BOTANY-II

WORKBOOK(ENGLISH MEDIUM)

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PREFACE

"I hear and I forget – I see and I remember - I do and I understand – I think and I learn"

The Board of Intermediate Education, Andhra Pradesh, Vijayawada made an attempt to provide work books for the thirst time to the Intermediate students with relevant and authentic material with an aim to engage them in academic activity and to motivate them for self learning and self assessment.

These work books are tailored based on the concepts of "learning by doing" and "activity oriented approach" to sharpen the students in four core skills of learning – Understanding, Interpretation, Analysis and Application.

The endeavour is to provide ample scope to the students to understand the underlying concepts in each topic. The workbook enables the student to practice more and acquire the skills to apply the learned concept in any related context with critical and creative thinking. The inner motive is that the student should shift from the existing rote learning mechanism to the conceptual learning mechanism of the core concepts.

I am sure that these compendia are perfect tools in the hands of the students to face not only the Intermediate Public Examinations but also the other competitive Examinations.

My due appreciation to all the course writers who put in all their efforts in bringing out these work books in the desired modus.

--- V. Rama Krishna, I.R.S.
Secretary,
B.I.E., A.P., Vijayawada.

Senior Intermediate Work Book
Botany
Unit –I Plant Physiology
Chapter 1 Transport in Plants

Note to the students:

1. ***Please read the text book and go through the lines before you solve these small questions in the work book.***
2. ***You may need to apply the knowledge given in the chapter "Transport in Plants" to solve some questions.***
3. ***Discuss the answers and solutions with your friends and your lecturer***.
4. ***The key concepts given above may give you some clues in solving the below questions***.

Key concepts of 'Transport in Plants':

Means of transport

➢ Movement of substances within the plants may be for short distances or long distances.
➢ The substances to be transported are water, mineral nutrients, organic nutrients and plant growth regulators.
➢ Diffusion, cytoplasmic streaming and active transport are involved in short distance transport.
➢ Longer distance transport occurs through ***translocation*** through xylem and phloem (vascular system).
➢ Diffusion is the only means of transport for gases to move inside the plant body.
➢ Diffusion facilitated by membrane proteins is called facilitated diffusion.
➢ ***Facilitated diffusion*** also is a passive transport which does not involve energy.
➢ ***Porins*** are proteins that form huge pores in the outer membranes of plastids, mitochondria and some bacteria which allow molecules of small protein size to pass through them.
➢ ***Uniporters*** transport molecules in one direction independently.
➢ ***Symport*** involves transport of two types of molecules together in one direction.
➢ ***Antiport*** is the movement of molecules in opposite direction through the same antiporter carrier.
➢ ***Active transport*** is the energy dependent transport against concentration gradient (from lower concentrated region to higher concentrated region). The membrane proteins act as pumps during this uphill transport.

Plant water relationships

- **<u>Water potential</u>** may be defined as the chemical potential of water or free energy of water in a cell or a system. It is denoted by the symbol Ψ_w and measured as Pa (pascals)
- Water potential is determined by the two components solute potential Ψ_s and pressure potential Ψ_p.
- Water always moves from the system containing higher water potential to a system with lower water potential.
- The water potential of pure water at standard temperatures which is not under any pressure is 'zero'.
- The magnitude of decrease in water potential due to dissolution of solute in a cell or a system is called ***solute potential***.
- For a solution at atmospheric pressure

  water potential Ψ_w = solute potential Ψ_s.
- The magnitude of increment in water potential due to entry of water into a cell is called ***pressure potential*** $\Psi_{p.}$
- The pressure exerted by the protoplasts due to entry of water against the rigid walls is called pressure potential $\Psi_{p.}$.
- Water potential of a cell is the sum of solute potential and its pressure potential
- $\Psi_w = \Psi_s + \Psi_p$
- ***Osmosis*** can be defined as the movement of water or solvent molecules from a region of higher water potential to a region of lower water potential through a differentially permeable membrane.
- ***Potato osmoscope*** and ***thistle funnel experiment*** are conducted to demonstrate osmosis.
- The pressure required to prevent water from diffusing into a cell is called ***osmotic pressure***.
- Numerically osmotic pressure is equivalent to the osmotic potential, but the sign is opposite. Osmotic pressure is the positive pressure applied and osmotic potential is negative.
- The shrinkage of protoplasm when a cell is placed in hypertonic solution is called ***plasmolysis.***
- ***Exosmosis*** leads to plasmolysis and the cell becomes flaccid. In such cells the water potential is equal to solute potential.
- When a cell is placed in hypotonic solution water enters into the cell by endosmosis and the cell becomes turgid.
- The pressure built up by the cytoplasm against the cell wall due to entry of water is called ***turgor pressure***.
- ***Imbibition*** is a special type of diffusion when water is adsorbed by solids and colloids causing enormous increase in their volume.

