process, which takes place in cells.

Types of Respiration

The two main types of respiration are: anaerobic respiration and aerobic respiration. The first phase of respiration called glycolysis, takes place in cytoplasm and is common in both anaerobic and aerobic respiration. During glycolysis, glucose is oxidized into two molecules of pyruvic acid with the yield of two ATP molecules.



(a) Anaerobic Respiration

Anaerobic respiration means, respiration in the absence of oxygen. During, anaerobic respiration glucose is not completely oxidized to carbon dioxide and water, but is converted into carbon dioxide and alcohol or lactic acid. This process is also called fermentation.

(i) Alcoholic Fermentation: In alcoholic fermentation, pyruvic acid produced during glycolysis is converted into ethyl alcohol and carbon dioxide. It occurs in yeast and some bacteria.



(ii) Lactic Acid Fermentation: During rough and continuous exercise our heart and lungs cannot provide enough oxygen to skeletal muscles as per increased requirement. During such vigorous exercise or labour, muscle cells start to carry out anaerobic respiration and each pyruvic acid molecule is converted into lactic acid. Bacteria which convert milk to yogurt also produce lactic acid.



Importance of Anaerobic Respiration

Anaerobic respiration is important for living organisms in following ways:

- (i) The earliest living organisms would have to produce energy by anaerobic respiration because the early earth had no free oxygen in its atmosphere.
- (ii) Anaerobic respiration by bacteria is used in cheese and yogurt making.
- (iii) Fermentation by yeast is used in wine making and baking industry.
- (iv) Anaerobic respiration, in the form of lactic acid fermentation provides some energy to muscle cells during running, labour or strenuous exercise.
- (v) **Aerobic Respiration:** Aerobic respiration means respiration in the presence and use of oxygen. During aerobic respiration, glucose molecule is completely broken-down in the presence of oxygen, to produce comparatively large amount of energy along with production of carbon dioxide and water. Aerobic respiration can be summed up by the following equation.



(P/11/07/11)

Q.13: Describe mechanism of aerobic respiration.

Ans. Mechanism of Aerobic Respiration

The breakdown of glucose does not take place in a single step but in a series of chemical reactions. Energy released from breakdown of glucose is stored in the form of chemical energy in ATP. The complete process of aerobic respiration is divided into four main phases: glycolysis, formation of acetyl CoA, Krebs cycle and electron transport chain.

1. Glycolysis

Glycolysis takes place in cytoplasm of the cell, outside the mitochondria. It occurs both in anaerobic and aerobic respiration. A single molecule of glucose is broken down into two molecules of pyruvic acid having 3 carbons. Two ATP molecules are produced as net energy gain. Two NAD⁺ molecules are reduced to NADH.



2. Formation of Acetyl CoA

Each pyruvic acid molecule is now oxidized to a two-carbon acetyl group which also combines with coenzyme A to form acetyl CoA. Carbon dioxide is removed and NADH is produced. The acetyl CoA enters mitochondrion where it will take part in Krebs cycle.



3. Krebs Cycle

Krebs cycle is a cyclic process which takes place in mitochondrial matrix. Coenzyme A is released and acetyl group is passed through a series of reactions. The products of this process are CO₂, NADH and FADH₂. Some energy is released to produce ATP directly, while more energy is pushed by oxidation of NADH and FADH₂ in ETC.



4. Electron Transport Chain (ETC)

(i) Electron transport chain is a series of electron carrier molecules located in the inner membrane of mitochondria.

(ii) The electrons that are removed by oxidation of glucose molecules during glycolysis and Krebs cycle are carried to ETC by NADH and FADH₂.

(iii) When electrons coming through NADH pass through ETC, they provide enough energy to synthesize three ATP molecules.

(iv) However, each FADH₂ produces only two ATP molecules.

(v) The final electron acceptor is oxygen atom which ultimately combines with hydrogen ions to produce water.



Fig. 7.12: An overview of aerobic respiration



ATP Usage in Body

The energy produced as ATP by cellular respiration is used in many ways e.g., working of muscles, nerve impulse transmission, growth and repair of cells, active transport, gland etc. In human body, brain uses maximum energy in the form of ATP i.e., 25% of ATP.

Multiple Choice Questions (Exercise)

1. Which is true about enzyme? (P/11/07/11)

- (a) all enzymes are not protein
- (b) all enzymes are vitamins
- (c) all enzymes are proteins
- (d) all proteins are enzyme

2. Lock and key hypothesis of enzyme action supports that: (P/11/07/11)

- (a) active sites are flexible
- (b) active sites are rigid
- (c) active site efficiency increases
- (d) active site can change its shape

3. Which graph shows how temperature affects the rate of an enzyme-controlled reaction? (P/11/07/11)



4. What is true about cofactors? (P/11/07/11)

- (a) break hydrogen bond in proteins
- (b) help facilitate enzyme activity
- (c) increase activation energy
- (d) are composed of proteins

- (c) ionization of cofactor
- (d) ionization of coenzyme

5. Change in pH can alter the active site by affecting the: (P/11/07/11)

- (a) ionization of amino acids
- (b) Shape of substrate

6. The catalytic region on enzyme recognizes and binds the substrate and carries the reaction. This region is called as: (P/11/07/11)

- (a) cofactor
- (b) activator
- (c) inhibitor
- (d) active site

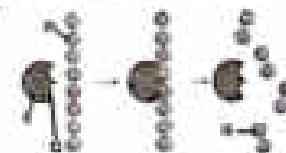
7. The graph shows the activity of three digestive enzymes at different pH levels. Which statement is correct? (P/11/07/11)

- (a) Enzyme X and Y are both active at pH 7
- (b) Enzyme X and Z are both active at pH 4
- (c) Enzyme Y and Z are both active at pH 4
- (d) Enzyme Y and Z are both active at pH 7



8. The diagram shows an amylase molecule catalysing the breakdown of a starch molecule. Which are the labelled parts P, Q, R and S? (P/11/07/11)

	Enzyme	Product	Substrate	Active site
(a)	P	Q	R	S
(b)	R	S	P	Q
(c)	S	P	Q	R
(d)	S	R	P	Q



9. Glycolysis is the breakdown of: (P/11/07/11)

- (a) fructose
- (b) glucose
- (c) lactose
- (d) maltose

10. The mechanism of ATP synthesis is: (P/11/07/11)

- (a) phosphorylation
- (b) photosynthesis
- (c) respiration
- (d) glucose



11. In aerobic respiration pyruvic acid changes to:
(a) glucose (b) fructose
(c) Acetyl CoA (d) citric acid

12. Which of these uses oxygen as the final acceptor?
(a) glycolysis
(b) electron transport chain
(c) Krebs cycle
(d) photosynthesis

13. Which of these produces carbon dioxide?
(a) Krebs cycle
(b) electron transport chain
(c) glycolysis
(d) photosynthesis

14. What are the products of light reactions in photosynthesis?
(a) ATP, NADPH and oxygen
(b) ATP and NADP
(c) ATP, PGA and oxygen
(d) PGA and oxygen

17. The diagram shows a pond weed in a test tube filled with water. Which conditions would cause the plant to produce more bubbles?

	Dissolved CO ₂	Light	Temperature
(a)	Present	Bright	Cool
(b)	Present	Bright	Warm
(c)	Present	Dim	Cool
(d)	Absent	Dim	Warm



18. Which of the following processes is used by plants to make oxygen during the process of photosynthesis?
(a) intake of water
(b) intake of CO₂
(c) Photolysis of water
(d) Calvin cycle

19. The diagram shows overview of cellular respiration.



15. The diagram shows an overview of photosynthesis. Which numbered molecule is organic biomolecule?



16. Which feature helps plants to make most food by the process of photosynthesis?

- (a) broad and flat leaves
(b) spiny leaves
(c) yellow leaves
(d) curled leaves

- Which labelled part represents NADH?
(a) X only (b) Y only
(c) Z only (d) Y and Z

20. A child left a carton on the lawn for two days. When the carton was picked up, the grass under it had turned yellow. What caused the grass to change colour?

- (a) lack of oxygen
(b) lack of carbon dioxide
(c) lack of light
(d) lack of water



Multiple Choice Questions (Additional)

21. Enzyme pepsin in the stomach has an optimum pH of about:

- (a) 3 (b) 4
(c) 2 (d) 5

22. If you add more substrate to already occurring enzymatic reaction and it has no effect on the rate of reaction, what is the form gives to this situation?

- (a) saturation (b) denaturation
(c) deactivation (d) inhibition

23. The active site of an enzyme:

- (a) never changes
(b) forms no chemical bond with substrate
(c) determines by its structure the specificity of the enzyme
(d) looks like a lump projecting from the surface of an enzyme

24. Which of the following is released when ES complex breaks?

- (a) enzyme (b) product
(c) substrate (d) enzyme and product

25. When enzyme attaches with substrate _____ is formed:

- (a) product (b) reactant
(c) ES complex (d) active site

26. Ionization of amino acids at the active site is affected by?

- (a) change in temperature
(b) change in substrate concentration
(c) change in pH
(d) change in temperature and substrate concentration

27. Set of biochemical reactions that occur in living organisms in order to maintain life is called?

- (a) catabolism (b) anabolism
(c) metabolism (d) mutualism

28. The biochemical reactions in which larger molecules are synthesized are called:

- (a) Anabolism
(b) metabolism
(c) catabolism
(d) digestive reactions

29. The biochemical reactions in which larger molecules are broken down are called:

- (a) metabolism (b) catabolism
(c) anabolism (d) mutualism

30. Which does yield energy?

- (a) anabolism (b) catabolism
(c) metabolism (d) none

31. Which does consume energy?

- (a) metabolism (b) anabolism
(c) both a and b (d) catabolism

32. In the presence of enzymes, reactions proceed at a:

- (a) slower rate (b) faster rate
(c) medium rate (d) very slow rate

33. Which of the following are not changed during the biochemical reactions?

- (a) substrate (b) products
(c) enzymes (d) ES complex

34. Enzymes convert the substrate into different molecules called:

- (a) reactants (b) products
(c) inhibitors (d) biomolecules

35. Pepsin enzyme works in:

- (a) stomach (b) large intestine
(c) small intestine (d) heart

36. Starch is broken down by an enzyme called:

- (a) lipase (b) pepsin
(c) amylase (d) none of these

37. If organic co-factors are loosely attached with enzymes they are called:

- (a) co-enzymes
(b) prosthetic group
(c) inhibitor enzymes (d) none of these

38. Many enzymes require cofactors for their proper working. Different cofactors belong to different groups. Pick the odd one:

- (a) vitamin A (b) coenzyme A
(c) NAD⁺ (d) Haem group

39. The chemicals which are involved as catalysts inside the living bodies are:

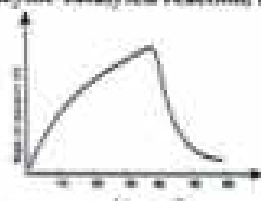
- (a) carbohydrates (b) fats
(c) protein (d) starch



40. Enzymes are biological catalysts which:

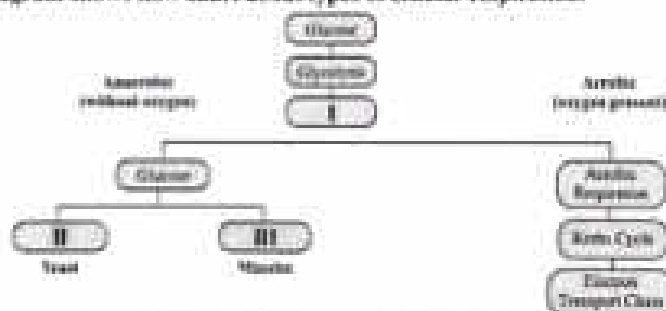
- (a) allow new chemical reactions to occur
- (b) are used up during chemical reactions
- (c) alter the direction of chemical reactions
- (d) alter the rate of chemical reactions

41. The graph below shows that the rate of an enzyme-catalysed reaction, its rate:



- (a) increases when the temperature is increased
- (b) decreases when the temperature is increased
- (c) increases with temperature up to a maximum of 40
- (d) remain unchanged

46. The diagram shows flow chart about types of cellular respiration:



	I	II	III
(a)	Lactic acid	Ethyl alcohol	Pyruvic acid
(b)	Ethyl alcohol	Pyruvic acid	Lactic acid
(c)	Pyruvic acid	Ethyl alcohol	Lactic acid
(d)	Pyruvic acid	Lactic acid	Ethyl alcohol

47. When a plant was kept in darkness for many days, its leaves turned yellow. Why?

- (a) leaves could not get oxygen
- (b) leaves could not get light and so there was no respiration

42. What is true about enzymes?

- (a) all parts of enzyme molecule take part in reaction
- (b) enzymes lower the activation energy of reaction
- (c) an enzyme can act upon any kind of substrates
- (d) they are needed in large quantities

43. One of the following may function as coenzymes for the enzymes:

- (a) proteins
- (b) carbohydrates
- (c) vitamins
- (d) DNA

44. Increase or decrease in temperature beyond the optimum temperature will

- (a) increase the rate of reaction
- (b) decrease the rate of reactions
- (c) not affect the rate of reaction
- (d) denature the enzyme

45. Trypsin, an enzymes, works at:

- (a) alkaline pH
- (b) acidic pH
- (c) neutral pH
- (d) pH does not affect its activity



48. In which component of the leaf cells, chlorophyll is present?

- (a) stroma
- (b) thylakoids
- (c) plasma membrane
- (d) cytoplasm

49. Which of these can enter into Krebs cycle?

- (a) glucose
- (b) pyruvic acid
- (c) citric acid
- (d) acetyl CoA

50. The major energy currency of all cells is:

- (a) ADP
- (b) ATP
- (c) AMP
- (d) P-bonds

51. There are _____ P-bonds in an ATP molecule.

- (a) three
- (b) nine
- (c) six
- (d) four

52. Alcoholic fermentation occurs in:

- (a) bacteria
- (b) yeast
- (c) man
- (d) bacteria and yeast

53. Lactic acid fermentation occurs in:

- (a) protozoans
- (b) skeletal muscles of humans
- (c) amoebae
- (d) yeasts

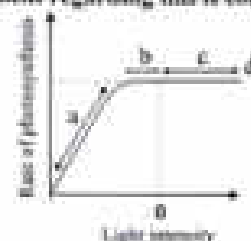
54. End product of glycolysis is:

- (a) $\text{CO}_2 + \text{ATP}$
- (b) CO_2
- (c) $\text{CO}_2 + \text{ATP} + \text{NADH}$
- (d) 2 pyruvic acid + 2ATP + 2NADH

55. After strenuous exercise you get tired because skeletal muscles accumulate:

- (a) lactic acid only
- (b) ethyl alcohol
- (c) lactic acid and CO_2
- (d) ethyl alcohol and CO_2

56. Study the given graph showing the effect of light intensity on the rate of photosynthesis. Which of the following statement regarding this is correct?



- (a) light is a limiting factor in the region 'a'
- (b) region 'c' represents that rate of photosynthesis is because some other factor became limiting

- (c) point 'd' represent the intensity of light at which some other factor became limiting
- (d) all of these

57. Which of the following is not a product of the light-dependent reactions of photosynthesis?

- (a) oxygen
- (b) ATP
- (c) NADPH
- (d) glucose

58. What is the main pigment used in photosynthesis?

- (a) carotene
- (b) xanthophyll
- (c) chlorophyll
- (d) anthocyanin

59. Where does the Krebs cycle occur in a cell?

- (a) nucleus
- (b) mitochondria
- (c) chlorophyll
- (d) endoplasmic reticulum

60. Which molecule is the final electron acceptor in aerobic respiration?

- (a) oxygen
- (b) carbon dioxide
- (c) glucose
- (d) water

61. What is the process of converting glucose into energy in the absence of oxygen?

- (a) photosynthesis
- (b) fermentation
- (c) oxidation
- (d) hydrolysis

62. During photosynthesis, which gas is taken in by plants?

- (a) oxygen
- (b) nitrogen
- (c) carbon dioxide
- (d) argon

63. What is the primary function of ATP in cells?

- (a) storing genetic information
- (b) providing structural support
- (c) transporting substances
- (d) transferring energy

64. In which part of the plant cell does photosynthesis occur?

- (a) mitochondria
- (b) nucleus
- (c) ribosome
- (d) chloroplast



65. Which process produces alcohol as a byproduct? 01/10/2020

- (a) lactic acid fermentation
(b) alcoholic fermentation
(c) aerobic respiration

(d) photosynthesis

66. What is the initial substrate for glycolysis? 01/10/2020

- (a) pyruvic acid (b) glucose
(c) ATP (d) NADH

Answer Key

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

Short Answer Questions (Exercise)

Q.1: Why enzymes are called biological catalyst? 01/10/2020

Ans. Enzymes are known as biocatalysts because they speed up and regulate the metabolic pathway of living organisms. Enzymes are mostly proteins that catalyze a chemical reaction in our body. They function as a catalyst that speed up the reaction by lowering the activation energy.

Q.2: Name the factors affecting enzyme activity. 01/10/2020

- Ans. (1) Temperature
(2) Substrate Concentration
(3) pH

Q.3: At what pH pepsin and trypsin enzymes act the best? 01/10/2020

Ans. Pepsin performs best in acidic medium in stomach at 2.00 pH whereas trypsin performs best in alkaline medium in small intestine at 8.00 pH.

Q.4: What happens to an enzyme when it is frozen below 0°C? 01/10/2020

Ans. At very low temperature (below 0°C) enzymes remain inactive due to fall in available

activation energy.

Q.5: Which protein digesting enzyme function in acidic medium? 01/10/2020

Ans. Pepsin is a protein digesting enzyme which functions in acidic medium.

Q.6: How enzyme lowers the activation energy? 01/10/2020

Ans. The need of activation energy acts as a barrier to the beginning of reaction. Enzymes (Biocatalysts) lower such barriers by decreasing the requirement of activation energy.

Thus in the presence of biocatalysts, reactions proceed at a faster rate. Enzymes lower the activation energy in several ways.

1. Enzymes may change the shape of the substrate.
2. Some enzymes alter the charge distribution on substrate.
3. Enzymes may position substrates together in the proper orientation.
4. Some enzymes add or remove functional groups on the substrate.



Q.7: Why are enzymes specific and why can't each one speed up many different reactions? 01/10/2020

Ans. Each enzyme is specific to a chemical reaction as it contains an active site which is an area of an enzyme that has specific shape which differs from one enzyme to another.

Q.8: Why small quantity of enzyme is enough for catalyzing large number of substrate molecules into products? 01/10/2020

Ans. Because enzymes have high capability to convert great quantities of substrate into product. Enzymes increase the rate of reaction

and remain unaffected by reaction which is being catalyzed.

Q.9: According to induced fit model, the active site is flexible. Does it mean that any substrate can attach with this flexible active site? If not, then explain. 01/10/2020

Ans. Enzymes are very specific for the substrate. One enzyme can act on a particular substrate because active sites possess specific geometric shapes that fit with specific substrates. According to induced fit model, the active site is slightly flexible but not flexible enough that any substrate can attach with active site.

Q.10: Sketch the structure of ATP. 01/10/2020

Ans. Structure of ATP Molecule

ATP molecule consists of three components:

1. Adenine (double ringed nitrogen base)
2. Ribose (Five carbon sugar)
3. Three Phosphate Groups (PO₄) linked in a chain called a triphosphate group. Adenine nitrogen base binds to ribose sugar and becomes adenosine.

Adenine + Ribose Sugar → Adenosine



Q.11: Write the equation of: (a) photosynthesis (b) fermentation (c) aerobic respiration. 01/10/2020

Ans. (a) Photosynthesis



(b) Fermentation



(c) Aerobic Respiration



Q.12: Name the products of anaerobic respiration in muscle cells. 01/10/2020

Ans. lactic acid (C₃H₇CO₂)

Q.13: Why dark reactions of photosynthesis are called so? 01/10/2020

Ans. Once the light reactions produce ATP and NADPH, a photosynthetic cell can fix carbon dioxide to synthesize sugar molecules. These reactions do not depend directly on light that is why it is called dark reactions.

Q.14: How photosynthesis and aerobic respiration are interlinked with each other? 01/10/2020

Ans. Both are interlinked in the following ways:

- (i) Both take place in living organisms.
- (ii) Energy conversion takes place in both processes.
- (iii) The exchange of carbon dioxide and oxygen during photosynthesis and cellular respiration worldwide helps to keep



atmospheric oxygen and carbon dioxide at stable levels.

(iv) Photosynthesis requires the product of aerobic respiration (CO_2 and H_2O) while

Short Answer Questions (Additional)

Q.15: A graph is drawn for two reactions. Identify the graphs X or Y as catalyzed or non catalyzed reaction? Support your answer with reasons.



Ans. X: Non catalyzed reaction (reaction without enzymes) Y: Catalyzed reaction (reaction with enzymes) Graph 'Y' is enzyme catalyzed reaction because it shows lower activation energy. All chemical reactions require activation energy. Enzymes lower the activation energy of the reaction. Therefore reactions convert into products at minimum energy requirement.

Q.16: Classify the following metabolic reactions A and B.



Ans.

(i) A is catabolic reaction	(i) B is anabolic reaction
(ii) Energy is released in catabolism	(ii) Energy is utilized in anabolism

Q.17: Define activation energy. Write its role in enzyme action.

Ans. The minimum amount of energy required to start a reaction is called activation energy. All chemical reactions require activation energy. The need for activation

aerobic respiration requires the products of photosynthesis (glucose and oxygen).

energy acts as barrier in the beginning of reaction. Enzymes lower the activation energy.

Q.18: Define co-factors. Give two examples.

Ans. Some enzymes require non-protein molecules or ions to work, these molecules or ions are called co-factors. Co-factors can either be inorganic e.g. metal ions or organic e.g. Flavins and haem.

Q.19: Describe lock and key model of enzyme action.

Ans. Emil Fischer proposed the lock and key model of enzyme action. The active site has particular rigid shape into which the specific substrate fits exactly. The substrate is imagined being like a key whose shape is complementary to the enzyme or lock. Once the product is formed it no longer fits into the active site and escapes into the surrounding medium. The active site is free to combine again with another substrate molecule.



Q.20: What do you know about the substrates and the products of the reaction?

Ans. Substrates are the molecules at which enzymes act and are called substrates.

Products are the molecules formed after catalytic action are called products.

Q.21: What do you mean by saturation of active sites?

Ans. When all the active sites of the enzymes are occupied (at high substrate concentration) and adding more substrate

molecule do not find free active sites, this state is called saturation of active sites and the reaction rate does not increase.

Q.22: How enzymes are named?

Ans. Enzymes are named by adding the suffix -ase to the names of the substrate that they modify (i.e. amylase and tyrosinase), or the type of reaction they catalyze (dehydrogenase, decarboxylase). Some have arbitrary names (pepsin and trypsin).

Q.23: Name the phases of aerobic respiration.

Ans. Phases of aerobic respiration are:
(i) Glycolysis (ii) Krebs cycle (iii) Electron transport chain

Q.24: Can pyruvic acid enter in Krebs cycle directly? Explain briefly.

Ans. No it cannot enter in Krebs cycle directly. Each pyruvic acid molecule is oxidized to a two-carbon acetyl group which also combines with coenzyme A to form acetyl CoA. Carbon dioxide is removed and NADH is produced. The acetyl CoA enters mitochondrion where Krebs cycle will occur.

