CLASS XI

BIOTECHNOLOGY

STUDY MATERIAL

CLASS- XI (2024-25)
COURSE
STRUCTURE

One Paper **Time: 3 hrs.**
Max. Marks 70+30

Units		Marks
Unit- I	Biotechnology: An overview	5
Unit-II	Molecules of Life	20
Unit-III	Genetics and Molecular Biology	20
Unit-IV	Cells and Organisms	25
	Practical	30
	Total	**100**

CLASS XI
(Theory)

One Paper Time: 3 hrs. **Total Marks: 70**

Unit-I Biotechnology: An overview **5 Marks**

Chapter 1: Biotechnology: An Overview

Historical Perspectives, Technology and Applications of Biotechnology, Global market and Biotech Products.

Unit-II Molecules of Life **20 Marks**

Chapter 1: Biomolecules: Building Blocks

Building Blocks of Carbohydrates - Sugars and their Derivatives, Building Blocks of Proteins
- Amino Acids, Building Blocks of Lipids - Simple Fatty Acids, Glycerol and Cholesterol,Building Blocks of Nucleic Acids – Nucleotides.

Chapter 2: Macromolecules: Structure & Function

Carbohydrates - The Energy Givers, Proteins - The Performers, Enzymes - The Catalysts,Lipids and Biomembranes - The Barriers, Nucleic Acids - The Managers

Unit-III Genetics and Molecular Biology **20 Marks**

Chapter 1: Concepts of Genetics

Historical Perspective, Multiple Alleles, Linkage and Crossing Over, Genetic Mapping.

Chapter 2: Genes and Genomes: Structure and Function

Discovery of DNA as Genetic Material, DNA Replication, Fine Structure of the Genes, From Gene to Protein, Transcription – The Basic Process, Genetic Code, Translation, Mutations, Human Genetic Disorders.

Unit IV Cells and Organisms **25 Marks**

Chapter 1: The Basic Unit of Life

Cell Structure and Components, Organization of Life

Chapter 2: Cell Growth and Development

Cell Division, Cell Cycle, Cell Communication, Nutrition, Reproduction, Immune Response inAnimals.

PRACTICALS

Note: Every student is required to do the following experiments during the academicsession.

1. Preparation of buffers and pH determination
2. Sterilization techniques
3. Preparation of bacterial growth medium
4. Cell counting
5. Sugar Estimation using Di Nitro Salicylic Acid test (DNS test)
6. Assay for amylase enzyme
7. Protein estimation by biuret method

Scheme of Evaluation

Time: 3 Hours **Max. Marks 30**

The scheme of evaluation at the end of session will be as under:

Two experiments	:	20
Marks Viva on experiments	:	5
Marks Practical record	:	5 Mark

Prescribed Books:

1. **A Text Book of Biotechnology -** Class XI : Published by CBSE, New Delhi
2. **As reference- Biotechnology -** Class XI : Published by NCERT, New Delhi
3. **A Laboratory Manual of Biotechnology -** Class XI : Published by CBSE, New Delhi

Unit-I Biotechnology: An overview

Chapter 1: Biotechnology: An Overview

Multiple Choice Questions

1. What are the different products of fermentation?
   a. Acid
   b. Alcohol
   c. Gases
   d. All of the above
2. Which of the following bacteria is not used for fermentation?
   a. Lactobacillus
   b. Leuconostoc
   c. Escherichia
   d. Enterococcus
3. Which of the following is the correct sequence of steps for setting curd?
   a. Cold milk + curd → incubation → curd formation
   b. Warm milk + curd → incubation → curd formation
   c. Warm milk + curd → refrigeration → curd formation
   d. Cold milk+ curd → refrigeration → curd formation
4. Why warm milk is used for curd preparation?
   a. Warm milk helps the growth of bacteria
   b. Hot milk may kill bacteria
   c. Very cold milk may render bacteria inactive
   d. All the reasons given above are true
5. Microbial fermentation is an example of
   a. Bioprocess technology
   b. Cell culture
   c. Recombinant DNA technology
   d. All of the above
6. Bioprocess technology is the use of-
   a. Unicellular microorganisms
   b. Enzymes
   c. Yeast
   d. All of the above

7. Which of the following are products of bioprocess technology?
   a. Bread, pickle
   b. Wine, beer
   c. Human insulin, hepatitis B vaccine
   d. All of the above
8. What is cell culture technology?
   a. Growing cells outside living organisms
   b. Growing unicellular microbes in a medium
   c. Creating genetically modified microbes
   d. Creating genetically identical sheep
9. What is cloning?
   a. Generating identical molecules
   b. Generating identical cells
   c. Generating identical plants and animals.
   d. All of the above
10. SNCT involves
    a. Transfer of somatic nucleus to an enucleated zygote
    b. Transfer of sperm nucleus to an enucleated zygote
    c. Transfer of somatic nucleus to an enucleated ovum
    d. Transfer of sperm nucleus to an enucleated ovum

a. h

12.RDT involves
   a. Manipulation of DNA
   b. Recombining DNA from different sources
   c. Modification of plants and animals
   d. All of the above

13.What is protein engineering?
   a. Improvement of proteins
   b. Changing proteins
   c. Modification of proteins using RDT
   d. None of the above

14.Which of the following mammalian cells are used to produce inactivated polio virus?
   a. Chinese hamster ovary cells
   b. Baby hamster kidney cells
   c. Human lung fibroblasts
   d. Monkey kidney epithelial cell

15.What can be done to improve crop yields?
   a. Disease resistance
   b. Pest resistance
   c. Abiotic stress resistance
   d. All of the above

Assertion and Reason type questions

Answer these questions selecting the appropriate option given below:

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

1. technos are used to clean our environment

1. Assertion: Bioremediation technologies are used to clean our environment

   Reason: Bioremediation removes toxic substances from contaminated soils and groundwater.

   Answer: A

2. Assertion: Cloning technology generates a population of genetically identical molecules, cells and organisms.

   Reason: Cloning is used for drug discovery, transgenic crops and livestock improvement.

   Answer: A

3. Assertion: Recombinant DNA technology is used to make precise manipulations at gene level.

   Reason: Recombination of genes is a process for making clones of animals.

   Answer: C

4. Assertion: Biotechnology has wide applications in crop improvement.

   Reason: Genetically modified crops may have properties of stress tolerance, improved nutritional value and other beneficial properties.

   Answer: A

2 Mark Questions

1. Define biotechnology. Why is modern biotechnology considered multidisciplinary in nature?
   Biotechnology can be defined as-
   "Any technological application that uses biological systems, living organisms or derivatives thereof to make or modify products or processes for specific uses" (Food and Agriculture Organization).

   Modern biotechnology considered multidisciplinary in nature as it is dependent on various disciplines of sciences for the achievement of the goal of making specific products for betterment of human life.

2. Mention any two applications of biotechnology in crop improvement.
   Gene cloning- drug discovery, development of transgenic crops
   Animal cloning- improve livestock

3. Outline the steps involved in SCNT.
   - Enucleation of Ovum (Removing nucleus) and transfer the nucleus of a somatic cell to the enucleated ovum
   - The resulting cell behaves like a zygote and develops as the clone of the donor of the somatic cell
4. How are engineered proteins different from existing proteins? Mention the applications of engineered proteins.
   Engineered proteins do not exist in nature and are improvement of the existing proteins.
   Applications- drug development, food processing, industrial manufacturing
5. Name any four traditional fermented foods of India.
   Dahi, Srikhand, Jalebi, Bhatura,etc

3 Mark Questions

1. What is cloning? How is molecular cloning different from animal cloning? Mention any two applications of molecular cloning.
   Cloning technology allows us to generate a population of genetically identical molecules, cells, plants or animals.
   Molecular or gene cloning is the process of creating genetically identical DNA molecules. Animal cloning is done to create copies of animals.
   Two applications of molecular cloning-
   a. Drug discovery
   b. Development and production of transgenic crops

2. What is cell culture technology? Mention one application of plant and animal cell culture each.
   Cell culture technology is the growing of cells outside of living organisms.
   Plant cell culture is an important source of compounds used as flavours, colours, and aromas by the food-processing industry.
   Animal cell culture - Livestock breeding

3. Name any two unicellular organisms that are most commonly used in bioprocess technology. Name any two products produced in each of these organisms.

   Yeast (*Saccharomyces cerevisiae)* and bacteria (*Escherichia coli).*

   Products produced in *Escherichia coli*- Insulin, human growth Hormone, somatostatin, interferon, Bovine growth hormone.

   Products produced in *Saccharomyces cerevisiae* - Hepatitis B virus surface antigen (vaccine against Hepatitis B)

4. What are biosensors? How do biosensors function? Mention any two applications of biosensors.
   Biosensor technology couples the knowledge of biology with microelectronics. A biosensor is composed of a biological component, such as a cell, enzyme or antibody, linked to a tiny transducer—a device powered by one system that then supplies power (usually in another form) to a second system.

   Biosensors are detecting devices that rely on the specificity of cells and
   molecules to identify and measure substances at extremely low concentrations. When the substance of interest binds with the biological component, the transducer produces an electrical or optical signal proportional to the concentration of the substance.

   Biosensors can be used for:
   measurement of nutritional value,
   freshness and safety of food
   location and measurement of environmental pollutants

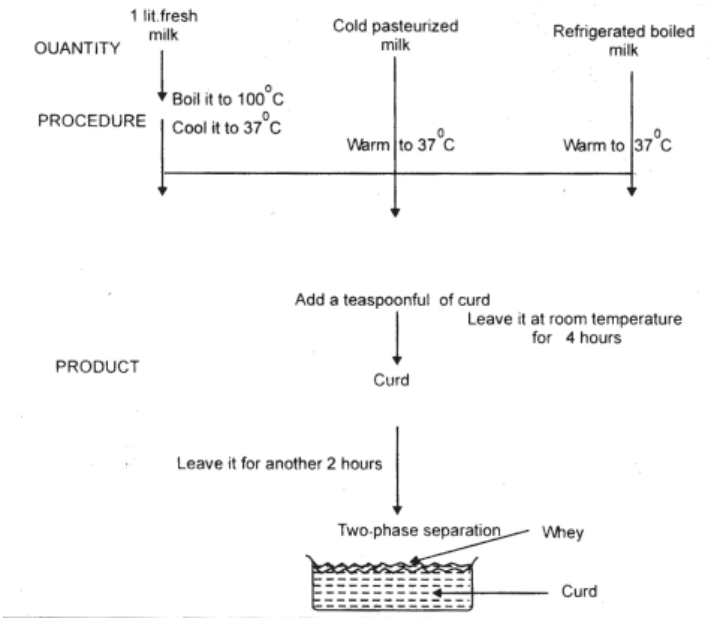
5. What is nanobiotechnology? Mention any two applications of this technology.

Nanotechnology is the study, which involves manipulation and manufacture of ultra-small structures and machines made of as few as one molecule. Nanobiotechnology uses the knowledge of nanotechnology and biomolecules
of cell to produce desired technology.

Some applications of nanobiotechnology includes; fast diagnosis of disease, bio-nanostructures creation for getting functional molecules into cells, improvement of specificity and timing of drug delivery.

5 Mark Questions

Study the flow diagram of curd production in industry. Study the diagram and answer the following questions:



a) Why is the milk boiled or pasteurized before using it for curd preparation?
   Boiling the milk or pasteurization of milk kill all the microbes in the milk

b) Why is curd added to milk for preparing curd?
   Curd contains the bacteria (*Lactobacillus*) which turns milk into curd

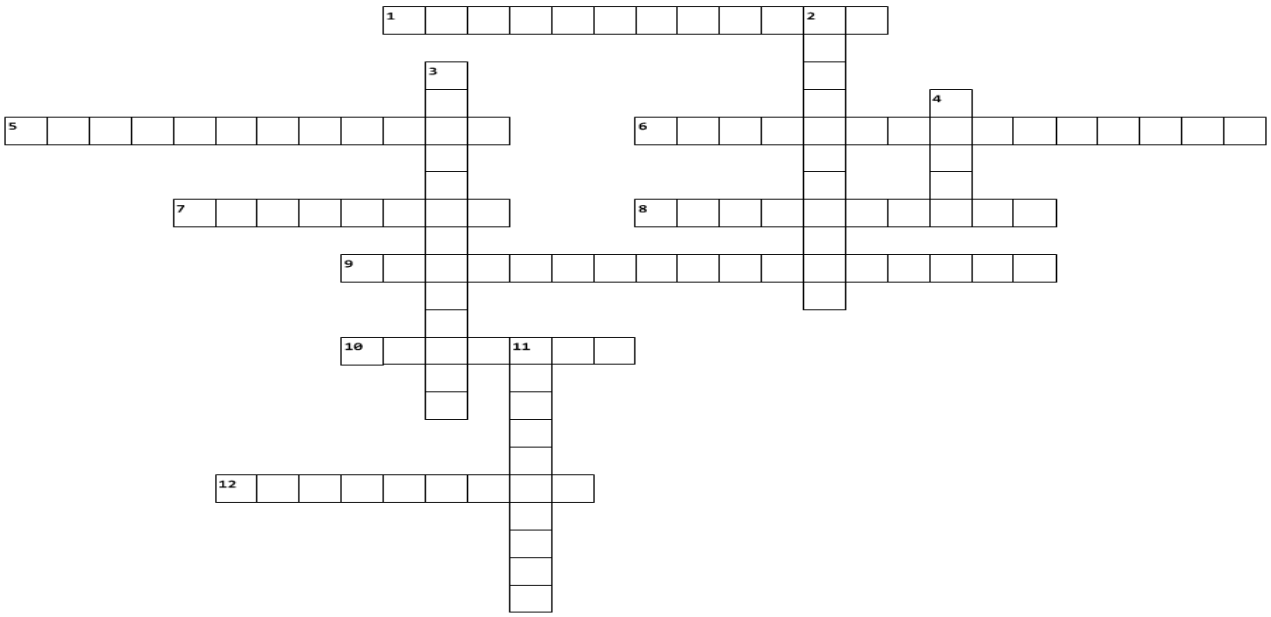
c) Why is it important to warm the milk before adding curd
   Curd bacteria need warm temperatures to grow.

d) Why is the milk left at room temperature after the curd is mixed in it?

Curd bacteria can grow at room temperature

e) If after mixing curd in the milk we keep the mixture in the refrigerator what will be the result after 4 hours?
Curd will not be formed as the growth of the bacteria is very slow at low temperatures.

CROSSWORD



Across

1. Study of chemical processes in living systems

5. Process that produces alcohol, acid and gas

6. Drug or medicine used in medical treatment

7. Science of heredity and variations in organisms

8. Characteristics or indicative of a disease

9. Coupling of nanotechnology and biomolecules

10. Process of creating copies of molecules or organisms

12. Microelectronics coupled with biology

Down

2. Joining of DNA fragments from two different sources is _____ DNA technology
3. Use of living systems to make or modify products and processes
4. Unicellular eukaryotic cells that is commonly used in bioprocess
11. Study of defense mechanism of human body

Unit-II Molecules of Life

Chapter 1: Biomolecules: Building Blocks

Contents of the chapter

- Building Blocks of Carbohydrates - Sugars and Their Derivatives
- Building Blocks of Proteins - Amino Acids
- Building Blocks of Lipids - Simple Fatty Acids, Sphingosine, Glycerol and Cholesterol
- Building Blocks of Nucleic Acids - Nucleotides

Chapter 2: Macromolecules: Structure and Function

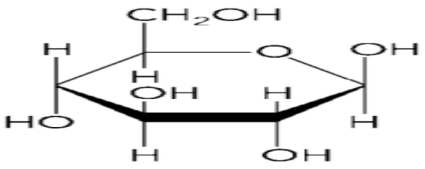
Contents of the chapter

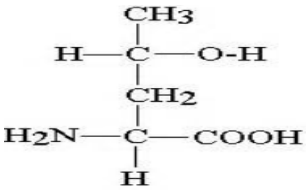
- Carbohydrates - The Energy Givers
- Proteins - The Performers
- Enzymes - The Catalysts
- Lipids and Biomembranes - The Barriers
- Nucleic Acids - The Managers

UNIT-2: MOLECULES OF LIFE

CHAPTER 1: BIOMOLECULES: BUILDING BLOCKS

MULTIPLE CHOICE QUESTIONS:

1	_____ is an example of ketohexose? a) D-Glucose b) D-Glyceraldehyde c) D-Fructose d) D-Mannose
2	Which of these is not an absolute characteristic of any monosaccharide? a) Presence of aldehyde or ketone functional group b) Polyhydoxy groups c) Presence of 3 to 7 carbon atoms d) Formation of Haworth Projection (ring structure)
3	The anomeric carbon atom of D Galactose is: a) C 1 b) C 2 c) C 3 d) C 4
4	Identify the monosaccharide depicted here:  a) Alpha D Galactose b) Beta D Galactose c) Alpha D Glucose d) Beta D Glucose
5	Which of the following generally forms a furan ring? a) D-Glucose b) D-Glyceraldehyde

<table>
<tr><td></td><td>c) D-Fructose
d) D-Mannose</td></tr>
<tr><td>6</td><td>Identify the amino acid and its category:
 
a) Serine, Polar Uncharged
b) Threonine, Polar Uncharged
c) Methionine, Hydrophobic
d) Leucine, Hydrophobic</td></tr>
<tr><td>7</td><td>The amino acid that gives yellow colour in Ninhydrin Test is:
a) Lysine
b) Tryptophan
c) Proline
d) Asparagine</td></tr>
<tr><td>8</td><td>Identify A & B in the given table:
<table><tr><th>Amino Acid</th><th>Derivative</th><th>Function</th></tr><tr><td>Tryptophan</td><td>A</td><td>B</td></tr></table>
a) A: Serotonin; B: Neurotransmitter
b) A: GABA; B: Neurotransmitter
c) A: Thyroxine; B: Hormone
d) A: Histamine; B: Allergic Reactions</td></tr>
<tr><td>9</td><td>Which of these enzyme catalysed reactions are carried out by vitamin Pantothenic acid?
a) Transaminase Reactions
b) Acyl transfer reactions
c) Molecular rearrangement reactions
d) Decarboxylase reactions</td></tr>
<tr><td>10</td><td>Which of these chemicals is used in Acrolein test?
a) Ninhydrin
b) Bromine
c) Potassium Hydrogen Sulphate
d) Ferric chloride</td></tr>
<tr><td>11</td><td>The bond present between the pyrimidine nitrogenous base and ribose sugar of a nucleotide is:
a) Peptide bond
b) Phosphodiester bond
c) N1-C1’ glycosidic bond
d) N9-C1’ glycosidic bond</td></tr>
<tr><td>12</td><td>The disaccharide Lactose id made up of which of these:
a) α D Glucose + β D Glucose
b) β D Galactose + β D Glucose
c) α D Glucose + β D Fructose
d) α D Galactose + β D Glucose</td></tr>
<tr><td>13</td><td>In the pathological laboratories, which of these tests is conducted to detect the</td></tr>
</table>

	blood/urine sugar levels? a) Orcinol Test b) Acrolein Test c) Benedict's Test d) Bromine water Test
14	In the formation of hemiacetal ring structure of D Glucose, functional groups of which of the following carbons would react? a) C1 and C4 b) C2 and C5 c) C1 and C5 d) C2 and C4
15	Which of these reactive groups of amino acids is involved in the Ninhydrin test? a) Carboxylic group b) Phenolic group c) Sulfhydryl group d) Alpha amino group
16	Which of these is an un saturated fatty acid? a) Oleic acid b) Palmitic acid c) Stearic acid d) All of the above
17	Acrolein test can be performed to detect which of these? a) Fatty acids b) Triglycerides c) Phospholipids d) Both b & c
18	Identify the nitrogenous base which has amino function group at C6: a) Adenine b) Guanine c) Thymine d) Uracil
19	Which if these nitrogenous bases is not present in DNA? a) Adenine b) Guanine c) Thymine d) Uracil
20	If you are using diphenyl amine, you are detecting the presence of which of these? a) Saturated Fatty Acid b) Reducing Sugar c) Deoxyribonucleotides d) Ribonucleotides
21	Upon demethylation, the structure of Thymine would resemble: a) Adenine b) Guanine c) Cytosine d) Uracil
22	Which of these elements is not present in a nucleotide?

	a) C b) H c) P d) S
23	The structure of Glucose and Galactose differ at which carbon atom? a) C1 b) C3 c) C4 d) C5
24	Which of these is not an aromatic amino acid? a) Tyrosine b) Serine c) Phenylamine d) Tryptophan
25	Which of these is a non-reducing sugar? a) Lactose b) Maltose c) Sucrose d) Both a and b
26	Amino acids naturally occur in _____ configuration about their Cα position a) D b) L c) Both D and L d) Either D or L
27	_____ is an amino alcohol a) Sphingosine b) Stearic Acid c) Palmitic Acid d) Cholesterol
28	Which functional groups of monosaccharides are involved in formation of ring structures? a) Acid b) Hydroxy c) Carbonyl d) Both b & c
29	The non polar amino acid containing a 'S' atom is a) Cysteine b) Methionine c) Proline d) Serine
30	Which of these is a component of a nucleotide? a) Ribose Sugar b) Inorganic Phosphate c) Nitrogenous Base d) All of these

Answers:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C	D	a	d	C	b	c	A	b	c	D	b	c	c	d
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A	D	a	D	C	d	d	C	b	c	B	a	d	b	d

Assertion-Reason Based Questions

The following questions are A-R based questions consist of two statements– Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

A. Both Assertion and Reason are true and the reason is the correct explanation of the assertion

B. Both Assertion and Reason are true but the reason is not the correct explanation of the assertion

C. Assertion is true but Reason is false

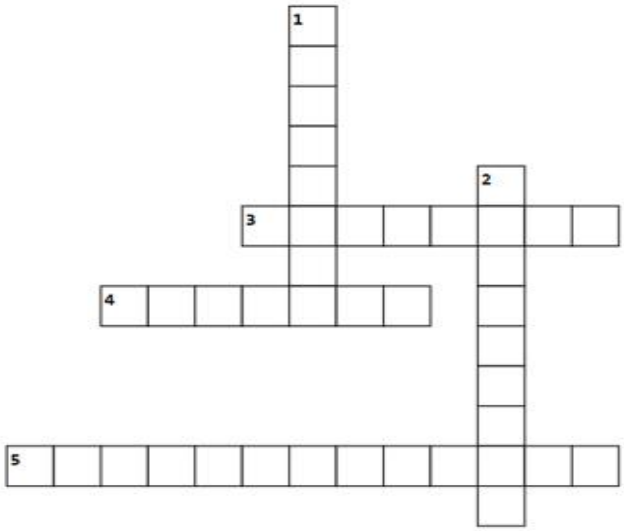
D. Both Assertion and Reason are false

1. Assertion: The bond between two monosaccharides is formed due to dehydration. Reason: The bond is formed between OH group of anomeric 'C' of one monosaccharide and OH of another monosaccharide.
2. Assertion: Sugars with free anomeric carbon are called reducing sugars. Reason: These can reduce alkaline solutions of copper salts.
3. Assertion: Proline gives a purple product in Ninhydrin test. Reason: Proline has alpha amino group that reacts with Ninhydrin.
4. Assertion: Nitrogenous bases are heterocylic. Reason: All Nitrogenous bases are made up of two rings.
5. Assertion: The carbon atom carrying carbonyl group is called anomeric carbon in ring structure. Reason: The carbon atom becomes assymetric upon forming ring structure.
6. Assertion: Glucose is classified as an aldose. Reason: Glucose has an aldehydic functional group and is a hexose.
7. Assertion: Cholesterol is the most abundant steroid in animals. Reason: Steroids are a special group of lipids derived from cholesterol.
8. Assertion: DNA is the hereditary material of a cell. Reason: DNA is made up of deoxyribonucleotides.
9. Assertion: Sucrose is a non-reducing sugar Reason: Sucrose is made up of glucose and fructose
10. Assertion: There are many forms of biomolecules in a cell Reason: These biomolecules work in isolation.