Long distance transport of water

- ***Mass flow*** is the movement of substances in bulk from one point to another as a result of pressure differences between the two points.
- This bulk flow of substances through the conducting or vascular tissues of plants is called ***translocation***.
- ***Apoplast*** is the system of adjacent cell walls and intercellular spaces in the plant. As water moves in the apoplast system without crossing the membranes it occurs at a faster rate.
- ***Symplast*** is a system of interconnected protoplasts and plasmodesmata. As water has to enter the cell membranes it occurs at a slow rate.
- A ***mycorrhiza*** is a symbiotic association of a fungus with a root system. The fungus helps in increasing the area of absorption and assists in solubilisation and mobilization of phosphates. It also prevents invasion of other root pathogens.
- The loss of water as liquid from the plant is called ***guttation***. It is mainly due to root pressure.
- Guttation occurs through ***hydathodes*** present in the leaves of some plants.
- The upward movement of water through the xylem elements from roots to shoot system against gravitation is called '***ascent of sap***'.

Transpiration

- ***Dixon*** proposed cohesion-tension-'transpiration pull model' to explain the upward movement of water.
- The ascent of xylem sap is transpiration driven and depends on
  - ***Cohesion*** – mutual attraction between water molecules.
  - ***Adhesion*** – attraction of water molecules to polar surfaces (tracheary elements)
  - ***Transpiration pull*** –driving force created by transpiration to pull water upwards.
- These three forces give high tensile strength and high capillarity to water which help in its upward movement to greater heights.
- ***Transpiration*** is the loss of water in the form of vapour from living tissues of aerial parts of a plant.
- Transpiration is a phenomenon of environmental importance as it plays a crucial role in ***SPAC*** (Soil-Plant Atmospheric Continuum).
- Transpiration occurs mainly through stomata, and occasionally by cuticle and lenticels.
- The stomata open during day time are ***photoactive*** stomata.
- The stomata that open during night time are ***scotoactive*** stomata. Ex: *Bryophyllum*

➢ Dorsiventral leaves are ***hypostomatal*** (more stomata on lower epidermiss) and isobilateral leaves are ***amphistomatal*** (nearly equal number of stomata on both surfaces.
➢ ***Levitt*** proposed K^+ pump theory to explain the mechanism of photoactive stomatal opening and closing.
➢ ABA (abscisic acid) acts as a natural ***anti-transpirant*** during water stress conditions and drives out K^+ ions out of guard cells and making them close.
➢ In succulent plants stomata open during night due to accumulation of organic acids at night.
➢ Transpiration helps to supply water and minerals for photosynthesis. It creates a congenial temperature by evaporative cooling.
➢ As transpiration causes huge loss of water it is considered as '***necessary evil'.***

Uptake and transport of mineral nutrients

➢ Mineral ions are absorbed mostly by active transport uphill or sometimes by passive transport.
➢ Transport proteins of endodermal cells are the ***control points*** where a plant adjusts the quantity and type of solutes that reach the xylem.
➢ Endodermis transports ions in one direction only due to presence of suberin.
➢ Elements like phosphorus, sulphur and nitrogen are remobilized from older senescing leaves to younger leaves.
➢ Structural elements like calcium are not remobilised.

Phloem transport

➢ The direction of movement through phloem is ***bi directional*** while that of xylem is ***unidirectional.***
➢ Phloem sap contains mainly water and sucrose, other sugars, hormones and amino acids.
➢ ***Munch*** experiment helps in understanding bi-directional transport in phloem.
➢ ***Pressure flow hypothesis*** explains the translocation of sugars from source to sink.
➢ ***Girdling experiment*** is conducted to identify the tissues that transport food. This experiment shows that phloem is the tissue responsible for translocation of food towards the roots.

I – Fill in the blanks using the words given under

Solute potential, crescograph, 92%, active transport, Jagadish Chandra Bose, Levitt, translocation,osmosis, 1%, imbibition

1. Diffusion of water across a differentially permeable membrane is ……..
2. Uphill transport and energy utilisation are characters of ……..
3. J.C.Bose used.....to record growth of plants.
4. A water melon contains nearly.....% of water in it.
5. Water potential is equal to.....in a flaccid cell.
6. The books "Irritability of plants and Nervous mechanisms in plants" are written by ……
7. The bulk movement of substances through the conducting or vascular tissues of plants is called ……..
8. K^+ pump theory to explain stomatal movements was proposed by ……
9. Doors and windows are tight and swollen during winter and rainy season due to ……
10. % of water reaching the leaf is used in photosynthesis.

II– Read the following statements and tick the right answer.

11. Energy is utilised during this kind of transport.
    Passive transport/active transport.
12. Which of the elements is not remobilised from older leaves to younger ones?
    Phosphorus/calcium
13. The movement in phloem is
    Bidirectional / unidirectional
14. Mutual attraction between water molecules is
    Cohesion / adhesion
15. Water loss as vapour from the plant is
    Transpiration / guttation
16. Mycorrhizae are very important for seeds to germinate in
    Cycas / Pinus
17. The pathway of water which involves protoplasts is
    Apoplast / symplast
18. Dry wood and seeds absorb water by
    Imbibition / Diffusion
19. The pressure exerted by the protoplasts due to entry of water against rigid cell walls is
    Solute potential / Pressure potential
20. Plasmolysis occurs when a cell is placed in
    Hypertonic / hypotonic solution.

III – Carefully observe the following statements. Denote whether they are true or false.