Q.25: What is acetyl Co-A?

Ans. Before entering in Krebs cycle, pyruvic acid combines with coenzyme A and changed into a 2-carbon compound called acetyl Co-A.

Q.26: Define aerobic respiration.

Ans. A type of respiration in which complete oxidation of glucose occur with maximum release of energy in presence of oxygen.



Q.27: What is alcoholic fermentation?

Ans. In this type of anaerobic respiration, pyruvic acid is further broken down into alcohol ($\text{C}_2\text{H}_5\text{OH}$) and carbon dioxide (CO_2).
Pyruvic Acid $\rightarrow$ Ethyl alcohol + Carbon dioxide

Q.28: What is AMP?

Ans. AMP stands for adenosine monophosphate. ADP is broken down to AMP and P_i is released.



Q.29: Define anaerobic respiration (Fermentation).

Ans. Some organisms oxidize their food incompletely without using any molecular oxygen called anaerobic respiration. Glucose is incompletely oxidized with less amount of energy released. It is of two types: (i) Lactic acid fermentation (ii) Alcoholic fermentation.

Q.30: Why it is said that all life depends on photosynthesis?

Ans. Two main products of photosynthesis are glucose and oxygen.

Role of Glucose

Glucose is used to make cellulose, starch, proteins, fat and other organic compounds.

Glucose is stored in stem, roots, fruits, and seeds in the form of glucose or starch e.g. grapes, mangoes, apples, carrots, turnips etc. All the heterotrophs directly or indirectly depend on food prepared by autotrophs by the process of photosynthesis.

Role of Oxygen

All aerobic organisms for respiration use oxygen gas released as a by-product during photosynthesis. Thus, all life forms are completely dependent on photosynthesis.

Q.31: Differentiate between catabolism and anabolism.

Ans.

Anabolism	Catabolism
- It includes biochemical reactions in which larger molecules are synthesized. - Energy is utilized in anabolism. - It is constructive process. - Examples: Photosynthesis, protein synthesis and assimilation.	- It includes the biochemical reactions in which larger molecules are broken down. - Energy is released in catabolism. - It is a destructive process. - Examples: Respiration and digestion of food.



Q.32: In light reactions of photosynthesis why photosystem II comes before the photosystem I?

Ans. Because photosystem II was evolved earlier than photosystem I. Chlorophyll-a of photosystem II absorbs light and a pair of

electron is emitted from it. These emitted electron pair passes through electron transport chain and provides energy for ATP synthesis. Light also acts on photosystem I which also gives out an electron pair. These electrons and two H^+ of water reduce $NADP^+$ to $NADPH$.

SLO based Reference Material

Short Answer questions

Q.33: What do you know about Karl Lohmann and Fritz Lipmann?

Ans. ATP was discovered by Karl Lohmann in 1929, and its role as the cell's primary energy currency was established by Fritz Lipmann in the 1940s, earning him a Nobel prize in 1953.

Q.34: Only the related key can open the lock. How this fact is true for enzyme? Explain with examples.

Ans. The statement "only the related key can open the lock" describes the specificity of enzyme-substrate interactions. Enzymes have active sites that are precisely shaped to fit specific substrates, much like a lock fits only a specific key. This specificity ensures that enzymes catalyze only their intended reactions. For example, the enzyme lactase only binds to lactose to break it down into glucose and galactose, while amylase specifically targets starch to convert it into sugars. This precise fit between enzyme and substrate is crucial for the enzyme's catalytic activity.

Q.35: Write the difference between

a) Catalyst and enzyme

b) Intra cellular and extracellular enzymes.

Ans. a) Catalyst and Enzyme

Catalyst is a substance that increases rate of a chemical reaction without itself undergoing any permanent chemical change. While enzymes are proteins that speed up biochemical reactions and are not changed during the reaction.

b) Intracellular and extracellular enzymes

Intracellular Enzymes	Extracellular Enzymes
- Enzymes which remain inside the cell to speed up the reaction are called intracellular enzymes. - Example: Enzymes of glycolysis working in cytoplasm.	- Enzymes that work outside the cell are called extracellular enzymes. - Example: Pepsin enzyme working in the stomach cavity.

Q.36: Give names and examples of different types of cofactors.

Ans. Inorganic cofactors: Metal ions such as zinc, copper, iron etc.

Organic Cofactors

Some important vitamins such as riboflavin, thiamine and folic acid.

Q.37: What happens to an enzyme when it is heated up to 100°C ?

Ans. When temperature is raised well above the optimum temperature the heat energy increases the vibrations of enzyme molecules and the globular structure of enzyme is lost. This is known as denaturation of enzyme. So, at 100°C enzymes get denatured.

Q.38: Define cofactor. Categorise it into different types.

Ans. Some enzymes require non-protein molecules or ions for their proper working are called as cofactors. There are three types of cofactors: activator, prosthetic group and coenzyme.

Activator

Many enzymes require inorganic metal ions such as zinc, copper, iron and chloride etc.



For example salivary amylase activity is increased in the presence of chloride ions.

Prosthetic Group: If the cofactor is tightly bound to enzyme it is called as prosthetic group. Prosthetic groups are organic molecules. For example haem group.

Coenzyme: When the cofactor is detachable organic molecule it is called as coenzyme. Examples are NAD, coenzyme A and vitamin A.

Q.39: Why muscles are fatigued and discomforted after vigorous exercise?

Ans. During strenuous exercise, anaerobic respiration causes lactic acid to accumulate in muscle cells and surrounding tissues. This accumulation can lead to muscle fatigue and discomfort. To ease this condition the lactic acid from muscles is transported to the liver through blood which converts it into glucose. This glucose can then be released back into the blood stream to provide energy to muscle and other tissues, effectively recycling lactic acid into usable energy.

SLO Based Reference Material

Long Answer Questions

Q.1: Describe the comparison of aerobic and anaerobic respiration.

Ans.

	Anaerobic Respiration	Aerobic Respiration
Reactants	Glucose	Glucose and Oxygen
Products	- Ethyl alcohol in Alcoholic Fermentation - Lactic acid in Lactic Acid Fermentation	CO_2 and H_2O
Oxidation	Incomplete	Complete
Location	In Cytoplasm	In Cytoplasm and Mitochondria
Stages	1. Glycolysis 2. Fermentation	1. Glycolysis 2. Krebs Cycle 3. Electron Transport Chain
Oxygen requirement	No	Yes
Energy yield	Low (2 ATP)	High (36-38 ATP)

Q.2: Describe Comparison of respiration and photosynthesis.

Ans.

	Respiration	Photosynthesis
Type of Metabolism	Catabolism	Anabolism
Occurs in	All living things	Only green parts of plants
When it occurs	All the time	Only in day light
Organelle involved	Cytoplasm and Mitochondria	Chloroplast
Reactants	Glucose and Oxygen	CO_2 and H_2O
Products	CO_2 and H_2O	Glucose and Oxygen
Energy Conversion	Chemical energy is released in the form of kinetic energy	Light energy is trapped in the form of chemical energy
Phases	Three Phases 1. Glycolysis 2. Krebs Cycle 3. Electron Transport Chain	Two Phases 1. Light dependent reactions 2. Light independent reactions



Q3: Answer the questions related to the given figure.

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1. This figure is depicting the overview of photosynthesis. Identify the input A, B and output C, D of photosynthesis.

ii. Enlist the events that take place in stroma of chloroplast with the help of flow chart.

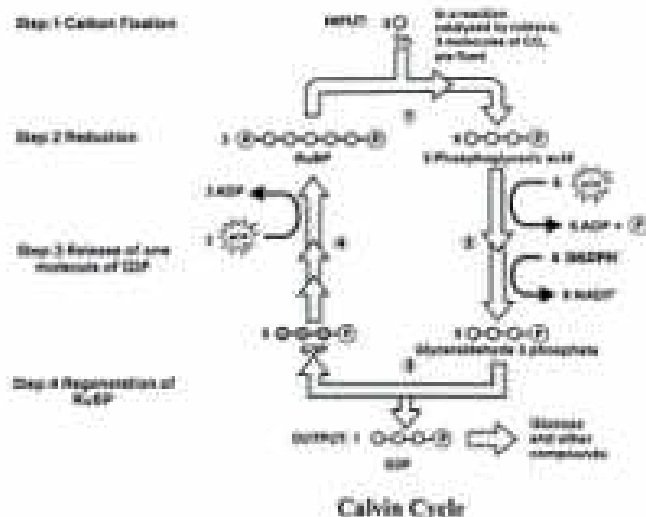
Ans. (B) A is H_2O , B is CO_2 , C is carbon dioxide and D is sugar.

(ii) In the stroma of chloroplast the process of light independent reaction or Calvin cycle takes place.

The following are the events of light independent reaction:

- CO₂ molecules are combined with 5-carbon compounds to form 2 temporary 6-carbon compounds, each of which splits into two 3-carbon compounds.
- The 3-carbon compounds are reduced to 3-carbon carbohydrates by using ATP and hydrogen from NADPH. The 3-carbon carbohydrates are used to manufacture glucose.
- The 3-carbon carbohydrates are also used to regenerate the original 5-carbon compounds. This step also utilizes ATP.

Flow chart of Calvin cycle is drawn below.



08

PLANT PHYSIOLOGY

Q.1: Define plant physiology. Explain it briefly.

Abstract

Ans. Plant physiology is the branch of botany, which deals with various questions related to functions of plant body.

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

It includes how plants grow from seed to the whole body, how plants absorb water and minerals and transport them to the leaves, how plants prepare organic solutes and transport them to the rest of the body, how plants exchange carbon dioxide and oxygen with their environment, how plants adapt themselves in changing environmental conditions and how plants produce their young ones to continue their species.

Q.1: Define nutrients and nutrition. Describe types of nutrients and the importance of nitrogen and magnesium in Plants. (04) State that nitrogen is important in protein synthesis and magnesium for chlorophyll formation.

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Ans. Nutrition in Plants

Abstract

Any substance that provides necessary elements to the organism for growth and metabolism is called nutrient. In general, a nutrient may be organic or inorganic; however, plant nutrients are inorganic.

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

The term nutrition is applied to all the processes that are involved in the utilisation of nutrients in growth or various metabolic activities of the body. Plants are autotrophs as they obtain inorganic nutrients such as water, carbon dioxide and certain minerals from the environment and convert them into organic compounds.

Types of Plant Nutrients

Major Researcher's Insights

Sixteen elements have been found essential for plant growth. Nine of these are required in fairly large quantities (greater than 0.05% dry weights) and are therefore known as macronutrients. These include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, and magnesium.

Salicyromycin derivatives

The remaining seven elements are needed in traces or small amounts (less than 0.01% dry weight) for normal plant growth and development that are known as micronutrients. These include iron, boron, manganese, copper, molybdenum, chlorine, and zinc.

(II) Importance of Nitrogen in Protein Synthesis

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Nitrogen is a macronutrient in the plant which is mainly absorbed by the plant from soil through their roots in the form of inorganic nitrogenous compounds like nitrates (NO_3^-).

Background:

The major source of nitrate in the soil is the decomposition of dead organic matter.

However, in the nitrogen depleted soils, it can be added in the form of nitrogen fertilizers.

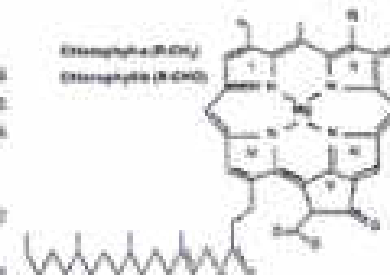


Fig. 10.1: Molecular structure of Cytosine

**Role**

(i) In plant body these nitrogenous compounds are used to make amino acids, nucleotides, and chlorophyll. The amino acids are then utilised in protein synthesis.

(ii) As the protein is the most abundant organic constituent of the plant body therefore, nitrogen deficiency in plant can lead to severe growth retardation.

(iii) The most obvious symptom of nitrogen deficiency in plant is the chlorosis i.e., yellowing of plant leaves due to deficiency of minerals, as the deficiency of nitrogen inhibits chlorophyll formation.

(2) Importance of Magnesium in Chlorophyll Formation**Introduction**

Magnesium is a macronutrient in the plant which is mainly absorbed by the plant from soil through their roots in the form of inorganic Mg^{2+} ions.

Source

The major source of magnesium in the soil is the decomposition of dead plant debris. However, in the magnesium depleted soils, it can be added in the form of dolomitic limestone or magnesium fertilizers like magnesium sulphate ($MgSO_4$).

Role

In plant body, the magnesium is used to make chlorophyll therefore, magnesium deficiency in plant can also lead to chlorosis.

Q.3: What is transport in plants? Why is transport necessary?

OR

Ans. Plants absorb nutrients from the soil which are then utilised in the leaves to prepare organic nutrients by photosynthetic activity. These organic solutes are also to be moved to different parts of the plant body. When organic solutes are utilised in plant body, some waste compounds are also produced which are then removed out of the plant body. All these movements of materials are generally referred to as transport in plants.

Need of Transport

In a plant body, transport occurs at three different levels:

At 1st Level

The materials are moved from outside to inside the plant body because plant needs mineral nutrients and water to maintain its life activities which are to be absorbed from the soil, however, gases like CO_2 and O_2 are obtained from air.

At 2nd Level

The materials are transported within the plant body from one place to another because the inorganic nutrients must be transported to the leaves so that they can be used to prepare organic solutes by photosynthetic activity. These organic solutes are also to be moved to different parts of the plant body so that they can be used in plant growth and metabolism.

At 3rd Level

The materials are moved from inside to outside the plant body because when organic solutes are utilised in plant body, some waste compounds are also produced which are then removed out of the plant body. These are the reasons why transport in plants occurs at three different levels.

Q.4: Explain the internal structure of root and root hairs.

OR

Ans. **Introduction**

Root is an underground part of the plant, which serve as the organ of uptake of mineral nutrients and water. It possesses large surface area due to extensive branching system and root hairs which make them favourable for organ of uptake.

Types of Roots**(1) Tap Root**

Dicot plants have tap root which consists of a thick primary



root that bears several secondary roots. Each secondary root further consists of large number of tertiary roots.

(2) Fibrous Root

On the other hand, monocot plants have fibrous adventitious roots that show no differentiation of primary, secondary and tertiary roots.

Internal Structure of Root and Root Hairs**(1) Epidermis**

In both monocot and dicot roots, the outermost layer is called epidermis.

(2) Root Hairs

Many cells of the epidermis have extensions that are penetrated the spaces among soil particles. These extensions of the root epidermal cells are called root hairs, which increase approximately 67% surface area of the root.

(3) Cortex

Inner to the epidermis is a ground tissue called the cortex.

(4) Endodermis

The inner lining of the cortex is called the endodermis.

(5) Casparian Strips

The endodermal cells have deposition of a wax, the suberin in their radial walls. These depositions are in the form of strips called the Casparian Strips.

(6) Vascular bundles

Inner to the endodermis is the pericycle which surrounds the innermost vascular bundles. The vascular bundle consists of xylem and phloem which are arranged in the form of ring in monocot root with central ground tissue called as pith. Whereas, in the dicot roots, the vascular bundles are present in the form of star shape in the centre of the root without the presence of pith.

Q.5: Describe how uptake of mineral salts and water by active and passive transport occur in plants? (OR) Describe how roots take water and mineral salts by active and passive absorption?

OR

Ans. **Functions of Root**

Plant roots serve two vital functions: anchoring the plant in soil and absorbing essential minerals and water.

Key Nutrients for Photosynthesis

To support the process of photosynthesis, plants require these key nutrients: carbon dioxide, water, minerals, and light.

Absorption of Nutrients

To obtain these nutrients, roots develop an extensive branching system and are covered by root hairs. These root hairs are the primary sites for the absorption of water and minerals. With these two materials (minerals and water from the soil, carbon dioxide from the air, and light energy), plants synthesise all the compounds they need. While most minerals enter the root hairs or epidermal cells of the roots through bulk flow with water, some are absorbed through diffusion, facilitated diffusion, or active transport.

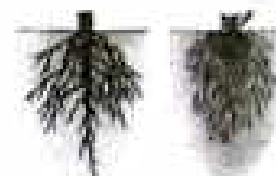


Fig. 8.2: Tap root in dicot plants (Left), Fibrous Adventitious root in Monocot plants (Right)

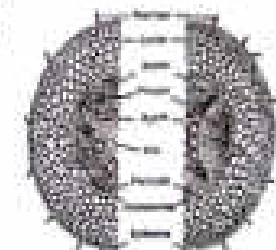


Fig. 8.3: T.S. of monocot root (Left) T.S. of dicot root (Right)

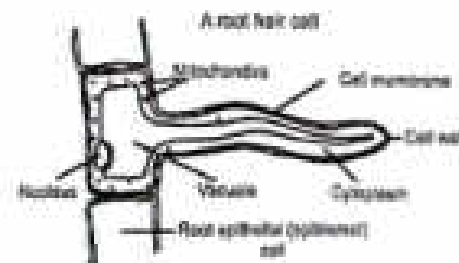


Fig. 8.4: Structure of root hair



Mechanism of Mineral Absorption by Root

(i) Absorption of Minerals from Water by Active and Passive Process

Plants absorb minerals from water in the soil. When minerals are stuck to soil particles and not dissolved in water, plants cannot use them. Only those minerals can be absorbed that are dissolved in soil water. Plants take in minerals through root cells using both passive and active processes that require energy, specifically ATP.

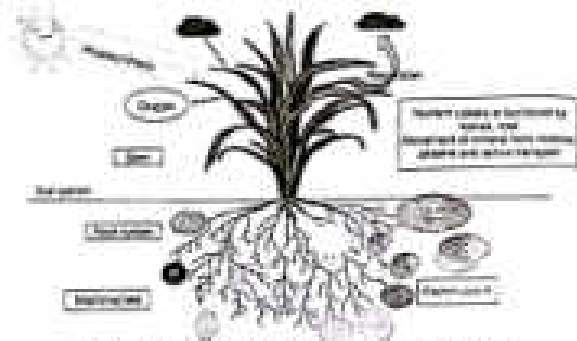


Fig. 8.5: Uptake of mineral nutrients by the plant.

(ii) Uptake of Minerals Through Diffusion

Passive uptake happens through diffusion, as minerals move along their concentration gradient through plasmodesmata to cells in the root's cortex, endodermis, and pericycle before reaching the xylem cells. They are then pulled up by transpiration.

(iii) Transport Through Facilitated Diffusion

Certain nutrients are transported from the soil into the epidermal cells of roots through their cell membranes by a process called facilitated diffusion. In facilitated diffusion, proteins within the cell membrane act as carrier molecules to help move nutrients across the membrane. These carrier proteins are found in the cell membranes of epidermal and other root cells.

(iv) Active Transport

Active transport on the other hand, requires energy and allows plants to take in minerals even when their concentration inside the root cells is higher than in the soil. This is against the natural concentration gradient, and it involves the use of ATP. Active transport is selective and relies on respiration. Some ions can also move through passive transport.

Mechanism of Water Absorption by Root

(i) Transport through Osmosis

Absorption of water by roots occur by means of a passive transport mechanism called osmosis. This is the movement of water molecules through a partially permeable membrane from an area where they are more concentrated to an area where they are less concentrated.

(ii) Endosmosis and Exosmosis

If water moves into a cell through osmosis, it's called endosmosis, and if it moves out of the cell, it's called exosmosis.

In the epidermal cells of roots, the cell wall allows water and minerals to pass through freely.

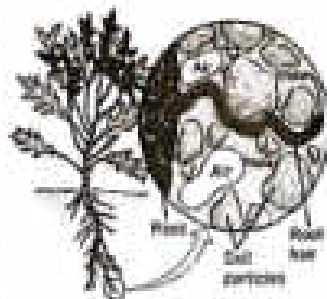


Fig. 8.6: Uptake of water by the plant



However, the cell membrane is selectively permeable, meaning it only allows certain substances from the solution to pass through. Water entering the epidermal cells follows the concentration gradient, moving through the cortex, endodermis, pericycle, and finally into the xylem cells.

Q.6: Describe transpiration and relate this process with the cell surface and stomatal opening and closing.

(BY SCORER)

Ans. Introduction

Plants absorb water from the soil by the roots. This absorbed water moves in the aerial parts of the plant from where the most of this water (approx. 99%) has been lost in the form of vapours into the atmosphere. This loss is called transpiration.

Types of Transpiration

(1) Stomatal Transpiration

90% of this loss occurs through the stomata present mainly in the leaves and some other aerial parts of the plant. This is called stomatal transpiration.

(2) Cuticular Transpiration

Some other amount of this absorbed water (7-9%) is lost from general body surface through the cuticle, called as cuticular transpiration.

(3) Lenticular Transpiration

A very little amount of water (less than 3%) is also lost through lenticels which are scar like regions (with ruptured epidermis and loosely packed underlying cortical cells) present in the stem. This is called lenticular transpiration.

Importance of Transpiration

(i) Transpiration is a vital process for the plant as it not only provides cooling to the plant but also help to absorb the water and dissolved minerals and to move them in upward direction to the leaves. Therefore, without transpiration plants are unable to survive.

(ii) On the other hand, transpiration is generally regarded as disadvantageous as it shows great loss of absorbed water so, an unchecked excessive transpiration can lead to the wilting (loss of turgor) and ultimately death of the plant.

Relation of Transpiration with Leaf Surface Area and Stomatal Opening and Closing

(i) Transpiration mainly occurs through the stomata, which are present on the leaf surface. So, the plants having large surface area of the leaves having more stomata show greater rate of transpiration as compared to the plants having narrow and reduced surfaces of the leaves having less stomata.

(ii) Similarly, more transpiration is generally observed in day time than night as the stomata are widely open during day and nearly close at night.

Q.7: Describe temperature, wind and humidity as factors affecting the rate of transpiration.

Ans. Introduction

The rate of transpiration is influenced by several environmental factors like temperature, wind, and humidity etc.

Measurement of Transpiration

The rate of transpiration can be measured by using a simple apparatus called the potometer which is shown in the diagram.

(1) Effect of Temperature

(i) On a sunny day with strong sunlight, the air temperature rises, and this increase in temperature lowers the humidity in the air. As a result, more water evaporates from the surfaces of plant mesophyll cells, which leads to a higher rate of transpiration.



Fig. 8.7: Investigation of rate of transpiration by using potometer



- (ii) For every 10°C increase in temperature, the rate of transpiration roughly doubles.
- (iii) However, when the environmental temperature becomes very high, around $40-45^{\circ}\text{C}$, it causes the stomata on plant leaves to close. This closure helps the plant conserve its much-needed water because excessive loss can be detrimental.
- (iv) If these higher temperatures persist for an extended period and the soil doesn't have enough water, the plants may start to wilt and could eventually die.

(2) Effect of Wind

Wind is moving air, and it speeds up the diffusion of water molecules. This leads to a higher rate of evaporation from the surfaces of mesophyll cells.

In contrast, when the air is calm and still, the movement of water molecules (diffusion) slows down, resulting in a decreased rate of transpiration.