Answers:

1	2	3	4	5	6	7	8	9	10
A	a	D	c	a	a	B	A	b	d

CROSS WORDS

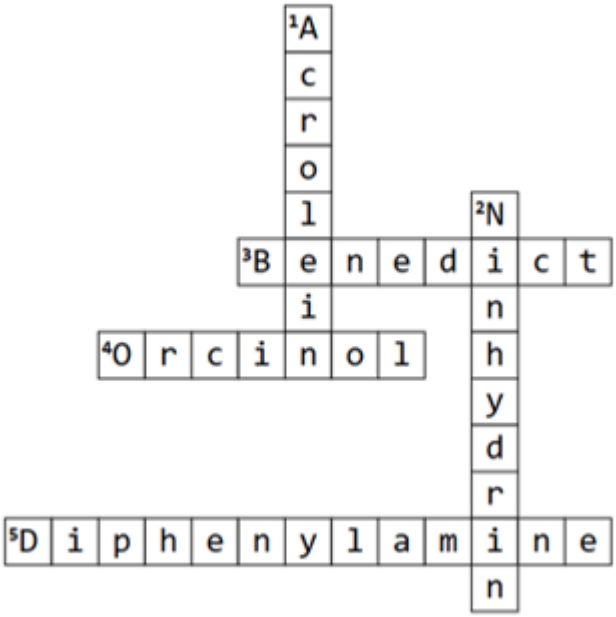


Across

3. Reducing Sugar
4. Pentose Sugar
5. Deoxyribose

Down

1. Triglycerides + Phospholipids
2. Amino Acids

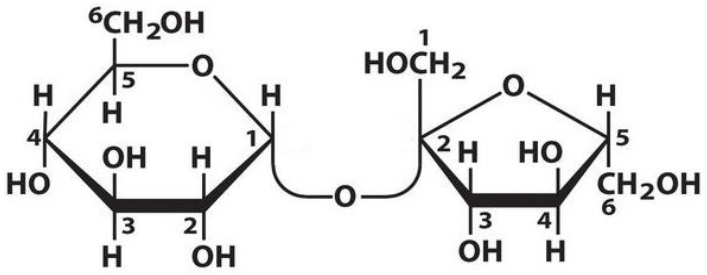


ANSWER:

VERY SHORT ANSWER TYPE QUESTIONS (2 MARKS)	
1.	**Identify the following:** **a) The bond between ribose sugar and nitrogenous base.** **b) The coenzyme derivative of the vitamin thiamine**. Answer: a) N Glycosidic Bond b) Thiamine Pyrophosphate

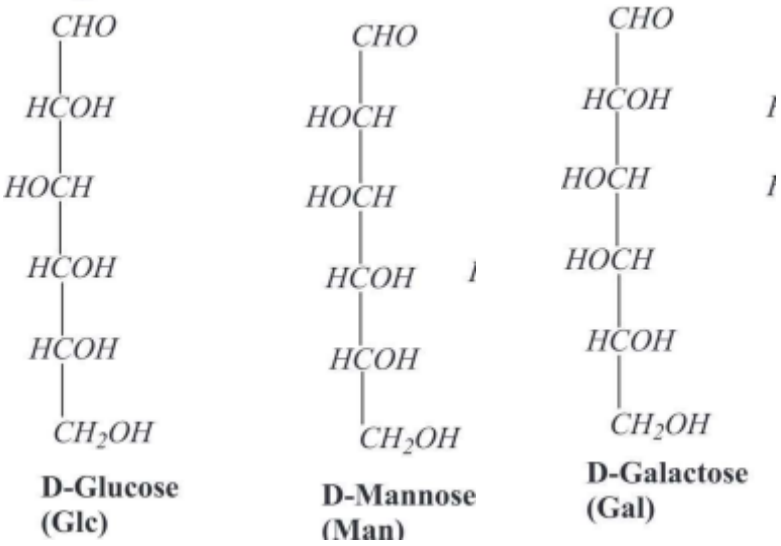
2.	**What is a glycosidic bond?** Answer: Glycosidic bonds are formed due to condensation reaction between hydroxyl residue on C-1 of one monosaccharide and the C-4 on other monosaccharide..
3.	**What are reducing sugars? How would you test for the presence of reducing sugars in a sample?** Answer: A reducing sugar can act as a reducing agent as it has a free aldehyde or ketone group. Benedict's test can detect reducing sugars.
4.	**What is the difference between α & β anomers?** In Haworth projection (cyclic), if the OH group on far right it is up α anomer (same plane with last C) while if it is opposite it is β anomer.
5.	**Name the two monosaccharides that are present and Sucrose and also name the glycosidic bond.** α D Glucose and β D Fructose. A 1->2 Glycosidic bond.
6.	**What are nitrogenous bases? Name the purines & pyrimidines.** A *nitrogenous base* is simply a *nitrogen* containing heterocylic molecule that has the same chemical properties as a *base*. They are particularly important since they make up the building blocks of DNA and RNA.
7.	**Name the sulphur containing amino acids. Which of these is polar by nature?** Methionine and Cysteine are sulphur containing amino acids. Cysteine is polar.
8.	**Name any two hydroxyl containing amino acids. Which of these is aromatic by nature?** Tyrosine and Serine. Tyrosine is aromatic amino acid.
9.	**How can the understanding of a biomolecule be essential for a Biotechnologist?** A Biotechnologist can devise methods to manipulate cells and their constituents and help make big leap in the understanding of health and diseases and thus can contribute for human welfare.
10.	**Naturally occurring amino acids have which configuration about their alpha carbon atom? Give one example of exception.** Naturally occurring amino acids have ''L configuration about their alpha carbon atom except rarely in some bacterial cell walls.
11.	**What are conenzymes? Conenzymes are derived mostly from which group of vitamins?** Co-enzymes are small organic molecules derived from vitamin precursors that facilitate the activity of many enzymes. They are particularly derived from vitamins belonging to the B-complex group
12.	**Identify these nucleotides?** **a) 6 amino purine** **b) 2 keto 6 amino pyrimidine** **c) 2 amino 6 keto purine** **d) 2,4 diketo 5 methyl pyrimidine** a) Adenine b) Cytosine c) Guanine d) Thymine.
13.	**What does the term 'residue' denote in a nucleotide?** The term 'residue' denotes that during the formation of the nucleotide, a part of the molecule is bonded to another, usually by the elimination of water and, hence, what is left is termed as a residue.
14.	**What is the difference between a ribose and deoxyribose sugar? Name the bond present between the pentose sugar and the inorganic phosphate of a nucleotide?**

	A ribose sugar has 2' OH group while a deoxyribose sugar lacks the 2' OH group. The bond present between the pentose sugar and the inorganic phosphate of a nucleotide is phosphoester bond.
15.	**How many hydrocarbon rings are present in cholesterol? What are special group of lipids derived from cholesterol?** Four hydrocarbon rings are present in cholesterol. Steroids are the special group of lipids derived from cholesterol.

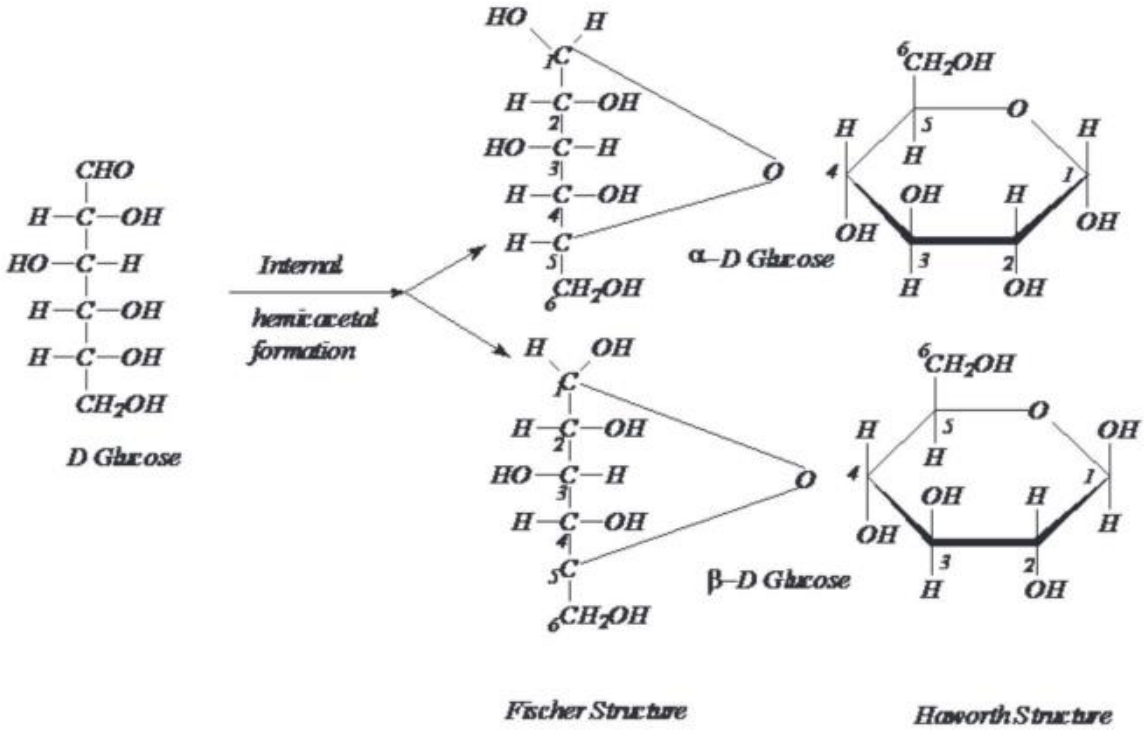
SHORT ANSWER TYPE QUESTIONS (3 MARKS)	
1.	**Identify the disaccharide and write the names of the monosaccharides in it in their correct order with their anomeric forms:**  Sucrose formed of α D Glucose and β D Fructose.
2.	**Write any two tests for detecting lipids.** **Answer:** a) Acrolein test: Acrolein test is used to detect the presence of triglycerols or phospholipids. The glycerol component when heated with potassium hydrogen sulphate ($KHSO_4$) gets dehydrated to form unsaturated aldehyde called acrolein which has a pungent smell. b) Bromine Water test: **Bromine water is used to test for unsaturated fats because it changes colour in their presence by adding bromine across their double bonds and hence a coloured solution of bromine decolourized.**
3.	**Fill in the blanks:** A: GABA (Gamma amino Butyric Acid) B: Tryptophan C: Allergic reactions
4.	**a) What are the different components of a nucleotide?** **b) What is the difference between a nucleotide and a nucleoside?** **b) Why does the heterocyclic nature of ring of nitrogen base mean?** a) A pentose sugar residue, an inorganic phosphate residue and a nitrogenous base. b) A nucleoside is made up of a pentose sugar residue and a nitrogenous base while nucleotide is a nucleoside bonded with an inorganic phosphate residue. c) The ring of nitrogen bases are made up of 'C' and 'N' atoms.
5.	**Describe the test conducted to detect the presence of deoxyribonucleotides.**

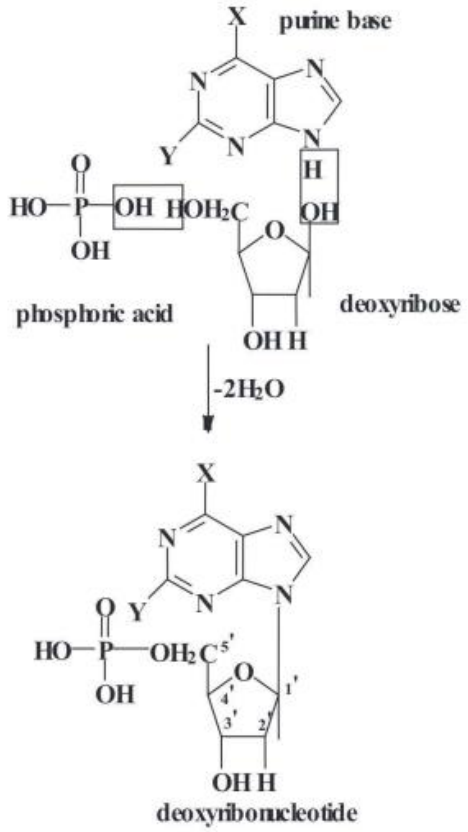
Amino Acid	**Derivative**	**Function**
Glutamic Acid	**A**	**Neurotransmitter**
B	**Auxin (Indole acetic acid)**	**Plant Hormone**
Histidine	**Histamine**	**C**

	Deoxyribonucleotides react with diphenylamine under acidic conditions to give a blue coloured complex. The reaction involves the dehydration of a-deoxyribose of the nucleotide or DNA in the presence of acid to m-hydroxylevulinic aldehydes which react with diphenylamine to form the coloured complex.
6.	**a) Name any four reactive groups present in amino acids which can be used for different reactions.** **b) Which of these reacts with the reagent Ninhydrin?** **c) Amino acids undergo which kind of reaction with Ninhydrin?** a) Amino acids have many reactive groups like the α amino group, the carboxylic groups, phenolic groups, sulphydryl groups, alcoholic groups etc b) Alpha amino group reacts with Ninhydrin c) Oxidative deamination
7.	**i) Identify the common names of these chemicals or products involved in Ninhydrin test.** **a) Triketohydrindene hydrate** **b) Diketohydrin** **ii) What are liberated upon reaction of Ninhydrin with alpha amino group of amino acid?** i) a) Ninhydrin b) Ruhemann's Purple ii) Ammonia, carbon dioxide, an aldehyde, hydrindantin
8.	**Draw the structure of any** **a) polar amino acid** **b) positively charged amino acid** c) **aromatic amino acid** Any correct drawing.
9.	**a) Explain the test that is used to detect the presence of reducing sugars in blood/urine of patients.** **b) Name another test used to detect reducing sugars.** **a)** Benedict's Test: CuSO4 in Benedict's solution reacts with free anomeric carbon atom of reducing sugar to form a yellow to red precipitate of Cuprous Oxide. $CuSO_4$ -> Cu^{2+} + $SO4^{2-}$ Cu^{2+} (ox) + Reducing Sugar -> Cu^{+} (Red) Cu^{+} + O_2 -> $2Cu_2O$ (Red ppt) b) Fehling's test.
10.	**i. Name the chemical used in the following:** **a. Benedict's test** **b. Acrolein test** **c. Test for unsaturated fatty acids** **d. Catalyst in Orcinol method** **ii. Name any two steroid hormones.** i. a. $CuSO_4$ b. KHSO4 c. Br Water d) $FeCl_3$ ii. Estrogen & Progesterone
11.	**Draw the strcture of one saturated and one unsaturated fatty acid.** Structure of saturated fatty acid : Stearic Acid and one unsaturated fatty acid: Oleic acid
12.	**Draw the structure of dAMP** Correct structure

13.	**a) Why is the carbonyl carbon atom of monosaccharides called as anomeric carbon in ring structure?** **b) Name any two functional groups present in monosaccharides** **c) Name one aldotetrose.** a) The carbonyl carbon atom of monosaccharides is called as anomeric carbon in ring structure because it becomes chiral in ring structure with two anomeric forms b) Hydroxyl and carbonyl groups c) D-Erythrose
14.	**a) Draw the structure of lactose** **b) Name the two monosaccharides in lactose** **c) Name the bond between the two monosaccharides in lactose** a) Correct structure of lactose b) B D Galactose & β D Glucose c) B 1-> 4
15.	**Draw the Fischer projections of D Glucose, D Mannose and D Galactose. Name the carbon atoms which differ in the configuration of D Glucose and D Mannose.**  D Glucose and D Mannose at carbon atom 3 in the configuration

LONG ANSWER TYPE QUESTIONS (5 MARKS)	
1.	**a) Name and describe the test for amino acids.** **b) Which amino acid gives a differently coloured complex for the above test and why?** **c) What are reducing sugars?** **a) Ninhydrin Test (Triketohydrindantin hydrate)**: Ninhydrin is a very powerful oxidising agent & in its presence amino acids undergo oxidative deamination liberating ammonia, carbon

	dioxide, a corresponding aldehyde and reduced form of ninhydrin. The ammonia formed from alpha amino group reacts with ninhydrin and its reduced product (hydrindantin) to give a blue complex called Ruhemann's purple (diketohydrin). **b) Proline is an exception as it forms yellow complex.** **c) Reducing Sugars:** Sugars bearing atleast one free anomeric carbon atom that has not formed any glycosidic bond and can reduce mild oxidizing agents. Example: Maltose and Sucrose.
2.	**How is Haworth Projection of a monosaccharide formed from its Fischer projection?** **Fischer to Haworth Projection:** • The simple sugars have two major functional groups – hydroxyl and carbonyl groups. One internal OH group can react with the carbonyl group which can react to form hemiacetals or hemiketals leading to form a ring structure. • 5 membered ring structures are called 'furanoses' and six membered ring structures are called 'pyranoses'. • The carbonyl carbon atom (C 1 in aldoses and C 2 in ketoses) is called the anomeric Carbon atom because on formation of a ring structure, the carbon atom becomes asymmetric leading to the formation of two configurations or anomeric forms called alpha anomers and beta anomers. 
3.	**a) Show the formation nucleotide by representing all the components and the reactions between them.**

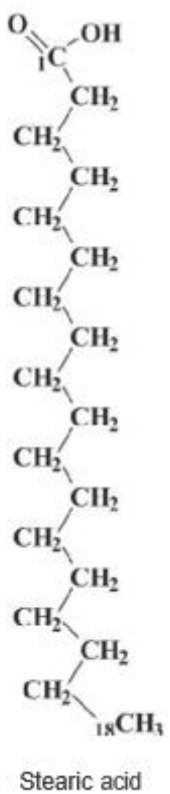


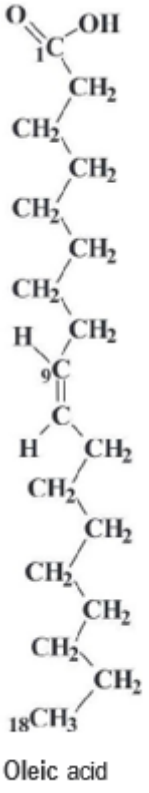
c) Why are carbon atoms in ribose sugar of a nucleotide prefixed with (') symbol?

To differentiate from the carbon atoms of nitrogenous base.

4. a**) Compare the structure of saturated and unsaturated fatty acid with the help of a diagram.**

b) Name and explain the test that differentiates between saturated and unsaturated fatty acids.

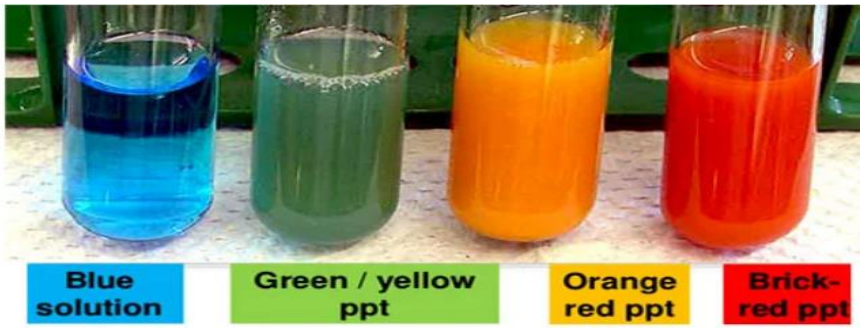

Stearic acid

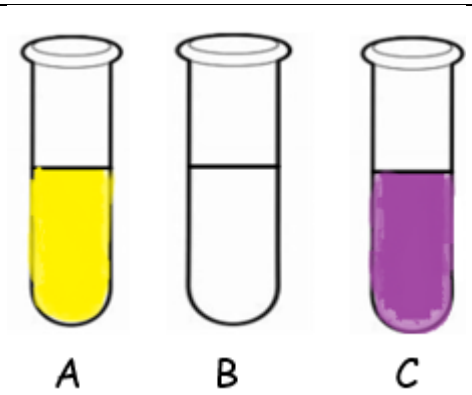

Oleic acid

a)

b) Unsaturated fatty acids add halogens across their double bonds and a coloured solution of bromine water, for example, is decolorized.

5.	**a) What is the molecular formula of carbohydrates?** **b) What are the properties of monosaccharides?** **c) Give an example of ketohexose.** a) Molecular formula of carbohydrates are multiples of $(CH_2O)n$. b) Properties of monosaccharides are: i) A ketone or an aldehyde functional group ii) Polyhydroxy alcohols iii) 3 to 7 Carbon atoms. c) Fructose is a ketohexose.