21. Rate of diffusion is affected by concentration gradient.
    True / false
22. No membrane is required for active transport.
    True / false
23. Osmosis occurs from lower water potential to higher water potential.
    True / false
24. Shrinkage of protoplasts is seen when a cell is placed in hypertonic solution.
    True / false
25. Wheat seeds show more imbibiton when compared to pea seeds.
    True / false.
26. Pressure difference between two points is required for mass flow.
    True / false
27. The movement of water is relatively slow in apoplast.
    True / false
28. Transpiration pull is due to low concentration of water vapour in the atmosphere.
    True / false
29. In succulent plants organic acids accumulate and make guard cells turgid during night.
    True / false
30. C_4 plants loose more water than C_3 plants during photosynthesis.
    True / false.

IV - Match the items in section A with the items in Section B

A	B
31.Guttation [ ]	a. Porins
32.Apoplast [ ]	b. Cell walls
33.Mass flow [ ]	c. ABA
34.Plasmolysis [ ]	d. Long distance transport
35.Osmosis [ ]	e. Demonstration of food transport
36.Facilitated diffusion [ ]	f. Differentially permeable membrane

37.Natural antitranspirant [ ]	g. Bidirectional transport
38.*Bryophyllum* [ ]	h. Root pressure
39.Phloem [ ]	i. Scoto active stomata
40.Girdling experiment [ ]	j. Shrinkage of protoplasm

V-After reading the text book try to answer these simple questions on your own in one word or a sentence.

41. Do you know who first observed that plants too have life and feelings?
    ……
42. Can you name the direction of transport of water through xylem?
    …….
43. As the source and sink are variable in the plant body what may be the direction of transport of organic nutrients along with water in phloem?
    ……
44. Gases like CO_2 and O_2 move inside the plant during the processes of photosynthesis and respiration. Which is the most convenient means of movement of such gases inside the plant body?
    ……
45. A carrier protein is transporting molecules across the cell membrane downhill without utilizing energy. What do you call this type of diffusion as?
    ……..
46. Is it possible that facilitated diffusion occur against concentration gradient? (i.e from low concentration to high concentration)
    …….
47. A beaker contains pure water without any solute dissolved in it under standard temperature with no pressure acting on it. What would be water potential of water in the beaker.
    …….
48. A phloem sieve tube contains dissolved sugars along with water and there is entry of water from adjascent xylem into it. how can you calculate the water potential of the sieve tube.(Write the relationship between the water potential Ψ_w ,solute potential Ψ_s and pressure potential Ψ_p in the sieve tube cell).
    ……..

49. You have taken the epidermal peelings of Rheodiscolor leaf and placed them in 70% sugar solution. What do you observe when you place the cells under a microscope?
    …….
50. Which phenomenon you studied in this chapter is useful in preserving pickles?
    ……

VI- After reading the lesson try to explain the following concepts in one or two sentences each

51. Define osmosis using the terms lower concentrated solution and higher concentrated solution.
    ……
    ……
    ……
52. What do you understand by the word 'active transport'?
    ……
    ……
    …….
53. Explain the type of potential that is responsible for increase in water potential of a cell?
    ……
    ……
    …….
54. Define osmosis using the term "Water potential".
    ……
    ……
    …….
55. What does the term mass flow or bulk flow mean?
    ……
    ……
    ……
56. Which association in this chapter hints about a biofertilizer? How is it useful in plant nutrition?
    ……
    ……
    ……
57. A plant is overwatered in the evening. What phenomenon do you observe from its leaves early in the morning.Define it. What is it due to?
    ……
    ……
    …….
58. During radial conduction of water into the root from root hair towards the xylem water moves at a faster rate and also at a

lower rate (by crossing the membranes) through two different systems. Name them and define.

……
……
…….

59. What do you understand by the word 'turgor pressure'? Explain.

……
……
…….

60. You have collected a small piece of gum from the bark of a tree and placed it in water. What do you observe? What is it due to?

……
……
……

VII – Multiple choice questions

61. If you assume that the solute potential of a cell is -0.5 and its pressure potential to be 0.3 what is the water potential of that cell? [ ]

a. -0.2
b. 0.2
c. -0.8
d. 0.8

62. For a solution at atmospheric pressure [ ]

a. $\Psi_w = \Psi_s$
b. $\Psi_w = \Psi_p$
c. $\Psi_w = \Psi_s - \Psi_p$
d. $\Psi_w = \Psi_s + \Psi_p$

63. Energy and membrane dependent, highly selective transport is [ ]

a. Imbibition
b. Simple diffusion
c. Facilitated transport
d. Active transport

64. Which of the following is **not true** regarding osmosis? [ ]

a. It does not require a membrane
b. It occurs from higher water potential to lower water potential
c. It occurs from low concentrated solution to a high concentrated solution

d. It occurs from higher water concentration to lower water concentration

65. Which of the following statements is true? [ ]

a. Osmotic pressure and osmotic potential are numerically equivalent but sign is opposite
b. Osmotic pressure is negative and osmotic potential is positive
c. Both are negative
d. Both are positive

66. Water movement along the concentration gradient occurs in [ ]

a. Active transport, facilitated diffusion and diffusion
b. Facilitated diffusion, diffusion and imbibition
c. Active transport, diffusion and imbibition
d. Active transport, facilitated diffusion and imbibition