(3) Effect of Humidity

Humidity is the percentage of water vapours in the air. In dry air (low humidity), water molecules diffuse more rapidly from the surfaces of mesophyll cells, air spaces, and through stomata to the outside of the leaf. This results in more water being lost, which increases the rate of transpiration. Conversely, in humid air, the diffusion rate slows down, leading to a significant decrease in the rate of transpiration.

Q.8: How does transport of water and salts within plant body (Ascent of Sap) take place?

Ans. Introduction

Root epidermal cells absorb water and minerals from the soil. These substances are then transported from the roots to the leaves. This upward movement of water and dissolved minerals through the xylem tissue is known as the "ascent of sap." This process requires a passage and a significant amount of force because it occurs against the force of gravity, especially in tall plants.

TACT Theory

It is now quite evident that passage of ascent of sap is the xylem tissue and the most widely accepted theory that explains the force responsible for ascent of sap is called the TACT theory.

Passage of Ascent of Sap

Xylem is a complex and permanent tissue which act as passage for ascent of sap.

Types of Xylem Cells

Two type of xylem cells: Tracheids and Vessel are very important.

(i) Tracheids are long, dead cells with pointed ends

(ii) Xylem vessels are long, dead, and thick walled tube-like structures formed by the fusion of vessel cells (vessel elements) placed end to end. Both are essential for water and mineral transport as well as structural support.

Factors for Ascent of Sap

According to the TACT theory, four factors work together to make a force that move water and minerals up a plant.

These factors are Transpiration pull, Adhesion, Cohesion, and

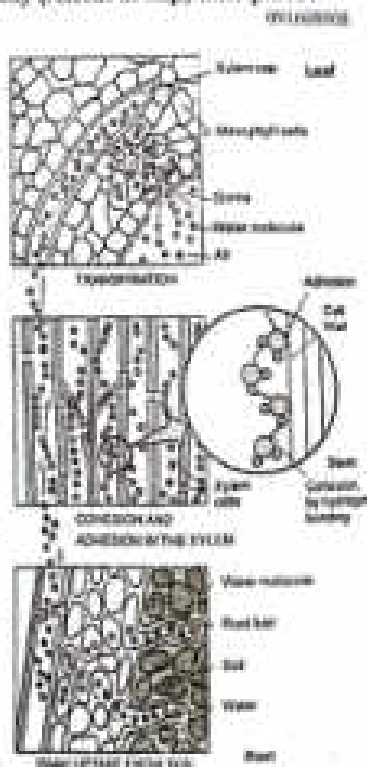


Fig. 8.16 Movement of water in xylem through TACT Mechanism



Tension, forming the acronym TACT.

(i) Transpiration Pull

When stomata (tiny openings) on leaves are open, water evaporates from the leaves into the air, creating a pulling force known as transpiration. This pull makes water move from the roots to the leaves through the xylem tissue.

(ii) Adhesion

Adhesion is the attraction between water molecules and other substances. Water is strongly attracted to the walls of the xylem cells because both water and cellulose (in cell walls) are polar molecules. This adhesion helps water move upward in the plant against gravity. It also keeps water in the xylem when transpiration is not happening.

(iii) Cohesion and Tension

Cohesion is the attraction between nearby water molecules, which is possible because water is a polar molecule.

Tension refers to the tension created in the water column. These forces help hold the water molecules together in a continuous column within the xylem.

Working of TACT Force

Imagine the column of water in the xylem as strong as a steel wire. Hydrogen bonds among water molecules create cohesion, holding the water molecules together like a string. As long as transpiration continues (water evaporating from leaves), the string of water remains tense and is pulled upward as a single unit. This bulk flow of water to the top of the plant is driven by solar energy, as it's the evaporation from leaves that causes the transpiration pull.

Q.9: Explain the mechanism of food translocation by the theory of pressure flow mechanism. (OR) What is translocation? Describe pressure flow mechanism of translocation in plants.

Ans. Introduction

The transport of prepared food (organic solutes) to different parts of the plant through the phloem tissue is translocation.

Passage of Translocation

It is evident that translocation occurs through phloem tissues which are complex and permanent plant tissues. Sieve tube elements and companion cells are important components of phloem.

Sieve Tubes

Sieve Tubes are long tube-like structures that transport organic solutes (like sucrose) throughout the plant. Since sieve tube elements lack nuclei, companion cells next to them control their functions. Together, sieve elements and companion cells act as conducting channels for moving organic solutes.

Direction of Translocation

This movement is not just up or down; it goes in various directions. We usually say that translocation goes from a "source" to a "sink." A "source" is

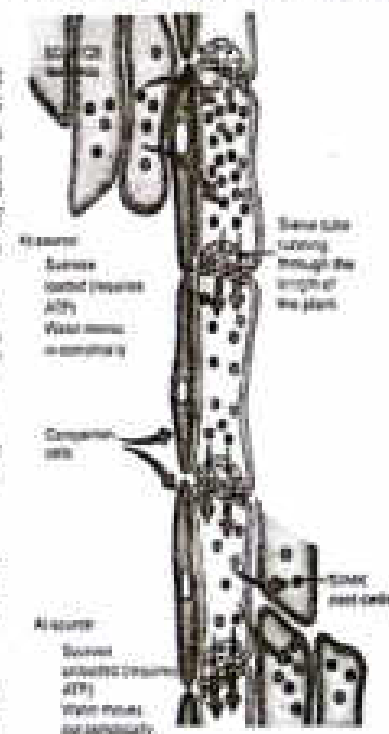


Figure: 8.3 Pressure flow Mechanism for Passage Transports. Sugar is actively loaded into the sieve tube at the source. As a result, water moves into the sieve tubes by osmosis. At the sink, the sugar is actively unloaded, and water leaves the sieve tube by osmosis.



supplies food (like leaves making food), and a "sink" uses food (like roots or storage organs). Leaves are sources, fruits are sinks, and stems and roots can act as both.

Composition of Translocating Fluid (Phloem Sap)

Phloem sap contains about 10-25% dry matter. Most of this dry matter is sucrose (a kind of sugar), with some other organic compounds.

Mechanism of Translocation (Pressure Flow or Mass Flow Theory)

The most accepted idea for how organic solutes moves in plants is the "pressure flow" or "mass flow" theory. Here's how it works:

1. Sugars produced in source regions, like leaves or storage areas, are loaded into the phloem's sieve tube elements by companion cells.
2. This active transport raises the sugar concentration and reduces the water concentration in the phloem. This makes the phloem cells more "sweet."
3. Water moves into the phloem through osmosis from nearby xylem cells, increasing hydrostatic pressure (pressure from water) in the phloem cells. This pressure pushes the sugary solution away from the source (usually a leaf).
4. The pressure difference, from the high-pressure source to the lower-pressure sink, causes translocation. It's like water being pushed through a hose.
5. When the solution reaches a sink, like the roots, root cells actively absorb the organic solutes. This makes the phloem sap less "sweet."
6. The loss of solutes in phloem sap increases solute potential and water potential, causing water to flow back into the xylem tubes.

So, it's like a system of moving food and water around the plant, driven by differences in pressure and the needs of different plant parts.

Q.10: Describe the process of gas exchange in plants.

(09/03/2021)

Ans. Introduction

Gas exchange is the type of respiration that occurs at organismic level. Gas exchange is when the entire organism exchanges gases with the environment. The goal is to make sure that the organism must be provided with oxygen which is needed for cellular respiration, where complex organic compounds are broken down, and carbon dioxide is produced which is to be removed in outer environment.

Stomata and Gas Exchange

Every cell in a plant does its own gas exchange, depending on what it needs. This exchange mainly happens through two openings: stomata (tiny openings in leaves) and lenticels (small openings in stems). This exchange happens through a process called diffusion.

Pattern of Gas Exchange in Leaves (Photosynthetic Parts)

The plants being photosynthetic autotrophs show different pattern of gas exchange in day and night through the leaves.

Pattern of gas exchange between plant and environment		
	In daytime	In night time
Inhale	Carbon dioxide (CO_2)	Oxygen (O_2)
Exhale	Oxygen (O_2)	Carbon dioxide (CO_2)

(a) At the Day time

During the day, plants are busy with both photosynthesis (making food) and respiration. The rate of photosynthesis varies throughout the day as it mainly depends upon light intensity. Generally, the rate of photosynthesis is greater than rate of respiration, therefore, the photosynthesis needs more carbon dioxide than what respiration produces, so plants bring in extra carbon dioxide



from the environment. On the other hand, photosynthesis produces more oxygen than respiration needs, so plants release excess oxygen.



Fig. 8.10: Pattern of gas exchange in leaves and roots in day and night

(b) At Night Time

At night, plants act more like animals. They absorb oxygen and release carbon dioxide because there's no photosynthesis happening in the dark.

(c) At Dawn and Dusk Time

During dawn and dusk, when light intensity is low, the rates of photosynthesis and respiration become equal. This means the carbon dioxide produced by respiration is enough for photosynthesis, and the oxygen released by photosynthesis is used in respiration. At this point, there's no net exchange of gases with the environment, and we call it the "compensation point of photosynthesis."

Pattern of Gas Exchange in Roots (Non-photosynthetic Parts)

Roots also exchange gases with soil air through root epidermal cells which involves absorption of oxygen and release carbon dioxide because there's no photosynthesis happening in the roots and it remains same day and night.

Q.11: What is homeostasis in plants? Explain its importance.

(09/03/2021)

Ans. Introduction

Homeostasis in plants refers to the adjustment or adaptation of plants to varying degrees of environmental temperatures and availability of water and salts in the soil.

Importance of Homeostasis

- (i) Homeostasis in plants is essential for their survival, growth, and reproduction.
- (ii) Homeostatic mechanisms help plants respond to temperature changes, allowing them to survive in various climates.
- (iii) Homeostasis ensures that plants maintain adequate hydration levels.
- (iv) Homeostasis allows plants to respond to various stressors, such as drought, salinity, pathogens, and herbivores.
- (v) Plants can activate specific defense mechanisms to mitigate damage.
- (vi) It enables them to adapt to changing environmental conditions and maintain internal stability, ultimately contributing to their ecological success.

Q.12: Describe the mechanism of adaptation of plants for the excretion.

(09/03/2021)

Ans. Introduction

Unlike animals, excretion in plants is a very broad term, which encompasses the removal of anything from plant body. Plants have a different way of getting rid of waste compared to animals. Plants make various organic and inorganic compounds that they store for different reasons and remove when needed.

Ways of Excretion in Plants



Following are different ways of excretion in plants:

(i) Excretion of Carbon dioxide and Oxygen

Carbon dioxide is the waste of respiration which is excreted from plant body at night during gas exchange process. Similarly, oxygen is the waste of photosynthesis which is excreted in day during the same gas exchange process.

(ii) Excretion of Water

Water is produced as waste of both photosynthesis and respiration and it is also absorbed from soil. The excretion of water occurs through the plant body during the process of transpiration.

(iii) Excretion Through Leaves

Plant cells have large vacuoles that can store useful stuff or waste. Sometimes, these stored substances can build up and form crystals in the vacuoles. Leaves are key players in this process. When the leaves are loaded with large amount of pigmented compounds, they turn yellow. Remember, this yellowing is not due to lack of chlorophyll as happens in chlorosis.

Such leaves are generally fallen from plants in autumn season. In this way leaves act as organ of excretion, therefore, such leaves are also called **exeretophores**. This is why gardeners like using decomposed autumn leaves as a mineral-rich source for plants.

(iv) Excretion Through Stem and Branches

Some trees deposit unusual chemicals in their branches and trunks, especially in old xylem that's no longer used for water transport. Ebony trees, for instance, produce very dark wood in their centers. Plant scientists consider these deposits as waste materials. Although, these wastes are not removed but are dumped in one part of the body as we put the trash in waste bin however, it is still present in the home.

(v) Excretion Through Roots

Some plants actively release waste compounds into the soil, almost like using them as chemical weapons against other plants competing for resources. Coelifer trees are known for this tactic.

Q.13: Explain osmotic adjustment (Osmoregulation) in plants.

Ans. Introduction

Osmotic adjustment, also known as **osmoregulation**, is like a plant's way of maintaining the right balance of water and solutes in its body. This balance creates three different situations: hypotonic, hypertonic, and isotonic.

Hypotonic Situation

When a cell is in a watery environment with more water and less stuff dissolved in it (solvent), water moves into the cell, making it swell up and firm (we call this "turgid").

Hypertonic Situation

If a cell is in an environment with less water and more dissolved stuff than it has inside (cell sap), water moves out of the cell, causing it to shrink and become limp (we call this "flaccid"). Both of the situations, hypotonic and hypertonic, require the plant to make adjustments to keep things in balance.

Ideal Situation (Isotonic)

The best scenario for a cell is when the water and solute balance inside and outside the cell is just right. In this "isotonic" situation, there's no net movement of water in or out of the cell. However, this balance is rarely found in a plant's natural environment.

Osmotic Adjustment in Different Plant Groups

Plants are categorized into three groups based on their water availability:

(a) **Hydrophytes**: (live in water-rich environments).

(b) **Mesophytes**: (thrive where water is moderately available).



(c) **Xerophytes** (adapted to extreme dry conditions).

These groups have distinct adaptations:

- Transpiration rates vary, with hydrophytes having the highest and xerophytes the lowest.
- Stomatal placement differs, hydrophytes have them on the upper leaf surface, mesophytes on the lower surface, and xerophytes have sunken stomata.
- Stomatal behaviour varies, hydrophytes keep stomata open day and night, mesophytes open them during the day, and xerophytes open them at night.
- Cuticle thickness on leaves differs, with xerophytes having the thickest, mesophytes a thinner cuticle, and hydrophytes almost none.
- Water storage capacity varies, with xerophytes, known as succulents, storing ample water.

Multiple Choice Questions (Exercise)

- Chlorosis does not occur due to the deficiency of:
 - Sulphur
 - Magnesium
 - Phosphorus
 - Calcium
- Most of the uptake of water and minerals from soil takes place through:
 - epidermal cells
 - root cap
 - root
 - root hair
- The sugar moves through phloem is mostly in the form of:
 - glucose
 - sucrose
 - maltose
 - lactose
- Which category of plants stores a small amount of water and has a thin cuticle?
 - Hydrophytes
 - Xerophytes
 - Mesophytes
 - Succulents
- What is a key role of leaves in managing waste in plants?
 - Storing waste materials
 - producing chlorophyll
 - absorbing water from the soil
 - converting waste into energy
- When the rate of photosynthesis become equal to that rate of respiration in the plant body. Which of the following pattern of gaseous exchange occurs between plant and its environment?
 - Carbon dioxide is absorbed, and oxygen is released.
 - Oxygen is absorbed, and carbon dioxide is released.
 - Both carbon dioxide and oxygen are absorbed.
 - Neither carbon dioxide nor oxygen are absorbed.
- What is the role of companion cells in the translocation process?
 - They store excess solutes in the phloem.
 - They help regulate water potential in the xylem.
 - They actively transport sugars into the phloem's sieve tube elements.
 - They assist in the absorption of water by roots.
- What drives the translocation of organic solutes in plants?
 - Differences in sugar concentration.
 - Differences in leaf size.
 - Differences in root structure.
 - Differences in stem length.
- According to the TACT theory, what are the four factors that work together to move water and minerals up a plant?
 - temperature, humidity, sunlight and soil type.
 - Transpiration pull, adhesion, cohesion, and tension.
 - stomata, xylem, phloem and roots.
 - stomata, xylem, phloem and flowers.
- What drives the bulk flow of water to the top of the plant according to the TACT theory?
 - root pressure.
 - soil moisture.
 - solar energy from photosynthesis.
 - transpiration from the leaves.



Multiple Choice Questions (Additional)

11. Food is transported in plants in the form of:
(a) proteins (b) glucose
(c) starch (d) sucrose
12. The diagram show pressure flow mechanism through phloem. Which labelled part will act as sugar sink?
(a) A (b) B
(c) C (d) D



13. The rate of transpiration is increased when:
(a) light is low
(b) temperature decreases
(c) humidity increases
(d) none of these
14. Pressure flow mechanism is about:
(a) translocation of food
(b) transport of water
(c) opening of stomata
(d) transpiration
15. Absorption of water molecules through root hairs is due to:
(a) active transport
(b) diffusion
(c) Osmosis
(d) pressure flow
16. According to pressure-flow theory one of the following is not a sink:
(a) root (b) leaves
(c) stem tubers (d) fruits

17. When you suck a cold drink using drinking straw, it resembles with:
(a) diffusion
(b) flow of material in xylem
(c) flow of material in phloem
(d) root pressure
18. Which of the following is not a characteristic of xerophyte?
(a) have deep roots
(b) presence of paracymbria
(c) have broad leaves
(d) less number of stomata in present
19. Maintenance of internal body temperature is called:
(a) osmoregulation (b) excretion
(c) thermoregulation (d) transpiration
20. The plants, which live completely or partially submerged in fresh water are:
(a) xerophytes (b) halophytes
(c) mesophytes (d) hydrophytes
21. All of the following are the adaptations of xerophytes except:
(a) thick cuticle
(b) large number of stomata
(c) sunken stomata
(d) deep root system
22. The loss of water in the form of drops from tips of leaf is called:
(a) excretion (b) guttation
(c) transpiration (d) evaporation
23. What is produced during respiration?
(a) CO_2 (b) H_2O
(c) CO_2 and H_2O (d) N_2
24. Which of the following is not function of roots in plants?
(a) absorption of water
(b) photosynthesis
(c) anchor the plant
(d) nutrient absorption
25. Which of the following elements are micronutrients for plants?
(a) nitrogen (b) zinc
(c) carbon (d) phosphorus

26. Which process is not involved in water transport in plants?
(a) transpiration
(b) photosynthesis
(c) root pressure
(d) capillary action
27. What are the roles of stomata in plants?
(a) gaseous exchange
(b) water absorption
(c) Transpiration
(d) Nutrient uptake
28. Which of the following are ways hydrophytes adapt to osmotic conditions?
(a) developing deep roots
(b) having thick cuticle
(c) producing large leaves
(d) developing sunken stomata
29. Which component is not the part of the plant's vascular system?

- (a) xylem (b) phloem
(c) root hairs (d) stomata
30. What roles does magnesium play in plants?
(a) aids in water transport
(b) is a component of chlorophyll
(c) promotes early root formation
(d) involved in enzyme functions
31. Which of the following are not types of transpiration?
(a) stomatal (b) cuticular
(c) lenticular (d) root
32. What are the not functions of leaves in plants?
(a) photosynthesis
(b) water storage
(c) waste storage
(d) gas exchange

Answer key

1.	(d)	2.	(d)	3.	(b)	4.	(c)	5.	(a)
6.	(d)	7.	(c)	8.	(a)	9.	(b)	10.	(d)
11.	(d)	12.	(b)	13.	(d)	14.	(a)	15.	(c)
16.	(b)	17.	(b)	18.	(c)	19.	(c)	20.	(d)
21.	(b)	22.	(b)	23.	(c)	24.	(b)	25.	(b)
26.	(b)	27.	(a)	28.	(c)	29.	(d)	30.	(b)
31.	(d)	32.	(b)						

Short Answer Questions (Exercise)

- Q.1: Why is transpiration called necessary evil?
Ans. Importance of Transpiration
(i) Transpiration is a vital process for the plant as it not only provides cooling to the plant but also help to absorb the water and dissolved minerals and to move them in upward direction to the leaves. Therefore, without transpiration plants are unable to survive.
(ii) On the other hand, transpiration is generally regarded as disadvantageous as it shows great loss of absorbed water so, an unchecked excessive transpiration can lead to the wilting (loss of turgor) and ultimately death of the plant.

- Q.2: What is the composition of translocating fluid?
Ans. Translocating fluid (phloem sap) contains about 10-25% dry matter. Most of this dry matter is sucrose (a kind of sugar), with some other organic compounds.
Q.3: Why gardeners like to use autumn leaves in their soil?
Ans. When leaves are loaded with large amount of pigmented compounds, they turn yellow. Such leaves are generally fallen from plants in autumn season. In this way leaves act as organ of excretion. Therefore, such leaves are also called excretionaries. That is why



gardeners like using decomposed autumn leaves as a mineral rich source for plants.

Q.4: What is the effect of temperature on the rate of transpiration? (01/00/01)

Ans. (i) On a sunny day with strong sunlight, the air temperature rises, and this increase in temperature lowers the humidity in the air. As a result, more water evaporates from the surfaces of plant mesophyll cells, which leads to a higher rate of transpiration.

(ii) For every 10°C increase in temperature, the rate of transpiration roughly doubles.

(iii) However, when the environmental temperature becomes very high, around 40-45°C, it causes the stomata on plant leaves to close. This closure helps the plant conserve its much-needed water because excessive loss can be detrimental.

(iv) If these higher temperatures persist for an extended period and the soil doesn't have enough water, the plants may start to wilt and could eventually die.

Q.5: Write any three osmotic adjustments in hydrophytes. (01/00/01)

Ans. They have developed mechanisms for the removal of extra water from their cells.

(i) Hydrophytes have broad leaves with large number of stomata on their upper surfaces. This characteristic helps them to remove the extra amount of water.

(ii) Hydrophytes keep stomata open day and night.

(iii) Hydrophytes almost have no cuticle.

Q.6: What is the pattern of gas exchange between plant and environment at the time of dawn and dusk? (01/00/01)

Ans. During dawn and dusk, when light intensity is low, the rates of photosynthesis and respiration become equal. This means the carbon dioxide produced by respiration is enough for photosynthesis, and the oxygen released by photosynthesis is used in

respiration. At this point, there's no net exchange of gases with the environment, and we call it the "compensation point of photosynthesis."

Q.7: Why plants absorb carbon dioxide and release oxygen during daytime? (01/00/01)

Ans. During the day, plants are busy with both photosynthesis (making food) and respiration. The rate of photosynthesis varies throughout the day as it mainly depends upon light intensity.

Generally, the rate of photosynthesis is greater than rate of respiration, therefore, the photosynthesis needs more carbon dioxide than what respiration produces, so plants bring in extra carbon dioxide from the environment. On the other hand, photosynthesis produces more oxygen than respiration needs, so plants release excess oxygen.

Q.8: Define following terms: (01/00/01)

(i) Osmotic adjustment

(ii) Transpiration

(iii) Translocation

(iv) Micronutrients (v) Excretophores

(vi) Vascular bundle (vii) Xylem

(viii) Adhesion (ix) Cohesion

Ans. (i) Osmotic Adjustment

Osmotic adjustment, also known as osmoregulation, is like plant's way of maintaining the right balance of water and solutes in its body.

(ii) Transpiration

Plants absorb water from the soil by the roots. This absorbed water moves in the aerial parts of the plant from where the most of this water (approx. 99%) has been lost in the form of vapours into the atmosphere. This loss is called transpiration.

(iii) Translocation

The transport of prepared food (organic solutes) to different parts of the plant through the phloem tissue is translocation.

(iv) Micronutrients

The seven elements are needed in traces or small amounts (less than 0.05% dry weight) for normal plant growth and development that are known as micronutrients. These include

iron, boron, manganese, copper, molybdenum, chlorine, and zinc.

(v) Excretophores

Plant cells have large vacuoles that can store useful stuff or waste. Sometimes, these stored substances can build up and form crystals in the vacuoles. Leaves are key players in this process. When the leaves are loaded with large amount of pigmented compounds, they turn yellow. Remember, this yellowing is not due to lack of chlorophyll as happens in chlorosis.