CASE BASED QUESTIONS (5 MARKS)	
1.	**Benedict's Test: Benedict's Test is used to test for simple carbohydrates. The Benedict's test identifies reducing sugars which have free ketone or aldehyde functional groups. Benedict's solution can be used to test for the presence of glucose in urine / blood.** **Some sugars such as glucose are called reducing sugars because they are capable of transferring hydrogens (electrons) to other compounds, a process called reduction. When reducing sugars are mixed with Benedict's reagent and heated, a reduction reaction causes the Benedict's reagent to change colour. The colour varies from green to dark red (brick) or rusty-brown, depending on the amount of and type of sugar.**  **Source:** Benedict's Test- Principle, Preparation, Procedure and Result Interpretation (microbiologyinfo.com) **a) What are reducing sugars?** **b) From the above figure, conclude the presence of reducing sugar in different samples.** **c) Write the reaction of Benedict's test.** a) Sugars bearing atleast one free anomeric carbon atom that has not formed any glycosidic bond and can reduce mild oxidizing agents. b) Blue -> none, Green -> traces of reducing sugar, Orange -> moderate reducing sugar, Red -> excess amounts of reducing sugar.

	c) $CuSO4$ in Benedict's solution reacts with free anomeric carbon atom of reducing sugar to form a yellow to red precipitate of Cuprous Oxide. $CuSO_4$ -> Cu^{2+} + $SO4^{2-}$ Cu^{2+} (ox) + Reducing Sugar -> Cu^{+} (Red) 4 Cu^{+} + O_2 -> $2Cu_2O$ (Red ppt)
2.	 **In the above figure, there are three test tubes, each labelled as A, B and C. This reaction has been performed to test for ninhydrin.** **a) Conclude reaction in the different test tubes.** **b) Explain the principal of the ninhydrin test.** a) The test tube A tests positive for proline, test tube B tests negative for amino acids, test tube C tests positive for other amino acids except proline. b) Ninhydrin is a very powerful oxidising agent & in its presence amino acids undergo oxidative deamination liberating ammonia, carbon dioxide, a corresponding aldehyde and reduced form of ninhydrin. The ammonia formed from alpha amino group reacts with ninhydrin and its reduced product (hydrindantin) to give a blue complex called Ruhemann's purple (diketohydrin).
3.	**Lipids are important constituents of biological membranes and are generally sparingly soluble in water, but are readily soluble in organic solvents. Some of the important building blocks of larger lipids are the long-chain hydrocarbons containing fatty acids (stearic and oleic acid), the C,8 amino alcohols (sphingosine), glycerol and cholesterol (present in animal cell membranes). Steroids are a special group of lipids derived from cholesterol, the most abundant steroid in animals.** **a) Name one organic solvent in which lipids can dissolve.** **b) What are the simplest lipids?** **c) Name two glycerol derived lipids.** **d) Which lipid is the main constituent of plasma membranes.** e) **Which is the most abundant steroid in animals?** a) Choloroform b) Fatty acids c) Triglycerols & Phospholipids d) Phospholipids e) Cholesterol
4.	**A 22-year-old biochemistry student is studying the structural differences between**

	deoxyribonucleotides and ribonucleotides in her course. She learns that both types of nucleotides contain purines and pyrimidines, but there are specific distinctions in their compositions. Adenine and guanine, which are purines, are found in both deoxyribonucleotides and ribonucleotides. In contrast, cytosine is a common pyrimidine in both types, whereas thymine is exclusive to deoxyribonucleotides, and uracil is exclusive to ribonucleotides. Furthermore, she notes that the purines and pyrimidines are bonded to the sugar phosphate residue by a glycosidic bond involving the C-1' of the sugar and the N-9 of a purine or the N-1 of a pyrimidine. **i) Which of the following statements accurately describes a structural characteristic of nucleotides?** **A. Thymine is present in ribonucleotides but not in deoxyribonucleotides.** **B. Cytosine is only found in deoxyribonucleotides.** **C. Uracil is present in deoxyribonucleotides but not in ribonucleotides.** **D. Adenine and guanine are found in both deoxyribonucleotides and ribonucleotides.** Ans: D. **ii) Which nitrogenous base is found in RNA but not in DNA?** Ans: Uracil iii) **What is the bond between a pyrimidine and a ribose sugar?** Ans: N1 -> C1' iv) **Which nitrogenous base is methyl containing?** Ans: Thymine **v) What is the net charge of nucleic acids and why?** Ans: Negative because of the presence of phosphate groups.
5.	**A 20-year-old biochemistry student is revising for her upcoming exam on carbohydrates. She learns that sugars like glucose, fructose, and sucrose are carbohydrates with molecular formulas that are multiples of $(CH_2O)n$, classifying them as carbon hydrates. She studies that monosaccharides, which can have up to six carbon atoms, are fundamental building blocks of larger carbohydrates and other biomolecules. Depending on the number of carbon atoms, these monosaccharides are categorized into trioses, tetroses, pentoses, and hexoses. Additionally, they possess either an aldehydic or ketonic functional group, leading to classifications such as aldoses and ketoses. For instance, glucose, an aldohexose, has six carbon atoms and an aldehydic group, while fructose, a ketohexose, also has six carbon atoms but contains a ketonic group. She also notes that all naturally occurring sugars have a D-configuration based on the asymmetric carbon of D-glyceraldehyde.**

i) Which of the following correctly describes a characteristic of monosaccharides?

A. Glucose is a ketohexose with a D-configuration.
B. Fructose is an aldopentose with a D-configuration.
C. Monosaccharides with an aldehydic functional group are called ketoses.
D. A sugar with five carbon atoms and an aldehydic group is called an aldopentose.

Ans: D

ii) Depending on what are the monosaccharides considered trioses, pentoses, hexoses etc?

Ans: Number of carbon atoms

iii) **Name any two functional groups of monosachharides?**

Ans: Aldehyde, Ketone, Hydroxy

iv) **What is the natural configuration of monosachharides?**

Ans: Dextrorotatory.

v) **Which carbon atom is carbonyl carbon atom in ketoses?**

Ans: C2

Unit-III Genetics and Molecular Biology

Marks- 20

Chapter 1: Concepts of Genetics

Contents of the chapter

- Historical Perspective
- Multiple Alleles
- Linkage and Crossing Over
- Genetic Mapping

Chapter 2: Genes and Genomes: Structure and Function

Contents of the chapter

- Discovery of DNA as Genetic Material
- DNA Replication
- Fine Structure of Genes
- From Gene to Protein
- Transcription-The Basic Process
- Genetic Code
- Translation
- Regulation of Gene Expression
- Mutations
- DNA Repair
- Human Genetic Disorders

UNIT – III :- GENETICS AND MOLECULAR BIOLOGY

CHAPTER – 1:- CONCEPTS OF GENETICS

QUESTION BANK

MULTIPLE CHOICE QUESTIONS (1 mark)

Q.1 Mendel's Law of Independent Assortment holds good for genes located on—
a) Non-homologous chromosome **b)Homologous chromosome**
c)Extra nuclear genetic material d)same chromosome

Q.2 What would be the genotype of the parents if the offspring have the phenotype in 1:1 proportion ?
a)Aa x Aa b)AA X AA c)Aa x AA **d)Aa x aa**

Q,3 The recombination frequency between the four linked genes is as follows :
I. Between X & Y is 40% II. Between Y & Z is 30%
III. Between Z & W is 10% IV. Between W & X is 20%
Select the option that shows the correct order of the position of W,X,Y & Z genes on the chromosome .

a)Y-X-Z-W **b)Y-W-Z-X** c)X-Y-Z-W d)Z-X-Y-W

Q.4.In Antirrhinum RR is phenotypically red flowers, rr is white and Rr is pink.
Select the correct phenotypic ratio in F1 generation when a cross is performed between RR X Rr

a) 1red:2pink:1white b)2pink:1white **c)2red:2pink** d)All pink
b)

Q.5 In a dihybrid cross, if you get 9:3:3:1 ratio it denotes that ---
a) the alleles of two genes are interacting with each other
b) it is a multigenic inheritance
c) it is a case ogf multiple allelism
d)the alleles of two genes are segregating independently

Q.6 Person having genotype IAIB would show the blood group as AB . This is because of
a)Pleiotropy **b)co-dominance** c)segregation d)incomplete dominance

Q.7 Distance between genes & percentage of recombination shows-----
a) a direct relationship b) an inverse relationship
c) a parallel relationship d) no relationship

Q.8 If a plant with genotype AaBb is self-fertilized, the probability of getting

AABB genotype will be (A and B are not linked)

a) 1/2 b) 1/4 c) 1/8 **d) 1/16**

Q.9 9:7 ratio in the F2 generation represents

a) Incomplete dominance b)Co-dominance **c)Epistasis** d)Complementary interaction

Q.10 An exception to Mendel's law is

a)Independent assortment **b)Linkage** c)Dominance d)Purity of gametes

Q.11 Homozygosity and heterozygosity of an individual can be determined by

a)Test cross b)Back cross c)Self-fertilization d)All of the above

Q.12 If a colorblind woman marries an average-visioned man, their sons will be

a)**Three-fourths colorblind and one-fourth normal**
b)One-half colorblind and one-half normal
c)All normal visioned d)All colorblind

Q.13 Farmers planted 200 kernels of corn and produced 140 tall & 40 short plants.

The genotypes of these offspring are likely similar :

a)TT, tt **b)TT, Tt, tt** c)TT, Tt d)Tt, tt

Q.14 What if the 25th codon (UAU) of the gene encoding a 50 amino acid polypeptide is mutated to UAA?

a) A 24 amino acid polypeptide is formed

b)A 25 amino acid polypeptide is formed

c)**A 49 amino acid polypeptide is formed**

d)Two polypeptides of 24 and 25 amino acids are formed

Q.15 In most species, mitochondrial DNA is passed down from

a)DNA b)Mother and Father c)Father **d)Mother**

SHORT ANSWER TYPE QUESTIONS SA-I (2 marks)

Q.1 Define genes, alleles, homozygous, heterozygous, monohybrid cross, dihybrid cross**.**

Ans. Genes: The basic hereditary unit of life.
Alleles: The different forms of a gene.
Homozygous: When all the alleles of a gene are identical.
Heterozygous: When the alleles of a gene are different.
Monohybrid cross: A *monohybrid cross* is a breeding experiment between parental generation organisms that differ in a single given trait.

Dihybrid cross: A *dihybrid cross* is a breeding experiment between parental generation organisms that differ in a two given traits.

Q.2 What are oligogenes and polygenes?

Ans. Oligogenes: A gene that produces or significantly affects the expression of a qualitative heritable characteristic, acting either alone or with a few other genes.

Polygenes: A gene whose individual effect on a phenotype is too small to be observed, but which can act together with others to produce observable variation.

Q.3 What are the Mendelian Laws of genetics?

Ans. Law of Dominance: Mendel's Law of Dominance states that recessive alleles will always be masked by dominant alleles.

Law of Segregation of genes: The Law of Segregation states that every individual organism contains two alleles for each trait, and that these alleles segregate (separate) during meiosis such that each gamete contains only one of the alleles.

Law of Independent Assortment: The Law of Independent Assortment states that alleles for separate traits are passed independently of one another from parents to offspring.

Q.4 What were the reasons behind Mendel's success?
Ans.

a) Selection of bisexual plant.
b) Record keeping and mathematical derivations.
c) Study of one character at a time.

Lucky in selecting traits that were present in different chromosomes.

Q.5 What is the difference between autosomes and sex chromosomes?

Ans.An autosome is a chromosome that is not an allosome (a sex chromosome). Autosomes appear in pairs whose members have the same form but differ from other pairs in a diploid cell, whereas members of an allosome pair may differ from one another and thereby determine sex.

Q.6 What is the difference between qualitative and quantitative inheritance?
Ans.The trait with quantitative genetic inheritance is caused by segregation of many gene pairs, each with small effect. At the same time the trait is influenced by a lot of minor environmental effects while qualitative inheritance follow Mendelian laws and are generally controlled by one or two genes.

Give some examples of traits controlled by qualitative & quantitative inheritance?
Qualitative inheritance: Blood type, enzyme defects.
Quantitative: Skin & eye color.

Q.7 Define gene mapping by taking an example of your choice. Define Centimorgan (CM).
Ans: The basis of gene mapping can be best understood by taking the simplest example of three genes A, B and C located in a linear order on a chromosome.
We know the degree of separation between genes A and B and that between genes B and C, then it should be possible to estimate the distance between genes A and C. Distance is calculated based on the recombination frequencies in the segregating progeny and is known as the genetic distance, which is often expressed in the unit centiMorgan (cM).
One cM corresponds to roughly one percent recombination frequency between the two genes

Q.8 Explain the relation between gene expression and environmental control in quantitative gene expression.

Ans.P= G+ E, where P is total phenotype, G is the gene effect while E is the environmental effect

Q.9 Define linkage and crossing over.

Ans. Genes (alleles) present on the same chromosome normally do not show independent segregation because they are physically linked together (called as linkage) (Fig. 7). Still there is some degree of assortment during meiosis due to the process of crossing over involving breaking and rejoining (exchange) of DNA segments between homologous chromosomes

Crossing over is a process that breaks the original linkage between the genes present in chromosomes, The amount of such crossing over depends primarily upon the distance between the genes

Q.10 Diagrammatically show crossing over process and linkage.

Ans. Linkage

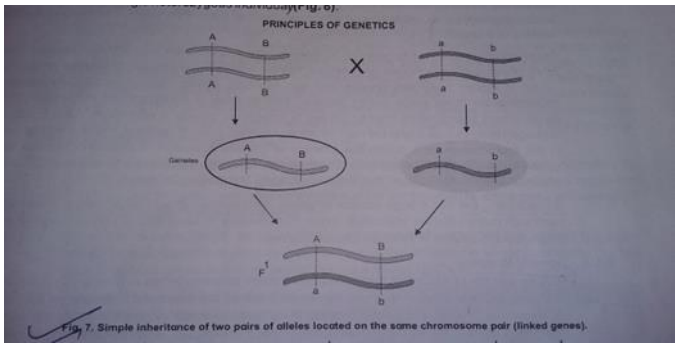


Fig. 7. Simple inheritance of two pairs of alleles located on the same chromosome pair (linked genes).

Crossing over

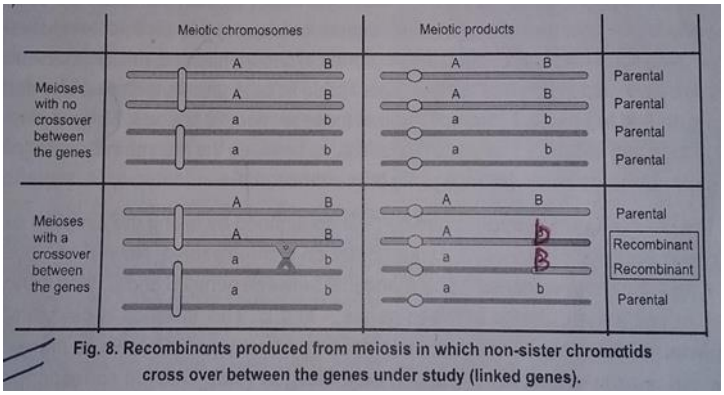


Fig. 8. Recombinants produced from meiosis in which non-sister chromatids cross over between the genes under study (linked genes).

SHORT ANSWER TYPE QUESTIONS SA-II (3 marks)

Q.1 *Explain sex linked inheritance with some examples.*

Ans. Genes that are carried by either sex chromosome are said to be sex linked. Men normally have an X and a Y combination of sex chromosomes, while women have two X's. Since only men inherit Y chromosomes, they are the only ones to inherit Y-linked traits. Men and women can get the X-linked ones since both inherit X chromosomes.

Eg: colorblindness & Hemophilia in humans, eye color in drosophila.

Q.2 *What is Linkage? How does it challenge Mendel's law of independent assortment?*
Ans. Genetic linkage is the tendency of genes that are close together on a chromosome to be inherited together during the meiosis phase of sexual reproduction.

It challenges law of independent assortment as the law states that all genes assort independently and new combinations are found in F2 while due to linkage parental combinations appear more in F2.

Q.3 What is crossing over? How does recombination frequency depend upon crossing over?

Ans. Chromosomal crossover (or crossing over) is the exchange of genetic material between homologous chromosomes that results in recombinant chromosomes during sexual reproduction during pachytene stage of meiosis.

Recombination frequency is a measure of genetic linkage and is used in the creation of a genetic linkage map. Recombination frequency is the frequency with which a single chromosomal crossover will take place between two genes during meiosis.

Q.4 What are multiple alleles? Give one example.

Ans. Multiple alleles is a type of non-Mendelian inheritance pattern that involves more than just the typical two alleles that usually code for a certain characteristic in a species. With multiple alleles, that means there is more than two phenotypes available depending on the dominant or recessive alleles that are available in the trait and the dominance pattern the individual alleles follow when combined together.

The human ABO blood type is a good example of multiple alleles.

Q.5 Explain the chromosomal theory of inheritance in brief.

Ans.The chromosomal theory of inheritance was proposed independently by Sutton and Boveri.:

a) Like homologous chromosomes alleles are also in pairs.
b) Like homologous pair of chromosomes alleles also segregate during gamete formation.

Like homologous pair of chromosomes alleles also assort independently

Q.6 Differentiate between codominance and incomplete dominance.

Ans. Incomplete dominance: In the snapdragon, *Antirrhinum majus*, a cross between a homozygous white-flowered plant and a homozygous red-flowered plant will produce offspring with pink flowers This type of relationship between alleles, with a heterozygote phenotype intermediate between the two homozygote phenotypes, is called **incomplete dominance**.

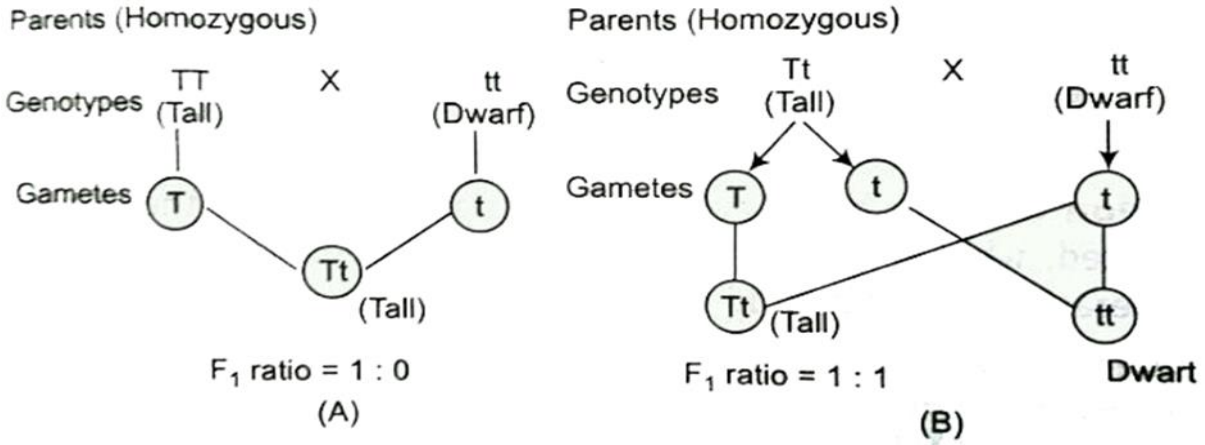
Codominance: In which both alleles are simultaneously expressed in the heterozygote. Eg. ABO blood group in humans.

Q.7 Explain the Hardy-Weinberg's Law in brief.

Ans. The Hardy–Weinberg states that allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences, mutations and if there is random mating.

Q.8 Define test cross. Derive the value.

Ans A Test cross involves F1 individuals with the recessive parents. It helps to determine whether a dominant phenotype is homozygous or heterozygous for a specific allele.



Q.9 Taking an example of your choice prove the law of an independent assortment.

Ans Dihybrid cross- The alleles of two (or more) different genes get sorted into gametes independently of one another

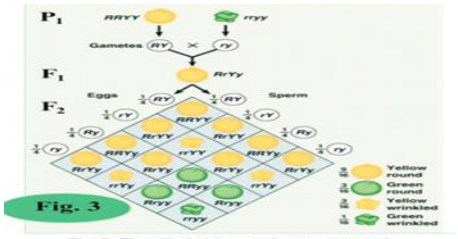


Fig. 3. The dihybrid cross between round, yellow seeds and wrinkled, green seeds in pea plant shows the independent assortment of characters in F2 generation.

Q.10 What do you mean by extranuclear inheritance ? What are the features of it ?
Ans. The inheritance due to the genes present in the cytoplasm and not on chromosome (mitochondria & chloroplast) is called Extranuclear or Cytoplasmic Inheritance .

The characters controlled by cytoplasmic genes show the features :-
i) Lack of Mendelian segregation and typical Mendelian ratio
ii)Governed by mitochondrial or chloroplast DNA
iii)They show maternal inheritance as these characters are usually transmitted only by ovules(uniparental maternal inheritance), with some exceptions where male parent (like pollen) can also contribute to cytoplasm.(biparental)
Eg:- Inheritance of leaf variegation of *Mirabilis jalapa* plant, inheritance pattern of petite mutants of Saccharomyces cerevisiae ,

LONG ANSWER TYPE QUESTIONS (5 marks)

Q.1 What are additive and non additive gene interactions?

Ans. Additive genetic effects [Ratio 15:1]: A mechanism of quantitative inheritance such that the combined effects of genetic alleles at two or more gene loci are equal to the sum of their individual effects.

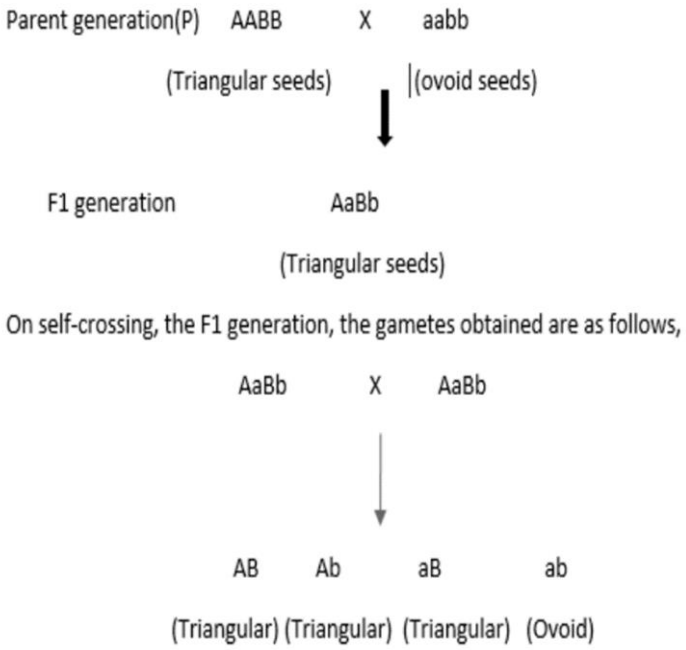
Non additive Interaction:

Epistasis: Epistasis is the interaction of different loci to produce a particular trait in a nonadditive way. Scientists have discovered that a great many traits depend on epistatic relationships among a number of different genes.

Complementary gene interaction [Ratio: 9:7]: Involves two pairs of non-allelic genes. When dominant forms of both the genes involved in complementary gene interaction are alone have same phenotypic expression. But, if they are present in combination, yield different phenotypic effect.

Supplementary Gene interaction [Ratio: 9:3:4]: Involves two pairs of non-allelic genes. One of the dominant gene has visible effect itself. Second dominant gene expresses itself when supplemented by the other dominant gene of a pair. Coat color (black, albino and agouti) of mice follows supplementary gene interaction.

Dominant Epistasis [12 : 3 : 1 Ratio]: When a dominant allele at one locus can mask the expression of both alleles (dominant and recessive) at another locus, it is known as dominant epistasis. In other words, the expression of one dominant or recessive allele is masked by another dominant gene.