67. The exudation of water droplets along the margins of tomato leaves in the early morning is [ ]

a. Transpiration
b. Imbibition
c. Guttation
d. Diffusion

68. Water potential of guard cells decreases due to [ ]

a. Accumulation of K^+ ions
b. Passive influx of Cl^- ions
c. Efflux of H^+ ions
d. All the above

69. Assertion : C_4 plants are photosynthetically more efficient than C_3 plants.
Reason : C_3 plants fix more carbon with less water [ ]

a. A is true and R is correct explanation of A
b. A is true R is false
c. A is false and R is true
d. Both A and R are false

70. Lewitt explained stomatal movements by [ ]

a. pH analysis
b. CO_2 concentration
c. K^+ pump
d. All the above

VIII – Check if you can answer some questions from previous NEET (AIPMT) and EAMCET papers

1. In land plants, the guard cells differ from other epidermal cells in having
   1) Cytoskeleton
   2) Mitochondria
   3) Endoplasmic reticulum
   4) Chloroplasts (AIPMT2011)

2. Study the following list

List I	List II
A. Henry Dixon	I. Bioelectrical responses
B. Statler and Taylor	II. Cohesion-Tension theory
C. Levitt	III. Active proton concept
D. J.C.Bose	IV. Water potential
	V. Term 'Physiology'

   The correct match is

	A	B	C	D
1)	V	I	IV	II
2)	II	IV	III	I
3)	II	III	IV	V
4)	V	II	I	III

(EAMCET 2012)

3. Which of the following statements is not true for stomatal apparatus?
   1) Guard cells invariably possess chloroplasts and mitochondria
   2) Guard cells are always surrounded by subsidiary cells
   3) Stomata are involved in gaseous exchange
   4) Inner wall of guard cells are thick

   (NEET Karnataka 2013)

4. Which of the following criteria does not pertain to facilitated transport?
   1) Transport saturation
   2) Uphill transport
   3) Requirement of special membrane proteins
   4) High selectivity (NEET 2013)
5. Assertion: Application of cytokinins causes the opening of stomata
   Reason: Cytokinins induce the influx of potassium ions in to the guard cells
   1) Both A and R are true but R is not the correct explanation of A
   2) A is true but R is false
   3) A is false but R is true
   4) Both A and R are true and R is the correct explanation of A

   (EAMCET 2013)
6. Identify the correct pair of statements from the following

I. The attraction between two water molecules in xylem vessels is called adhesion.
II. The number of molecules of oxygen absorbed is more than the number of CO_2 molecules released when one molecule of Triolein is completely oxidised in respiration.
III. *Bacillus mycoides* is a nitrifying bacteria
IV. Continuous system of cell walls and inter cellular spaces in plant tissue is called apoplast

1) II and III
2) III and IV
3) II and IV
4) I and IV

(EAMCET 2013)

7. Deficiency symptoms of nitrogen and potassium are visible first in
   1) Senescent leaves
   2) Young leaves
   3) Roots
   4) Buds (AIPMT 2014)

8. Study the following table showing the components of water potential of four cells in an actively transpiring plant.

Cell	Solute potential	Pressure potential
A	-0.68	0.42
B	-0.75	0.36
C	-0.83	0.47
D	-0.57	0.29

   Identify the four cells as root hair, cortical cell, endodermal cell (lacking casparian strips) and pericycle cell respectively in young root (assuming symplastic water flow through them)
   1) ACBD
   2) BDCA
   3) DACB
   4) ADCB (APEAMCET 2014)

9. Root pressure develops due to
   1) Passive absorption
   2) Active absorption
   3) Increase in transpiration
   4) Low osmotic potential in soil (AIPMT 2015)

10. A column of water within xylem vessels of tall trees does not break under its weight because of
    1) Lignification of xylem vessels
    2) Positive root pressure

3) Dissolved sugars in water
4) Tensile strength of water

(AIPMT 2015)

11. Match the following

A	B
A. Scotoactive stomata	i. Opening and closing of photoactive stomata
B. Guttation	ii. Transpiration
C. Tensile strength	iii. Water loss in liquid phase
D. K^+ pump theory	iv. Night transpiration
	v. Antitranspirant

	A	B	C	D
1)	IV	III	II	I
2)	IV	V	II	III
3)	III	IV	V	II
4)	III	I	IV	II

(APEAMCET 2015)

12. The correct ascending sequence of cells with respect to water potential is

A	B	C	D
π =-0.8MPa	-1.0MPa	-0.9MPa	-0.3MPa
P = +0.4MPa	+0.5MPa	+0.2MPa	+0.2MPa

1) ABCD
2) CBAD
3) CABD
4) CDBA

(APEAMCET 2015)

13. Water vapour comes out from the plant leaf through the stomatal opening. Through the same stomatal opening carbon dioxide diffuses into the plant during photosynthesis. Reason out the above statements using one of following options:
    1) One process occurs during day time and the other at night
    2) Both processes cannot happen simultaneously
    3) Both processes can happen together because the diffusion coefficient of water and CO_2 is different
    4) The above processes happen only during night time

(NEET 2016)