Such leaves are generally fallen from plants in autumn season. In this way leaves act as organ of excretion, therefore, such leaves are also called excretophores. This is why gardeners like using decomposed autumn leaves as a mineral-rich source for plants.

(vi) Vascular bundle

There are two types of compound tissues in plants: (a) xylem (b) phloem.

Together they form the vascular bundles. Both xylem and phloem are composed of more than one type of cells. Xylem tissue is responsible for the transport of water and dissolved substances from roots to aerial parts. Phloem are responsible for the conduction of dissolved organic matter (food) between different parts of plant body.

(vii) Xylem

(1) Xylem tissue is responsible for the transport of water and dissolved substances from roots to aerial parts.

(2) They provide support to plant body because of presence of lignin in its secondary cell walls. Lignin makes these walls thick and rigid.

(b) Hydrophytes and Xerophytes

Hydrophytes	Xerophytes
1. They live in water-rich environments.	1. These plants are adapted to extreme dry conditions.
2. Rate of transpiration is highest.	2. They exhibit lowest rate of transpiration.
3. Stomata are present on the upper surface of leaf.	3. Xerophytes possess sunken stomata.
4. These plants have thin cuticle.	4. Thick cuticle is present in them.

(c) Monocot root and dicot root



(viii) Adhesion

Adhesion is the attraction between water molecules and other substances. Water is strongly attracted to the walls of the xylem cells because both water and cellulose (in cell walls) are polar molecules. This adhesion helps water move upward in the plant against gravity. It also keeps water in the xylem when transpiration is not happening.

(ix) Cohesion

Cohesion is the attraction between nearby water molecules, which is possible because water is a polar molecule.

Q.9: Write the difference between (01/00/01)

(a) Micronutrients and macronutrients

(b) Hydrophytes and xerophytes

(c) Monocot root and dicot root

(d) Transpiration and translocation

(e) Translocation and ascent of sap

(f) Xylem and phloem

(g) Pattern of gas exchange in leaves and roots (01/00/01)

Ans. (a) Micronutrients and macronutrients
Macronutrients

Sixteen elements have been found essential for plant growth. Nine of these are required in fairly large quantities (greater than 0.05% dry weights) and are therefore known as macronutrients. These include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, and magnesium.

Micronutrients
The remaining seven elements are needed in traces or small amounts (less than 0.05% dry weight) for normal plant growth and development that are known as micronutrients. These include iron, boron, manganese, copper, molybdenum, chlorine, and zinc.



Monocot Root	Dicot Root
1. The xylem and phloem bundles are usually arranged in a ring on the inner side of the pericycle.	1. The xylem usually occupies the centre of the root and is star-shaped.
2. The pericycle gives rise to lateral rootlets only.	2. The pericycle gives rise to lateral rootlets and a portion of the cambium and later becomes completely meristematic to form the cork cambium.
3. The pith is usually present.	3. The pith is usually absent.
4. The cambium is absent as a rule.	4. The cambium is present between xylem and phloem.
5. There is as a rule no secondary growth.	5. Secondary growth takes places.

(d) Transpiration and translocation

Transpiration	Translocation
(i) Plants absorb water from the soil by the roots. This absorbed water moves in the aerial parts of the plant from where the most of this water (approx. 99%) has been lost in the form of vapours into the atmosphere. This loss is called transpiration.	(i) The transport of prepared food (organic solutes) to different parts of the plant through the phloem tissue is translocation.
(ii) Transpiration always occurs against the gravity.	(ii) Translocation does not always occur against gravity.
(iii) Transpiration involves mainly the xylem cells.	(iii) Translocation involves both xylem and phloem cells.

(e) Translocation and ascent of sap

Translocation	Ascent of Sap
(i) The transport of prepared food (organic solutes) to different parts of the plant through the phloem tissue is translocation.	(i) The upward movement of water and minerals from downward the root to the aerial parts of the plant.
(ii) It takes place through the phloem tissue.	(ii) It takes place through xylem tissue.

(f) Xylem and phloem

Xylem	Phloem
(1) Xylem conducts water and mineral salts and provide support and strength.	(1) Phloem conducts prepared food from leaves to stem and roots etc.
(2) Xylem consists of two main types of cells namely tracheids and vessel elements.	(2) Two main types of cells in the phloem namely sieve tube element and companion cells.

(g) Pattern of gas exchange in leaves and roots

Gas exchange in Leaves	Gas exchange in Roots
(1) Plants are photosynthetic autotrophs and show different patterns of gas exchange during day and night through leaves. During day time plants inhale carbon dioxide (CO_2) and exhale oxygen (O_2) while during night they inhale oxygen and exhale carbon dioxide through their leaves.	Roots also exchange gases with soil air through root epidermal cells which involves the absorption of oxygen and release of carbon dioxide. This gaseous exchange remains the same during day and night because photosynthesis does not takes place in roots.

**Short Answer Questions (Additional)****Q.10: Name some waste products of plants.****Ans.**

- (i) CO_2 (ii) Excess Oxygen
(iii) Excess Water (iv) Calcium oxalate
(v) Latex (vi) Resins
(vii) Gums

Q.11: How carbon dioxide and oxygen are removed from plants?

Ans. As the process of respiration takes place continuously, so carbon dioxide is also produced continuously. Photosynthesis takes place at day time in the plants, during which oxygen is released.

CO_2 produced during respiration at day time is used in photosynthesis. Only a small quantity of oxygen produced during photosynthesis is used by plants for respiration. The rest of the oxygen is released through stomata and lenticels. At night no photosynthesis takes place. So, CO_2 is released as by product and atmospheric oxygen is used for respiration in plants.

Q.12: What is the importance of homeostasis?

Ans. (i) Many chemical reactions are going on inside our body. Molecules are being built up and broken down in our cells.

Q.16: What is difference between osmoregulation and thermoregulation?**Ans.**

Osmoregulation	Thermoregulation
Osmoregulation is defined as maintenance of the amounts of water and salts in body fluid i.e. blood and tissue fluids e.g. glucose concentration.	The maintenance of internal body temperature is called thermoregulation e.g. human body temperature is kept constant at 37°C .

Q.17: Define excretion.**Ans.**

The process by which metabolic wastes are eliminated from body to maintain the internal conditions at equilibrium is

called excretion e.g. urea, salts of uric acid and water are eliminated out of body through excretion.

Q.18: Differentiate between evaporation and transpiration.**Ans.**

Evaporation	Transpiration
(1) The process of liquid changing into vapour even below its boiling point is called evaporation.	(1) The loss of water as vapours from the aerial parts of the plants is known as transpiration.



(2) Evaporation is a type of process that occurs on the surface of a liquid as it changes into the gas phase.

Q.19: Differentiate between sink and source.

Ans. A location in a plant where sugar is being produced either by photosynthesis or by

(2) It takes place through stomata, lenticels and cuticle.

the breakdown of stored starch is called a sugar source; green leaves and stem.

A location in a plant where sugar is consumed or stored is called a sugar sink e.g., young leaves, fruits etc.

Q.20: Differentiate between pith and cortex.

Ans.

Pith	Cortex
Pith is a small area in the centre of vascular bundles of plants.	Cortex consists of many layers of parenchyma cells, inner to epidermis.

Q.21: Differentiate between guard cells and epidermal cells.

Ans.

Guard Cells	Epidermal Cells
A pair of guard cells form a stoma, which is involved in the gas exchange of plants.	Epidermal cells provide a protection to the plant from the external environment.

Q.22: What is cohesion-tension theory?

Ans. According to this theory, water is transported through xylem 'pipeline' from roots to leaves due to pressure difference of transpiration. In the narrow tubes of vessels and tracheids, the combination of cohesion and tension form a continuous column of water from roots up to the leaves.

Q.23: Define endodermis and pericycle.

Ans. Endodermis refers to the inner layer of cortex that surrounds the vascular bundle.

Pericycle is a single ring like layer internal to the endodermis.

Q.24: Which tissue is responsible for the transport of water and dissolved substances in plants? Describe its structure.

Ans. Xylem tissue is responsible for the transport of water and dissolved substances from roots to the aerial parts. Due to the presence of lignin, the secondary walls of its cells are thick and rigid. That is why xylem tissue also provides support to plant body.

Two types of cells are found in xylem tissue i.e., vessel element and tracheids.

Vessel elements have thick secondary cell walls. They lack end walls and join together to form long tubes. They are dead empty cells.

Tracheids are slender cells with overlapping ends. The cell wall is lignified and has pits. Tracheids are hollow, empty, dead cells when mature. They provide mechanical support to plant.

SLO based Reference Material

Short Answer questions

Q.25: How would you differentiate between xylem sap and phloem sap?

Ans. Sap is a fluid found in the vascular system of plants, primarily in the xylem and phloem tissues. It serves as the medium for transporting water, nutrients, hormones, and sugars through the plant.

Xylem sap

This fluid is rich in water and minerals.

Phloem sap

This fluid is rich in sugars (i.e., sucrose).

Q.26: Define the following:

(i) Autotrophs (ii) Heterotrophs

Ans. (i) Autotrophs

Autotrophs are organisms that can produce their own food from inorganic substances, typically through photosynthesis.



(ii) Heterotrophs

Heterotrophs are organisms that cannot synthesize their own food and rely on consuming other organisms or organic substances for energy and nutrients.

Q.27: How does gaseous exchange in aquatic plants differ from terrestrial plants?

Ans. Terrestrial plants exchange gases such as oxygen and carbon dioxide with the atmosphere while aquatic plants do so through diffusion from dissolved oxygen and carbon dioxide in water.

Q.28: What do you know about aerenchyma?

Ans. Some aquatic plants have specialized tissues called aerenchyma, which have large air

space that allow gases to diffuse more easily from the leaves to other parts of the plant, such as roots.

Q.29: What is the role of water in the uptake and transport of nutrients in plants?

Ans. Water plays a pivotal role in the uptake and transport of nutrients in plants. It serves as a solvent, allowing nutrients to dissolve and be absorbed through roots and drives the movement of these nutrients within the plant through processes like transpiration.

Q.30: What is chlorosis?

Ans. Chlorosis is a condition where leaves fail to synthesize sufficient chlorophyll leading to reduced photosynthesis and pale coloured leaves.

SLO Based Reference Material

Long Answer Questions

Q.1: Describe osmotic adjustment in plants.

Ans. Introduction

Osmoregulation is the process of maintaining salt and water balance in the body. Efficient functioning of the plant cells and the whole plant depends upon maintaining the water content in a state of equilibrium.

(i) Hydrophytes

Fresh water plants have adaptation to remove water.

Adaptations

In hydrophytes the leaves have larger surface area and have large number of stomata on upper surface for transpiration.

Example: Water lily.

(ii) Halophytes

Halophytes are plants growing in areas of high salinity.

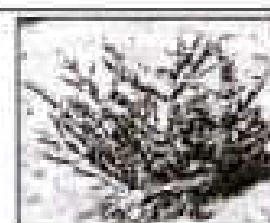
Adaptations

Some have adventitious roots for water and ion uptake, some store water. Some regulate their salt contents by excreting salts from glands at the leaf margins.

Example: mangroves.



Hydrophytes



Halophytes



Xerophytes

**(iii) Mesophytes**

Mesophytes are plants growing in areas having adequate water and have adaptations to reduce water loss.

Adaptations

These plants have cuticle, protected stomata and leaf fall.

Example: rose plant.

(iv) Xerophytes

Xerophytes are plants growing in dry regions, deserts etc.

Adaptations

They show several adaptations for reducing water loss, obtaining and storing water.

Examples

Some plants e.g., cactus has fleshy stem to store water. Cactus plants have their leaves very early and have thick cuticle and sunken stomata. Sometimes leaves are modified into spines. They usually have deep extensively branched roots to absorb more water.

Q.2: Give importance of homeostasis with reference to plants.

Answer:

Ans. Importance of Homeostasis in Plants

The importance of homeostasis in plants lies in its crucial role in maintaining a stable internal environment, which is essential for survival, growth, and overall health. Here are key aspects that highlight the significance of homeostatic processes in plants:

Water Balance

Water is vital for plants, not only as a component of photosynthesis but also for maintaining cell turgidity and transporting nutrients. Plants regulate their water balance through processes such as opening and closing stomata, adjusting root absorption, and altering leaf orientation. This regulation ensures they conserve water during drought and absorb adequate amounts during wet conditions.

Nutrient and Ion Uptake

Homeostasis extends to the regulation of nutrient and ion uptake. Plants selectively absorb minerals from the soil through their roots, adjusting their uptake in response to internal nutritional needs and external availability. This selective uptake is essential for the synthesis of plant molecules and overall health.

Temperature Regulation

Homeostasis in plants includes mechanisms to manage internal temperatures, which is necessary for optimal enzymatic and metabolic activity. Unlike animals, plants cannot move to different locations to manage temperature, so internal mechanisms, like altering transpiration rates, are vital for temperature control. Plants can control the opening and closing of stomata to regulate the rate of transpiration and adjust the internal temperature accordingly.

Reproductive Success

By maintaining homeostasis, plants ensure a more stable environment for reproduction, which is essential for species survival. Homeostatic control ensures that reproductive tissues are protected and energy is allocated appropriately to maximise reproductive success. Overall, homeostasis in plants is essential to survive and thrive in varying environmental conditions. These processes ensure that plants maintain internal stability despite external changes, which is vital for their life cycle and ecological role.



Q.3: Enlist the role of micronutrient and macronutrient in plant growth by giving examples.

Ans.

Nutrients	Elements	Role in Plant
Macronutrients	Nitrogen	Essential for the synthesis of proteins, chlorophyll and nucleic acids.
	Magnesium	Integral part of chlorophyll, also plays a role in enzyme activation and stabilizing the structure of nucleic acids.
	Phosphorus	Promotes early root formation and growth, involved in photosynthesis, respiration, energy storage, and transfer.
	Potassium	Involved in carbohydrate metabolism, responsible for opening and closing of stomata.
	Calcium	Essential for plant cell division and growth, component of cell wall.
Micronutrients	Sulphur	Found in two amino acids and several enzymes essential for metabolism.
	Boron	Essential component of cell wall formation, involved in sugar transport.
	Zinc	Necessary for chlorophyll production, act as a cofactor for numerous enzymes.
	Copper	Enzyme activation and reproductive development.
	Manganese	Involved in splitting of water and release of oxygen during photosynthesis.
	Iron	Helps in chlorophyll synthesis and certain enzymes.
	Chloride	Required for osmotic regulation.
	Molybdenum	Nitrogen fixation; convert atmospheric nitrogen into nitrate.



UNIT 09

PLANT REPRODUCTION

Q.1: Define reproduction. Explain asexual reproduction and its types in detail.

Ans. Definition

Plants, like all living organisms, have a remarkable ability to produce and create new young ones. This is called reproduction.

Asexual Reproduction

Introduction: Asexual reproduction is a straightforward method of creating new plant life.

Explanation

(a) In this process, only one parent plant is involved, and it gives rise to offspring that are essentially clones, sharing the exact genetic makeup of the parent.

(b) Asexual reproduction is distinct that it doesn't rely on the formation of specialized reproductive cells called gametes or the complex process of meiosis, which shuffles genetic material to produce variations.

(c) Asexual reproduction relies on simpler methods, such as cell division or the growth of specialized structures. This simplicity and genetic uniformity make asexual reproduction a reliable and efficient way for some plants to propagate and expand their population.

Types of Asexual Reproduction

Asexual reproduction includes binary fission, budding, spore formation and vegetative propagation.

1. Binary Fission / Explain the mechanism of binary fission in bacteria

Definition

Binary fission is a simple way of making more of something. It's like splitting something into two equal parts.

Explanation

This method is commonly used for making more of certain tiny living things, like bacteria, some one-celled creatures called protozoa, and some small animals without backbones but no true plant is known to use this process.

Example: Binary Fission in Bacteria

- In bacteria, first, the copy of their DNA is formed so that there are two identical sets.
- Then, these sets move to opposite ends of the bacteria.
- Next, the middle part of the bacteria starts to fold in, dividing the stuff inside into two parts.
- A new wall forms between these two parts.
- This whole process ends with two new bacteria, which will keep growing and eventually split into more.

2. Budding / Describe the mechanism of budding in yeast

Definition

In this kind of asexual reproduction, a tiny outgrowth called bud emerges on the parent's body.

Example: Budding in Yeast

- In yeast, which is a single-celled fungus, an outgrowth forms on one side of the cell.

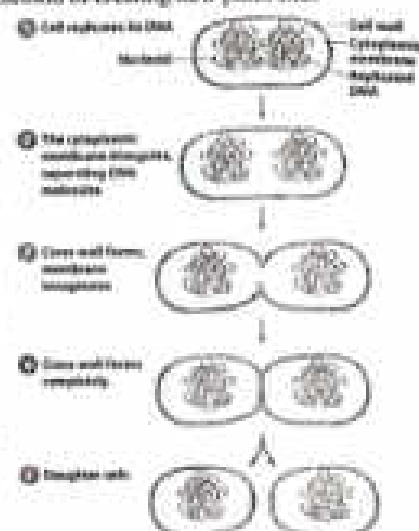


Fig. 9.1: Steps of Binary fission in Bacteria



- Inside the cell, the nucleus splits into two by mitosis, and one of these new nuclei gives rise to the outgrowth.
- Sometimes, the parent cell can have more than one of these outgrowths growing at the same time.

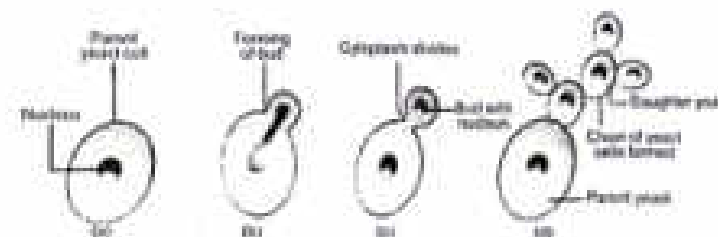


Figure: 9.2 Process of budding in yeast

- Each outgrowth gets bigger and becomes more like the parent.
- Eventually, the outgrowth can break away from the parent.
- In other cases, the outgrowths stay attached, and this leads to groups of individuals living close together, almost like a little community.

Types of Buds

In higher plants, the outgrowths are often developed which are of two types i.e., vegetative bud and floral bud. The vegetative buds give rise to new branches and leaves, and floral buds give rise to new flowers.

3. Spore Formation

Definition

Spores are very small, unicellular, non-motile, thick walled resistant, asexual reproductive bodies.

Examples

(a) Rhizopus

- In many fungi, like *Rhizopus*, when they're ready to make new ones, their body cells create strong, protective bags called sporangia on the tip of a stalk called sporangiophores.
- Inside these bags, cells divide a lot and make many tiny cells called spores.
- Each spore has a tough shell called a cyst that helps it survive unfavourable period.
- When the sporangia are grown up, they pop open and let the spores out.
- When the conditions become favourable, these spores start growing into new *Rhizopus*.

(b) Bacteria (actinomycete)

- In unfavourable conditions, some types of filamentous bacteria, such as actinomycete, also make spores.
- These bacterial spores are also tough with thick walls.
- They form outside the bacterial cells, so they are called exospores.
- Upon germination each spore from parental filament give rise to several new bacterial filaments.

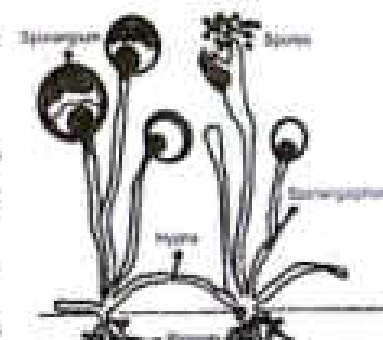


Fig. 9.3: Spore formation in *Rhizopus*



(c) Endospore Formation in Bacteria

- Under unfavourable conditions, some species of bacteria reproduce by forming spores, e.g. *Clostridium* and *Bacillus* species.
- These bacterial spores are also thick-walled.
- They are formed inside bacterial cells, so are called endospores.
- In this way these bacteria are capable to pass unfavourable period.
- When conditions are good, each endospore germinates and resumes normal life again.

Spores in Seed Producing Plants

This is important to note that the microspore and megaspore in seed producing plants or the spores of bryophytes and pteridophytes that give rise gametophyte body are not supposed to be the part of asexual reproduction because during the spore formation in these plants meiosis generally involves.

4. Parthenogenesis

Definition

Parthenogenesis is the development of an offspring directly from unfertilized eggs.

Explanation

(i) No Meiosis and Fertilization

In flowering plants it is defined as the asexual formation of a seed from the maternal tissues of the ovule, avoiding the processes of meiosis and fertilization, leading to embryo development.

(ii) Apomixis

This can happen due to various triggers, such as changes in environmental conditions or hormonal signals. Parthenogenesis in plants is also known as apomixis.

(iii) Form of Asexual reproduction

Since parthenogenesis involves the creation of offspring without the fusion of genetic material from two parents, it is considered a form of asexual reproduction.

5. Vegetative Propagation

Definition

Asexual reproduction in plants is called vegetative propagation. A new plant is produced from a vegetative part of the parent plant.

Kinds of Vegetative Propagation

(1) Natural Vegetative Propagation / Describe the methods of natural vegetative propagation in plants.

Introduction

Natural vegetative propagation in plants refers to the process by which plants reproduce asexually using their own natural mechanisms, without any human intervention.

Explanation

In this method, new plants are generated from various vegetative structures of the parent plant, such as roots, stems, leaves, or specialised structures like runners or bulbs. These structures develop into independent plants, and since they originate from the same parent, they often have identical genetic characteristics.

Types of Natural Vegetative Propagation

Following are the types of natural vegetative propagation:

(i) Bulbs

Definition

Bulbs are compact, thickened, vertically growing, underground stems enveloped by thick, succulent (fleshy) leaves, serving as



Fig. 9.1: Bulb (Onion)



reservoirs of stored nutrients.

Adventitious Roots

Beneath the bulb's base, adventitious roots sprout, while shoots emerge from its upper region. Each shoot, is capable to be developed into a new plant.

Examples: Species like tulips, onions, and lilies utilize bulb to produce their young ones.

(ii) Corm

Definition

Corms are compact, thickened, vertically growing, underground stems that store food but not enveloped by fleshy leaves. At the top of a corm, buds are present. These buds give rise to shoots, which then develop into new plants.

Examples: Plants that reproduce using corms include daffodil and garlic.

(iii) Rhizome

Definition

Rhizomes are flat, horizontal underground stems that have small scale-like leaves.

Explanation

(i) Along the rhizome, there are distinct nodes and internodes.

(ii) At these nodes, buds are formed.

(iii) The buds on the upper side of the rhizome grow into shoots, while the lower side produces adventitious roots.

(iv) These shoots are capable to develop into new plants.

Examples: Plants like ginger, ferns, and water lilies use rhizomes for reproduction.

(iv) Stem Tubers

Definition

Stem tubers are swollen tips of underground stem that primarily serve as storage structures found in certain plants.

Explanation

Stem tubers often have "eyes" or bud clusters on their surface, from which new shoots can grow when conditions are suitable.

Examples: Plants that produce stem tubers include potatoes and yam. These structures serve as a source of food and a means of propagation for the plants that produce them.