Male / Female	AB	Ab	aB	ab
AB	AABB (T)	AABb (T)	AaBB (T)	AaBb (T)
Ab	AABb (T)	AAbb (T)	AaBb (T)	Aabb (T)
aB	AaBB (T)	AaBb (T)	aaBB (T)	aaBb (T)
ab	AaBb (T)	Aabb (T)	aaBb (T)	aabb (O)

RATIO – 15:1

Q.2 *Explain in brief the extra nuclear inheritance with the help of examples.*
Ans.; Extranuclear inheritance or cytoplasmic inheritance is the transmission of genes that occur outside the nucleus. It is found in most eukaryotes and is commonly known to occur in cytoplasmic organelles such as mitochondria and chloroplasts or from cellular parasites like viruses or bacteria.

Shell coiling in Limnae: In the snails (gastropods), the shell is spirally coiled. In most cases the direction of coiling of the shell is clockwise, if viewed from apex of the shell. This type of coiling is called dextral. However, in some snails the coiling of shell may be counter clockwise or sinistral. Both types of coilings are produced by two different types of genetically controlled cleavages, one being dextral cleavage, another being sinistral cleavage.

Chloroplast inheritance in variegated four 'o' clock plant: Mirabilis contains three types of leaves and parts: (1) Full green leaves or branches having chloroplast, (2) White (pale) leaves and branches having no chloroplast, (3) Variegated branches having leukoplast in white (pale) areas and chloroplast in green patches. The nature of maternal leaf type decides the progeny leaf type.

Petite in yeast: The petite mutants in yeast fail to grow on carbon source such as glucose and produce smaller colonies (the "littles") when grown on sugars such as glucose.Since this difference can be observed only when such yeast cultures are kept in a oxygen- containing environment; so it is concluded that petite mutants have a defective aerobic respiratory mechanism.These petites differ from wild type, called grande and are characterized by (i) their insensitivity to inhibitors of aerobic pathways (such as cyanide), (ii)

absence of cytochromes a, a_3, b and a number of other changes in mitochondrial respiratory enzymes; (iii) incomplete development of mitochondria; and (iv) lack of stainability of petite mitochondria. The petite mutants can be segregational, i.e., they follow Mendelian segregation and, therefore, presumably controlled by chromosomal genes. They may also be vegetative, i.e., non- segregational or extra-chromosomal. The genetic basis of petite character is a cytoplasmic factor which may be absent or defective in petites. Thus, a vegetative petite can be neutral or it may be suppressive. The neutral petites are not transmitted while suppressive petites are transmitted to a fraction of vegetative diploid progeny.

Q.3 A dihybrid heterozygous tall and yellow pea plant was crossed with the double recessive plant. (i) What type of cross is this?

(ii) Work out the genotype & phenotype of progeny

(iii)What principle of Mendel is illustrated through the result of this cross?

Ans: When a dihybrid heterozygous tall and yellow pea plant was crossed with the double recessive plant then (i) What type of cross is this?

Ans: This type of cross is known as a test cross. (ii) Work out the genotype & phenotype of progeny

(iii) What principle of Mendel is illustrated through the result of this cross?

Ans: Through the result of testcross Mendel's Principle of Independent Assortment is illustrated. According to the principal, in the inheritance of contrasting characters, the factors of each pair of characters segregate independently of the factors of the other pair of characters.

Q.4 A double recessive plant was crossed with a dihybrid heterozygous round, yellow seeded garden pea (Pisum sativum).

a. What type of cross is this?
b. Find out the phenotype and genotype of the progeny
c. Which of Mendel's principles is illustrated through the result of this cross?

Ans. (a) When a double recessive plant was crossed with a dihybrid heterozygous round, yellow seeded garden pea (Pisum sativum) then, this type of cross is called a dihybrid test cross.

(b) Below given is the Work-out the phenotype and genotype of the progeny-

Gametes (RY), (Ry), (rY), (ry) X (ry)				
	Gametes	RY	Ry	rY	ry
F_1 progeny	ry	RrYy Round, Yellow	Rryy Round and Green	rrYy Wrinkled Yellow	rryy Wrinkled Green
Phenotypic ratio	: 1	: 1	: 1	: 1	
Genytopic ratio	: 1	: 1	: 1	: 1	

(c) Through the result of the dihybrid test cross Mendel's principle of independent assortment is illustrated.

COMPETENCY – BASED QUESTIONS

Q.1 The human male never passes on the gene for haemophilia to his son. Why is it so?

Ans: The human male never passes on the gene for haemophilia to his son because the gene for haemophilia is present on the X chromosome. A male has only one X chromosome which he receives from his mother and the Y chromosome from his father. The human male passes the X chromosome to his daughters or female progeny and not to the sons or male progeny.

Q.2 A woman with an O blood group marries a man with an AB blood group (i) Work out all the possible phenotypes and genotypes of the progeny. (ii) Discuss the kind of dominance in the parents and the progeny in this case.

Ans: When a woman with an O blood group marries a man with an AB blood group then

(i) Work out all the possible phenotypes and genotypes of the progeny.

Ans: All the possible phenotypes of the progeny include blood groups A and B and genotypes of the progeny will be A Ii and B Ii because blood group AB has alleles A B I I and blood group O has ii which on the cross gives both types of blood groups A and B while the genotype of progeny will be A Ii and B Ii . Father's genes: A B I I Mother's genes: ii Therefore, the cross will be

Mother's genes→ Father's genes↓	i	i
I^A	I^Ai	I^Ai
I^B	I^Bi	I^Bi

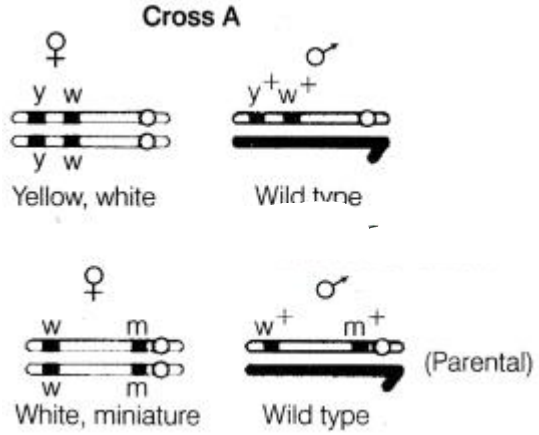
(ii) Discuss the kind of dominance in the parents and the progeny in this case.

Ans: In the above-mentioned case, the kind of dominance in the parents and the

Q.3A man with AB blood group marries a woman with O group blood.
(i) Work out all the possible phenotypes and genotypes of the progeny.
(ii) Discuss the kind of domination in parents and progeny in this case?

Ans: When a man with AB blood group marries a woman with O group blood then (i) Half the progeny will have blood group A with genotype A O I I & half the progeny will have blood group B with genotype B O I I .
(ii) In this case both the genes A I and B I are dominant over the O I gene therefore the progeny shows either blood group A or B. Since in parents both the dominant genes are present together this phenomenon is called codominance.

Q.4 Study the figures given below and answer the question



Identify in which of the crosses, the strength of linkage between the genes is higher. Give reasons in support of your answer. (Foreign 2014)
Ans:

The strength of linkage is higher in the cross A than in cross B because linkage is higher when two genes are present closely on the same chromosome than those genes which are far apart. In cross B, the chances of crossing over or recombination are higher because the genes are loosely linked.

Q.5 In a dihybrid cross, white-eyed, yellow-bodied female Drosophila crossed with red-eyed, brown-bodied male Drosophila produced in F_2-generation 1.3% recombinants and 98.7% progeny with parental type combinations. This observation of Morgan deviated from Mendelian F_2-phenotypic dihybrid ratio. Explain, giving reasons Morgan's observation.
Ans:
The results obtained were due to the linkage. It is the phenomenon in which two or more linked genes are inherited together and their frequency of recombination in a test cross progeny is less than the expected 50%. In Morgan's experiment on Drosophila, the genes for eye colour and body colour show linkage and do not allow crossing over during gamete formation. Hence, parental type progeny is in greater ratio than that of recombinants.

ASSERTION – REASONING QUESTIONS

Q.1 Assertion : A gamete contains a single allele for each trait.
Reason : During gametogenesis, the two alleles of each trait segregate, on passing into each gamete at random.
Ans.A- Both A & R are correct and R is the correct explanation of A

Q.2 Assertion : In four -O' clock or snapdragon plant, a cross between a homozygous white-flowered individual and a homozygous red-flowered one produces pink-flowered plants.
Reason : In these plants, the flower colour is determined by three alleles.
Ans: C – A is true but R is false .

Q.3 Assertion : In a person with AB blood group, the erythrocytes carry both A and B antigen on their surface.
Reason : The alleles IA& IB that produce AB blood group, are codominant and both are expressed.
Ans A- Both A & R are correct and R is the correct explanation of A

Q.4 Assertion : Frequency of crossing overs is higher then the observed frequency of recombination of traits in the offsprings.
Reason : More than one cross over many occur simultaneously between the same chromatids.
Ans. A-If both A and R are true and R is the correct explanation of A.

Q.5 Assertion : A woman is capable of sueing a man of refusing to own a child, who has blood group O. The man has blood group B and woman has A.

Reason : She is right as genetically, he can be the father of the child.

Ans:- A both A and R are true and R is the correct explanation of A.

Q.6 Assertion: There is expression of only one gene of the parental character in Mendelian monohybrid cross in F1 generation .
Reason: In a dissimilar pair of factors one member of the pair dominates the other .

Ans:- B Assertion & Reason both are correct but reason is not correct explanation of assertion

Q.7 Assertion: When the two genes in a dihybrid cross are situated on the same chromosome , the proportion of parental gene combinations is much higher than non-parental type .
Reason: Higher parental gene combinations can be attributed to crossing over between two genes .

Ans. C Assertion is correct statement but reason is wrong statement

Q.8 Assertion: Haemophilia never occurs in female .
Reason: Genes for Haemophilia located on X-Chromosome

Ans. D- Assertion is wrong statement but reason is correct statement .

Q.9 Assertion:- Mendel used true-breeding pea lines for artificial pollination experiments for his genetic studies.
Reason: For several generations, a true-breeding line shows the stable trait inheritance and expression.

Ans.- A -Both A and R are true and R is the correct explanation of A

PASSAGE-BASED / CASE-BASED / SOURCE-BASED QUESTIONS

CASE-STUDY – I

Read the following passage and answer the given questions:
Hybridisation experiment carried out by Mendel where he crossed tall and dwarf pea plants to study the inheritance of one gene. He collected the seeds produced as a result of this cross and grew them to generate plants of the first hybrid generation. This generation is also called the Filial1 progeny or the F1. Mendel observed that all the F1 progeny plants were tall, like one of its parents; none were dwarf (Figure 5.3). He made similar observations for the other pairs of traits – he found that the F1 always resembled either one of the parents, and that the trait of the other parent was not seen in them.

I. If a plant heterozygous for tallness is crossed with homozygous dwarf plants , what will be the proportion of plants produced in F2 generation ? What type of cross is it ?(2)
Ans. Tall (Tt) – 50% Dwarf (tt) – 50 % Phenotypic ratio - 1:1 Genotypic Ratio-1:1
Test Cross

II. At what stage the separation of alleles occurs during hybridisation as per Mendel's principle of segregation ? (1)
Ans. Gamete formation

III. In a monohybrid cross the F2 progeny shows ¾ proportion tall plants and ¼ proportion dwarf plants, what is the proportion of homozygous plants in F2 generation ? (1)
Ans- 50%

CASE-STUDY – II

Mendelian disorders are mainly determined by alteration or mutation in the single gene. These disorders are transmitted to the offspring on the same lines as we have studied in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by the pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sicklecell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc.

I. Which disease related to blood disorder is called Royal disease? (1)
Ans.- Haemophilia

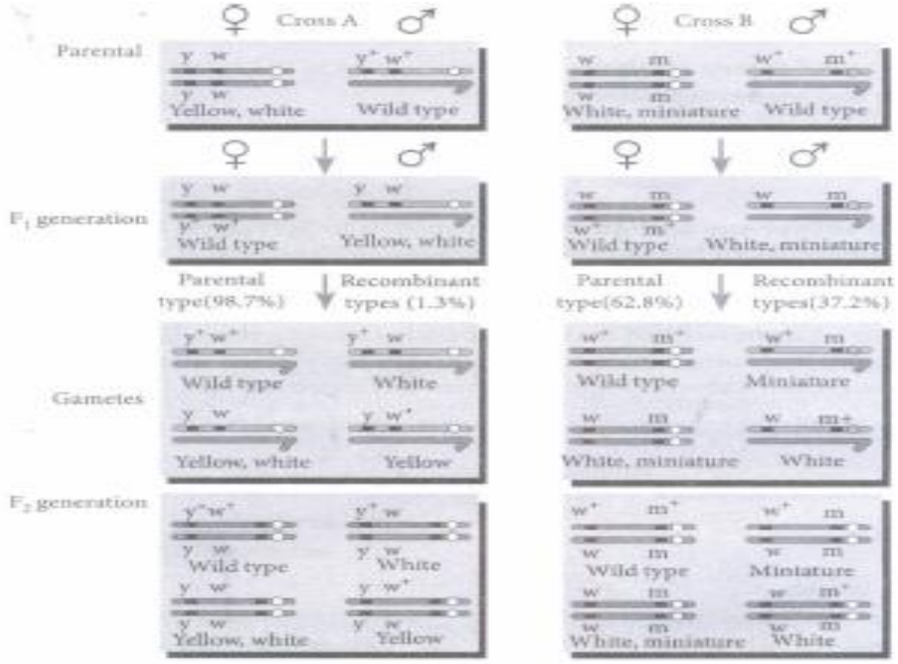
II. Cystic fibrosis is an autosomal recessive genetic disorder. What are the chances that the child would have the disease if any one of the parent (either mother or father)is a carrier of the faulty cystic fibrosis gene (Cc)? (1)
Ans. 0 percent

III. If the father in a family has a disease while the mother is normal, the daughters only are inherited by this disease and not the sons. Name this type of disease? Give an example of X-linked recessive chromosomal disorder . (2)

Ans. Sex-linked dominant, Color blindness, Haemophilia

CASE-STUDY – III

During a study of inheritance of two genes, teacher asked students to perform an experiment. The students crossed white eyed, yellow bodied female Drosophila with a red eyed, brown bodied male Drosophila (i.e., wild). They observed that progenies in F_2 generation had 1.3 percent recombinants and 98.7 percent parental type combinations. The experimental cross with results is shown in the given figure.[**Note**: Dominant wild type alleles are represented with (+) sign in superscript.]



(i) In the given experiment, identify the linked genes ? What are linked genes

Ans. Genes for eye colour and body colour are linked (1)

Linked gene remain together , are inherited together & retain their parental combination in the progeny

(ii) Genes white eyed and yellow bodied located very close to one another on the same chromosome tend to be transmitted together ,what do we call them ? (1)

Ans- Linked genes

(iii)
State
any

Ans.(a) The physical distance between two genes determines strength of linkage

(b) The physical distance between two genes determines frequency of crossing over

two conclusions that can be drawn from the above Experiment ? (2)

CHAPTER – 2:- GENES AND GENOMES: STRUCTURE AND FUNCTION

QUESTION BANK

MULTIPLE CHOICE QUESTIONS (1 mark)

1. Frederick Griffith discovered-
    a) DNA is the genetic material
    b) RNA is the genetic material
    c) Sterptococcus has two strains
    d) Bacterial transformation
2. Who proposed semiconservative mode of replication for DNA?
    a) Watson and Crick
    b) Meselson and Stahl
    c) Hershey and Chase
    d) Beadle and Tatum
3. The discontinuously synthesized DNA fragments are later joined by:
    a) DNA helicase
    b) Topoisomerase
    c) DNA ligase
    d) DNA polymerase
4. Some amino acids are coded by more than one codon. Hence genetic code is :
    a) Unambiguous
    b) Non-specific
    c) Degenerate
    d) Universal
5. Which of the following anticodons will hybridize with the mRNA codon 5'---AUG---3'.
    a) 5'----UAC—3'
    b) 5'---TAC---3'
    c) 3'--UAC---5'
    d) 3'---TAC—5'

6. In a transcription unit, the promoter is located towards

    a)**5'end of the structural gene**
    b)3'end of the structural gene
    c)5'end of the template strand
    d)3'end of the coding strand

7. The primer in DNA replication is

    a)**Small ribonucleotide polymer**
    b)Helix destabilizing protein
    c)Small deoxyribonucleotide polymer
    d)Enzyme joining nucleotides of new strands

8. Genetic information is transferred from nucleus to cytoplasm through
    1. RNA
    2. Anticodon

3. DNA
4. Lysosomes

9. The enzyme involved in transcription

1. DNA Polymerase I
2. DNA Polymerase III
3. **RNA Polymerase**
4. DNA Polymerase II

10. Non-sense codons participate in

1. Releasing t-RNA from polynucleotide chain
2. Formation of unspecified amino acids
3. Terminating message of gene-controlled protein synthesis
4. Conversion of sense DNA into non-sense DNA

11. The proofreading enzyme in DNA replication is

1. Primase
2. **DNA Polymerase I**
3. Ligase
4. DNA Polymerase II

12. Select a ribozyme

1. Peptidyl transferase
2. Helicase
3. Ribonuclease-P
4. **Both (a) and (c)**

13. Which step does not occur in translation?

1. **Replication**
2. Termination
3. Elongation
4. Initiation

14. The energy source for the elongation process is

1. Creatine-PO_4
2. **GTP**
3. ATP
4. All of the above

15. The anticodon of initiation codon for protein synthesis is

1. UUU
2. AUG
3. **UAC**
4. CAU

16. Which enzyme is not produced during lactose catabolism by E.coli?

1. **β-galactosidase**
2. Lactose Permease
3. Thiogalactoside transacetylase
4. Lactose dehydrogenase

17. The eukaryotic replication of DNA is

1. **Bidirectional with many origins**
2. Unidirectional with many origins
3. Bidirectional with a single origin
4. Unidirectional with a single origin

18. The amino acid coded by 3 codons is

1. Proline
2. **Isoleucine**
3. Tryptophan
4. Serine

19. Spliceosomes are absent in the cells of

1. Plants
2. Animals
3. **Bacteria**
4. Fungi

20. A molecule that acts as a genetic material must fulfil the following traits, except

1. It should be structurally and chemically unstable
2. **It should have the ability to generate its replica**
3. It should facilitate slow changes necessary for evolution.
4. It should be able to express itself in the form of Mendelian characters.

21. What will the amount of guanine in a DNA if the total amount of adenine and thiamine in the DNA is 45%?

1. 45%
2. 65%
3. **27.5%**
4. 22.3%

22. Which was the last human chromosome to be completely sequenced ?
(a) **Chromosome 1**
(b) Chromosome 11
(c) Chromosome 21
(d) Chromosome X

23. n some viruses, DNA is synthesised by using RNA as template. Such a DNA is called
(a) A – DNA

(b) B – DNA
(c) **cDNA**
(d) rDNA.

24 If the sequence of initrogen bases of the coding strand of DNA in a transcription unit is: 5' – ATGAATG – 3', the sequence of bases in its RNA transcript would be
(a) 5' – AUG A AUG – 3'
(b) 5' – UACUU AC – 3'
(c) 5' – CAUUCAU – 3'
(d) **5' – GUAAGUA – 3'.**

25. he amino acid attaches to the tRNA at its
(a) 5'- end
(b**) 3' – end**
(c) anticodon site
(d) DHUloop.

26. The structure in chromatin seen as 'beads-on string' when viewed under electron microscope are called
(a) nucleotides
(b) nucleosides
(c) histone octamer
(d**) nucleosomes.**

27. They year 2003 was celebrated as the 50th anniversary of discovery of
(a) transposons by Barbare Me Clintock
(b) **structure of DNA by Watson and Crick**
(c) Mendel's laws of inheritance
(d) biotechnology by Kary Muliis.

28. The three codons which result in the termination of polypeptide chain synthesis are
(a) UAA, UAG, GUA
(b) **UAA, UAG, UGA**
(c) UAA, UGA, UUA
(d) UGU,UAG,UGA

29. Amino acids which are specified by single codons are
(a) phenylalanine and arginine
(b**) tryptophan and methionine**
(c) valine and proline
(d) methionine and aroinine.

30. The mutations that involve addition, deletion or substitution of a single pair in a gene are referred to as
(a) **point mutations**
(b) lethal mutations
(c) silent mutations
(d) retrogressive mutations.

SHORT ANSWER TYPE QUESTIONS SA-I (2 marks)

Q.1. Define Aneuploidy. How is it advantages?
Answer- Any change in the number of chromosomes .
One of the primary applications of aneuploidy in **crop improvement** is the development of new plant varieties.

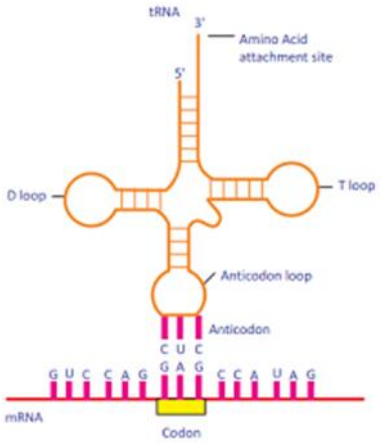
Q.2. What is the difference between Pericentric and Paracentric chromosome inversion?

Answer- Pericentric inversions include the centromere, while paracentric inversions occur outside of the centromere.

Q.3. What are the properties of Genetic Code?
Answer- Triplet code

- Non-ambiguous and Universal
- Degenerate code
- Nonoverlapping code
- Commaless
- Start and Stop Codons
- Polarity- 5' to 3'

Q.4. Draw neat labelled diagram of tRNA.
Answer:-



Q.5. Describe the role of Helicases, DNA polymerase and DNA ligase.
Answer- DNA Polymerase: It helps in the replication of double-stranded DNA into two identical DNA molecules Helicase: It helps in the separation of double-stranded DNA into single strands allowing each strand to be copied.
Ligase: It acts as glue by joining 2 DNA fragments to form a new DNA strand

Q.6. Define the following: Overlapping genes, Repetitive DNA, split genes , gene clusters, endosymbiosis.
Answer:- Overlapping genes: An overlapping gene is a gene whose expressible nucleotide sequence partially overlaps with the expressible nucleotide sequence of another gene. In this way, a nucleotide sequence may make a contribution to the function of one or more gene products.

Repetitive DNA: Repeated sequences (also known as repetitive elements, or repeats) are patterns of nucleic acids that occur in multiple copies throughout the genome.

Split genes: An interrupted gene (also called a split gene) is a gene that contains sections of DNA called exons, which are expressed as RNA and protein, interrupted by sections of DNA called introns, which are not expressed.