14. Which of the following facilitates opening of stomatal aperture?
    1) Decrease in turgidity of guard cells
    2) Radial orientation of cellulose microfibrils in the cellwall of guard cells
    3) Longitudinal orientation of cellulose microfibrils in the cell wall of guard cells
    4) Contraction of outer wall of guard cells

(NEET 2017)

15. Identify the wrong statement
    1) The degree of decrease of chemical potential of water depends on concentration of solute
    2) Bacterial and fungal spores are killed when they enter into pickles and jams due to plasmolysis
    3) Process of water exudation is called transpiration
    4) Reverse plasmolysis will occur when flaccid cells are placed in hypotonic solution

    (APEAMCET 2016)

16. Casparian strips occur in
    1) Epidermis
    2) Pericycle
    3) Cortex
    4) Endodermis (NEET 2018)

17. Which of the following elements is responsible for maintaining turgor in cells?
    1) Magnesium
    2) Sodium
    3) Potassium
    4) Calcium (NEET 2018)

18. Xylem translocates
    1) Water only
    2) Water and mineral salts only
    3) Water, mineral salts and some organic nitrogen
    4) Water, mineral salts, some organic nitrogen and hormones

    (NEET 2019)

19. What is the direction of movement of sugars in phloem?
    1) Non – multidirectional
    2) Upward
    3) Downward
    4) Bidirectional

    (NEET 2019)

20. Choose the correct statements
    A. Porins allow molecules of small proteins present in membrane of mitochondria, chloroplast and bacteria
    B. When a living cell is kept in hypertonic solution the water potential is equal to solute potential
    C. Carrier proteins will allow all substances across the membrane whereas pumps transport large molecules in a passive method
    D. Bulk flow can be achieved through diffusion.
        1) AB
        2) CD
        3) AD
        4) BC (APEAMCET 2019)

UNIT –I Plant Physiology Chapter 1 Transport in plants

Key I, II and III and IV

1	**Osmosis**	**11**	**Active transport**	**21**	**True**	**31**	**h**
2	**Active transport**	**12**	**Calcium**	**22**	**False**	**32**	**b**
3	**Crescograph**	**13**	**Bidirectional**	**23**	**False**	**33**	**d**
4	**92%**	**14**	**Cohesion**	**24**	**True**	**34**	**j**
5	**Solute potential**	**15**	**Transpiration**	**25**	**False**	**35**	**f**
6	**Sir Jagadeesh Chandra Bose**	**16**	***Pinus***	**26**	**True**	**36**	**a**
7	**Translocation**	**17**	**Symplast**	**27**	**False**	**37**	**c**
8	**Lewitt**	**18**	**Imbibition**	**28**	**True**	**38**	**i**
9	**Imbibition**	**19**	**Pressure potential**	**29**	**True**	**39**	**g**
10	**1%**	**20**	**Hypertonic solution**	**30**	**False**	**40**	**e**

Key to V

41. Sir Jagadish Chandra Bose
42. Unidirectional
43. Bidirectional
44. Diffusion
45.Facilitated diffusion
46. No
47. Zero
48. $\Psi_{w} = \Psi_{s} + \Psi_{p}$ (The water potential in the sieve tube is equal to the sum of its
solute potential and pressure potential)
49. Plasmolysis (Shrinkage of protoplasts in the cells due to exosmosis
50. Plasmolysis

Key to VI

51. The movement of water from a region of lower concentrated solution to a region of higher concentrated solution through a selectively/differentially permeable membrane is called osmosis.
52. The uphill transport of molecules (from lower concentration to higher concentration) across membranes by carrier proteins utilizing energy against concentration gradients is called active transport.
53. Pressure potential. It is the pressure built up in the cell due to entry of water into it./ The magnitude of increment in water potential in a turgid cell due to entry of water is called pressure potential./ The pressure exerted by the protoplasts due to entry of water against the cell walls is pressure potential.

54. The movement of water from a region of higher water potential to a region of lower water potential through a differentially permeable membrane is called osmosis.
55. Mass flow is the movement of substances in bulk from one point to another as a result of pressure differences between two points.
56. Mycorrhiza. Mycorrhiza formed by the symbiotic association of a fungus on roots of higher plants helps in increasing the area of absorption and also help in solubilising and mobilizing phosphates during mineral absorption. Thus Mycorrhizae act as bio fertilizers which minimises the use of phosphate fertilizers..
57.Guttation. Water loss in the form of liquid along the margins and surface of leaves is called guttation. It is mainly due to root pressure.
58. Apoplast and Symplast. Apoplast is the system of interconnected cell walls and intercellular spaces (non-living) through which water moves at a faster rate in the plant. Symplast is the system of interconnected protoplasts and plasmadesmata (living) through which water moves at a slow rate in the plant.
59. The pressure built up by cytoplasm against the cell wall due to entry of water into a cell is called "Turgor pressure". It is seen in turgid cells filled with water.
60. The gum swells up and we can observe increase in its volume. It is due to imbibition.