(v) Stolon or Runners

Definition

The above-ground parts of plants like strawberries and creeping buttercups are typically very short, with most of their structure below the ground. These short stems are known as stolons, and they carry leaves and flowers.

Explanation

(i) After the main shoot has blossomed, side buds create long shoots that grow horizontally along the ground, often called stolons or runners.

(ii) These runners have small scale-like leaves at specific points, and they have long sections between these points.

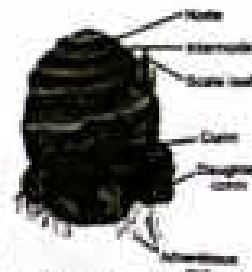


Fig. 9.2: Corm (Tulip)



Fig. 9.3: Rhizome (Ginger)



Fig. 9.4: Stem tuber (Potato)



(iii) At each of these points where the leaves are, there is a bud that has the potential to grow into both a shoot and roots.

(iv) So, a whole new plant can develop at these points, getting nourishment from the parent plant through the runner for a while.

(v) Eventually, the runner dries up and withers away, leaving a new independent plant growing a short distance from the parent.

(vi) This is how a strawberry plant, for example, can make many new plants without using seeds.



Fig. 9.8: Stolon or runner



Fig. 9.9: Suckers

v) Suckers

Definition

Suckers typically emerge as small shoots from the underground parts of a plant, such as the root system or near the base of the main stem. These shoots can develop into new plants.

Explanation

(i) As the suckers grow, they form their own stems, leaves, and roots.

(ii) They essentially become self-sustaining plants but remain connected to the parent plant for a period.

(iii) Suckers may receive nutrients and water from the parent plant, helping them establish themselves.

(iv) This is especially beneficial in adverse conditions where it might be challenging for new plants to survive on their own.

(v) Over time, the suckers develop their own root system and become less dependent on the parent plant for sustenance.

(vi) Eventually, they can thrive independently.

(vii) Suckers are a common method of natural vegetative propagation in various ground cover plants such as lawn grass.

(viii) Vegetative Propagation by Leaves

Introduction

(i) In Bryophyllum, a type of plant, new plantlets are created along the edges of its leaves.

(ii) These plantlets are like tiny versions of the parent plant.

(iii) When they detach from the parent plant and fall onto the soil below, they have the ability to grow and develop into separate, self-sustaining plants.

(2) Artificial Vegetative Propagation / Describe any two methods of artificial vegetative propagation in plants.



Fig. 9.10: Vegetative propagation by leaves in Bryophyllum



Introduction

Artificial vegetative propagation is adapted when people purposely grow plants to meet specific needs. The part of the plant used for this is called a "vegetative propagule." These methods help to keep the good qualities of plants, like taste, color, and resistance to diseases.

Methods of Artificial Vegetative Propagation

Two common methods of artificial vegetative propagation are stem cuttings and graftings.

(a) Stem Cuttings

Definition

Stem cuttings are small segments or cut pieces of stems having at least one node.

Explanation

(i) New plants can be made from some plants by placing a cut piece of a stem in water or damp soil.

(ii) Roots start growing from the bottom of the stem into the soil, while the top part keeps growing and making leaves.

(iii) If sometimes, the cutting does not start growth, then the cut ends must be treated with a special plant hormone called auxin to stimulate the growth.

(iv) Sometimes, it is required to cover the top part of the cutting with plastic or a glass jar to reduce water loss.

Examples: This method is often used to propagate roses, ivy, grapevines, and chrysanthemums.

(b) Grafting

Definition

This method involves joining two plant parts together to create a single, new plant.

Explanation

(i) This method is commonly used to reproduce desirable plant varieties, like fruit trees or ornamental plants, and it's a skilled practice often performed by gardeners and farmers.

(ii) Two plant parts are involved in grafting: the scion and the rootstock.

(iii) The scion is the upper part of the plant, which includes the desired characteristics such as specific fruit or flower traits.

(iv) The rootstock is the lower part, which provides the root system and stem support.

(v) Precise cuts are made on both the scion and rootstock.

(vi) The cuts are usually made at specific angles to maximize contact between the two parts.

(vii) The scion is carefully attached or inserted into the rootstock.

(viii) This connection is crucial for the transport of water, nutrients, and other substances between the two parts.

(ix) To ensure a secure connection, the graft is typically bound with grafting tape, rubber bands, or other materials.

(x) This helps to hold the scion in place until the graft heals.

(xi) Once the graft has healed, the plant begins to grow, producing leaves, flowers, and fruit based on the characteristics of the scion.

(c) Cloning (Tissue Culturing) / Explain the procedure of plant tissue culture and illustrate your answer with suitable diagrams.

Definition

Cloning is a method of producing genetically identical individual from the single parental cell.

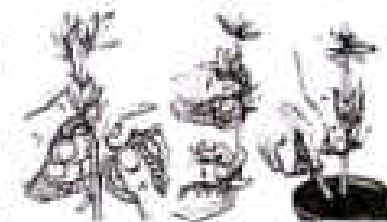


Fig. 9.11: Propagation by stem cutting

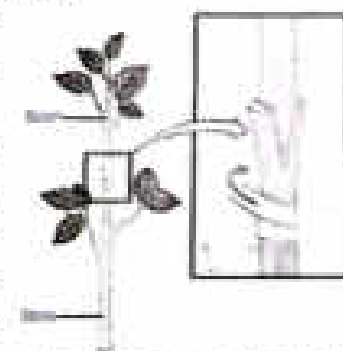


Fig. 9.12: Propagation by grafting



Explanation

(i) In plants term "cloning" refers to the tissue culturing in which a single plant cell or piece of tissue is grown on artificial nutrient medium under aseptic conditions (microbe free environment) to develop a genetically identical copy (clone) of the parent plant.

(ii) This method of artificial vegetative propagation is also called micropropagation.

(iii) The first cell or tiny piece of the parent plant used in tissue culture is called an "explant."

(iv) This explant is placed on a special nutrient medium to grow and become an undifferentiated mass of cells known as "callus."

(v) The callus is then treated with different substances to make it produce shoots and later roots.

(vi) This whole process results in the creation of a young plant called a "plantlet." These plantlets are carefully moved into the soil in their natural surroundings to continue growing.

Q.2: Write a note on sexual reproduction.

Ans. Introduction

Sexual reproduction in plants like animal also involves the fertilization of gametes (egg and sperm) and formation of zygote and embryo.

Mechanism of Gamete Formation

Different groups of plants, like bryophytes, pteridophytes, and seed plants (spermatophytes) have different mechanisms of gamete formation and fertilization.

(i) Bryophytes and Pteridophytes

In bryophytes and pteridophytes, the sperms are like little swimmers; they can move around and find the egg cells. So, they need water to do this. It could be dew or rain, but water is the key to their reproductive success.

(ii) Seed Producing Plants

On the other hand, seed producing plants (gymnosperms and angiosperms) have their own methods. They don't rely on water to get their sperms to the egg cells. They have special techniques for this.

Haplo-diplontic Life Cycle

(i) One of the prominent features of plants is the haplo-diplontic life cycle i.e., haploid gametophyte (gamete producing plant body) generation and diploid sporophyte (spore producing plant body) generation that regularly alternate with each other during the life cycle.

(ii) In some plants like bryophytes, the gametophyte generation is more prominent (dominant) while the sporophyte is very much reduced. In rest of the plant kingdom sporophyte is dominant generation whereas gametophyte is very small creature.

Sexual Reproduction in Flowering plants (Angiosperms)

In flowering plants (angiosperms), the major plant body is the sporophyte, which may be a herb, shrub or a tree. Flowers are the reproductive parts of these plants.

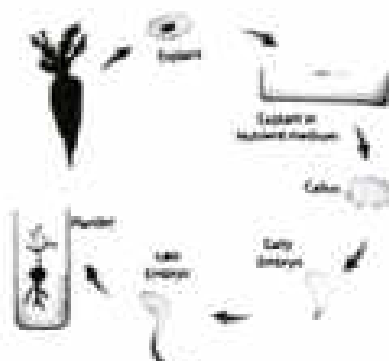


Fig. 9.13: Steps in plant tissue culturing

TEACHING

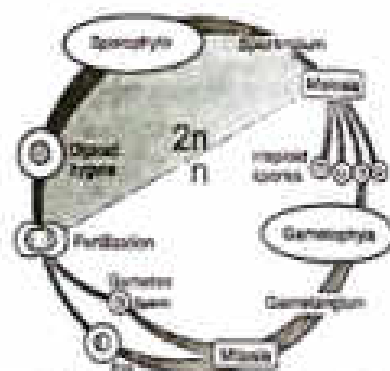


Fig. 9.12: Steps in plant sexual reproduction

Structure of a Flower

Introduction

A flower is like a plant's special tool for making new plants. It's a part of the plant that's been changed and adapted for the job of reproduction.

Parts

(i) Pedicel

A flower generally consists of a stalk called pedicel. This is like the flower's stem, holding it up.

(ii) Thalamus

At the top of the pedicel, there's a swollen part called the thalamus. It's like the flower's platform.

(iii) Floral Leaves

The thalamus generally possesses four kind of parts called floral leaves which are arranged in whorls (circles) on the upper surface of thalamus.

(iv) Calyx

The outermost circle is called the "calyx." It's made up of green leaves called "sepals," and it's like a protective cover for the inside parts of the flower.

(v) Corolla

Just inside the calyx, there's another circle called the "corolla," which consists of variously colored floral leaves called petals.

(vi) Androecium

Deeper inside the corolla, the "androecium," which is all about the male parts of the flower, called "stamens." These are important for making pollen.

(vii) Gynoecium

Right in the center, there's the "gynoecium." This is where the female parts are, in something called the "carpel" or "pistil." This is where the magic happens, where new seeds start to form.

Accessory Whorls

The calyx and corolla, the outer two circles, are like the flower's protectors. They keep everything safe inside but do not take part in reproduction directly therefore, called accessory whorls.

Necessary Whorls

The androecium and gynoecium, the inner two circles, are the real stars of the show when it comes to making new plants. They are the ones that make the flower's magic happen and help it to reproduce that is why they are called necessary whorls.

Formation of Microspores and Megaspores

(i) Stamen

Each stamen consists of a long stalk, the filament and a bilobed swollen tip called the anther. In the anther lobes, four pollen sacs (microsporangia) are present that produce haploid pollen grains (microspores) by meiosis.

(ii) Carpel

Each carpel or pistil consists of a sac like structure in the bottom called ovary, a long tubular structure above the ovary called style and a swollen tip present on the style called stigma. The ovary contains one to numerous ovules (megaspores). Each ovule possesses one upon mother cell that undergoes meiosis to produce four megaspores. Out of four, only one is capable to survive further and becomes functional megaspore.

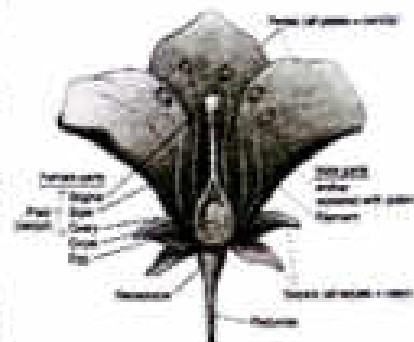


Fig. 9.14: Structure of typical flower



Pollination

(i) Definition

When microspores are formed, the wall of pollen sacs bursts and the microspores are liberated. The microspores are transferred from anther of stamen to the stigma of carpel by means of wind, insects, or other animals. This event is known as pollination and the microspores during pollination are called pollen grains.

(ii) Self Pollination

If the pollination occurs within the same flower or between two flowers of the same plant, it is called self-pollination.

(iii) Cross Pollination

If the pollination occurs between two flowers of separate plants, it is called cross pollination which causes more genetic variability in coming generations.

Formation of Male and Female Gametophytes / Describe the structure and development of male and female gametophyte.

(1) Development of Male Gametophyte

(a) Formation of Two Sperm Nuclei

Microspores (pollen grains) germinate on the surface of stigma to produce a male gametophyte. In this process, the microspore nucleus first divide by mitosis to form two nuclei i.e., tube nucleus and the generative nucleus which divides further to form two sperm nuclei.

(b) Formation of Male Gametophyte

The tube nucleus controls the formation of pollen tube from which microspore, passes down through the style and ultimately penetrates the ovule. This whole structure that comprises microspore body, pollen tube, tube nucleus and the two sperm nuclei, is referred to as male gametophyte.

(2) Development of Female Gametophyte

(a) Formation of Egg

Meanwhile, the nucleus of functional megaspore in the center of ovule divides three times by mitosis to make 8 nuclei. At this stage, three nuclei out of eight migrate at one end of the ovule, the central one of them becomes egg while two side one are called synergids. Three other nuclei migrate at another end of the ovule, and act as antipodals.

(b) Diploid Secondary Nucleus of Female Gametophyte

The remaining two daughter nuclei rest in the center of the ovule and are called polar nuclei which in some cases fuse together to become diploid secondary nucleus before the entry of sperm. This whole structure which comprises body of megaspore, three antipodals, two synergids, two polar nuclei or secondary nucleus and an egg, is referred to as female gametophyte or embryo sac.

Fertilization and the Formation of Zygote and Endosperm Nucleus

(a) Formation of Zygote

When the pollen tube penetrates the ovule, one sperm nucleus is fused with egg to form diploid zygote and other sperm nucleus is fused with polar nuclei or secondary nucleus to make triploid endosperm nucleus.

(b) Double Fertilization

Since one male gametophyte contributes two sperm nuclei for fertilization, therefore, this event is called double fertilization. It is assumed that the rest of nuclei in embryo sac such as synergids and antipodals control the process of fertilization.

Seed and Fruit Formation

After fertilization, the ovule is transformed into seed therefore, it is defined as "ripened ovule" whereas, the surrounding wall of the ovary is transformed into fruit, hence it is defined as "ripened ovary".

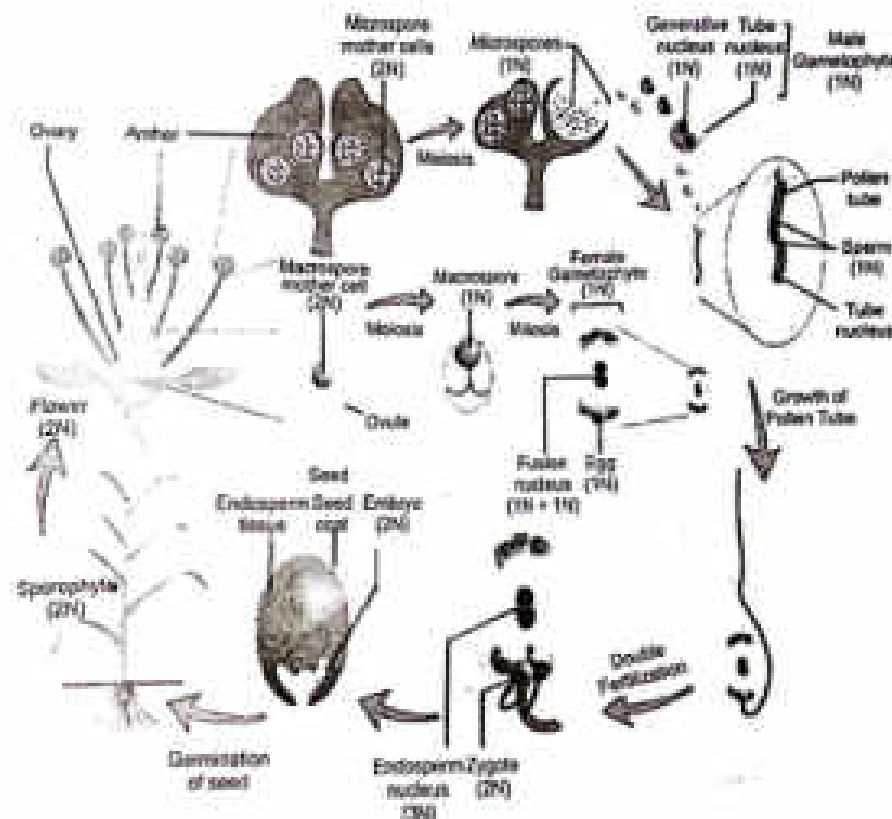


Fig. 5.15: Different steps of sexual reproduction in plants

Q.3: Describe adaptations in insect-pollinated and wind-pollinated flowers.

01100003

Ans.

Adaptations in insect-pollinated and wind-pollinated flowers		
Features	Insect Pollinated Flowers	Wind Pollinated Flowers
Size	Generally large	Generally small
Color	Petals highly colored	Petals green or dull in color
Nectar	Produce nectar	Do not produce nectar
Floral arrangement	Flowers face upwards	Flowers hang down for easy shaking
Stamens and stigmas	Enclosed inside ring of petals	Hang out of ring of petals
Pollen grains	Small number produced/ heavy and sticky	Large number produced/light with smooth surface
Stigma	Fishhook shaped with no branches	Feathery branches for catching pollen

Q.4: Describe the structure of seed.

01100004

Ans. Introduction

Angiosperm seeds are made up of these important parts:



1. Embryo

This part comes from the union of male and female cells (zygote). It's like a baby plant that's not fully grown yet.

2. Endosperm

The second part is called the endosperm. It's like a storage space for food and comes from a special cell inside the seed.

3. Seed Coat

Introduction

The last part is like the seed's protective jacket. It's called the seed coat and it develops from the outer part that used to wrap around the seed when it was part of the plant.

Function of Seed Coat

The seed coat can be thin like paper (think of peanuts) or thick and tough (like coconuts). It keeps the baby plant safe from harm and stops it from drying out.

Hilum

There's a little mark on the seed coat called the "hilum," which is where the seed used to be connected to the plant.

Microphyte

There's something called the "microphyte" which is like a door that the seed uses to get water.

Parts of Embryo

(a) Embryo

Inside the seed, embryo is an immature plant. It consists of a radicle, a plumule and one or two cotyledons (seed leaves). The radicle of embryo grows into new root while the plumule grows into new shoot upon seed germination. Therefore, radicle and plumule are called embryonic root and embryonic stem respectively.

(b) Epicotyl

The embryonic stem above the point of attachment of cotyledon(s) is called epicotyl.

(c) Hypocotyl

The embryonic stem below the point of attachment is hypocotyl.

(d) Seed; A Store of Nutrients

Within seed, there is a store of nutrients for the seedling that will grow from embryo. In angiosperms, the stored food is derived from the endosperm tissue. This tissue is rich in oil or starch and protein. In many seeds, the food of the endosperm is absorbed and stored by cotyledons. So, inside a tiny seed, there's a whole world waiting to grow into a new plant.

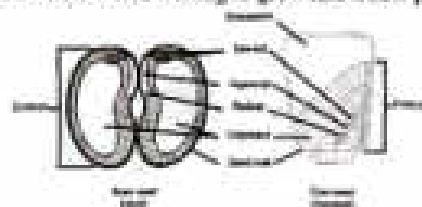


Fig. 9.16: Structure of seed

Q.5: Define seed germination. Explain its two types and write down the conditions for germination.

Ans. Definition

For seeds to start growing, they need to be in the right place and at the right time. This process is called seed germination, and it's like the start of a plant's life.



Explanation

In this process, the seed absorbs water, which makes it swell and breaks open the seed coat. First, a root pops out from a part called the radicle. This root grows quickly and starts taking in water and nutrients from the soil. Then, a tiny shoot called the plumule begins to grow. It stretches up and out of the soil.

Types of Seed Germination

There are two main ways seeds can start growing:

1- Epigeal Germination

Definition

In this type, the part called the hypocotyl stretches out and forms a hook, pulling the seed leaves (cotyledons) above the ground.

Examples: Beans, cotton, and papaya are examples of seeds that do this.

2- Hypogeal Germination

Definition

Here, it's the epicotyl that stretches and forms a hook, but the seed leaves (cotyledons) stay underground.

Examples: Peas, maize, and coconuts are examples of seeds that germinate this way.

Conditions for Seed Germination

(a) Internal Conditions

For seeds to start growing, they need the right conditions, both inside and outside. Inside, the seed must have a living baby plant (embryo) and enough stored food.

(b) External Conditions

Outside, there are three key conditions:

- 1. Water (Moisture):** Most seeds have very little water inside them. They can't start growing until they soak up water from the environment. This water is used to break down stored food and help the parts of the baby plant to grow.
- 2. Oxygen:** Just like we need oxygen to breathe, the cells in the baby plant need it too. It helps them do their job.
- 3. Temperature:** Different seeds like different temperatures to start growing. For most plants, the best temperature is between 25-30°C. So, when the seed gets these conditions right, it's like a green light for the baby plant to begin its journey.