Gene clusters: A gene cluster is a group of two or more genes found within an organism's DNA that encode for similar polypeptides, or proteins, which collectively share a generalized function & are correlated

Endosymbiosis: endosymbiotic theory, is an evolutionary theory of the origin of eukaryotic cells from prokaryotic organisms

Q.7. What are promoters, exons, introns?

Answer:-Promoter: A promoter is a region of DNA that initiates transcription of a particular gene by binding to RNA polymerase. Promoters are located near the transcription start sites of genes, on the same strand and upstream on the DNA.

Exons: An exon is any part of a gene that will encode a part of the final mature RNA.

Introns: An intron is any part of a gene that will not encode a part of the final mature RNA and will be removed by splicing.

Q.8. What is the central dogma of life?

Answer:- The central dogma of molecular biology describes the flow of genetic information in cells from DNA to messenger RNA (mRNA) to protein.

Q.9. What is charging of tRNA?

Answer:-It is the binding of the tRNA with the specific amino acid by the following steps:

a) Amino Acid + ATP -> Amino acyl AMP + ADP

b) Amino acyl AMP + tRNA -> Amino acyl tRNA + AMP.

Both the steps are catalysed by amino acyl tRNA synthetase enzyme.

Q.10.

Name the different types of eukaryotic RNA polymerases and their roles.

Answer:- RNA polymerase I: transcribes rRNA.

RNA polymerase II: transcribes mRNA.

RNA polymerase III: transcribes tRNA

Q.11. What is the difference between sense and antisense strand of DNA?

Answer:- Sense Strand: The strand of DNA which is not transcribed and is similar to the mRNA.

Antisense Strand: The strand of DNA which is transcribed and is complementary to the mRNA

Q.12. What is Wobble hypothesis?

Answer- Wobble hypothesis states that the genetic codes are degenerate. It explains that the third base pairing varies with respect to the base at the third position like G may pair with T or U.

Q.13. Differentiate between transition and transversion mutation.

Answer- Transition- It is the substitution of a purine from another purine base or pyrimidine from another pyrimidine (C↔TC↔T or A↔GA↔G)

Transversion- is the substitution of a purine from a pyrimidine or pyrimidine from a purine.

Q.14. What are the 3 processes of central dogma?

Answer- From existing DNA to make new DNA (DNA replication) From DNA to make new RNA (transcription) From RNA to make new proteins (translation).

Q.15. What is the difference between exons and coding exons?

Answer- An exon is a region of the genome that ends up within an mRNA molecule. Exons are coding, in that they contain information for making a protein, whereas introns are non-coding.

SHORT ANSWER TYPE QUESTIONS SA-II (3 marks)

Q.1What are nucleosomes? Draw the structure of a nucleosome.

Answer:-A nucleosome is a basic unit of DNA packaging in eukaryotes, consisting of a segment of DNA wound in sequence around eight histone protein cores.

The Histones of all higher organisms have five major proteins namely, H_1, H_{2A}. H_{2B}, H_3, H_4.

DNA is wrapped twice around the beaded octamer & the exit sites of DNA are sealed by H_1 protein

The strand of DNA interconnecting two nucleosome beads is called linker DNA.

Q.2What are the post transcriptional modifications in eukaryotes?
Answer:- a) Capping: The addition of 7 methyl guanosine to the 5' end of an mRNA. (prevents degradation of mRNA from nucleases and helps in localization)
b) Splicing: The removal of introns and joining of exons of the heterogenous mRNA.
c) Polyadenylation: The addition of a polyA tail at the 3' end of a mRNA.

Q.3.What is Griffith's experiment of transformation?
Answer:-Griffith's experiment, reported in 1928 by Frederick Griffith, was the first experiment suggesting that bacteria are capable of transferring genetic information through a process known as transformation.
Griffith used two strains of Pneumococcus. These bacteria infect mice. He used a type III-S (smooth) and type II-R (rough) strain. He injected mice with the strains and observed the following:
Mouse + R strain -> live mouse.
Mouse + S strain -> Mouse dead
Mouse + R strain + heat killed S strain-> Mouse killed (live S strain were obtained from dead mouse)

Q.4.Who confirmed Griffith's experiment and how?
Answer:- The Avery–MacLeod–McCarty experiment was an experimental demonstration, reported in 1944 by Oswald Avery, Colin MacLeod, and Maclyn McCarty, that DNA is the substance that causes bacterial transformation.

R strain + extract of heat killed S strain + RNase -> S strain
R strain + extract of heat killed S strain + DNase -> R strain
R strain + extract of heat killed S strain + protease -> S strain

Q.5.What is Hershey and Chase's experiment?
Answer:- Hershey and Chase used T2 phage, a bacteriophage, for their experiments. The phage infects a bacterium by attaching to it and injecting its genetic material into it. They put labels on phage DNA with radioactive Phosphorus-32. They then followed the phages while they infected E. coli. They found that the radioactive element was only in the bacteria, and not in the phage.
In a second experiment, they put labels on the phage protein with radioactive Sulfur-35. After the phage was attached to the bacterium, the radioactive element was found in the phage, but not in the bacteria. This showed them that genetic material which infects the bacteria is DNA
Diagram:- Refer pg. No. 67 (Text book)

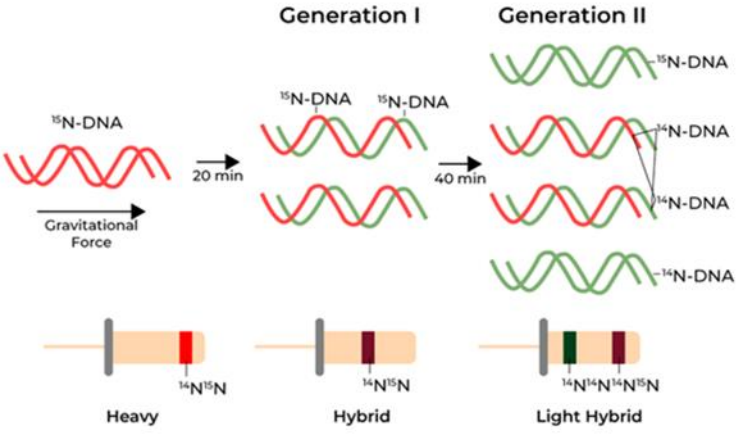
Q.6. Give a brief account of the different human genetic disorders along with their ploidy and characteristics.
Answer:- Klinefelter syndrome (KS) also known as 47,XXY or XXY, is the set of symptoms that result from two or more X chromosomes in males. The primary feature is sterility.

Down syndrome is usually caused by an error in cell division called "nondisjunction." Nondisjunction results in an embryo with three copies of chromosome 21 instead of the usual two leading to mental retardation.
Turner syndrome (TS), also known as 45,X or 45,X0, is a condition in which a female is partly or completely missing an X chromosome leading to sterility.

Q.7.Describe the numerical and structural changes in chromosomes.
Answer:-Numerical changes:
Structural changes:
1.Deletion 2. Duplication 3.Inversion 4.Translocation
Diagrams:- Refer pg No. 83 (Text book)
Differentiate the DNA repair mechanisms in prokaryotes and eukaryotes.
Prokaryotes: Photoreactivation is a type of DNA repair mechanism. It is the recovery of ultraviolet irradiated damages of DNA by visible light. As the name suggests, it is a light dependent process. In this DNA repair

method cells recovers its DNA after UV exposure induced damages by photolyases which activates only in presence of light.
Eukaryotes: Nucleotide excision repair (NER) is a particularly important excision mechanism that removes DNA damage induced by ultraviolet light (UV). UV DNA damage results in mostly thymine dimmers that are repaired by DNA glycosylases and DNA polymerases.

Q.8. 1Differentiate between transition and transversion mutation.
Answer- Transition- It is the substitution of a purine from another purine base or pyrimidine from another pyrimidine (C⟷TC⟷T or A⟷GA⟷G)
Transversion- is the substitution of a purine from a pyrimidine or pyrimidine from a purine.
Q.9.Describe briefly the experiment performed byMeselson & Stahl to show that DNA Replication is semi-conservative .
Answer:- 1. MESELSON AND STAHL EXPERIMENT
➢This experiment was performed to prove the semi conservative nature of DNA replication. Matthew Meselson & Franklin Stahl experimented with bacteria E.coli in 1958.
Step 1. E.Coli was grown in a medium with N-15 for several generations
•Step 2. E.coli with only N-15 in their DNA were transferred to a medium with N-14
•Cells of E.coli were allowed to divide. Sample was taken and DNA was extracted periodically as cell division continued to check what type of DNA is being formed now. One replication in E.coli takes around 20 minutes. So, generation I is formed in 20 minutes.
•Therefore samples are taken after 20 minutes, then again after 40 minutes. Densities of DNA from the sample were measured to reach to results & conclusion.
2. Results
•Generation I: DNA was found to have intermediate density after 1 replication
•Generation II: Equal amounts of DNA with two different densities were found.
3. Conclusion
a) Presence of a hybrid/ intermediate density excluded Conservative hypothesis. Had it been Conservative hypothesis, Generation 1 would have been either Blue(N-15) or Green(N-14); and not an Intermediate one.
b) Presence of N-14 DNA in Generation II excluded Dispersive hypothesis. If it was Dispersive, each DNA should have had the same density. But, in Generation II, we could see 50% of the DNA have intermediate density, whereas remaining 50% have N-14 density.
c)Semi-conservative hypothesis could explain the entire experimental result. Separation of strands concept could explain the outcomes of Generation I & II.
d)Thus, it was proved that DNA replication is Semi-conservative in nature.



Q.10. Describe briefly the experiment performed by Griffith to show that DNA is the genetic material of the organisms .
Answer:- . A. GRIFFITH'S EXPERIMENT
1.When the R strain was injected into the mice. The mice survived as R cell were avirulent strains.
2.When the S strain was injected into the mice. The mice died as the S cell were virulent strains.
3. when he killed some virulent S cells by boiling them and injected these heat-killed S cells into mice. The mice survived,

4.when mice were injected with a mixture of heat-killed S cells and live R cells, the mice died as a result of pneumococcal infection. ➢Furthermore, the bacteria isolated from a mouse that had died from such a mixed infection were only of the S type.

➢These results showed that the live R cells had somehow been replaced by or transformed to S bacteria.

➢Conclusion: 'Transforming principle' present in the cell debris of S cells which is responsible for the observed transformation of R cells to S cells.

Diagram:- refer to the content

LONG ANSWER TYPE QUESTIONS (5 marks)

Q.1. What are the different enzymes and proteins involved in DNA replication and what are their roles?

Answer:- 1.Topoisomerases are enzymes that participate in the overwinding or underwinding of DNA by causing nick in one strand and religating it after one rotation.

2.Helicases: Unwind double strands of DNA by breaking hydrogen bonds.

3.Single strand binding (SSB) proteins: Binds to single strands of DNA to prevent rebinding of the strands.

4.Primase: It is an enzyme involved in the replication of DNA and is a type of RNA polymerase. It catalyzes the synthesis of a short RNA (or DNA in some organisms) segment called a primer complementary to a ssDNA template.

5.DNA polymerases : These are enzymes that synthesize DNA molecules from deoxyribonucleotides. DNA polymerase I (Kornberg enzyme) has 5' -3' exonuclease activity and helps in removal of primers and joining okazaki fragments. The main enzyme is DNA polymerase III which has high processivity and performs replication.

6.DNA ligase: seals the nicks or gaps in DNA strands by constructing phosphodiester bond between 3'-OH & 5'-PO_4 of fragments of DNA.

Q.2. Give a brief account of the mechanism of DNA replication.

Answer:- SEMI-DISCONTINUOUS REPLICATION -Replication starts at the ori site and results in formation of a replication bubble which forms a replication fork in both directions.

Initiation: The helicases unwind theDNA strands while SSBs bind to the single strands. The primaes forms the primers on both the strands.

Elongation: DNA polymerase III polymerises in 5'-3' direction but there are two strands in opposite directions so the two new strands that are formed are of two types i.e.

Leading strand: the strand is formed continuously in 5'-3' direction.

Lagging strand: it is formed in small fragments called okazaki fragments which are later joined together.

:

a)During DNA replication one of the newly synthesized strands is polymerized in the 5' to 3' direction, while the other strand is polymerized in the 3' to 5' direction.

•b)Synthesis of the 3' to 5' strand (called the lagging strand), is synthesized discontinuously as a series of short DNA fragments. Each of these fragments is synthesized with the usual 5' to 3' polarity and is referred to as Okazaki fragment, after R. Okazaki, who first identified them.

c)In case of bacteria, these fragments are 1000-2000 nucleotides in length, but in eukaryotes, these fragments are probably less than 200 nucleotides long.

d)Finally these separate Okazaki fragments are joined together to produce the daughter strand. •The other strand which grows overall in the 5' to 3' direction (called the leading strand) is synthesized continuously.

e)During DNA replication, one strand is synthesized continuously and the other strand is synthesized discontinuously, replication is said to be semi-discontinuous.

f)For the synthesis of the lagging strand, priming is a repeated process that must occur every time a new Okazaki fragment is initiated. This would leave the lagging strand not as a single piece of DNA, but as a series of disconnected short pieces of DNA attached to RNA primers.

g)In E. coli, the RNA primers are excised by the 5' to 3'exonuclease activity of DNA polymerase I and the new DNA is synthesized by the 5' to 3' polymerase activity of the same enzyme. The adjacent Okazaki fragments are then joined together by ligase, to form an intact lagging strand.

Q.3. Explain the different steps of transcription.

Answer:- Transcription is the first step in gene expression, in which information from a gene is used to construct a functional product such as a protein. The goal of transcription is to make a RNA copy of a gene's DNA sequence. For a protein-coding gene, the RNA copy, or transcript, carries the information needed to build a polypeptide (protein or protein subunit).

Stages of transcription

Initiation. RNA polymerase binds to a sequence of DNA called the promoter, found near the beginning of a gene. Each gene (or group of co-transcribed genes, in bacteria) has its own promoter. Once bound, RNA polymerase separates the DNA strands, providing the single-stranded template needed for transcription.

Elongation. One strand of DNA, the template strand, acts as a template for RNA polymerase. As it "reads" this template one base at a time, the polymerase builds an RNA molecule out of complementary nucleotides, making a chain that grows from 5' to 3'. The RNA transcript carries the same information as the non-template (coding) strand of DNA, but it contains the base uracil (U) instead of thymine (T).

Termination. Sequences called terminators signal that the RNA transcript is complete. Once they are transcribed, they cause the transcript to be released from the RNA polymerase.

Q.4. Give a brief account of the mechanism of translation.

Answer:-

Initiation: Translation begins with the binding of the small ribosomal subunit to a specific sequence on the mRNA chain. The small subunit binds via complementary base pairing between one of its internal subunits. and the ribosome binding site, a sequence of about ten nucleotides on the mRNA located anywhere from 5 and 11 nucleotides from the initiating codon, AUG. Once the small subunit has bound, a special tRNA molecule, called N-formyl methionine, or fMet, recognizes and binds to the initiator codon. Next, the large subunit binds, forming what is known as the initiation complex. With the formation of the initiation complex, the fMet-tRNA occupies the P site of the ribosome and the A site is left empty and this entire initiation process is facilitated initiation factors that help with the binding of ribosomal subunits and tRNA to the mRNA chain.

Elongation: With the formation of the complex containing fMet-tRNA in the peptidyl site, an aminoacyl tRNA with the complementary anticodon sequence can bind to the mRNA passing through the acceptor site. This binding is aided by elongation factors that are dependent upon the energy from the hydrolysis of GTP. Elongation factors go through a cycle to regenerate GTP after its hydrolysis. Now, with tRNA bearing a chain of amino acids in the p site and tRNA containing a single amino acid in the A site, the addition of a link to the chain can be made. This addition occurs through the formation of a peptide bond, the nitrogen-carbon bond that forms between amino acid subunits to form a polypeptide chain. This bond is catalyzed by the enzyme peptidyl transferase. The peptide bond occurs between the carboxyl group on the lowest link in the peptide chain located at the p site and the amine group on the amino acid in the A group. As a result, the peptide chain shifts over to the A site, with the original amino acid on the A site as the lowest link in the chain. The tRNA in the A site becomes peptidyl RNA, and shifts over to the P site. Meanwhile, the ribosome engages in a process called translocation: spurred by elongation factors, the ribosome moves three nucleotides in the 3' prime direction along the mRNA. In other words, the ribosome moves so that a new mRNA codon is accessible in the A site.

Termination: At termination, the polypeptide is freed from the ribosome at the termination codon, and tRNAs stop bringing the amino acids in the polypeptide chain.

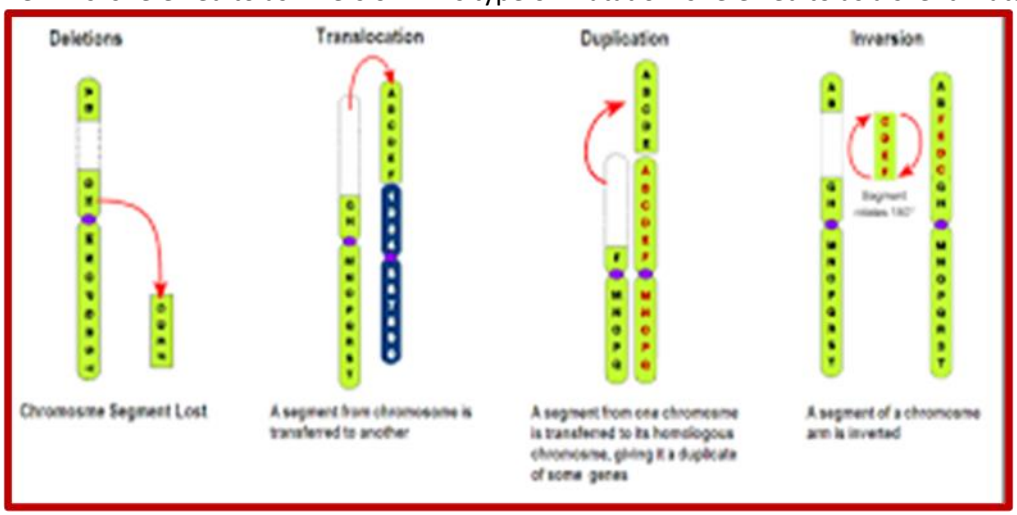
Q.5 What is mutation ? Expolain various types of Chromosomal mutation with diagrams

Answer:- The changes that occur in the nucleotide of DNA sequence. Such hereditary changes called as "mutations".

Types of Chromosomal mutsation :-

1.Duplication: When the sister chromatids are not the replica of each other and are not able to split in the middle due to some redundancy in the genes of that sequence, duplication occurs. These sister chromatids are separated into different cells where they overexpress the traits and produce more proteins.

2.Deletion: Deletion of a part of a chromosome during meiosis resulting in the break-off in the chromosome and losing the part is deletion. Deletion is a fatal mutation as it can cause the death of the zygote if the sequence lost is vital for survival.
3.Translocation: When the broken piece of the chromosome is not completely lost but it gets attached to a different, non-homologous chromosome that has also lost a part. This is referred to as translocation. It can cause serious problems due to the genes encoded in the wrong location.
4.Inversion: a part of a chromosome breaks off and is inverted. It then attaches itself to the same chromosome. This is referred to as inversion. This type of mutation is referred to as a silent mutation.



ASSERTION – REASONING QUESTIONS

Q.1 Assertion : If each strand from a parental DNA acts as template for synthesis of a new strand, the two double stranded daughter DNA thus produced would be indentical to the parental DNA molecule.
Reason : The length of DNA double helix in a typical mammalian cell is calculate simply by multiplying the total number of bp with distance two consecutive bp.
Answer -A (If both assertion and reason are true and the reason is the correct explanation of the assertion.)

Q.2. Assertion : In transforming principle, when streptococus pneumoniae (Pneumococcus) bacteria are grown on a culture plate, some produce smooth shiny colonies (S) while other produce rough colonies (R).
Reason : S strain bacteria have a mucous (polysaccharide) coat, while R strain does not.
Answer- A (If both assertion and reason are true and the reason is the correct explanation of the assertion.)

Q.3 Assertion : Split genes are found in eukaryotes.
Reason : Introns or intervening sequences are found in prokaryotes.
Answer- C (If assertion is true but reason is false.)

Q.4 Assertion: The primary transcript produced in eukaryotic is translated without undergoing any modification or processing.
Reason: The hn-RNA in humans has exons and introns.
Answer- D (If both assertion and reason are false.)

Q.5 Assertion :Transcription is the mode in which DNA passes its genetic information to RNA.
Reason : Transcription takes place in the cytoplasm of eukaryotic cells.
Answer- (c) If the Assertion is true but the Reason is false.

Q.6. Assertion-DNA replication is semi-conservative in nature
Reason-In each cycle of replication the complementary strands of parental double helix is conserved .
Answer - A (If both assertion and reason are true and the reason is the correct explanation of the assertion.)

Q.7 Assertion- The human genome comprise of a large amount of repetitive sequences

Reason- The repetitive sequences in the genome don't have direct coding functions.
Answer- B (If both assertion and reason are true but the reason is the not the correct explanation of the assertion)

Q.8 Assertion- P site & A site of a ribosome are different
Reason- P site is present in smaller unit & A site is present in larger unit
Answer - - (c) If the Assertion is true but the Reason is false

Q.9.Assertion- A non-overlapping code means that a base in mRNA is not used for different codon.
Reason- In translating mRNA molecule the codons do not overlap, but read sequentially .
Answer- A (If both assertion and reason are true and the reason is the correct explanation of the assertion.)

Q.10.Assertion- Histones are basic proteins of major importance in packaging of eukaryotic DNA.
Reason- Histones are five major types H1, H2A. H2B, H3, H4.
Answer- B (If both assertion and reason are true but the reason is the not the correct explanation of the assertion)

PASSAGE-BASED / CASE-BASED / SOURCE-BASED QUESTIONS

CASE-STUDY-I

The process of translation requires transfer of genetic information from a polymer of nucleotides to synthesise a polymer of amino acids. The relationship between the sequence of amino acids in a polypeptide and nucleotide sequence of DNA or mRNA is called genetic code. George Gamow suggested that in order to code for all the 20 amino acids, code should be made up of three nucleotides.

Q.1. What is a codon?(1)
Ans. A part of the messenger RNA molecule that has a sequence of 3 bases coding for an amino acid.