Key to multiple choice question VII and VIII

VII		VIII		VIII	
1	a	1	4	11	1
2	a	2	2	12	2
3	d	3	2	13	3
4	a	4	2	14	2
5	a	5	4	15	3
6	b	6	3	16	4
7	b	7	1	17	3
8	d	8	4	18	4
9	b	9	1	19	4
10	c	10	4	20	1

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II Year Botany

UNIT-1 PLANT PHYSIOLOGY
MINERAL NUTRITION

All living organisms require macromolecules, such as carbohydrates, proteins and fats, and water and minerals for their growth and development.

In 1860 Julius von Sachs, a prominent German botanist, demonstrated for the first time that plants could be grown to maturity in a defined nutrient solution in complete absence of soil. "The technique of growing plants in a specified nutrient solution is known hydroponics".Hydroponics has been successfully employed as a technique for the commercial production of vegetables such as tomato, seedless cucumber and lettuce.

Essential Mineral Elements

Criteria for Essentiality

(a) The element must be absolutely necessary for supporting normal growth and reproduction.

(b) The requirement of the element must be specific and not replaceable by another element.

(c) The element must be directly involved in the metabolism of the plant.

essential elements are divided into two categories based on their quantitative requirements.

1) Macronutrients 2) Micronutrients.Macronutrients are generally present in plant tissues in large amounts(in excess of 10 mmol Kg dry matter). They include carbon, hydrogen, oxygen, nitrogen, phosphorous, sulphur, potassium, calcium and magnesium.

Micronutrients or trace elements are needed in very small amounts (less than 10 mmol Kg of dry matter). These Include Iron, manganese, copper, molybdenum, zinc, boron, chlorine and nickel.

Essential elements can also be grouped into four broad categories on the basis of their diverse functions.

Essential elements that are components of biomolecules and hence are structural elements of cells . carbon, hydrogen, oxygen and nitrogen etc

Essential elements that are components of energy-related chemical compounds in plants get magnesium in chlorophyll and phosphorus in ATP

Essential elements that activate or inhibit enzymes. For example, Mg is an activator for both ribulose bisphosphate carboxylase oxygenase and phosphoenolpyruvate carboxylase, both of which are eritical rhymes in photosynthetic carbon fixation Zn is an activator of alcohol dehydrogenase and Mo of nitrogenase during nitrogen metabolism.

Some essential elements can alter the osmotic potential of a cell. Potassium plays an important role in the opening and closing of stomata.

Essential elements perform several functions. They participate in various metabolic processes in the plant cells such as permeability of cell membrane, maintenance of osmotic concentration of cell sap, electron-transport systems buffering action and enzymatic activity. They also act as major constituents of macromolecules and co-enzymes.

Nitrogen: This is the essential mineral nutrient element required by plants in the greatest amount. Nitrogen is required by all parts of a plant, particularly the meristematic tissues and the metabolically active cells. Nitrogen is one of the major constituents of proteins, nucleic acids, enzymes, vitamins and hormones.

Phosphorus: Phosphorus is a constituent of cell membranes, certain proteins, all nucleic acids and nucleotides, and is required for all phosphorylation reactions.

Potassium: It is required in more abundant quantities In the meristematic tissues, buds, leaves and root tips. Potassium helps to maintain an anion-cation balance in cells and is involved in protein synthesis, opening and closing of stomata, activation of enzymes and in the maintenance of the turgidity of cells.

Calcium: Calcium is required by meristematic and differentiating tissues, During cell division, It is used in the synthesis of cell wall, particularly as calcium pectate in the middle lamella. It is also needed during the formation of mitotic spindle. It activates certain enzymes and plays an important role in regulating metabolic activities. Calcium is also an important element that helps in photolysis of water during photosynthesis.

Magnesium: It activates the enzymes of respiration and photosynthesis and is involved in the synthesis of DNA and RNA. Magnesium is a constituent of the ring structure of chlorophyll and helps to maintain the ribosome structure.

Sulphur: Sulphur is present in two amino acids - cysteine and methionine, and is the main constituent of several coenzymes, vitamins (thiamine, biotin, coenzyme A) and ferredoxin. Sulphur forms disulphide bridges which help in stabilizing the protein structure.

Iron: Iron is required in larger amounts compared to other micronutrients. It is an Important constituent of proteins Involved in the transfer of electrons like ferredoxin and cytochromes. It activates catalase enzyme, and is essential for the formation of chlorophyll.

Manganese: it activates many enzymes involved in photosynthesis, respiration and nitrogen metabolism. The function of manganese is in the splitting of water to liberate oxygen during photosynthesis. It is also an activator fo IAA oxidase enzyme

Zinc: Zinc activates various enzymes, especially carboxylases. It is also needed in the synthesis of auxin

Copper: It is essential for the overall metabolism in plants. Like iron, it is also a structural component of electron carriers like cytochrome C oxidase in mitochondria and plastocyanin in chloroplast.

Boron: Boron is required for the uptake and utilisation of Ca, membrane functioning pollen germination, cell elongation, cell differentiation and carbohydrate translocation.

Molybdenum: 1t is a component of several enzymes, including nitrogenase and nitrate reductase. both participate in nitrogen metabolism,

Chlorine: Along with Na and K, it helps in determining the solute concentration and the anion-cation balance in cells. It is essential for the water-splitting reaction in photosynthesis, a reaction that leads to oxygen evolution.