Multiple Choice Questions (Exercise)

- Which of the following is incorrect about asexual reproduction?
 - (a) Single parent contributes genetic material
 - (b) No gamete formation is involved.
 - (c) Offspring are genetically identical
 - (d) Contributes in evolution of new species
- Which of the following is the benefit of sexual reproduction?
 - (a) This is rapid way of reproduction
 - (b) This is complex mechanism of reproduction
 - (c) It can occur any time in life cycle
 - (d) It contributes genetic variability in successive generations



3. Which of the following modes of asexual reproduction generally occurs during unfavorable conditions? (MCQ) (10/10/2021)

- (a) Binary fission
(b) Budding
(c) Spore formation
(d) Parthenogenesis

4. Which of the following processes is also known as apomixis? (MCQ) (10/10/2021)

- (a) Binary fission
(b) Budding
(c) Spore formation
(d) Parthenogenesis

5. Which of the following is compact, thickened, vertically growing, underground stem enveloped by thick, succulent (fleshy) leaves, surviving as reservoir of stored nutrients? (MCQ) (10/10/2021)

- (a) Bulb (b) Corm
(c) Rhizome (d) Stem tuber

6. In Bryophyllum, small plantlets that are much like tiny versions of the parent plant, are created along the: (MCQ) (10/10/2021)

- (a) root tip
(b) edges of its leaves
(c) stem surface
(d) all of these

Multiple Choice Questions (Additional)

11. Parthenogenesis involves: (MCQ) (10/10/2021)

- (a) Sexual reproduction
(b) A process by which an unfertilized egg develops by itself
(c) Both sexes being expressed in one individual
(d) Reproduction in mammals

12. Spores are produced in a structure known as: (MCQ) (10/10/2021)

- (a) Capsule
(b) sporangium
(c) bud
(d) sporangophore

13. Zygote in flowering plants develops into: (MCQ) (10/10/2021)

- (a) Endosperm (b) Embryo
(c) Micropyle (d) Seed coat

7. If sometimes, the stem cutting does not start growth, then the cut ends must be treated with which of the following special plant hormone to stimulate the growth? (MCQ) (10/10/2021)

- (a) auxin
(b) Abscissic acid
(c) Auxin
(d) Ethane

8. The first cell or tiny piece of the parent plant used in tissue culture is called: (MCQ) (10/10/2021)

- (a) Baby plant (b) Planlet
(c) Seedling (d) Explant

9. Which of the following part of the plant that's been changed and adapted for the job of reproduction: (MCQ) (10/10/2021)

- (a) Flower
(b) Leaf
(c) Root
(d) Meristematic tissue

10. Which of the following parts of the flower are called accessory whorls? (MCQ) (10/10/2021)

- (a) Androecium and gynoecium
(b) Calyx and corolla
(c) Androecium and corolla
(d) Calyx and gynoecium

14. The process by which an embryo is activated to form a seedling is called: (MCQ) (10/10/2021)

- (a) Propagation (b) Vegetation
(c) Germination (d) Fertilization

15. Fruit is formed by the enlargement of: (MCQ) (10/10/2021)

- (a) Embryo in the ovule
(b) Ovary containing the seed
(c) Anther (d) Sepal

16. How many sperms are involved in fertilization in a flower? (MCQ) (10/10/2021)

- (a) One (b) Two
(c) Three (d) Four

17. The offspring from asexual reproduction in plants are likely to: (MCQ) (10/10/2021)

- (a) Be more resistant than their parent to disease
(b) Develop into a new variety
(c) Grow bigger than their parents
(d) Have the same flower colour as their parent



18. After fertilization which structure develops into the seed of a flowering plant? (MCQ) (10/10/2021)

- (a) Carpel (b) Ovary
(c) Ovule (d) Style

19. Which flower structure produce pollen? (MCQ) (10/10/2021)

- (a) Anther (b) petal

21. In flowering plants, the gametophyte generation consists of: (MCQ) (10/10/2021)

Megagametophyte			Microgametophyte	
	Name	Number cells	Name	Number cells
(a)	Ovule	4	Pollen	2
(b)	Ovule	8	Pollen grain	2
(c)	Embryo Sac	4	Pollen grain with pollen tube	3
(d)	Embryo Sac	8	Pollen grain with pollen tube	3

22. Three characteristics of a specific method of asexual reproduction are listed below: (MCQ) (10/10/2021)

- Division of nucleus
- Division of cytoplasm
- Invagination of cell membrane

Identify the method

- (a) Multiple fission
(b) Spore formation
(c) Binary Fission
(d) Parthenogenesis

23. A horizontal underground stem with scale leaves and nodes is called: (MCQ) (10/10/2021)

- (a) Tuber (b) Bulb
(c) Rhizome (d) Corm

24. In binary fission of amoeba, the offspring lack genetic variation because they: (MCQ) (10/10/2021)

- (a) Are limited in number
(b) Are produced sexually
(c) Are unicellular organisms
(d) Contain a single chromosome

25. In which one of the following method of artificial vegetative propagation, a new plant can be grown on another plant? (MCQ) (10/10/2021)

- (a) Cutting (b) Tissue culturing
(c) Cloning (d) Grafting

26. In a flower, the embryo sac is formed inside the: (MCQ) (10/10/2021)

- (a) Anther (b) Filament
(c) Ovule (d) Style

(c) Carpel (d) Stigma

20. In addition to water, what is essential for the germination of seed? (MCQ) (10/10/2021)

- (a) Carbon dioxide
(b) Oxygen and suitable temperature
(c) Oxygen and soil
(d) soil and suitable temperature

27. Identify the mode of vegetative propagation in the following plant: (MCQ) (10/10/2021)



- (a) Bulb (b) Rhizome
(c) Stolon (d) Corm

28. Growing an entirely new plant from part of the original plant is called: (MCQ) (10/10/2021)

- (a) Budding
(b) Regeneration
(c) Fragmentation
(d) Vegetative propagation

29. Rhizopus reproduces asexually by: (MCQ) (10/10/2021)

- (a) Binary fission
(b) Budding
(c) Spore formation
(d) Endospore formation

30. A corm develops into new garlic plant. This process of reproduction is called: (MCQ) (10/10/2021)

- (a) Vegetative propagation
(b) Regeneration
(c) Mitosis
(d) Gametogenesis

31. Pollination is the transfer of pollens: (MCQ) (10/10/2021)

- (a) Anther to stigma (b) Stigma to anther
(c) Sepal to petal (d) Petal to sepal



32. Double fertilization in plants means:

- (a) Fusion of two sperms with two egg cells
- (b) Fusion of one sperm with egg cell and other sperm with fusion nucleus
- (c) Fusion of two sperms with single egg cell
- (d) Fusion of tube nucleus with fusion nucleus and sperm egg cell.

33. During binary fission, the nucleus of parent organism divides into two by:

- (a) Sexual reproduction
- (b) Meiosis
- (c) Mitosis
- (d) Asexual reproduction

34. In fungi, the spore is covered by a thick wall called:

- (a) Sporangium
- (b) Sporophyte
- (c) Cyst
- (d) Endospore

35. Spores which are formed inside bacterial cells are called:

- (a) cysts
- (b) Spores
- (c) Endospore
- (d) All of these

36. It reproduces by bulbs:

- (a) Garlic
- (b) Ginger
- (c) Ferns
- (d) Tulips

37. Flowers of wind pollination produce:

- (a) Petals
- (b) Nectar
- (c) No nectar
- (d) Do not reproduce

38. It germinates by apical germination:

- (a) Pea
- (b) Maize
- (c) Beans
- (d) coconut

39. Part of flower which changes into fruit is

- (a) Ovule
- (b) Ovary
- (c) Petals
- (d) Anther

40. Roses, Ivy, grapevines and sugar cane are reproduced:

- (a) Leaves
- (b) Suckers
- (c) Cuttings
- (d) Suckers and cuttings

41. Hypogeal germination takes place in:

- (a) Beans
- (b) Maize
- (c) cotton
- (d) papaya

42. The endosperm nucleus is:

- (a) Haploid
- (b) Diploid
- (c) Triploid
- (d) Tetraploid

43. The second whorl of the flower is:

- (a) Calyx
- (b) Corolla
- (c) Androecium
- (d) Gynoecium

44. Which of the following is a method of asexual reproduction in plants?

- (a) Pollination
- (b) Fertilization
- (c) Budding
- (d) cross-pollination

45. What is the main purpose of flowers in plants?

- (a) Photosynthesis
- (b) Support
- (c) Reproduction
- (d) Food storage

46. Which part of the plant is responsible for sexual reproduction?

- (a) Roots
- (b) Leaves
- (c) Flowers
- (d) Stems

47. In vegetative propagation, the offspring are:

- (a) Genetically different from the parent
- (b) Genetically identical to the parent produced from seeds
- (c) Not capable of growing independently
- (d) Produced from seeds

48. Parthenogenesis in plants refers to:

- (a) Seed formation with fertilization
- (b) Seed formation without fertilization
- (c) Formation of fruits without seeds
- (d) Pollination by insects

49. Which is not a method of artificial vegetative propagation?

- (a) Grafting
- (b) Budding
- (c) Layering
- (d) Stem cutting

50. What role does the stigma play in plant reproduction?

- (a) Produces pollen
- (b) Absorbs sunlight
- (c) Captures pollen
- (d) Stores nutrients

51. Double fertilization involves:

- (a) Fusion of two sperms
- (b) Fusion of sperm and egg
- (c) Fusion of sperm and fusion nuclei
- (d) both b and c

52. Which part of a seed gives rise to the future root?

- (a) Plumule
- (b) Cotyledon
- (c) Radicle
- (d) Epicotyl

53. What is the main advantage of sexual reproduction in plants?

- (a) Rapid reproduction
- (b) Genetic variation
- (c) Simplicity
- (d) Consistency



Answer Key

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

Short Answer Questions (Exercise)

Q.1: Define cloning. Which process of plant is supposed to be a cloning?

Ans. Cloning is a method of producing genetically identical individual from the single parental cell.

(i) In plants term "cloning" refers to the tissue culturing in which a single plant cell or piece of tissue is grown on artificial nutrient medium under aseptic conditions (microbe free environment) to develop a genetically identical copy (clone) of the parent plant.

(ii) This method of artificial vegetative propagation is also called micropropagation.

Q.2: Enlist any two suitable conditions for germination of seed.

Ans. 1. Water (Moisture)

Most seeds have very little water inside them. They can't start growing until they soak up water from the environment. This water is used to break down stored food and help the parts of the baby plant to grow.

2. Oxygen

Just like we need oxygen to breathe, the cells in the baby plant need it too. It helps them do their job.

Q.3: Explain the structure of embryonic stem.

Ans. Plumule is the part of embryo which grows into new shoot upon seed germination. Therefore, plumule is called embryonic stem.

Epicotyl

The embryonic stem above the point of attachment of cotyledon(s) is called epicotyl.

Hypocotyl

The embryonic stem below the point of attachment of cotyledons is called hypocotyl.

Q.4: Explain the role of livestock.

Ans. (1) They are providers of income and employment for producers and others working in, sometimes complex, value chains.

(2) They are a crucial asset and safety net for the poor, especially for women and pastoralist group and they provide an important source of nourishment for billions of rural and urban house holds.

(3) Livestock provide hides and skins, meat, eggs and milk for the country and are a valuable source of trade internationally.

(4) Buffalo, cattle and horses are an important asset in animal draught power, as they pull carts and wagons carrying supplies all over the country.

(5) Livestock feeds the plants and plant feed the livestock.

Q.5: Explain the event of double fertilization in angiosperms.

Ans. The type of fertilization in flowering plants, in which one sperm nucleus is fused with egg to form diploid zygote and other sperm nucleus is fused with polar nuclei or secondary nucleus to make triploid endosperm



nucleus. Since one male gametophyte contributes two sperm nuclei for fertilisation. Therefore, this event is called double fertilisation.

Q.6: Explain the structure of embryo sac.

Ans. (a) Formation of Egg

The nucleus of functional megaspore in the center of ovule divides three times by mitosis to make 8 nuclei. At this stage, three nuclei out of eight migrate at one end of the ovule, the central one of them becomes egg while two side one are called synergids. Three other nuclei migrate at another end of the ovule and act as antipodals.

(b) Diploid Secondary Nucleus of female Gametophyte

The remaining two daughter nuclei rest in the center of the ovule and are called polar nuclei which in some cases fuse together to become diploid secondary nucleus before the entry of sperm. This whole structure which comprises body of megaspore, three antipodals, two synergids, two polar nuclei or secondary nucleus and an egg, is referred to as female gametophyte or embryo sac.

Q.7: Justify that sexual reproduction in plants is more beneficial than asexual reproduction.

Ans. (1) Organisms produced by sexual reproduction have variation which is adapted to various environments.

(2) They are less likely to be affected by various diseases.

(3) Though asexual reproduction is faster and more energy efficient, sexual reproduction helps preserve genetic diversity through new combinations of alleles during meiosis and fertilisation.

Q.8: Define/Describe/Explain briefly:

Apomixis, Pollination, Male gametophyte, Epigeal germination, Fertilisation, Binary fission, Budding, Sporangiothores, Rootstock, Bulb, Rhizome.

Ans. Apomixis

Parthenogenesis in plants is also known as apomixis.

Pollination

When microspores are formed, the wall of pollen sacs bursts and the microspores are liberated. The microspores are transferred from anther of stamen to the stigma of carpel by means of wind, insects, or other animals. This event is known as pollination and the microspores during pollination are called pollen grains.

Male Gametophyte

Pollen tube, tube nucleus and the two sperm nuclei, is referred to as male gametophyte.

Epigeal Germination

In this type, the part called the hypocotyl stretches out and forms a hook, pulling the seed leaves (cotyledons) above the ground. Beans, cotton, and papaya are examples of seeds that do this.

Fertilization

The process that involves the fusion of male gametes (pollen) and female gametes (egg) to produce diploid zygote.

Binary Fission

Binary fission is a simple way of making more of something. It's like splitting something into two equal parts.

Budding

In this kind of asexual reproduction, a tiny outgrowth called bud emerges on the parent's body.

Sporangiothores

In many fungi, like Rhizopus, when they're ready to make new ones, their body cells create small, protective bags called sporangia on the tip of a stalk called sporangiothores.

Rootstock

The rootstock is the lower part, which provides the root system and stem support.

Bulb

Bulbs are compact, thickened, vertically growing, underground stems, enveloped by thick, succulent (fleshy) leaves, serving as reservoirs of stored nutrients. Species like tulips and onion utilize bulb to produce their young ones.



rhizomes

Rhizomes are flat, horizontal underground stems that have small scale-like leaves.

Examples: Plants like ginger, ferns and water lilies, use rhizomes for reproduction.

Q.9: Write the differences between

- Asexual reproduction and sexual reproduction
- Artificial vegetative propagation and natural vegetative propagation
- Scion and rootstock
- Grafting and stem cutting
- Bulb and rhizome
- Binary fission and budding
- Hypogeal and epigeal germination
- Self and cross pollination

Ans.

(a) Asexual reproduction and sexual reproduction

Asexual Reproduction	Sexual Reproduction
(i) In asexual reproduction there is no involvement of gametes and no mixing of heredity material.	(i) Sexual reproduction takes place by meiosis and there is mixing of genetic material.
(ii) These organisms fail to cope with the changing environment and if continue reproducing by this way, ultimately become extinct.	(ii) This helps the organisms to cope with the changing environment.

(b) Artificial vegetative propagation and natural vegetative propagation

Natural Vegetative Propagation	Artificial Propagation
It occurs naturally without human intervention.	It starts by human using various techniques.
It includes the processes like runners, tubers and bulb formation.	Grafting, cutting, layering and tissue culture are its common methods.
Natural spread and survival of species.	Crop improvement, rapid multiplication.
Plants propagate without human involvement.	Plants are selected based on desired traits for propagation by humans.
Plants are adapted to local environment where they propagate.	Plants may not adapt to local environment and may require care.

(c) Scion and rootstock

Scion	Rootstock
The scion is the upper part of the plant, which includes the desired characteristics such as specific fruit or flower traits.	The rootstock is the lower part, which provides support to the root system and stem.
It is involved in grafting and carefully attached or inserted into the rootstock.	It is also involved in grafting and is a rooted stem into which a scion or bud is grafted. Providing anchorage and nutrients.



(d) Grafting and stem cutting

Grafting	Cutting
(i) This method involves joining two plant parts together to create a single, new plant. (ii) This method is commonly used to reproduce desirable plant varieties, like fruit trees or ornamental plants.	(i) Stem cuttings are small segments or cut pieces of stem having at least one node. (ii) Examples: This method is often used to propagate roses, ivy, grapevines, and chrysanthemums.

(e) Bulb and rhizome

Bulb	Rhizome
Bulbs: Bulbs are compact, thickened, vertically growing, underground stems enveloped by thick, succulent (fleshy) leaves, serving as reservoirs of stored nutrients. Adventitious Roots: Beneath the bulb's base, adventitious roots sprout, while shoots emerge from its upper region. Each shoot, is capable to be developed into a new plant. Examples: Species like tulips, onions, and lilies utilize bulbs to produce their young ones.	Rhizomes: Rhizomes are flat, horizontal underground stems that have small scale-like leaves. Explanation: (i) Along the rhizome, there are distinct nodes and internodes. (ii) At these nodes, buds are formed. (iii) The buds on the upper side of the rhizome grow into shoots, while the lower side produces adventitious roots. (iv) These shoots are capable to develop into new plants. Examples: Plants like ginger, ferns, and water lilies use rhizomes for reproduction.

(f) Binary Fission and Budding

Binary Fission	Budding
(i) Binary fission is a simple way of making more of something. It's like splitting something into two equal parts. (ii) This method is commonly used for making more of certain tiny living things, like bacteria, some one-celled creatures called protozoa, and some small animals without backbones but no true plant is known to use this process. (iii) The parent cell duplicates its DNA and divides into two daughter cells each with complete set of genetic material. (iv) Cells typically divide along a specific axis or plane.	(i) In this kind of asexual reproduction, a tiny outgrowth called bud emerges on the parent's body. (ii) Commonly observed in multicellular organisms such as yeast, hydra and certain plants. (iii) The parent organism develops a small outgrowth called a bud which grows and eventually detaches from the parent to become an independent organism. (iv) Buds may form at various locations on the parent organism.

(g) Hypogeal and epigeal germination

Hypogeal Germination	Epigeal Germination
(i) It's the epicotyl that stretches and forms a hook, but the seed leaves (cotyledons) stay underground. (ii) Peas, maize, and coconuts are examples of seeds that germinate this way. So, seeds have their	(i) In this type, the part called the hypocotyl stretches out and forms a hook, pulling the seed leaves (cotyledons) above the ground. (ii) Beans, cotton, and papaya are examples of seeds that do this.



own ways of getting started on their journey of becoming full-grown plants.

(h) Self and cross pollination

Self Pollination	Cross Pollination
(i) If the pollination occurs within the same flower or between two flowers of the same plant, it is called self-pollination. (ii) Cereals, Grasses, Cereals etc.	(i) If it occurs between two flowers of separate plants, it is called cross pollination which ensures more genetic variability in coming generations. (ii) Rose, Sunflower, Buttercup etc.

Short Answer Questions (Additional)

Q.10: What are the advantages and disadvantages of vegetative propagation?

Ans. Advantages

The advantages of vegetative propagation are:

(a) Desired characters are retained in the offspring.

(b) A large number of identical plants can be grown.

(c) plants take less time to mature than the plants grown from seed.

Disadvantages

(a) New varieties are not produced.

(b) Plants are less resistant to diseases and environmental changes.

(c) Plants become localised.

Q.11: Name some ripened ovaries and aches eaten in daily life.

Ans. Fruits are ripened ovaries that are sweet and either succulent or pulpy, such as figs, mangoes and strawberries.

While seed is a ripened ovule with the product of fertilization, embryo enclosed in it. Number of seeds in a fruit depends on number of ovules in an ovary e.g. papaya flower has many ovules

in the ovary that develops into many seeds while mango has single ovule into the ovary that develops into a single seed.

Q.12: Write a short note on third whorl of a flower.

Ans. The third whorl contains the male reproductive structures and is known as the androecium.

The androecium consists of stamens, each stamen has filament and anther.

Q.13: How parthenogenesis is a type of asexual reproduction?

Ans. In parthenogenesis an unfertilized egg develops into new offspring.

Examples: Some fishes, frogs and insects reproduce by parthenogenesis e.g., honey bee queen lays two types of eggs. The unfertilized eggs develop into haploid males (drones) by parthenogenesis and fertilized eggs into diploid females (new queen and worker bees). Since parthenogenesis involves the creation of offsprings without fusion of gametes from parents it is considered a form of asexual reproduction.

Q.14: Complete the table related to structure of seed.

	Location	Importance
1.		Outer covering of seed
2.		Helps to attach the seed to ovary wall
3.	Micropyle	

Ans.

	Location	Importance
1.	Seed coat	Outer covering of seed
		Protects embryo from mechanical injury and from drying out.



E	Hilum	Seed coat	Helps to attach the seed to ovary wall
A	Microphyll	Seed coat	Water is absorbed during germination

Q.15: Differentiate between spore and endospore.

(10 marks)

Ans.

Spore	Endospore
It most of fungi like <i>Rhizopus</i> , when they reach at reproduction age, then body cells form thick walled seed called sporangia. Inside each sporangia, a cell divides many times and forms many daughter cells called spores.	Under unfavourable conditions, some species of bacteria reproduce by forming spores e.g. <i>Clostridium</i> and <i>Bacillus</i> species. Thick walled spores are formed inside bacterial cell. These are called endospores.

Q.16: Give the difference between epicotyl and hypocotyl.

(10 marks)

Ans. The embryonic stem above the point of attachment to cotyledon is called epicotyl and the embryonic stem below the point of attachment to cotyledon is called hypocotyl.

Q.17: What is the difference between monocotyledonous plants and dicotyledonous plants.

(10 marks)

Ans.

Monocotyledonous Plants	Dicotyledonous Plants
(a) Embryo with single cotyledon.	Embryo with two cotyledons.
(b) Roots are adventitious.	Roots develop from radicle.
(c) Flower parts in multiple of three.	Flower parts are multiple of four or five.
(d) Secondary growth absent.	Secondary growth often present.
(e) Leaf venation not parallel in the lamina.	Leaf venation is reticulate, i.e. veins form network in lamina.
(f) Examples: Wheat, maize, rice etc.	Examples: Apple, almond, mango etc.

Q.18: Complete the table to associate the adaptations with the relevant flowers.

(10 marks)

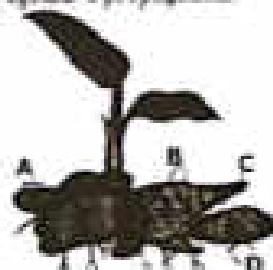
Insect pollinated flower	Wind pollinated flower
Colour	
Scent and nectar	
Pollen grain	

Ans.

Insect pollinated flower	Wind pollinated flower
Colour	Brightly coloured
Scent and nectar	Enclosed inside petals
Pollen grain	Small number produced Heavy and sticky
	Large number produced Light with smooth surface

Q.19: Following diagram shows the way of natural vegetative propagation.

(10 marks)



(a) Label the parts A, B, C and D

(b) Name this type of vegetative propagation and give example.

(c) From which part shoot and root of new plant arise.

Ans. (a)

A. Node B. Scale leaves

C. Bud D. Adventitious root

(b) Type of vegetative propagation is Rhizomes.

Example: Ginger, Fern, water lilies

(c) The buds present on the upper surface of rhizome give rise to shoot. The lower surface of rhizome produces adventitious roots.

Q.20: Double fertilization is a unique event in the life cycle of an angiospermic plant. Describe and sketch the process, also explain the fate of products of double fertilization.

(10 marks)

Ans. After pollination pollen grain germinates to develop a pollen tube containing a tube nucleus and two sperm nuclei. Inside the ovule microspore undergoes three consecutive mitosis to produce female gametophyte containing an egg (1N), fusion nuclei (2N) and other associated cells. Pollen tube enters the ovule and transfer both the sperms for fusion with two different cells of female gametophyte so called "double fertilization".

Q.21: Following diagram shows a type of seed germination.

(10 marks)



(a) Label the parts B and C

(b) Name and describe this type of seed germination and give examples.

(c) Precisely state two basic requirements for seed germination.

Ans. (a) Part B is cotyledon and Part C is hypocotyl.

(b) Diagram represents epigeal seed germination, in which hypocotyl elongate and form a hook like structure which pulls the cotyledon above the ground, e.g. beans, cotton, castor and papaya.

(c) Basic internal requirements for the seed germination are living embryo and sufficient food storage. External requirements include moisture (water), oxygen for aerobic respiration and suitable temperature range (25-30°C).

SLO based Reference Material

Short Answer Questions

Q.22: What do you know about the followings?

(10 marks)

(a) Clone

(b) Theophrastus

(c) Tepals

(d) Nectaries

(e) Pollen sacs

(f) Bisexual flowers

Ans. (a) Clone

A clone is an exact genetic replica of an organism or a cell. It has the same genetic combination as the parental organism/cell, making it an identical copy created by nature or through science.

(b) Theophrastus

Theophrastus is known as the father of botany. His most remarkable contribution is the discovery of sexual reproduction in plants, distinguishing it from vegetative reproduction. He also gave technical descriptions of grafting

and cutting. His work includes 'Historia Plantarum' (The Enquiry into Plants) and 'De Causis Plantarum' (On the causes of Plants).

(c) Tepals

In some flowers, petals and sepals are indistinguishable and are called tepals.

(d) Nectaries

Nectaries are glands that secrete nectar, a fluid that attracts pollinators. Nectaries can be located on any part of the flower.

(e) Pollen sacs

Anther contains four pollen sacs (microsporangia) each of which contains many diploid microspore mother cells.