Q.2. Three consecutive bases in the DNA molecule provide the code for each amino acid in a protein molecule. What is the maximum number of different triplets that could occurs ? What are non-sense codons ? (2)
Ans- 64
They never code for any amino acid -UAA, UAG, UGA

Q.3 Which DNA sequence would be needed to produce the following polypeptide sequence? Alanine-Arginine- Lysine- Phenylalanine (1)
Ans-CGT GCT TTC TTT

CASE-STUDY- II

Nondisjunction is the failure of homologous chromosomes to disjoin correctly during meiosis. It leads to the formation of a new cell with an abnormal amount of genetic material. A number of clinical conditions are the result of this type of chromosomal mutation. This results in the production of gametes containing a greater or lesser chromosomal amount than normal ones. Consequently, the individual may develop a trisomy or monosomal syndrome. Nondisjunction can occur in both Meiosis I and Meiosis II of the cellular division. It is also the main cause of many genetic disorders; however, its origin and process remain vague. Although it results in the majority of cases from errors in maternal meiosis II, both paternal and maternal meiosis I do influence it. Maternal age is considered a risk factor for trisomy, as well as recombination alterations and many others that can affect chromosomal segregation.

Q1. Which of the following conclusions can be true regarding aneuploidy? (1)
Ans.i)It is the presence of an extra chromosome in a diploid cell.
ii)It can be less number of chromosomes in a diploid cell.

Q.2. Wahat are the causes of Aneuploidy ? (2)
Ans.- i).Most of the aneuploidy results from errors in cell division involved in egg formation.

ii).Nondisjunction in meiosis I can lead to more abnormal cells than disjunction in meiosis II.

Q.3. Assertion: All types of genetic disorders are caused by chromosomal nondisjunction.
Reason: Chromosomal nondisjunction always affects female individuals.
Ans- Both assertion and reason are incorrect

CASE-STUDY - III

The process of copying genetic information from template strand of DNA and RNA is called transcription. It is mediated by RNA polymerase. Transcription takes place in the nucleus ofeukaryotic cells. In transcription only a segment of DNA and only one of the strands is copied into RNA.

Q.1.What is the binding site of RNA polymerase ? (1)
Ans. Promoter

Q.2.What are monocistronic structural genes ? Where do you find them ? (2)
Ans.- If a stretch of replicating DNA contains a single cistron, it is called monocistronic
Eukaryotes

Q.3.Assertion: A single RNA polymerase in prokaryotes synthesis all types of RNAs
Reason: Prokaryotic RNA polymerase has sigma factor. (1)
a) Both assertion and reason are true and reason is the correct explanation of assertion

Unit IV- Cells and Organisms
Marks: 25

Chapter 1: The Basic Unit of Life

Contents of the chapter

- Cell Structure and Components

Chapter 2: Genes and Genomes: Structure and Function

Contents of the chapter

- Cell Division
- Cell Cycle
- Cell Communication
- Nutrition
- Reproduction
- In Vitro Fertilization
- Immune Response in Animals

CHAPTER 1: BASIC UNIT OF LIFE

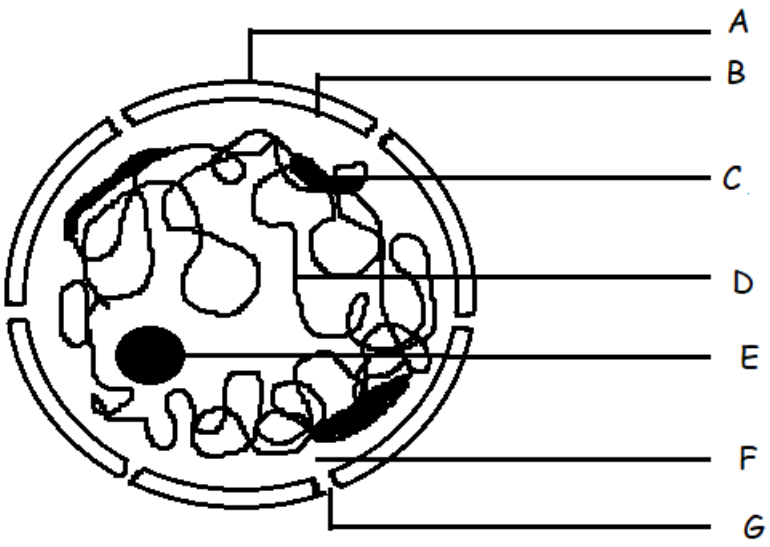
Multiple Choice Questions

1. Cell is basic _____
    a. Structural and functional unit of plants
    b. Structural and functional unit of animals
    c. Structural and functional unit of life
    d. Structural and functional unit of bacteria
2. All cells do not have-
    a. Cytoplasm
    b. Cell membrane
    c. Ribosome
    d. Mitochondria
3. Which of the following is true about bacteria?
    a. It is a prokaryotic cell
    b. It has a nucleus
    c. It has 80 S ribosomes
    d. It has no cell wall
4. Why plant cells and bacterial cells are tougher than animal cells?
    a. They are both prokaryote
    b. They both have cell wall

c. They both have nucleus
d. They have cytoplasm

5. Which of the following will be found in both bacteria and mitochondria?
   a. Cell wall
   b. Ribosomes
   c. Cristae
   d. Chlorophyll
6. Which of the following is not a function of cell membrane?
   a. It has surface receptors that receives signals
   b. It allows all the solutes in and out of the cell
   c. It separates the outside of cell from cytoplasm
   d. It the site of many metabolic reactions
7. Which of the following is not a function of membrane protein?
   a. Synthesis of proteins
   b. Cell-cell adhesion
   c. Channel for some solutes
   d. Metabolic reactions
8. Which of the following is not a feature of fluid mosaic model?
   a. Phospholipids are present in bilayer form
   b. Proteins are present in the bilayer
   c. Some proteins penetrate the lipid bilayer
   d. Central layer of lipid covered by protein on both side
9. What is the route of secretion of proteins from a cell?
   a. ER → Vesicles of ER → Cisternae of Golgi apparatus → Vesicles → Membrane of cell
   b. ER → Vesicles of ER → Cristae of Golgi apparatus → Vesicles → Membrane of cell
   c. Vesicles of ER → ER → Cisternae of Golgi apparatus → Vesicles → Membrane of cell
   d. ER → Vesicles of ER→ Vesicles → Cisternae of Golgi apparatus → Membrane of cell
10. Why is rough ER called so?
   a. It has rough surface due to vesicles
   b. It has rough surface due to ribosomes
   c. It has rough surface due protein synthesis
   d. It has rough surface due to cristae
11. Which of the following is not the function of Golgi body?
   a. Secretion of proteins from cell
   b. Synthesis of lysosomes
   c. Glycosylation of protein
   d. Synthesis of proteins
12. Microsomes are-
   I. Never found in intact cells
   II. Small sacs that are covered in ribosomes
   III. Formed due to homogenization of Endoplasmic Reticulum
   IV. Formed for transport of proteins within the cell
   a. I, II, IV
   b. I, III, IV
   c. I, II, III
   d. II, III, IV
13. Catalase are found in _____
   a. Peroxisome
   b. Lysosome
   c. Phagosome
   d. phagolysosome

14. Vesicles are formed from the ____ side of Golgi apparatus and fuse at the ____ side of the Golgi apparatus.
    a. Inner Concave, Outer Convex
    b. Outer Convex, Inner Concave
    c. Outer Concave, Inner Convex
    d. Inner Convex, Outer Concave
15. Which of the following is the correct pair of plastids and their functions?
    a. Chloroplast- storage of food
    b. Chromoplast- photosynthesis
    c. Amyloplast- storage of starch
    d. Proteoplast- storage of polysaccharides
16. Where is ribosome assembly done?
    a. Centre of nucleolus
    b. Centre of nucleus
    c. Periphery of nucleus
    d. Periphery of nucleolus
17. Ribosome is party assembled in _____ and the assembly is completed in _____
    a. Nucleus and cytoplasm
    b. Nuclear membrane and cytoplasm
    c. Nucleolus and nuclear membrane
    d. Nucleoplasm and nuclear membrane
18. In the following diagram parts of a nucleus are labelled A to G. Which of the following is the incorrect label?



    a. A- Outer Membrane
    b. F- Nucleoplasm
    c. D- Heterochromatin
    d. E- Nucleolus
19. Which organelle is called the powerhouse of cells?
    a. Plastids
    b. Nucleus
    c. Vacuole
    d. Mitochondria
20. Which of the following metabolic activity does not take place in the cytoplasm?
    a. Glycolysis- breakdown of sugar
    b. Synthesis of fatty acids

c. Synthesis of nucleotides
d. Synthesis of sugars

21. Under the microscope, how will a live cell look different from a dead cell?
    a. The live cell will show metabolism
    b. The live cell will show movement of chromatin
    c. The live cell will show movement of cytoplasm and organelles
    d. The live cell will the microfilaments and microtubules
22. Which cells are more likely to have a greater number of lysosomes?
    a. Muscles
    b. Macrophages
    c. Neurons
    d. Epithelial cells
23. Which of the following is not the content of cytosol?
    a. Inclusion bodies
    b. Amino acids
    c. Sugars and salts
    d. Nucleotides
24. The major role of cytoskeleton is –
    a. Maintaining the shape of cells
    b. Movement of cell
    c. Movement of organelles of cell
    d. All of these
25. Which of the following is not true about the inner membrane of mitochondria?
    a. It is highly folded inwards to form cristae
    b. It contains enzymes and electron transporters
    c. It is highly folded to form cisternae
    d. It is the site of ATP synthesis

Assertion and Reason Questions-

Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:
a. Both Assertion and Reason are true and the reason is the correct explanation of the assertion
b. Both Assertion and Reason are true but the reason is not the correct explanation of the assertion
c. Assertion is true but Reason is false
d. Both Assertion and Reason are false

26. Assertion: Chromoplasts are non- photosynthetic.
    Reason: They are present in fruits and flowers of plants and give them bright colours.
    Answer- B
27. Assertion: Mitochondria are called the power house of the cells.
    Reason: Mitochondria produce ATP with the help of proteins in its inner membrane
    Answer- A
28. Assertion: Macrophages have large number of primary lysosomes.
    Reason: Macrophages are involved in phagocytosis
    Answer- A
29. Assertion: Lysosomes contain hydrolytic enzymes.
    Reason: Lysosomes are synthesized by peroxisomes.
    Answer- C
30. Assertion: Cytoplasm of the living cell does not show cytoplasmic streaming.
    Reason: Cytosol is the insoluble part of cytoplasm.
    Answer- D
31. Assertion: Cell membrane has many proteins that carry out a variety of functions.
    Reason: Nuclear membrane does not have any proteins associated with it.

Answer- C

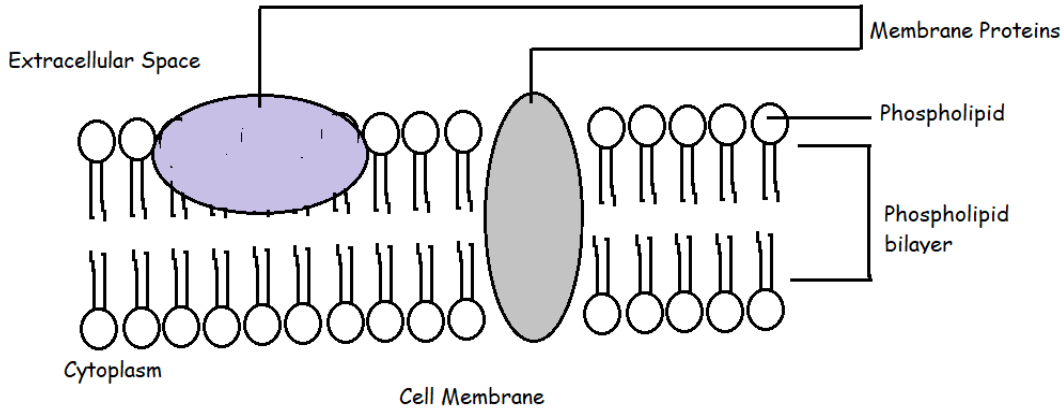
32. Assertion: Nucleolus of the nucleus stains lightly.
    Reason: Nucleolus is made up of proteins.
    Answer- D
33. Assertion: Cell membrane is semipermeable.
    Reason: The phospholipid bilayer does not allow water soluble substances like glucose to pass through it.
    Answer- A
34. Assertion: Plant cell is a prokaryotic cell.
    Reason: Plant cell does not have a cell membrane but only a cell wall.
    Answer- D
35. Assertion: Cytoplasm of the living cell does not show cytoplasmic streaming.
    Reason: Cytosol is the insoluble part of cytoplasm.
    Answer- D

Short Answer Type Questions

1. Distinguish between eukaryotic and prokaryotic cell

Eukaryotic cell	**Prokaryotic cell**
Membrane bound nucleus	No membrane bound nucleus
Membrane bound cell organelles	No membrane bound cell organelles
80 S ribosomes in cytoplasm	70 S ribosomes in cytoplasm

2. Draw the structure of cell membrane and label any two parts



3. Mention the characteristics of nucleus.
    - Spherical or ovoid and about 10 µm in diameter
    - Two membrane- outer and inner membrane
    - Outer membrane continues with ER
    - Contains -chromatin, nucleolus and nucleoplasm
    - Chromatin can be divided into heterochromatin and euchromatin
    - Nucleolus is a round structure contains large amount of DNA and rRNA
    - Nuclear membrane has pores
4. Distinguish between euchromatin and heterochromatin

Euchromatin	**Heterochromatin**
Loosely coiled chromatin	Highly coiled chromatin
Transcriptionally active part of genome	Transcriptionally inactive part of genome
Stains lightly	Stains darker

5. What are inclusion bodies?
    Insoluble cellular wastes or storage products in the cytoplasm are called inclusion bodies.

6. How are chloroplast similar to mitochondria? Similarities-
    - Both organelles have their own circular DNA
    - Both organelles have double membrane
    - Both organelles have 70 S ribosomes
7. How are mitochondria and chloroplast different?
    - Mitochondria generates ATP by oxidative phosphorylation while chloroplast uses light to generate ATP.
    - Chloroplast has green pigment- chlorophyll while mitochondria lack it.
8. Distinguish between microtubules and microfilaments

Microtubules	**Microfilaments**
Protein- tubulin	Protein- actin
Found in- cilia, flagella, and spindle fibre	Found in- cytoplasm below the membrane
Responsible for the movement of cell organelles, chromosomes, and cell (cilia and flagella)	Responsible for endocytosis, exocytosis, and movement of cells

9. What is the importance of plastids in plant cells?
    a. Plastid containing chlorophyll is important for photosynthesis
    b. Plastid containing other colours are important for brightly coloured flowers and fruits
    c. Plastids that do not contain any colour are important for food storage
10. What is phagolysosome?

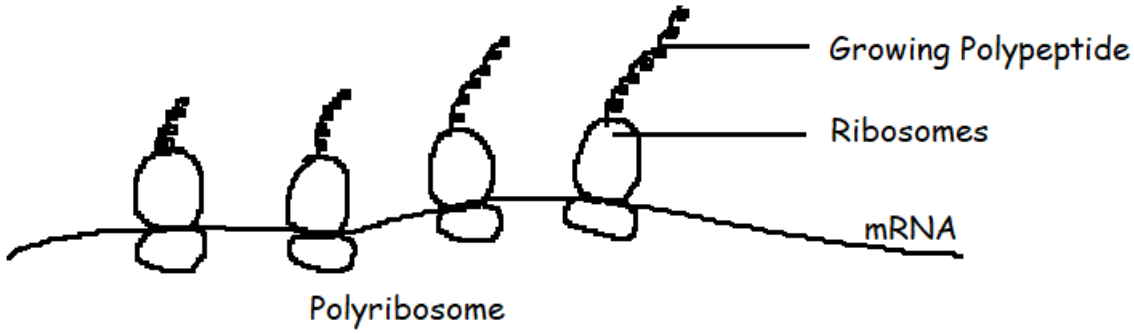
    Phagolysosomes are formed in a cell when a phagosome (formed due to endocytosis) is fused with lysosome (contains hydrolytic enzymes) to digest the content of the phagosome.

11. Why are ribosomes called ribonucleoproteins?

    Ribosomes contain equal amounts of rRNA and proteins. Hence, they are called ribonucleoproteins.

12. What is a nucleosome? What happens to the chromatin during cell division?
    The DNA and the histones are organized into beadlike structure called nucleosomes. The core is made up of histone proteins (octamer) and the DNA is wrapped around it.

    The chromatin that is thread and bead structure in an interphase nucleus condenses to form a dense structure called the chromosome during cell division.
13. What is polyribosome?
    Many ribosomes are attached to a single mRNA. This is used to synthesize proteins efficiently.



Polyribosome

14. What is glycosylation? What is the importance of glycoproteins?
    Addition of carbohydrate moiety to the proteins in cisternae of Golgi apparatus is called **glycosylation.**
    Glycoproteins serve as important receptors on cell surfaces.
15. What is the role of nucleolus in a cell?

It contains large amounts of DNA that codes for rRNA. rRNA is an important component of ribosomes. Hence, nucleolus has an important role in the synthesis of ribosomes.

Long Answer Type Questions

1. Observe the image given below and answer the following questions- [5]

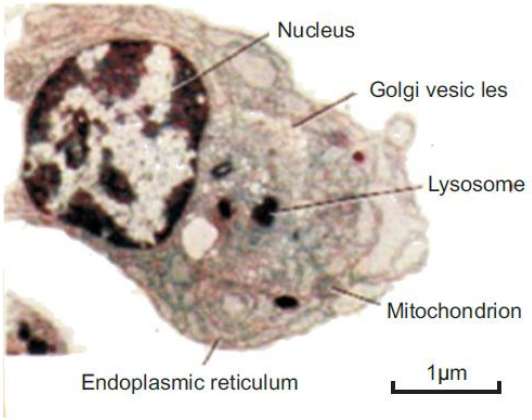


Image A

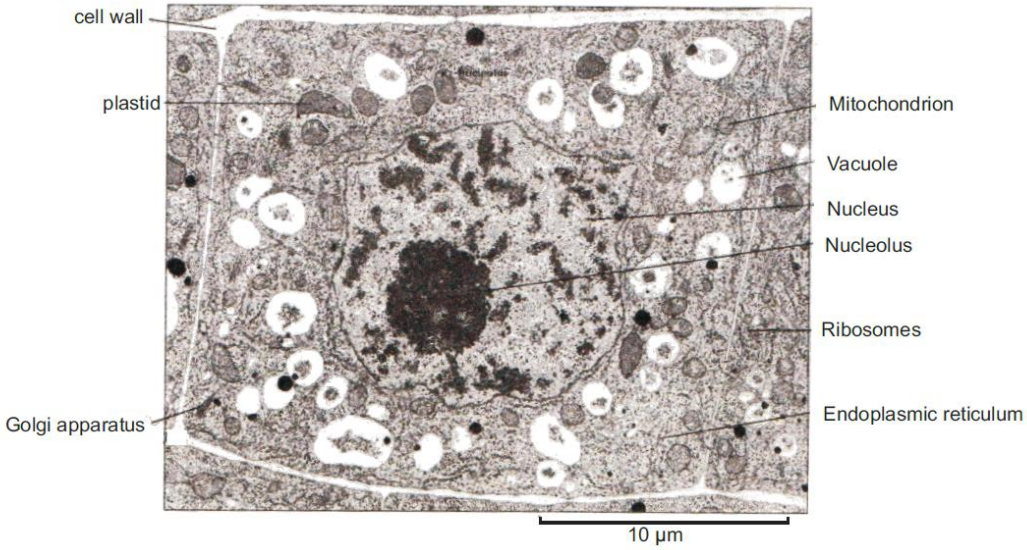


Image B

a. Identify images A and B.
   A- Animal Cell
   B- Plant cell

b. How are they different from each other?

Animal cell	Plant cell
Cell wall absent	Cell wall present
Plastids absent	Plastids present
Centrioles present	Centrioles absent

c. How are they similar to each other?
   They both have cell membrane and membrane bound organelles
   They both have cytoplasm which is the sire of many metabolic activities

2. Mention any five functions of cell membrane.
   a. It separates the interior of the cell from the external environment.

b. It controls exchange of gases, solutes etc., between the interior of the cell and its external environment.
c. It bounds the organelles in the cell such as nucleus, mitochondria, chloroplasts and Golgi apparatus where specialized metabolic pathways take place.
d. Sometimes it functions as the site for photosynthesis or oxidative phosphorylation.
e. It carries the receptors to which various ligands such as hormones, antibodies and other chemicals can attach and initiate a variety of reactions.

3. Mention any five functions of membrane proteins.
    a. Channel proteins that allow the movement of some molecules
    b. Membrane protein may function as enzymes
    c. Some glycoproteins help in cell-cell adhesion and play important role in immune system
    d. Some proteins act as receptors to external signals and relay the information to the nucleus
    e. Some membrane proteins act as electron carriers and help in the phosphorylation

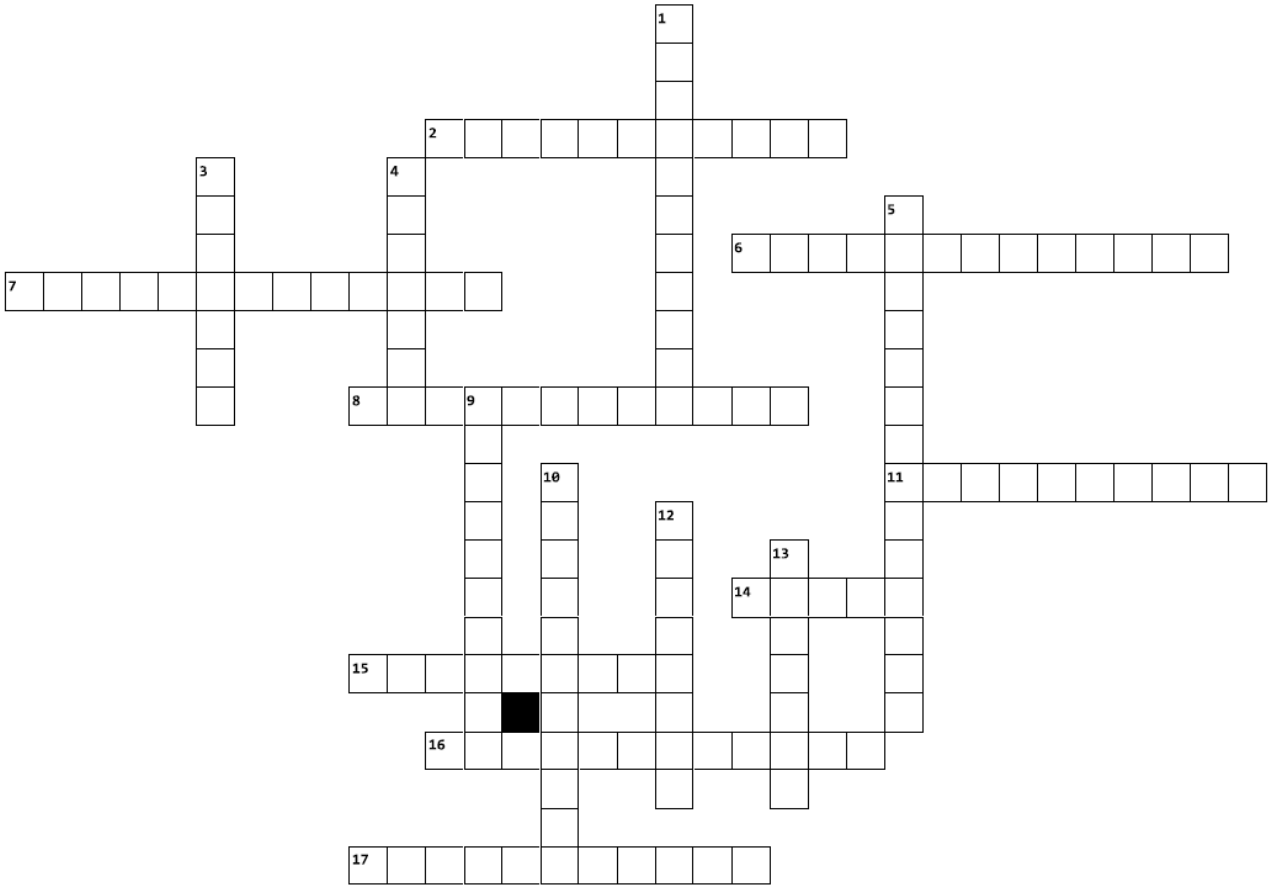
Case Based Question

1. Read the following excerpt and answer the following questions

Each ribosome consists of two subunits, one small and one large. Based on their sedimentation rate in a centrifuge machine, ribosomes are classified into two types, 70S and 80S. The 70S ribosomes are found in bacterial cells while 80S ribosomes are found in plant and animal cells. It is important to note that 70S ribosomes are also found in the mitochondria and chloroplasts of eukaryotes.