Nickel: It is recently recognized as the 17 essential nutrient as it acts as an activator for urease, an important enzyme of nitrogen metabolism.

Some of the Deficiency Symptoms of Essential Elements are chlorosis,Necrosis,stunted plant growth,premature fall of leaves and buds,inhibition of cell division ect.

Whenever the supply of an essential element becomes limited, plant growth is retarded. The concentration of the essential element below which plant growth is retarded is termed as critical concentration. deficiency of certain micronutrients . Zn. Cu. B, Mo. CI and Nickel physiological diseases such as mottled leaf dieback in citrus, heart-rot in beets, whiptail in cauliflower, bronzing in legumes and mouse ear in pecan respectively'

Toxicity of Micronutrients

Any mineral ion concentration in tissues that reduces the dry weight of tissues by about 10 per cent is considered to be toxic.

Mechanism of Absorption of Elements

The passive movement of ions Into the apoplast from the cell along the concentration gradient usually occurs through ion-channels. The trans- membrane proteins function as selective pores. The entry or exit of loans to and from the symplast against the concentration gradient requires the expenditure of metabolic energy which is an active process

The movement of ions is called fux; the inward movement into the cells is Influx and the outward movement, efflux.

Translocation of Solutes

Mineral salts are translocated through the xylem along with the ascending stream of water

Soil as Reservoir of Essential Elements. Since deficiency of essential minerals affect the crop-yield, there is often a need for supplying minerals through fertilizers Both macro-nutrients (N, P. K. S. etc. and micro-nutrients (Cu, Zn, Fe, Mn. etc.) form components of fertilisers and are applied as per need.

Metabolism of Nitrogen

Nitrogen Cycle

Nitrogen is a constituent of amino acids, proteins, hormones, chlorophylls and many vitamins. Plants compete with microbes for the limited nitrogen that is available in soll. The

process of conversion of molecular nitrogen to ammonia or nitrogen oxides. nitrites and nitrates is termed as nitrogen-fixation.The nitrates and ammonia thus formed are absorbed by plants and converted into amino acids, proteins, enzymes, nucleic acids. pigments and hormones. These constitute the organic form of nitrogen. When plants are eaten by animals this organic nitrogen is passed on into animal body. The process of absorbing nitrates, ammonia and chemical bonding the nitrogen with other elements to produce organic nitrogen in plants and thereby into animals constitutes nitrogen assimilation.Decomposition of organic nitrogen of dead plants and animals into ammonia Is called ammonification. Some of the ammonia re-enters the atmosphere but most of it is converted Into nitrate by soIL.

Ammonia is Oxidised to nitrite by the bacteria Nitrosomonas and or Nitrococcus. The nitrite is further oxidised to nitrate with the help of the bacteria Nitrobacter. These steps are called nitrification . These nitrifying bacteria are chemoautotrophs

The nitrate thus formed is aborbed by plants and is transported to the leaves. Nitrate present in the soil is also reduced to nitrogen by the process of denitrification, Denitrification is carried out by the bacteria Pseudomonas and Thiobacillus.

Biological Nitrogen Fixation

Only certain prokaryotic species are capable of fixing nitrogen. Reduction of nitrogen to ammonia by Living organisms is called biological nitrogen fixation, The enzyme, nitrogenase, which is capable of nitrogen reduction is present exclusively in prokaryotes. Such microbes are called N- fixers.

The nitrogen-fixing microbes can be free living or symbiotic. Examples of free living nitrogen-fixing aerobic microbes are Azotobacter and Beijerinckia while Rhodospirillum is anaerobic and Bacillus free-living. In addition, a number of cyanobacteria such as Anabaena and Nostoc are also free-living nitrogen-fixers.

Symbiotic nitrogen fixation Several types of symbiotic nitrogen fixing associations are known. The most prominent among them is the legume bacteria relationship. alfalfa. sweet clover, sweet pea, lentils, garden pea, broad bean, clover beans, etc. The most common association on roots is as nodules. The microbeFrankia also produces nitrogen fixing nodules on the roots of non-leguminous plants (c.g.. Alnus). Both Rhizobium and Frankia are free-living in soil but as symbionts can fix atmospheric nitrogen. nodule is red or pinkdue to the presence of leg haemoglobin.

Nodule

The nodule contains enzyme nitrogenase and leghaemoglobin. The enzyme nitrogenase is a Mo-Fe protein and catalyses the conversion of atmospheric nitrogen to ammonia, the first stable product of nitrogen fixation. The reaction is as follows:

$N, + 8H^+ + 8e^- + 16\ ATP \rightarrow 2NH_3 + H_2 + 16\ ADP + 16\ Pi$

To protect enzymes, the nodule contain an oxygen scavenger called leg-haemoglobin.

Fate of ammonia:While most of the plants can assimilate nitrate as well as ammonium ions, the latter is quite toxic to plants and hence cannot accumulate in them. Ammonium ionsused to synthesis amino acids in plants. There are two main ways

Reductive amination: In these processes, ammonia reacts with a-ketoglutaric acid and forms glutamic acid.

Transamination:It involves the transfer of an amino group from an amino acid to the keto group of a keto acid.