(f) Bisexual flowers

In bisexual flowers, both stamens and carpel are present in the same flower. In



unisexual flowers, stamens and carpels are present in separate.

Q.23: Why many plants have a mechanism to prevent self-pollination? 01/10/2021

Ans. Many plants have mechanisms to prevent self-pollination, such as the presence of structural barriers that reject pollen from the same plant, in order to promote genetic diversity through cross pollination. For example, in some species, the male and female reproductive organs are positioned in such a way that makes self-pollination physically

difficult or impossible or they may mature at different times (a phenomenon known as dichogamy) to inhibit self-pollination.

Q.25: Why tubers are significant in agriculture? 01/10/2021

Ans. Tubers are significant in agriculture because they yield more food per unit area of soil and time than most other crops and they can be stored for long periods without losing their nutritional value.

One example of a "Frankenstein tree" is the Tree of 40 Fruit, an art project by Sam Van Aken, a professor at Syracuse University. He grafted different fruit plants, such as peaches, plums, apricots, nectarines, and cherries, onto a single tree, creating a stunning display of blossoms and fruits in different colours and seasons.

SLO Based Reference Material Long Answer Questions

Q.1: Give the comparison between artificial and natural vegetative propagation. 01/10/2021
Ans. Similarities

Natural vegetative propagation and artificial propagation share some similarities due to their reliance on vegetative parts for plant reproduction. Here are three similarities:

- Both methods produce genetically identical offspring to the parent plant, resulting in clones.
- Both methods require no seeds for the propagation of new plants.
- Both methods can result in quicker development of plants compared to seed-based reproduction, as the new plants do not have to go through the seedling stage.

Differences between artificial and natural vegetative propagation

In summary, natural vegetative propagation is an unassisted form of asexual plant reproduction, while artificial propagation is a human-guided process using plant parts to create identical clones, often for commercial purposes.

Q.2: Explain how cloning in plants is a form of asexual reproduction and describe the advantages of using this method. 01/10/2021

Ans. Introduction

Cloning is the process of generating a genetically identical copy of a cell or an organism. In nature, organisms can produce clones through asexual reproduction.

Examples

Binary fission in bacteria produces identical clones. Artificially, cloning can create a whole organism identical to the individual whose genetic material was initially taken. For instance, Dolly, the sheep was the first successfully cloned mammal.

Explanation

Organism cloning (also called reproductive cloning) refers to the procedure of creating a new



multicellular organism genetically identical to another. In essence this form of cloning is an asexual method of reproduction, where fertilization or inter-gamete contact does not take place.

Advantages

(i) Exact copy of the DNA of the Parent Plant

Plants can also produce clones through asexual methods. These cloned plants possess an exact copy of the DNA of the parent plant, ensuring that any desirable traits present in the parent are precisely preserved in the offspring. Artificially, the tissue culture technique (micropropagation) is applied, which creates new plants from the cell, tissue or organ of the parent plant.

In tissue culturing technique, a small piece of plant tissue is taken from the parent plant and is placed in the culture medium containing all the necessary nutrients, hormones, and growth factors for the tissues to grow and develop into new plants.

(ii) Rapid Multiplication of a Plant

This technique allows for the rapid multiplication of a plant, which is particularly beneficial for propagating species that are difficult to grow from seeds or have a long generation time.

In agriculture and horticulture, cloning produces large quantities of plants with desirable traits, such as high yields, good taste, resistance to pests and diseases, and adaptability to specific environmental conditions.

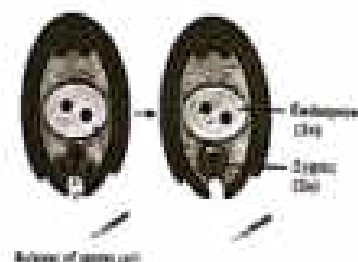
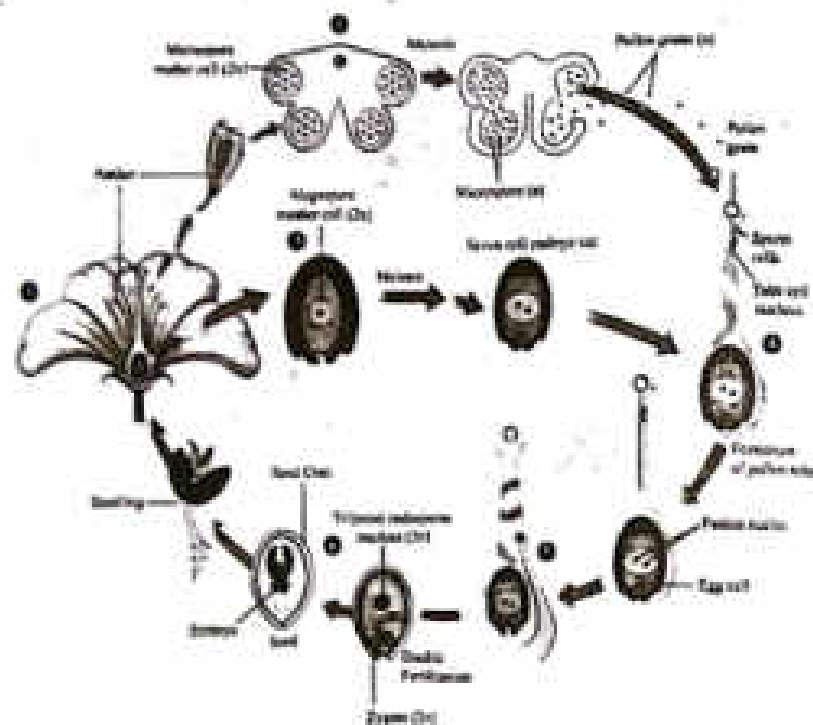


Cloning of plants through Tissue culture technique

Q.03: Enlist the steps of the life cycle of a flowering plant. 01/10/2021

Ans. The life cycle of a flowering plant consist of following steps:

- The development of the male gametophyte (the pollen grain) occurs in the anthers.
- The microspore mother cells develop into pollen grains. Mature pollen grains are released from the anther.
- Egg cell with associated structures develop from megaspore mother cells inside the ovule.
- Meanwhile, the pollen grain lands on a stigma and forms a pollen tube that grows into the style until it reaches the ovule in the ovary.
- The two sperm cells travel down the pollen tube. The first sperm fuses with the egg to form a diploid zygote; simultaneously, another sperm fuses with the two fusion nuclei, producing a triploid endosperm nucleus.
- The zygote matures into an embryo. Once the seed germinates, it develops into a new seedling, starting a new cycle.



UNIT 10

EVOLUTION

Q.1: What is evolution? Explain briefly.

09/10/2021

Ans. Definition

A change that occurs to living things over time.

Number of Species: The number of species of living things on earth currently exceeds a million.

Explanation

(i) Each species has its own manner of living and working.

(ii) Some species appear to be highly similar to one another, whereas others do not.

(iii) In many ways, a horse and a zebra are similar. Both of them, however, have some traits not present in the other.

(iv) Through the process of progressive transformation, all of the species alive today evolved from earlier ones.

Q.2: What is variation? Explain the sources of variation.

09/10/2021

Ans. Definition

The term variation refers to the differences in traits displayed by members of the same species.

Example

All domestic cats are members of the same species, they differ greatly in terms of size, coat colour, eye colour, hair length, and other characteristics.

Explanation

(i) Variations are beneficial for living organism as it helps in increasing their chances of survival of the particular organisms.

(ii) These are desirable variations as it helps them be more advanced and strong. Variations can sometime lead to a genetic defect hence becoming a harmful and an undesirable variation.



Fig. 10.1: Variation in domestic cats

Sources of Variation

Meiosis along with other factors serve as the main sources of variation. They are as follows:

1. Genetic recombination results from crossing over during gamete development.
2. Different chromosome combinations in gametes are formed by independent collections of chromosomes.
3. The process of fertilization in which one of the countless sperms fuses with an egg.
4. A mutation in the gamete-forming germ cells.
5. Gene flow, or the transfer of genes from one population of a species to another.



091610094

Q.3: Assess selection as a possible means of evolution.

Ans. Introduction

(i) According to scientists, the Earth is more than four billion years old.

(ii) New life forms developed from unicellular organisms.

(iii) All current living things developed gradually from earlier ones. Evolution is the gradual altering of a population's or species' traits over time in response to the environmental conditions.

(iv) Evolutionary changes can always be passed on to next generations.

Evidences of Evolution

(i) Variation Can Lead to Evolution

Some individuals of a population may have an advantage over other members as a result of population variations. These individuals will be able to have more progeny. Consequently, the population will gradually see more instances of that specific variant. With these variations, they will have a better chance of surviving and procreating. That's evolution.

(ii) Adaptation

An inherited trait or group of traits that increases an organism's chances of survival in specific environmental conditions is known as an adaptation. Members of a specie's population will compete with one another for resources. Only the healthiest, fittest, and strongest will survive and reproduce. If food or water is in little supply, there is little room for sharing, and there aren't many available partners.

Q.4: Explain the theory of evolution by natural selection with examples.

091610094

Ans. Introduction

Natural selection is the process through which organisms who possess traits that are helpful for reproduction in a certain environment produce more children in the following generation. As a result, they gradually expand the population's genetic diversity.

Bases of Theory of Natural selection

Natural selection theory is based on:

1. Overproduction

All living creatures are very fertile so that their populations could grow quickly to produce large number of offspring.

2. Competition

We can observe that population sizes do not rise to a very high level even after overproduction. The numbers largely stay constant. This is because food supplies and other resources are scarce. As a result, there is competition for resources and food.

3. Variations

No two organisms are the same. They will not have the same opportunities to survive and reproduce as others. A large portion of this diversity is heritable. Such qualities are inherited from parents through the genes of the offspring.

4. Natural Selection

Only those organisms who live and reproduce can give rise to the next generation. And only those organisms with the desirable variations will live till reproductive age. The population will have more advantageous genetic variations and fewer harmful ones after many generations. Natural selection is essentially an elimination process. Only fittest organisms will survive.

Observations of Darwin During Voyage on HMS Beagle

(i) Release of Book "On the Origin of Species by Natural Selection"

After a five-year voyage around the world in the ship HMS Beagle, Charles Darwin put forth the Theory of Natural Selection in 1838. In 1839, he released a book titled "On the Origin of Species by Natural Selection" recording his observations.



(ii) Observations of Galapagos Islands

(a) Charles Darwin was able to create his theory of natural selection when he visited the Galapagos Islands.

(b) He found a number of finch species that varied from island to island.

(c) He noticed that the form of the birds' beaks varied depending on the kind of food they ate.

(d) Darwin believed that the processes of speciation and adaptation were linked.

(e) The overall accumulation of adaptations in different environments, isolated from the original environment by geographic barriers, would lead to the formation of a new species from an ancestral form.

(f) The two groups could differ sufficiently over many generations to be classified as two different species.

(iii) Basic Patterns in Biological Diversity

Darwin identified three basic patterns in biological diversity:

(1) Global

(2) Local

(3) Variation over time in species

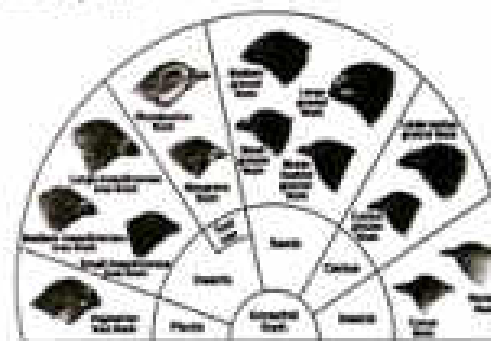


Fig. 18.2: Darwin's Observation of Species at Galapagos Islands

Selection: Means of Evolution

Natural selection causes population-wide changes in gene frequencies over time; as a result, individuals with more advantageous traits will be more prevalent in the population and individuals with less advantageous traits will be less prevalent.

Evidence of Natural Selection

Introduction

(x) In Britain, the Industrial Melanism of the peppered moth (*Biston betularia*) is a strong indicator of natural selection.

(y) Analysing a Case Study of Variation and Selection

The phrase "Changes in the environment can bring about changes in a population by natural Selection" is supported by evidence.

(z) Colour Variation in Moth

All reported variants of the peppered moth (*Biston betularia*) in the UK up until 1848 had light colours with dark patches. A dark-coloured moth was discovered in 1848, and by 1895, dark coloured moths made up 95% of the peppered moth population. This variety's dark colour resulted from a mutation.



(d) Light Coloured Moth

The moths fly at night and rest on tree trunks throughout the day. The light-coloured lichens growing on the tree trunks blended in with the colour of the light-coloured moth, giving it excellent concealment from predatory birds.

(e) Effects of Industrial Revolution

As the industrial revolution progressed, sulphur dioxide pollution from coal burning drove out lichens that were growing on trees in industrial locations, exposing the darker bark.

The predator birds can now easily locate and consume the light-coloured moths that are resting on dark-coloured trunks. Light-coloured moths are "seen and eaten by the birds" when they settle on dark-coloured trunks. The birds are serving as snappers. The dark colour was the adaptive variable that resulted in the selection advantage. 90% of the peppered moth population in England during the industrial era of pollution was black. 'Industrial Melanism' is the name given to the specific phenomenon. After the 1950s, England's industrial pollution was reduced, and as a result, the number of light-coloured moths also increased.



(a) Unpolluted Environment



(b) Polluted Environment

Fig. 10.3 (a) The light and dark coloured forms of the peppered moth are resting on a lichen-covered tree, (b) The light and dark coloured forms of the peppered moth are resting on a lichen free tree trunk, which was darkened by industrial air pollution.

Analysis

(1) The variation (change in bark colour) is an illustration of variation that is subject to selection (by the birds) in a changing environment.

(2) It demonstrates the truth of evolution.

(3) It points out that evolution and natural selection operate on the basis of genetic change within a population.

Q.5: Describe evidences of evolution.

Ans. Evidences of Evolution

Introduction

The evidence for evolution is compelling and extensive. Looking at every level of organization in living systems, biologists see the signature of past and present evolution.

Explanation

(1) Evidence from Palaeontology. / Describe the evidence of evolution according to palaeontology

In addition to offering strong evidence that ancient species were distinct from modern ones, fossils also show the evolution of organisms across time. To determine how long ago an organism lived in relation to another, scientists classify and age fossils from all around the world. The resulting fossil record shows the evolution of form over millions of years and tells the tale of the past. For example, researchers have found extremely comprehensive records demonstrating how humans and horses have evolved.

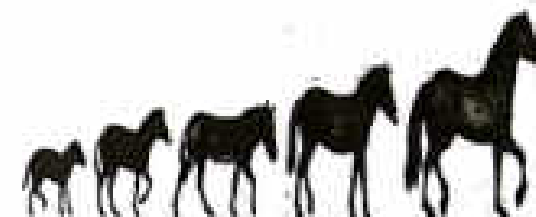


Fig. 10.4: Evolution of modern horse

(2) Evidence from Comparative Anatomy / How comparative anatomy proves evolution?

The existence of structures in creatures with the same fundamental shape is another type of evidence supporting evolution. For example, due to their origin in the appendages of a common ancestor, the bones in the limbs of a human, dog, bird, and whale all share the same general structure. The shapes and sizes of these bones have evolved over time in different animals, but their general structure has remained the same. These similar parts are known as homologous structures.

Some organisms possess such organs that don't appear to have any function at all now and are likely just the remains from a previous common ancestor. Vestigial organs are these inactive, non-functional structures that have lost their use over time. Wings on flightless birds, leaves on some cacti, and appendix in humans are a few examples of vestigial organs.



Fig. 10.5: Homologous structure of bones of limbs of mammals

(3) Evidence from Selective Breeding

Artificial selection is the practice of breeding domesticated and genetically enhanced plants and animals to produce offspring with desired genetic features. Selective breeding is the current name for artificial selection. Selective breeding and hybridization are the two techniques used to develop desired features in plants and animals.

(4) Improving Plants by Selection

Farmers have been using selection to create plants with desired features for ages. They frequently choose varieties that will cause the plants to grow larger, more quickly, be drought resistant, etc.

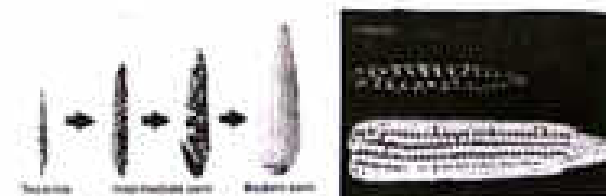
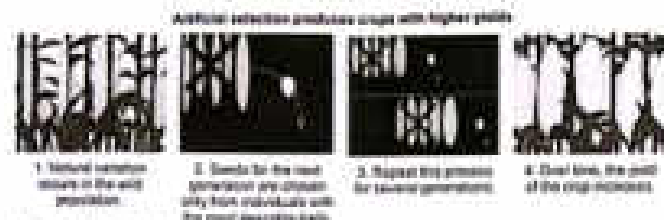


Fig. 10.6: Improving Plants by selection



(5) Improving Animals by Selection

Animals have also been subjected to selection. Cows that generate a lot of milk and high-quality meat are chosen for selective breeding. They serve as parents for the following generation. In this manner, a breed of cow that can produce more milk than the original breed is created.

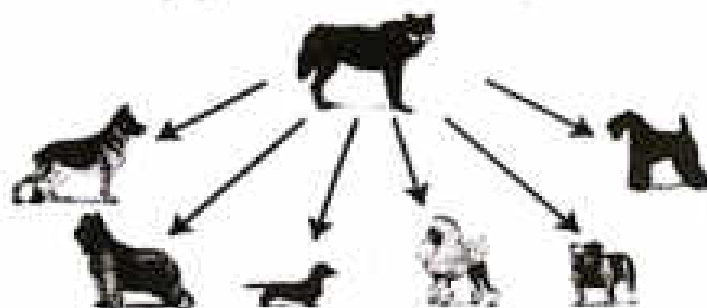


Fig. 18.7: Dog breeds produced from wolf by artificial selection

Q.6: Describe the comparison of natural selection and artificial selection.

09162006

Ans.

Natural Selection	Artificial Selection
Selection occurs when natural environmental condition changes.	It is selected by man.
Varieties are produced by mutations.	Varieties are produced by selective breeding.
It operates in natural population.	It operates in domesticated population.
It is a slow process and takes thousand to millions of years.	It is a fast process and results are immediate (in the next generation).
It is responsible for the great biological diversity.	It is responsible for new varieties different from starting generation.

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Q.7: Describe speciation.

Ans. Definition

The evolutionary process by which new biological species arise is called speciation.

Explanation

Two groups that originate from the same ancestor can become very different over time if they live in different places. When a species gets split into two geographical regions, the process of speciation starts. Each adapts to its own environmental conditions. After a while, individuals from one group can no longer reproduce with the other group. Ultimately, two new species have evolved from one.



Fig. 18.8: Speciation

Long Answer Questions (Additional)

Q.8: How does selective breeding provide evidence for evolution?

09162009

Ans. Selective breeding or artificial selection demonstrates evolution by showing how species can change over time through controlled reproduction. Here's how it provides evidence.

1. Domestication of Animals

Dogs

Modern dog breeds from Chihuahuas to great Danes, all originated from the gray wolf. Selection breeding for traits like size and behavior created this diversity.

Livestock

Animals like cows, sheep, pigs and chickens have been bred for traits such as meat yield, milk production, and egg laying capacity.

2. Domestication of Plants

Crops

Wild maize (teosinte) has corn with larger cobs and more kernels.

Fruits and Vegetables

Wild mustard has been bred into broccoli, cauliflower, Cabbage, Kale and Brussels sprouts.

3. Rapid Observable Changes

Selective breeding produces significant changes in species within a few generations.

Examples

Pigeons: Diverse plumage patterns and body sizes have been achieved through selective breeding.

Rabbits: Breeders have developed various rabbit breeds with distinct colours and ear types.

4. Genetic Evidence

Selective breeding shows how genetic changes lead to new traits.

Examples

Belgian blue cattle exhibit mutation in the myostatin gene.



5. Comparative Anatomy

Despite diverse breeds, skeletal structures reveals common ancestry modified through selection.

Examples

Different dog breeds show structural differences arising from common ancestor.

Conclusion

Selective breeding is a clear demonstration of evolution, showing how intentional selection for traits can lead to significant species changes, mirroring natural selection. This process supported by genetic evidence, robustly supports evolutionary principles.

Q.9: A specie of snail may have a yellow, pink or brown shell. Each colour shell may have dark bands, or have no bands. The snails are eaten by birds. Following observations were made:

- Most snails living on a plain background have no bands.
- Most snails living on green background are yellow.

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(a) Suggest an explanation for these observations.

(b) Predict the colour of snails living on dead leaves.

(c) Suggest which colour snails will be in summer and autumn.

Ans. (a) Explanation for the Observations

The distribution of snail shell colours and pattern can be explained by natural selection and camouflage, aiding their survival by making them less visible to predators.

1. Snails on a plain background have no bands. Bandless shells provide better camouflage on plain backgrounds, reducing predation.

2. "Snails on a green background are mostly yellow." Yellow shells blend with green surrounding, making snails less visible to predators.

3. Snails on rough backgrounds, providing camouflage.

(b) Prediction of Snail Colour on Dead Leaves

Snails on dead leaves would likely have:

(i) Brown shells: blending well with the brown colour of dead leaves.

(ii) Yellow shells: If leaves are more yellowish, yellow shells provide good camouflage.

(c) Prediction of Snail Colour in Summer and Autumn

Summer: "Yellow shells" to blend with lush green foliage.

Autumn: "Brown shells" to blend with overall the colours and patterns of snail shells are adaptive traits evolved for camouflage, aiding survival by reducing predation.

Q.10: Many small volcanic islands are located near South America; these are called Galapagos Islands. There is only one species of finches on South America continent but there are 14 species of finches on Galapagos Islands. Why there are more species on Galapagos Islands as compared to main land?

091409016

Ans. Geographic Isolation and Adaptive Radiation

(1) Geographic Isolation

The Galapagos Islands are far from the South American main land, isolating finch population and preventing gene flow.

(2) Adaptive Radiation

The islands offer diverse habitats and food sources, leading to the rapid evolution of multiple species from the original colonizing finches.

Mechanisms of Speciation

1. Natural Selection

Different environments and food sources on the islands led to the evolution of different beak shapes and sizes.



2. Genetic Drift

In small, isolated populations random changes in gene frequencies contributed to differences between populations.

3. Founder Effect

The initial genetic makeup of the colonizing finches influenced their evolutionary paths.

4. Reproductive Isolation: Over time, finches adapted to specific niches, leading to genetic and behavioural differences that prevented interbreeding.

Summary / Conclusion

The higher number of finch species on the Galapagos Islands compared to the main land is due to geographic isolation, diverse ecological niches, adaptive radiation and mechanisms like natural selection, genetic drift and reproductive isolation. These factors combined led to the evolution of 14 distinct finch species on the islands.