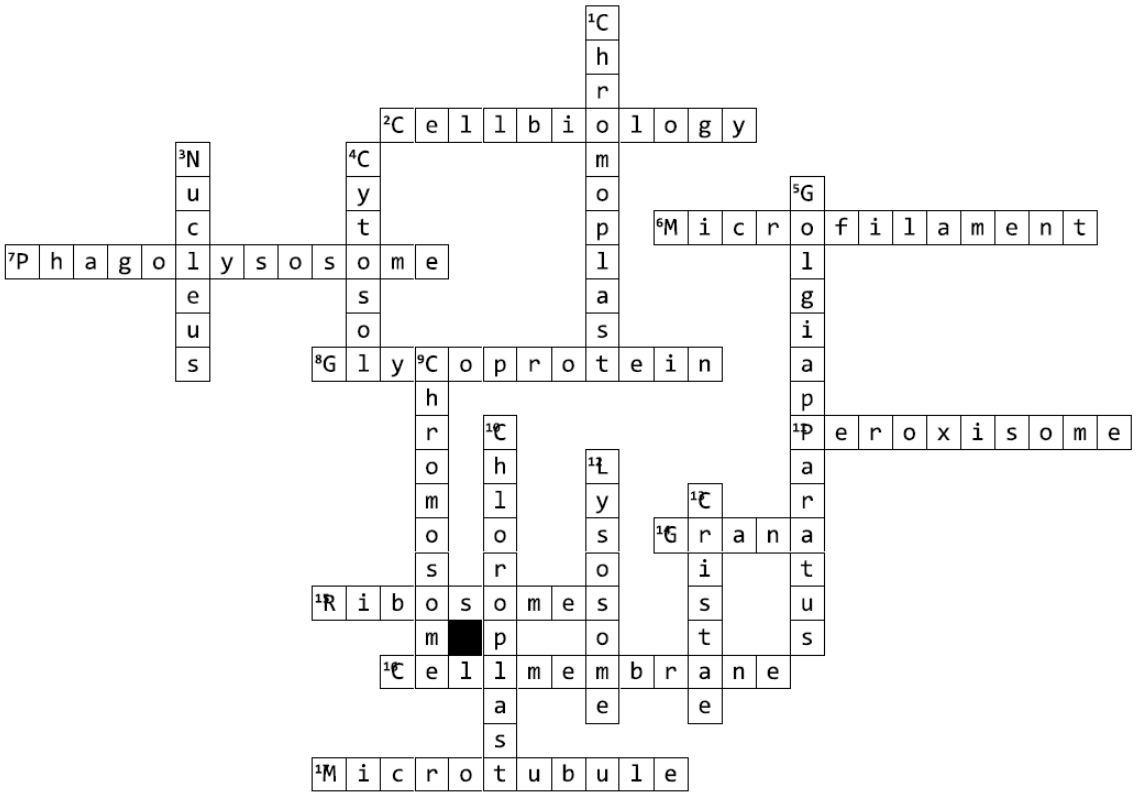
a. What is the location of ribosomes in eukaryotic and prokaryotic cell?
   Cytoplasm of cell and in eukaryotes on the Rough Endoplasmic Reticulum
b. Why is ribosome considered a dimer?
   Ribosomes are made of 2 subunit- one small and one large
c. Which organelles of eukaryotic cell contains 70S ribosomes? What can be inferred about the origin of organelles?
   Mitochondria and chloroplasts
   They may be related to prokaryotic cells

CROSSWORD PUZZLE



Across	Down
2. Study of cell and cellular processes **6.** Cytoskeleton that is made up of actin **7.** Phagocytic vesicle fused with lysosome **8.** Proteins that help with cell-cell adhesion **11.** Organelle that contain the enzyme peroxisome **14.** Stack of thylakoid **15.** RER is rough due to the presence of these **16.** Structure that surrounds all cells **17.** Cytoskeleton that is made up of tubulin protein	**1.** Coloured but non-photosynthetic plastid **3.** Membrane bound organelles that contain DNA **4.** Soluble part of the cytoplasm **5.** Cell organelle named after Camillo Golgi **9.** Chromatin is condensed during cell division to form ___ **10.** Plastid that contains photosynthetic pigments **12.** Single membrane bound organelle that contains digestive enzymes **13.** The inner membrane of mitochondria is folded to form ___

Answer



CHAPTER 2- CELL GROWTH AND DEVELOPMENT

Multiple Choice Questions

1. Cell division is important for organisms for which of the following reasons?
   a. Growth and repair
   b. Reproduction
   c. Distribution of genetic material among daughter cells
   d. All the above
2. Which of the following is the correct sequence of phases of mitosis?
   a. Prophase → anaphase → metaphase → telophase
   b. Prophase → metaphase → anaphase → telophase
   c. Prophase → telophase → anaphase → metaphase
   d. Anaphase → prophase → metaphase → telophase
3. The cell division in which all the daughter eukaryotic cells receive equal genetic material is ____
   a. Mitosis b. Meiosis

c. Cytokinesis d. Both a and b

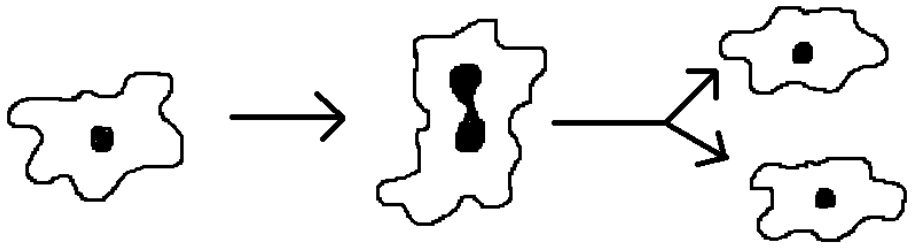
4. Which of the following is not observed in Prophase of mitosis?
   a. Condensation of chromatin
   b. Disassembly of cytoskeleton and assembly of mitotic spindle
   c. Assembly of nuclear envelope
   d. Attachment of spindle microtubules to the kinetochore of chromosome
5. Metaphase of mitosis is characterized by-
   a. Alignment of chromosomes at the equator of spindle
   b. Alignment of chromosomes at the poles of the spindle
   c. Alignment of chromosomes in the nucleus of the cell
   d. Alignment of chromosomes on the spindle fibre
6. Telophase of mitosis is not characterized by-
   a. Chromatids reach the opposite poles of spindle
   b. Appearance of nuclear envelope and other organelles
   c. Chromatids are uncoiled in the nucleus
   d. Chromosomes reach the opposite poles of spindle
7. Cytokinesis is _____
   a. Division of cytoplasm between daughter cells
   b. Division of nucleus between daughter cells
   c. Division of cytoplasm and nucleus
   d. Division of chromosomes between daughter cells
8. Karyokinesis is _____
   a. Division of cytoplasm between daughter cells
   b. Division of nucleus between daughter cells
   c. Division of cytoplasm and nucleus
   d. Division of cell organelles between daughter cells
9. How cytokinesis is carried out in plant cells?
   a. Cleavage furrow cuts the cytoplasm between two cells
   b. Cell plate formation between two cells
   c. Division of cytoplasm between daughter cells
   d. All of these
10. How cytokinesis is carried out in animal cells?
    a. Cleavage furrow cuts the cytoplasm between two cells
    b. Cell plate formation between two cells
    c. Division of cytoplasm between daughter cells
    d. All of these
11. Cell division that results in gamete formation in diploid organisms is ____
    a. Meiosis c. Binary fission
    b. Mitosis d. All of these
12. The correct sequence of stages in Prophase I of Meiosis I is
    a. Leptotene → zygotene → Diplotene → Pachytene →Diakinesis
    b. Leptotene → zygotene → Pachytene → Diplotene →Diakinesis
    c. Diakinesis → Diplotene → Pachytene → Zygotene → Leptotene
    d. Diplotene → Pachytene → Zygotene → Leptotene → Diakinesis
13. What is synapsis?
    a. Pairing of non- homologous chromosomes
    b. Paring of maternal and paternal homologues
    c. Exchange of chromatids in a chromosome

d. Exchange of parts of chromatids

14. Which of the following is true about Meiosis I and Meiosis II?
    a. Meiosis I and II are both reductional division
    b. Meiosis I is equational and Meiosis II is reductional division
    c. Meiosis II is equational and Meiosis I is reductional division
    d. Meiosis I and II are both equational division
15. How is Anaphase I different from Anaphase II?
    a. Homologous chromosomes separate in anaphase I and chromatids separate in anaphase II
    b. Homologous chromosomes separate in anaphase II and chromatids separate in anaphase I
    c. Homologous chromosomes separate in both anaphase II and anaphase I
    d. Chromatids of a chromosome separate in both anaphase I and anaphase II
16. The cell cycle is divided into two basic phases - _____ and _____.
    a. Prophase and Interphase
    c. Interphase and Mitosis
    b. Interphase and Meiosis
    d. Interphase and Metaphase
17. Which of the following is not a correct pair?
    a. G_o- Cells do not undergo division
    b. G_1- Growth of cells
    c. S- Synthesis of organelles
    d. G_2- Growth of cell for cell division
18. Which of the following check point of cell cycle checks the growth of cell?
    a. G_1/S checkpoint
    c. M phase checkpoint
    b. G_2/M checkpoint
    d. All of these
19. Which of the following check point of cell cycle checks the attachment of spindle fibres to chromosomes?
    a. G_1/S checkpoint
    c. M phase checkpoint
    b. G_2/M checkpoint
    d. All of these
20. DNA damage checkpoints which are operative during G_1, S, G_2 are regulated by
    a. Cdk2, Cdk4
    c. Cyclins only
    b. Cdk1 and B-cyclin
    d. CHK1 and CHK2
21. Intracellular signal transduction involves the molecules like-
    a. Cyclic AMP
    b. G-protein coupled receptors
    c. Ca^{2+} and calcium binding proteins
    d. MAP kinase
22. Which of the following is a group of micronutrients?
    a. Carbon, hydrogen, oxygen, nitrogen
    b. Phosphorus, manganese, sulphur, calcium
    c. Manganese, copper, zinc, cobalt
    d. Iodine, Carbon, phosphorus, sodium
23. Which of the following nutrients is synthesized in human gut by bacteria?
    a. Vitamin K and vitamin B12
    b. Vitamin B1 and Vitamin K
    c. Vitamin E and Vitamin B6
    d. Vitamin C and Vitamin D
24. Which of the following is not a correct pair of nutrient and deficiency disease?
    a. Iron or folic acid- anemia
    b. Vitamin D- bone deformities
    c. Vitamin B6 and B12- nervous tissue problems

d. Vitamin C- weak eyesight

25. Reproduction ensures-
    a. Continuity of species
    b. Transmission of genetic material from parents to offspring
    c. Diversity is generated in species
    d. All of these
26. Why is the entire progeny of bacteria identical to its parent cell?
    a. One single cell gives rise to the progeny
    b. Two cells fuse to give rise to progeny
    c. Variation in progeny arises due to random mutation
    d. Bacterial cell division is exponential in nature
27. Genetic recombination occurs in
    a. Asexual reproduction
    c. Sexual reproduction
    b. Vegetative propagation
    d. All of these
28. Genetic recombination occurs in bacteria by-
    a. Transformation
    c. Transduction
    b. Conjugation
    d. All of these
29. The mechanism by which genetic material from one bacterium is transferred to another by a phage (virus) is called:
    a. Transduction
    c. Transfection
    b. Transformation
    d. Transportation
30. Which of the following is not true about reproduction in plants?
    a. Plants undergo both sexual and asexual reproduction
    b. In apomixis, embryo and seeds are produced with fertilization
    c. In sexual reproduction there is double fertilization
    d. Sexually reproducing plants produce haploid gametes
31. Which of the following is not the correct pair?
    a. Zygote - embryo
    b. Triple fusion – primary endosperm nucleus
    c. Endosperm- gives rise to new plant
    d. Embryo sac- contains ovum
32. Identify the mode of reproduction in the image given below



    a. Asexual reproduction, multiple fission
    b. Asexual reproduction, binary fission
    c. Sexual reproduction, binary fission
    d. Sexual reproduction, multiple fission
33. Which of the following statements is not true about zygote?
    a. Fusion of male and female gametes results in formation of zygote
    b. Zygote carries a set of chromosomes from each parent
    c. Zygote grows and develops into mature organisms
    d. Zygote is a multicellular structure that develops into organism

34. Ovulation means
    a. Process of movement of an ovum in the fallopian tube in females
    b. Process of release of an ovum from one of the ovaries in females
    c. Process of fusion of ovum with sperm in fallopian tube in females
    d. Process of cell division that results in the formation of ovum in ovary
35. IVF includes the combination of three basic microtechniques in correct sequence is-
    I. Isolation and selection of male and female gametes
    II. Single zygote culture
    III. Fusion of pair of gametes
    a. III → II → I
    c. II → I → III
    b. I → III → II
    d. II → III → I
36. Which of the following is not a lymphoid organ?
    a. Liver
    c. Bone marrow
    b. Thymus
    d. Spleen
37. Which of the following is the correct pair of tissue and macrophages?
    a. Liver – Kupffer cells
    b. Lungs – Alveolar cells
    c. Paritoneal cavity- Paritoneal macrophages
    d. Basophils - Blood
38. Which of the following organisms possess immune system?
    a. Starfish
    c. Rat
    b. Earthworms
    d. Hydra
39. Which of the following is not a characteristic of macrophages?
    a. Macrophages are phagocytic cells
    b. Macrophages are large cells with many vacuoles
    c. Macrophages migrate from tissues to blood
    d. Macrophages can present antigens to T-lymphocytes
40. Which of the following is not an antibody?
    a. Ig G
    b. Ig M
    c. Ig A
    d. Ig

Assertion and Reasoning Questions

Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

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

41. Assertion: Interphase is the longest phase in cell cycle.
    Reason: Cells undergo growth and metabolic activities, DNA replication and many other processes during interphase.
    Answer- A
42. Assertion: Metaphase II and metaphase of mitosis are similar.
    Reason: Chromatids separate from the chromosome in both metaphase of mitosis and metaphase II.
    Answer- A
43. Assertion: Each chromosome consists of two sister chromatids.
    Reason: Chromatids are attached at the centromere which has a plate-like structure called kinetochore
    Answer- B
44. Assertion: Cells that enter the G_0 phase remain viable and metabolically active.
    Reason: Cells that have complete G_1, S and G_2 undergo mitosis.
    Answer- B
45. Assertion: Cell cycle is regulated by molecules- cyclins and Cdks.
    Reason: Proteins are phosphorylated by cyclin- Cdk complex.
    Answer- A
46. Assertion: Plants can synthesize their own food while animals cannot.
    Reason: Animals needs raw materials like water and carbon dioxide for preparation of food.
    Answer- C
47. Assertion: Most microbes like bacteria and fungi are saprotrophs.
    Reason: Bacteria and fungi obtain nutrients from digesting dead and decaying matter.
    Answer- A
48. Assertion: Pollination is the transfer of ovum from stigma to anther.
    Reason: Pollination can occur with the help of insects only.
    Answer- D
49. Assertion: Germination of seed causes embryo gives rise to a new plant.
    Reason: The endosperm of the seed provides food for the new plant.
    Answer- C
50. Assertion: IVF is the method of fertilization in a petri dish.
    Reason: IVF is part of a larger discipline called Assisted Reproductive Technologies
    Answer- B

Short Answer Type Questions

1. Mention the characteristics of Interphase.
   Characteristics of Interphase-
   i. Absence of visible chromosomes
   ii. Chromatin are uncoiled and nucleus looks homogenous
   iii. Highly active DNA replication, protein synthesis
2. What will happen if DNA damaged in a cell cycle?

If DNA is damaged then the checkpoints will arrest the cell cycle progression and allow for DNA repair before cell cycle is resumed.
Failure of the checkpoint control will result in increased DNA damage in the cell.

3. What is a signaling molecule? Mention the different types of signaling molecule with examples.

Signalling molecules are molecules which causes plant and animal cells respond.

These may be-

i. Simple molecules like ions and gases
ii. Complex proteins like hormones, growth factors and cytokines
iii. A class of lipids called eicosanoids includes signalling molecules like prostaglandins and leukotrienes.

The distance at which these signalling molecules act also varies.

a. Some act locally
b. Others carry signals over long distances.

4. What are receptors? Mention any two types of receptors.

Molecules (proteins) that bind to signal molecules are called receptors.
Two types of cell receptors-

a. Extracellular receptors
b. Intracellular receptors

5. What changes can be observed after a signaling molecule binds to a receptor?

Cellular response that may include-

a. changes in gene expression,
b. differentiation,
c. replication,
d. alteration of enzyme activity,
e. changes in ion permeability or
f. death of the cell.

6. What is a signal transduction pathway?

Once a signalling molecule binds receptor on a cell, it initiates a series of intracellular reactions towards interior of the cell and signal is transmitted from cell membrane to nucleus. This process is called **intracellular signal transduction.** The signal may be transmitted directly or via a cascade pathway involving many proteins. These pathways between the cell membrane and the cell nucleus are called **signal transduction pathways.**

7. What are macronutrients and how are they different from micronutrients? Why are the trace elements so important for living organisms?

Elements like manganese, copper, zinc, cobalt, selenium, and iodine are required in very small amounts and are called micronutrients or trace elements.
Micronutrients are required in very little amounts while macronutrients are required in larger quantities.
Some of these trace elements are part of vitamins and play important function in animal nutrition.

8. How do bacteria help in animal nutrition? Give examples to illustrate.

Bacteria which live in the gut of the animals, also help in animal nutrition. Bacteria in the human gut synthesize vitamin K and vitamin B_{12} that are absorbed by the human body and utilized for various

functions. Bacteria found in the rumen of cattle break down the cellulose of the fodder into smaller sugar molecules, which are absorbed by the cattle.

9. Mention the effects of deficiency of the following nutrients in human body-
   a. Protein
   b. Iron and folic acid
   c. Vitamin C
   d. Vitamin D
   e. Vitamin A
   f. Vitamin B6 and B12

Nutrient	**Effects of deficiency**
Protein	Stunted growth in children
Iron and folic acid	Anemia
Vitamin C	Scurvy
Vitamin D	Bone deformities
Vitamin A	Weak eyesight
Vitamin B6 and B12	Nervous tissue problem

10. What is reproduction? Why is it important?

    Reproduction refers to the ability of living organisms to produce individuals of the same species.
    Importance-
    Transmission of genetic material from parental generation to the next generation. Reproduction ensures continuity of the species.
    It also allows increase in the total number of individuals in the species.
    Diversity is generated in a species.

11. What is apomixis? Briefly describe its types.
    Embryos and seeds developed with of fertilization.
    Two types of apomixis
    - Facultative apomixis- Plants in which both apomixis and sexual reproduction takes place
    - Obligate apomixis- Plants in which reproduction occurs only by apomixis

12. What is vegetative propagation? Why is it called clonal propagation? Why is it asexual reproduction?
    Vegetative reproduction takes place when new individuals are produced from somatic cells (i.e., vegetative propagules like stem cuttings, tubers, bulbils, leaves, roots, etc.) This does not involve seed formation.

    The clone or all the individuals derived from vegetative parts will be exactly similar to the parent cell and each other in terms of genotype and phenotype, and therefore such propagation is also called clonal propagation.

    New plants arise from a single parent without any fusion of gametes. That's why it is asexual reproduction.

13. Fill in the blanks with the options given about the formation of pollen grains in plants-

The anther consists of _____ [4] pollen sacs, also called as microsporangia with ___ [2n] number of chromosomes. The cells of microsporangia undergo meiosis to produce microspores that is _____ [haploid]. The microspores divide _____ [meiotically] to produce pollen grains. A mature pollen grain consists of _____ [two] cells; one within the other i.e. the tube cell contains a generative cell within it. The generative cell divides to produce _____ [two] sperm cells.

14. Fill in the blanks with the options given about the formation of female gametes in plants-

    Within the ovary are one or more ovules attached to the ovary wall. The ovule has one or two outer layers of cells called _____ [integuments] and an opening called _____ [micropyle]. The integuments enclose the megasporangium that is _____ [diploid]. The megasporangium cells undergo meiosis and _____ [unequal] cytokinesis to produce ____ [four] megaspores (1n). The largest of these megaspores undergo _____ [mitotic, meiotic] divisions to produce a _____-celled [8] embryo sac. One of these cells is the egg. There is also a central cell containing ____ [two] polar nuclei and ____ [three] antipodals.

15. What is syngamy? What is the importance of this process?

    Fusion of gametic nuclei (male and female) is called syngamy or fertilization. This results in the formation of zygote. The zygote carries a set of chromosomes derived from each parent and restores diploid set of chromosomes. The zygote grows and develops into mature organism of the next generation.

16. Distinguish unisexual and bisexual organisms. Give examples of each.

Unisexual organisms	**Bisexual organisms**
Organisms that have both sexes in separate individuals – male and females	Organisms that have both sexes in same individuals- hermaphrodite
e.g. human beings, lions, deer	e.g. tapeworms, earthworms

17. What is IVF? How is it carried out (list the steps)?

Fertilization is carried out in a petri dish or test tube- babies are called test tube babies**.** Process in which ovum is fertilized by the sperm outside the female body. The fertilized ovum is allowed to divide and then the embryo is implanted in female body.

Process-

a. Stimulation of ovulation by females by using hormones
b. Ova are collected from female by aspiration needles
c. Eggs are separated from surrounding tissue
d. Eggs are incubated with sperms for 18 hours (ratio is 1: 75000)
e. Fertilized eggs are kept in special medium for 48 hours
f. Embryo should be 8-10 cells by 72 hours
g. Best embryos are transferred to the uterus of a female and it develops into a baby

18. Distinguish between primary lymphoid and secondary lymphoid organs.

Primary lymphoid organs	**Secondary lymphoid organs**
Organs in which the cells of immune system originate and mature.	Organs where the cells of immune system settle and function after maturation.
E.g. bone marrow and thymus	E.g. lymph nodes, spleen and GALT (Gut Associated Lymphoid Tissue)

19. Distinguish between T-lymphocytes and B-lymphocytes.

B-lymphocytes	T-lymphocytes
Lymphocytes that mature in Bone marrow	Lymphocytes that mature in Thymus
Mediates humoral immunity	Mediates cell mediated immunity
Produces immunoglobulins	Does not produce immunoglobulin

20. What are interleukins? What is the function of interleukin?

The macrophages break down the pathogens, then presents components of the pathogen to T-lymphocytes. After this, several cellular mechanisms occur in which several soluble substances called interleukins are produced by the macrophages, B-lymphocytes and T-lymphocytes.

Function of interleukin- B-lymphocytes and the T-lymphocytes get activated.

Long answer Type Questions

1. What is the significance of Prophase I of Meiosis I. Name the phases of Prophase I of Meiosis I where we can observe the following-

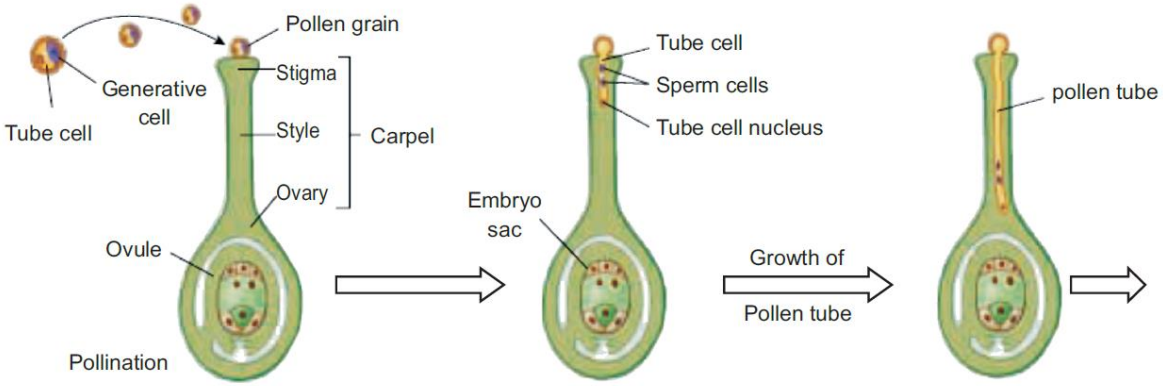
a. Pairing of homologues
b. Start of condensation of chromosomes
c. Crossing over
d. Chiasmata formation

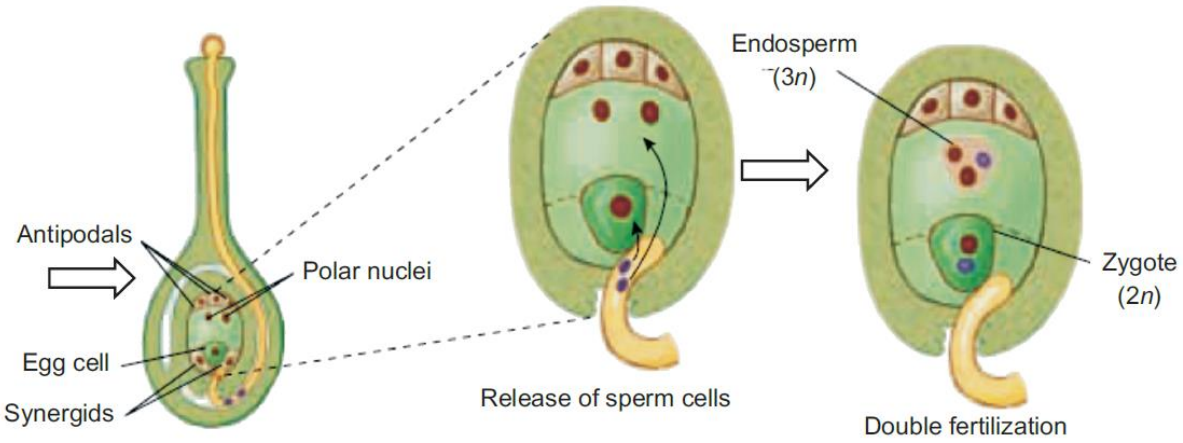
Recombination of non-sister chromatids of homologous chromosomes occurs in prophase I of meiosis I. This leads to the genetic variation in gamete formation.

a. Pairing of homologues- zygotene
b. Start of condensation of chromosomes - leptotene
c. Crossing over- pachytene
d. Chiasmata formation- diplotene

2. What is double fertilization? Explain with diagrams.

- Pollen tube reaches the micropyle end and two nuclei are released in the embryo sac.
- One nucleus fuse with the nucleus of ovum and forms zygote.
- Second nucleus fuse with the two polar nuclei- triple fusion (three haploid nuclei = 3n)- endosperm is formed.
- Two fertilization events are called double fertilization.

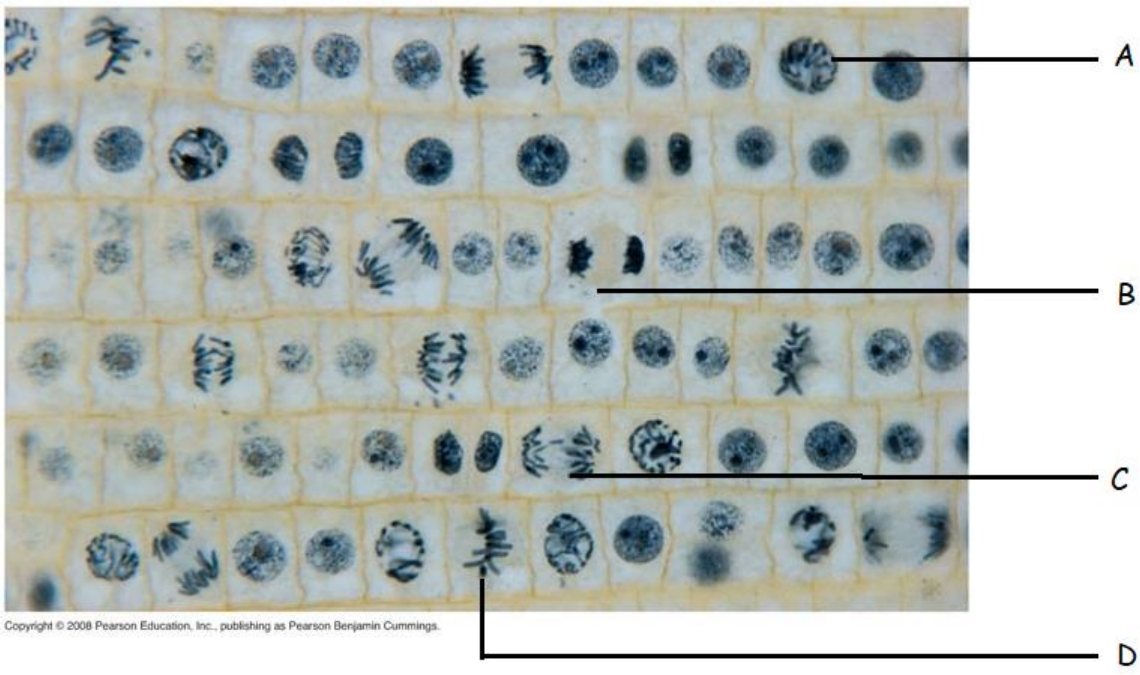




3. Distinguish between mitosis and meiosis.

Mitosis	Meiosis
One division of nucleus	Two divisions of nucleus
Two diploid daughter cells are produced	Four haploid daughter cells are produced
Occurs in somatic cells	Occurs in germ cells
No crossing over takes place	Crossing over takes place in Prophase I of Meiosis I
Involved in healing and growth	Involved in production of male and female gametes

4. Identify the stages labelled A, B, C and D in mitosis and mention the features of the stages. What is the importance of mitosis?



A- Prophase – The chromatin start condensation
B- Telophase- The chromatids reach the poles of spindle fibre
C- Anaphase- The chromatids are pulled towards the poles
D- Prometaphase/ metaphase- Arrangement of chromosomes on the metaphase plate.

Importance of mitosis

Growth and maintenance of the organisms

5. Bacteria reproduces asexually. How do variations arise in bacteria?
   Variations may arise by fusion of gametes or exchange of genetic materials between cells. In bacteria fusion of gamete does not occur but variations may occur due to the following reasons-

a. Transformation
   Cells do not come in contact with each other
   Donor cell → releases DNA → actively taken by recipient cell

b. Conjugation
   Donor bacterium has F plasmid (circular double stranded DNA which can confer some traits to the host cell)- F^+ Cell
   Recipient bacterium does not have F plasmid- F^- Cell
   Donor attaches to the recipient by a pilus and a copy of the plasmid is transferred to the recipient cell

c. Transduction
   Bacteriophage- virus that infects bacteria
   DNA is transferred from donor cell to recipient cell by bacteriophage

d. Random mutations that occur during DNA replication

6. List the cells of immune system and mention their functions.

Cells of Immune System	Functions
B lymphocytes	Mediate humoral immunity, Antigen presenting cells
T lymphocytes	Mediate cell mediated immunity
Dendritic cells	Skin immune function, Antigen presenting cells
Monocytes	Migrate to tissue become macrophages
Nuetrophils	Phagocytic cells
Macrophages	Phagocytic cells of tissues, Antigen presenting cells

Case Based Questions

1. **Asexual Reproduction in Microbes**
   Microorganisms such as bacteria reproduce mainly by asexual means in which a single organism divides to produce identical offspring. For example, a single bacterium at successive divisions will produce 2, 4, 8, 16, 32, …bacteria. Thus, during reproduction, the number of bacteria increases exponentially. This is called exponential or logarithmic growth. In this type of reproduction, there is no mixing of genetic material between two cells. Thus, the entire progeny is identical to the parental cell. Variation among the progeny, if any, is due to random mutations that occur in DNA during replication.

a. If there were 5 bacterial cells in the medium, under ideal conditions how many bacteria will be produced after 4 rounds of cell division.

$5 \times 2^4 = 80$ cells

b. Why are the microbe progeny similar to the parent cell?
The microbe progeny is similar to the parent cell as the parent cell under goes repeated division without any exchange in the genetic material.

c. Variations can also arise in bacteria due to transformation, transduction and conjugation. Discuss the role of virus in giving rise to variations in bacteria.
Virus infects a bacterium and its genetic material is integrated into the host cell. When a mature virus is formed some of the host DNA may become part of the viral DNA. When this virus infects another bacterium, it transmits the parts of the old bacterial DNA into the new host. This is how variations may be generated due to virus.

2. **Cell Cycle**
Study the cell cycle flow diagram below and answer the following questions-

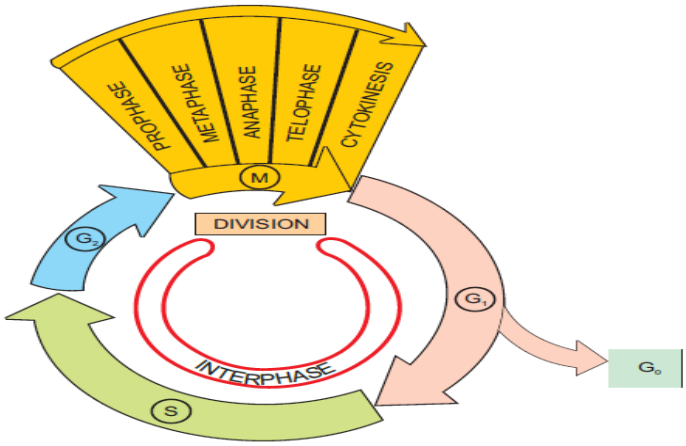


Figure- Cell Cycle

a. What does the G_o in the cell cycle signify?
The G_o in the cell cycle signifies those cells those are non-dividing. They may stay in this phase for a long time and my re-enter the cell cycle

b. If a cell completes cell cycle in 24 hours, how long does the interphase and division phase last for.
If a cell completes cell cycle in 24 hours, the interphase lasts for 23 hours and division phase lasts for one hour.

c. How is the cell cycle regulated? Mention the names of the molecules involved in the regulation of cell cycle.
Cell cycle is regulated by the check points. There are three check points-
G1/S- checks the growth of the cells, G2/M checks the DNA replication completion and the M checkpoint checks that all the spindle fibres are attached to the kinetochore of the chromosomes.
The molecules involved in the regulation of cell cycle are Cyclins and Cyclin Dependent Kinases

3. **Immune Response:**

The immune system has evolved to protect the host from a universe of pathogenic microbes that are themselves constantly evolving. The immune system also helps the host eliminate toxic or

allergenic substances that enter through mucosal surfaces. Central to the immune system's ability to mobilize a response to an invading pathogen, toxin or allergen is its ability to distinguish self from non-self. The host uses both innate and adaptive mechanisms to detect and eliminate pathogenic microbes.

a. Why does the immune system have to constantly evolve?

Pathogens are constantly evolving. So, the immune system must also evolve to protect the organism.

b. How do pathogens enter our body?
Pathogens may enter our body an injury in the skin or through the mucosal surface.

c. What must an immune system do before it responds to a chemical or pathogen? What would happen if this ability is lost?
Immune system must be able to recognise and distinguish self from non-self.
If it loses this property then it may attack its own cells and pathogens may escape the immune system

4. **Cytoskeletal structures of the cell**

Cytoskeleton is a system of filaments or fibres that is present in the cytoplasm of eukaryotic cells. These fibres are mainly of two types – microtubules and microfilaments. The filaments that comprise the cytoskeleton are so small that their existence was only discovered because of the greater resolving power of the electron microscope. The cytoskeleton organizes other constituents of the cell and has various other important functions.

a. Why is the cytoskeleton called so?
Maintain the structure of cell and movement of cell just as the skeletal system of our body.
b. What would happen if the cytoskeleton is not present in a cell?
The cell may lose its structure and the movement of the organelles may not occur
c. The chemical colchicine prevents the formation of spindle fibres during mitosis due to which cell division stops at metaphase. Which of the cytoskeletal structures do you think is affected by it? Why do you think that it is harmful for the cell?
It will inhibit the microtubules.
It will be harmful for the cell as there will be no cell division.

5. **The cell membrane**

The cell membranes are semipermeable, i.e., they allow the passage of some solutes through them but not the others. The membranes are composed of proteins and lipids. The lipids in the membranes are phospholipids. Earlier studies using electron microscope showed that the cell membranes were ca. 7.5 nm wide and consisted of 3 layers. The central layer is the lipid bilayer, on both sides of which, is present a protein layer. This was called **unit membrane hypothesis**. However, using several additional techniques, it has now been shown that phospholipids form a fluid lipid bilayer and that the protein molecules float in it. This is called **fluid mosaic model.**

a. Cell membranes do not allow water soluble molecules like glucose to pass through it freely. Why?
Cell membranes are composed of phospholipids which have a non-polar tail that are aligned in a bilayer. So, they are impermeable to water soluble molecules.

b. Why is the fluid mosaic model preferred over the unit membrane model?

Membrane is fluid in nature due to the presence of lipids. Proteins are embedded in the lipid bilayer and this can be proved by the fact that transmembrane proteins that transport other molecules

c. Name any four functions of proteins in the membrane?

Functions of membrane proteins (any four)

i. Receptors for ligands
ii. Electron carrier
iii. Channel and pore
iv. Cell to cell adhesion
v. Membrane protein in immune response

6. **Immunoglobulins**

Observe the diagram and answer the following questions-

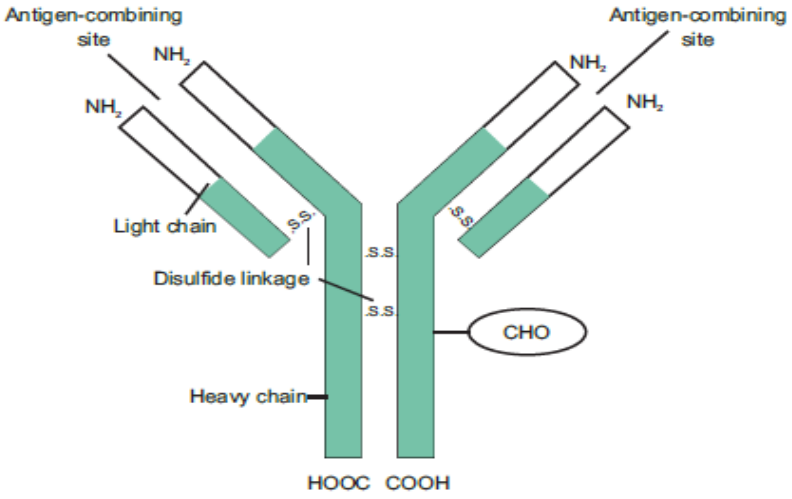


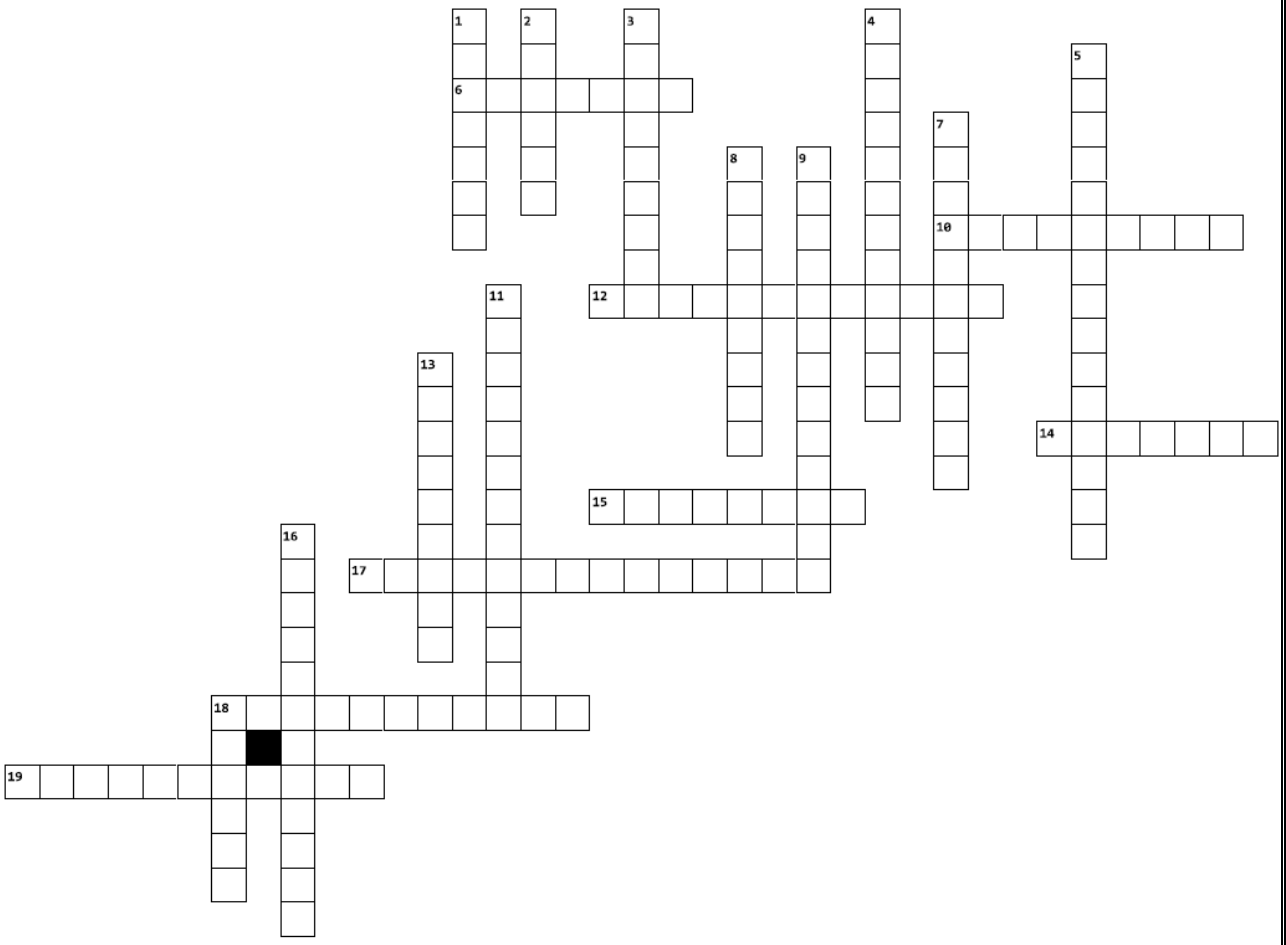
Fig. 13. Diagrammatic structure of an immunpglobulin (Ig) molecule

a. Which cells produce these molecules?
B lymphocytes- plasma cells

b. How many polypeptide chains constitute a single Ig molecule?
4- polypeptide chains, 2- heavy chain and 2 light chain

c. Which bond holds the polypeptide chain together in the molecule? Which type of immunity is mediated by Immunoglobulins?
Disulphide bridges or S-S bonds. Humoral Immunity

Cross Word Puzzle



Across

6. Cell division where 2 daughter cells receive equal genetic material
10. Release of mature ovum
12. Division of nucleus
14. Cell division where 4 haploid cells are produced
15. Seeds and embryo are developed without fertilization
17. Method of genetic recombination in bacteria where donor and recipient cells do not come into contact
18. Cell cycle is dependent on a series of ____ for progression from one stage to another
19. major signaling molecule in nervous, immune and circulatory systems

Down

1. Immunity that is mediated by antibodies
2. A pair of synapsed homologous chromosome
3. The X-shaped structures formed by separating chromosomes in Prophase I
4. Macrophages in liver
5. The process of division and differentiation to produce spermatozoa
7. Division of cytoplasm
8. Opening of the integuments
9. Fusion of male and female gamete
11. Asexual reproduction of Amoeba
13. The phase of nuclear division where chromosomes reach the poles of spindle
16. Immunity that is mediated by T-cells, macrophages and NK cells
18. Vegetative propagation is also known as_____ propagation

Answer