Multiple Choice Questions (Exercise)

- The process of — and — generate variation, and — produces adaptation to the environment. 091409011
(a) sexual recombination — natural selection — mutation
(b) genetic drift — mutation — sexual recombination
(c) mutation — sexual recombination — natural selection
(d) mutation — natural selection — genetic drift.
- Natural selection is sometimes described as "survival of the fittest." Which of the following most accurately measures an organism's fitness? 091409012
(a) its mutation rate
(b) how many fertile offspring it produces
(c) its ability to withstand environmental extremes
(d) how much food it is able to make or obtain
- The smallest biological unit that can evolve over time is: 091409013
(a) a specie
(b) an individual organism
(c) an ecosystem
(d) a population
- Which of the following pairs of structures is least likely to represent homology? 091409014
(a) the wings of a bat and the forelimbs of a human
(b) the haemoglobin of a baboon and that of a gorilla
(c) the brain of a cat and that of a dog
(d) the wings of a bird and those of an insect
- Organisms produce many more offsprings that can possibly survive on the limited amount of resources available to them. The offsprings that are most likely to survive are those that: 091409015
(a) are born first and grow fastest
(b) are largest and most aggressive
(c) have no natural predators
(d) are best adapted to the environment
- Natural selection operates to produce changes in: 091409016
(a) individuals (b) populations
(c) races (d) genes
- Speciation is the evolutionary process by which: 091409017
(a) a new population is formed
(b) a new breed is formed
(c) a new specie is formed
(d) a new race is formed



8. A mutation is: (09140021)
 (a) a change in appearance
 (b) a change in behaviour
 (c) a change in gene
 (d) a change in the environment
9. Farmers have bred Nelli-Ravi buffalo to produce more milk than older breeds. Which process was used to produce these cattle? (09140014)
 (a) adaptation

Multiple Choice Questions (Additional)

11. The breeding of domesticated plants and animals refers to: (09140023)
 (a) natural selection (b) artificial selection
 (c) wild selection (d) selection by chance
12. Some distinct characters of a variation are given: (09140022)
 • controlled by a single gene pair
 • distinct phenotype
 • least effected by the environment
 Select the trait having these characters
 (a) height (b) skin colour
 (c) IQ level (d) tongue rolling
13. Darwin proposed theory of natural selection in: (09140027)
 (a) 1859 (b) 1866
 (c) 1875 (d) 1880
14. The term artificial selection was proposed by: (09140024)
 (a) Darwin (b) Russell
 (c) Mendel (d) Abu Rayhan-al-Biruni
15. Natural selection operates to produce change in: (09140025)
 (a) individuals (b) populations
 (c) races (d) phyla
16. Speciation is the evolutionary process by which: (09140026)
 (a) a new gene pool is formed
 (b) evolutionary path of species converges
 (c) hybrid species is formed
 (d) shows differences in physical traits

- (b) natural selection
 (c) genetic engineering
 (d) selective breeding
10. Which results from the process of natural selection and adaptation? (09140028)
 (a) artificial selection
 (b) evolution
 (c) reproduction
 (d) selective breeding

17. Charles Darwin proposed that organisms produce many more offspring than can possibly survive on the limited amount of resources available to them. According to Darwin, the offspring that are most likely to survive are those that: (09140027)
 (a) are born first and grow fastest
 (b) are largest and most aggressive
 (c) have no natural predators
 (d) are best adapted to the environment
18. Types of difference shown by individuals of same species are: (09140028)
 (a) 1 (b) 2
 (c) 4 (d) 5
19. Among following the source of variations is: (09140029)
 (a) mutation (b) crossing over
 (c) both a and b (d) mitosis
20. It is change in characteristics of a population or species of organisms over the course of generations: (09140030)
 (a) replication (b) transcription
 (c) evolution (d) translation
21. All living things had been created in their current form only a few thousand years ago. This idea is known as: (09140031)
 (a) theory of special creation
 (b) evolution (c) variations
 (d) selective breeding
22. Charles Darwin published a book "On the origin of species by means of Natural selection in: (09140032)
 (a) 1859 (b) 1866
 (c) 1875 (d) 1880

23. It is the process by which the better genetic variations become more common in successive generations of population: (09140033)
 (a) variation
 (b) artificial selection
 (c) selective breeding
 (d) natural selection
24. Variations selected for their transmission to next generation are: (09140034)
 (a) favourable (b) continuous
 (c) discontinuous (d) unfavourable
25. Favourable variation in moths before industrial revolution was: (09140035)
 (a) light colour (b) dark colour
 (c) medium colour (d) bright colour
26. Favourable variation in moths after industrial revolution was: (09140036)
 (a) light colour (b) medium colour
 (c) dark colour (d) bright colour
27. Intentional breeding between individuals for certain traits, or combination of traits is called as: (09140037)
 (a) variations (b) evolution
 (c) natural selection (d) artificial selection
28. The anti-evolution idea is called: (09140038)
 (a) breeding theory
 (b) special evolution
 (c) theory of special creation
 (d) Darwinism
29. Which theory was proposed by Charles Darwin and Alfred Russel Wallace? (09140039)
 (a) Lamarckism
 (b) theory of special creation
 (c) theory of spontaneous generation
 (d) theory of natural selection
30. What is the primary mechanism of evolution? (09140040)
 (a) inheritance of acquired characteristics
 (b) natural selection
 (c) spontaneous generation
 (d) artificial selection
31. Which of the following is an example of a vestigial organ in humans? (09140041)

- (a) heart (b) appendix
 (c) brain (d) liver

32. Darwin observed the diversity of finches on which islands? (09140042)
 (a) Hawaiian islands
 (b) canary islands
 (c) Galapagos island
 (d) Falkland island
33. What is allopatric speciation? (09140043)
 (a) speciation due to genetic drift
 (b) speciation due to geographic isolation
 (c) speciation with in the same geographic area
 (d) speciation due to polyploidy
34. Which factor is considered as a source of variations? (09140044)
 (a) genetic mutation
 (b) crossing over
 (c) gene flow
 (d) all of these
35. In which book did Darwin explain his theory of natural selection? (09140045)
 (a) The Descent of Man
 (b) On the Origin of Species
 (c) The Expression of Emotions Animals
 (d) Voyage of the Beagle
36. What is the outcome of reproductive isolation? (09140046)
 (a) extinction of a species
 (b) speciation
 (c) genetic mutation
 (d) natural selection
37. Which one among the followings serve as a link between reptiles and birds? (09140047)
 (a) marine iguana (b) anchiornis
 (c) dodo (d) wombat
38. Which example demonstrates natural selection in bacteria? (09140048)
 (a) antibiotic resistance
 (b) photosynthesis
 (c) binary fission
 (d) symbiosis with other organisms



Answer Key

1.	(c)	2.	(c)	3.	(d)	4.	(d)	5.	(d)
6.	(b)	7.	(c)	8.	(c)	9.	(d)	10.	(b)
11.	(b)	12.	(d)	13.	(c)	14.	(d)	15.	(b)
16.	(b)	17.	(d)	18.	(b)	19.	(c)	20.	(c)
21.	(a)	22.	(b)	23.	(d)	24.	(a)	25.	(a)
26.	(c)	27.	(d)	28.	(c)	29.	(d)	30.	(b)
31.	(b)	32.	(c)	33.	(b)	34.	(d)	35.	(b)
36.	(b)	37.	(b)	38.	(a)				

Short Answer Questions (Exercise)

Q.1: Explain the homologous structures in plants. (01/10/2021)

Ans. Introduction

Homologous structures in plants refer to anatomical features that are similar in structure and position but may have different functions. These similarities suggest a common evolutionary origin. In plants, homologous structures can be observed in various parts of different plant species.

Explanation

(i) The structure of leaves in different plant species might vary in terms of size, shape and texture but they all share a common basic anatomical plane with a blade and petiole.

(ii) The structure of flowers in angiosperms while the flowers of different species may look quite different, they all consist of similar organs such as sepals, petals, stamens and pistils arranged in a similar pattern.

Q.2: Why the theory of evolution was attributed to Darwin? (01/10/2021)

Ans. The theory of evolution is attributed to Darwin because of his observations during voyage on HMS Beagle. After a five year voyage around the world in the ship HMS Beagle, Charles Darwin put forth the theory of natural selection in 1838. In 1859 he released a book titled "On the Origin of Species by Natural Selection" recording his observations.

Q.3: What is meant by descent with modification? (01/10/2021)

Ans. It refers to the process of evolutionary change over time, where species are descended from common ancestors but have undergone

modifications or adaptations to suit their environment.

Q.4: The diagram shows two varieties of moths in England. (01/10/2021)



(a) Which variety was more common when there was more air pollution? Give reason as well.

(b) Which variety is more common in England nowadays? Give reason as well.

Ans. (a) Dark coloured moth was more common because of the spread of the industrial revolution. Sulphur dioxide pollution from burning of coal killed off lichens growing on trees in industrial areas, exposing the darker bark. The tree trunk was further darkened by soot deposits. So in this type of trunk, dark coloured moth was well camouflaged with the darker bark.

(b) Light coloured moth is more common nowadays because light coloured moth was extremely well camouflaged as its colouration merged with that of the lichens growing on the trunk.

Q.5: Define / Describe / Explain briefly: Evolution, Homologous Organs, Speciation, Natural selection, Artificial selection, Industrial melanism, Palaeontology, Comparative Anatomy, Vestigial organs, Selective breeding. (01/10/2021)

Ans. • Evolution

A change that occurs in living things over time.

• Homologous organs

Homologous structures in plants refer to anatomical features that are similar in structure and position but may have different functions. These similarities suggest a common evolutionary origin. In plants, homologous structures can be observed in various parts of different plant species.

(i) The structure of leaves in different plant species might vary in terms of size, shape and texture but they all share a common basic anatomical plane with a blade and petiole.

(ii) The structure of flowers in angiosperms while the flowers of different species may look quite different, they all consist of similar organs such as sepals, petals, stamens and pistils arranged in a similar pattern.

• Speciation

The evolutionary process by which new biological species arise is called speciation.

• Natural Selection

Natural selection is the process through which organisms who possess traits that are helpful for reproduction in a certain environment produce more children in the following generation. As a result, they gradually expand the population's genetic diversity.

• Artificial Selection

Artificial selection is the process of selecting genetically improved and domesticated plants and animals by man and breeding them to get individuals of desired genetic traits. Artificial selection is now called selective breeding.

• Industrial Melanism

It refers to a phenomenon observed in certain species particularly moths, where the prevalence of dark-coloured individual increases in response to environmental pollution, such as industrialization. In polluted environments, dark-coloured moths have a higher survival rate compared to light coloured ones, as their colouration provides better camouflage against soot-covered tree bark. This change in colouration within population is



an example of natural selection acting on heritable traits in response to environmental changes.

• Palaeontology

It is the scientific study of prehistoric life and history of life on earth as revealed through the fossil record.

• Comparative Anatomy

It is the scientific study that examines and compares the similarities and differences in the body structures of different organisms is called comparative anatomy. It provides hints about how these animals are related and evolved.

• Vestigial Organs

Vestigial organs are organs, tissues or cells in a body which are no more functional the way they were in their ancestral form of the trait.

Examples

The human appendix is thought to be a vestigial structure, a remnant of larger caecum found in our herbivorous ancestors. Similarly wisdom teeth, ear muscle and body hairs (goose bumps) are considered as vestigial. Wings of flightless birds like kiwi and Ostrich are reduced and serve no useful functions.

• Selective Breeding

(1) Selective breeding, also called artificial selection where humans intentionally cross plants and animals with specific traits, operating under the same basic principles.

(2) The main difference between selective breeding and natural selection is that in selective breeding, human determine which traits are advantageous by doing so, humans (breeders) have been able to bring about significant genetic changes within species, creating a wide array of new breeds and varieties that differ dramatically from their wild ancestors.

Examples

A wide range of pigeon varieties with diverse and exciting characteristics have been created selective breeding.



Q.6: Differentiate between natural and artificial selection.

Ans.

Natural Selection	Artificial Selection
Selection occurs when natural environmental condition changes.	It is selected by man.
Varieties are produced by mutations.	Varieties are produced by selective breeding.
It operates in natural population.	It operates in domesticated population.
It is a slow process and takes thousand to millions of years.	It is a fast process and results are immediate (in the next generation).
It is responsible for the great biological diversity.	It is responsible for new varieties different from starting generation.

Short Answer Questions (Additional)

Q.7: Name sources of variation. 091410025

Ans. Following are the sources of variation:

1. Crossing over produces genetic recombination during gamete formation.
2. Independent assortment of chromosomes forming different combination of chromosomes in gametes.
3. Fertilization in which one of the millions of sperms combines with an egg.
4. Mutation in germ cells which will form gametes.
5. Gene flow, which is movement of genes from one population to another population of the same species.

Q.8: Give examples of artificial selection. 091410054

Ans. (i) Disease-resistant variety of wheat.
(ii) Broccoli, Cabbage, Cauliflower, Kale and Kohlrabi have been obtained from common wild mustard by artificial selection.

Q.9: Develop an idea that artificial selection is a means of improving plant yield? 091410057

Ans. Long before Darwin and Wallace, farmers and breeders were using the idea of selection to cause the major changes in the features of their plants and animals. They allowed only the plants and animals with

desirable characteristics to reproduce causing the evolution of farm stock. This process is called an artificial selection because people select the organism they want to reproduce. Essentially all present day crops have been extensively reshaped from their wild ancestors by the repeated application of artificial selection. For example the major cereals (rice, wheat, maize etc.) were all developed from wild grasses by artificial selection thousands of years ago.

Q.10: Define organic or biological evolution. 091410058

Ans. Organic or biological evolution is the change in characteristics of population or species of organisms over the course of generations.

The changes in an individual are not considered as evolution because evolution refers to populations, not to the individuals.

Q.11: What is anti-evolution theory or theory of special creation? 091410059

Ans. The anti-evolution idea supports that all living things had been created in their current form only a few thousand years ago. It is also known as theory of special creation.

SLO Based Reference Material

Short Answer Questions

Q.12: What is melanization? How it occurs? 091410060

Ans. Melanization refers to the process of melanin production in organisms. Melanin is a

pigment responsible for colouration in various living beings, including humans, animals and some species of fungi and plants. This process can occur in response to various environmental and biological factors.

Q.13: What is effect of industrialization on the peppered moth in Britain? 091410061

Ans. After industrialization, pollution killed the lichens, which made the bark appear dark. This made the black moths more hidden and the grey moths were visible to predators. As a result, the black moths had a survival advantage and their population increased.

Q.14: Enlist the factors which can contribute to speciation. 091410062

Ans. Various factors can contribute to speciation:

1. Physical barriers such as mountains, rivers (Geographical)
2. Changes in mating behaviour or preferences (Reproductive)
3. Addition of a new genetic combination in a population due to mutation (Genetic mutation)

Q.15: Where Galapagos Islands are located? 091410063

Ans. Galapagos Islands are group of volcanic islands located near the equator about 900 km west of South America.

Q.16: What do you know about Darwin? 091410064

Ans. Darwin set out on a voyage on HMS beagle at the age of 22. After returning back to England, he never left its shores again and finally formulated the hypothesis that "Evolution took place due to natural selection". He was an accomplished naturalist and one of

the studies he conducted was "Determination of role of earthworm in soil fertility".

Q.17: Name three unique organisms observed by Darwin on Galapagos Island. 091410065

Ans. 1. The Galapagos finches, also known as "Darwin's finches" have different beak shapes and sizes that are adapted to specific diets.

2. Galapagos tortoises have different shell shapes and sizes depending on their habitat and food sources.

3. The marine iguana (*Amblyrhynchus cristatus*) is a type of lizard that is only found on the Galapagos islands. It mainly eats marine algae and has adapted to its environment by having strong limbs, a flattened tail that makes it a proficient swimmer and dark colouration that helps it absorb heat.

Q.18: Differentiate between intraspecific competition and interspecific competition. Why the intensity of intraspecific competition is often high? 091410066

Ans. Intraspecific competition occurs within a single species, while interspecific competition takes place between different species. The intensity of intraspecific competition is often high because individuals of the same species have identical or similar needs for resources, such as food, space, and mates. Interspecific competition is a more direct force in shaping the evolutionary path of a species due to the direct competition for resources among genetically similar individuals.

SLO Based Reference Material

Long Answer Question

Q.1: Describe the evidence of evolution with reference to fossil record. 091410067

Ans. Introduction

The theory of evolution by Charles Darwin is backed by lots of evidence from different areas of science. Darwin's theory was mainly based on his observations of the distribution of species across different regions and the fossils he found.

Explanation

(i) Fossils are the preserved remains or impressions of ancient organisms typically found embedded in layers of rocks, ice and other materials.

(ii) They provide direct and visual evidence for evolution.



(iii) Although the record is not complete, palaeontology has helped us understand many evolutionary lines.

Examples

(i) The *Archaeopteryx* fossil serves as a link between reptiles and birds, exhibiting reptilian features like clawed digits and feathers and wings as seen in birds.

(ii) *Seymouria* is a transitional fossil that connects amphibians and reptiles. This animal possessed a unique combination of features, with limbs and an expected lifestyle resembling those of amphibians, while also displaying a skull and certain skeletal traits characteristic of early reptiles.

The existence of transitional fossils shows how characteristics from ancestral groups can be found in their descendants. This concept is further supported by the gradual changes observed in modern animals like horses, giraffes and elephants, which demonstrate the ongoing process of evolution from their ancient predecessors. The proof for evolution also comes from many other sources including embryology, comparative anatomy and molecular biology.

MODEL PAPER



Past Paper of Federal Board 2024

BIOLOGY 9th	پایہ 9 (بیالوجی)
Paper -I (Objective Type)	پرچہ I (موضوعی طرح)
Time Allowed: 15 Minutes	دقت: 15 منٹ
Maximum Marks: 12	کل نمبر: 12

Tick the right answer of each question according to the curriculum.

SECTION - A (Marks 12)

No.	Question	A	B	C	D
1	The given comparison never with the help of: 	Flagella	Cilia	Taxolins	Paraphagocytosis
2	At which stage of biological method "If and then" logic is used?	Observation	Hypothesis	Debate	Experiment
3	All of these are characteristics of fungi EXCEPT:	Eukaryotic organism	Chitin in cell wall	Mouldy on decomposition	Cellulose in cell wall
4	Cell engulfs substances by vesicle formation during:	Endocytosis	Osmosis	Exocytosis	Diffusion
5	In disease of thrombocytes in plant cells, _____ will stop:	Respiration	Photosynthesis	Translocation	Transport of materials
6	Pre-plant cells having 14 chromosomes shall have _____ chromosomes after mitosis:	7	14	21	28
7	Which graph shows effect of substrate concentration on the rate of controlled reaction?				
8	Determine amount of energy in given equation: $\text{FADH}_2 + 2\text{ADP} \rightarrow \text{FAD} + 2\text{ADP} + 2\text{H}^+ + 2\text{e}^-$	1.78 Cal	14.64 Cal	21.94 Cal	29.24 Cal
9	All of these are macro nutrients EXCEPT:	Potassium	Calcium	Molybdenum	Magnesium
10	Food moves through alimentary canal by:	Antiperistalsis	Peristalsis	Autolysis	Catabolism
11	Defect in endocrine causes _____ problems:	Kidney	Heart	Liver	Stomach
12	Which valve prevents the flow of blood from Right Ventricle to Right Atrium?	Tricuspid valve	Bicuspid valve	Semilunar valve	Pulmonary valve



Past Paper of Federal Board 2024

BIOLOGY 9th
Paper -II (Subjective Type)
Time Allowed: 2.45 Minutes
Maximum Marks: 53

پایہ 9 (بیالوجی)
پرچہ II (موضوعی طرح)
دقت: 2.45 منٹ
کل نمبر: 53

SECTION - B (Marks 10)

Q.1 Attempt the following long questions.

(11-13)

مطلوبہ: درج ذیل سوالات طویل جواب دیں۔

Q.1	Identify level of organization of the following: Bone, DNA, Muscles, Cartilage, Neuron and Golgi bodies.	1.5	OR	Differentiate between the following with example.	1.5
Q.2	Describe importance of data analysis for hypothesis.	1	OR	Describe location, structure and function of centrioles in the cell.	1
Q.3	Write down scientific names of Potato, Peas and Rice.	1	OR	Describe deficiency symptoms of water and dietary fibres in the body.	1
Q.4	Differentiate between extinct and endangered species. Give one example of each.	1.5	OR	Describe rules which are adopted while suggesting and documenting scientific names.	1
Q.5	Draw labelled diagram of prokaryotic (bacterial) cell.	1	OR	Draw a labelled diagram of Mitochondrion.	1
Q.6	The given diagram A and B looking to pistons. Identify and describe relevant features of these pistons.	1.5	OR	Identify labelled parts of the given diagram. Also write down name of diagram.	1.5
Q.7	What is anorexia? Describe causes and process of anorexia in the body.	1	OR	Describe effects of wind and humidity on the rate of transpiration.	1
Q.8	Describe symptoms, treatment and preventive measures of thalassemia.	1	OR	Describe the effects of temperature on activity of enzymes with the help of suitable graph.	1
Q.9	Which one is the more acceptable model for mechanism of enzyme action? Describe it.	1	OR	Describe the changes in the cell that occur during G-1 and G-2 phase of the interphase.	1
Q.10	What are the products of photosynthesis? Describe its two types.	1	OR	Draw flow chart for light dependent reactions of photosynthesis.	1
Q.11	Compare Glycolysis and Krebs cycle.	1.5	OR	Describe significance of mitosis.	1



SECTION - C (Marks 20)

Note: Attempt the following questions.

نوٹ: درج ذیل سوالات کے جواب دیں۔

Q.3	What is translocation? Discuss pressure flow hypothesis for translocation. وانتقال کسے کہتے ہیں؟ ان کو بیان کریں۔ پریشر فلو ہائپوٹھسز، اس کے بارے میں بحث کریں۔	1+4	OR	Discuss digestion in small intestine. Also draw labelled diagram of villus. چھوٹی آنت میں غذا کی ہضم کی وضاحت کریں۔ اس کے ہضم کی شکل کش کریں۔	3 + 2
Q.4	Discuss relationship of biology with other sciences. بیولوجی کے دیگر سائنسوں سے تعلق کی وضاحت کریں۔	1+3	OR	Discuss compound tissues in plants. گیہوں میں مرکبہ نالیوں کی وضاحت کریں۔	2.5 + 2.5
Q.5	In view of photosynthesis complete and balance the equation. Also discuss role of light and chlorophyll in photosynthesis. $CO_2 + H_2O \longrightarrow ?$ ((آکسیجن اور گلوکوز کے ساتھ متوازن اور مکمل مساوی بنائیے۔)) ((آکسیجن اور گلوکوز کے ساتھ متوازن اور مکمل مساوی بنائیے۔))	1+2 + 2	OR	Differentiate between pulmonary and systemic circulation. Also describe the functions of superior vena cava, inferior vena cava, aorta and pulmonary artery. شہری اور سرنگی گردش میں فرق کریں۔ اور (شہری وینا کوا، سفلی وینا کوا، آئٹا اور پولمونری آئٹا) کی فکشن بیان کریں۔	2+4
Q.6	Which is the largest gland in human body? Discuss its role in the body. انسانی جسم میں سب سے بڑا غدود کون سا ہے؟ اس کے جسم میں کردار بیان کریں۔	1+4	OR	Describe the structure and functions of cell membrane with the help of labelled diagram. خلیہ غش کی ساخت اور فکشن (ٹیگلڈ ڈیاگرام کے ساتھ) بیان کریں۔	3+3

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