The two most important amides - asparagine and glutamine.Amides contain more nitrogen than amino acids, they are transported to other parts of the plant via xylem vessels.The nodules of some plants (eg. soybean)export the fixed nitrogen as ureides. These compounds also have a particularly high nitrogen to carbon ratio.

Fill in the blanks with suitable answers:

The technique of growing plants in a specified nutrient solution is known as_____

In 1860 the scientist who demonstrated for the first time that plants could be grown to maturity in a defined solution in complete absence of soil is _____

Most of the minerals in the soil can enter plants through_____

Name the elements group which is present in the plant tissues in excess of 10 m mole kg^{-1} of dry matter _____

Example for Essential elements that are components of energy related chemical compounds in the plant _____

Essential elements that activate ribulose bisphosphate, carboxylase oxygenase, phosphoenol pyruvate carboxylase _____

Element responsible for opening and closing of stomata _____

Molybdenum is a component of_____,_____enzymes which participate in nitrogen metabolism.

Name the 17^{th} essential element _____

The concentration of the essential element below which plant growth is retarted is termed

as _____

Loss of chlorophyll leading to yellowing in leaves is known as_____

Necrosis means _____

The prominent symptom of_____toxicity is the appearance of brown spots surrounded by chlorotic veins.

Movement of ion is called _____

Inward movement of ion into the cells is called _____

Outward movement of ion is called_____

Name the element which activate carboxylase enzyme_____

Name the cation and anion that maintain osmotic balance in cells _____

Which element is required for formation of mitotic spindle _____

Which element is necessary for the synthesis of the chief photosynthetic pigment without being its structural component _____

Which micronutrient necessary for photolysis of water is absorbed by plants in anionic form _____

Any mineral ion concentration in tissues that reduces the dry weight tissues by about 10 percent is considered_____

Name an anaerobic, free living, photo-heterotrophic nitrogen fixing bacteria _____

Which microorganism produces nitrogen-fixing nodules in Alnus _____

When the cross section of root nodules of groundnut plant is observed under microscope, they appear pinkish due to presence of _____

Apart from the cortical cells, which other cells are stimulated to divide by the Bacteroids inside the root nodules _____

What is the ratio of electrons and protons required for the fixation of atmospheric molecular nitrogen through biological mode_____

What act as oxygen scavenger in the legume root nodule formation_____

In which way does asparagine differ from aspartic acid.Nitrogen more in_____

Through which tissue the amino acids are transported inside the plant body _____

Plants like the pitcher and Venus fly trap have special nutritional adaptations. Name the essential elements and its source _____

Excess of manganese induce deficienciesof_____elements.

What act as a reservoir of essential elements for plants_____

Nitrogen fixation is shown by prokaryotes only. Why not by eukaryotes _____

The element presents in more quantity in living organisms in addition to carbon, hydrogen and oxygen _____

Conversion of N_2 to Ammonia(or) Nitrogen oxide, Nitrite& nitrate is called _____

Example for nitrifying bacteria_____

Example for denitrifying bacteria _____

Choose the correct answer:

Choose one from the following which is not criteria for essentiality of an element.

A. For growth and development of plants.

B. deficiency of any one element cannot be met by supplying some other elements.

C. The elements must be indirectly involved in metabolism of plant.

D. In the absence of the element the plants do not complete their life cycle or set the seeds.

Essential elements are divided into how many categories based on their quantitative requirements.

2

4

5

Which of the following element group is present in plant tissue is more than 10 m mole kg^{-1} of dry matter?

C, H, N, Mg

C, H, N, Mn

N, K, S, Cu

Ca, Mg, Zn, B

Name the element group which is present in plant tissues less than 10 m mole kg^{-1} of dry matter.

Essential elements

Micronutrients

Macronutrients

None of the above

which of the following element group is present in plant tissue is less than 10 m mole kg^{-1} of dry matter.

Fe, Mn, K, B

Mn, Cu, Zn, cl

Mo, Cu, Ni, Fe

Zn, B, Mo, Mg

Number of elements needed for healthy growth and development of plants are

9

17

8

6

Which one of the following not used by Sachs in his hydroponics experiment?

Nutrient solution

Soil

Air circulation

Plant

Hydroponics has been employed as a technique for the commercial production of

Seedless cucumber

Lettuce

Tomato

All the above

The experimentdone by Sachs related to

Hydroponics

Osmosis experiment

Co_2 is necessary for photosynthesis

Plasmolysis experiment

The following elements are beneficial to higher plants in addition to 17 essentials elements.

Sodium, Silicon, Cobalt, Selenium

Carbon, Hydrogen, Oxygen, Nitrogen

Iron, Manganese, Copper, Molybdenum

Phosphorus, Potassium, Zinc, Chlorine

Structural elements of the cells.

C, H, O

C, H, N

H, O, N

All the above

Element which is a component of proteins, nucleic acids, enzymes, vitamins&hormones_____.

Au

Ag

N

None of the above

Plants absorb nutrients in the form of

Ions

Atoms

Molecules

None of the above

Choose the following statements which is not true regards to potassium.

Potassium does not help to maintain an anion-cation balance in cells.

It is absorbed as potassium Ion (K^+)

Helps in opening and closing of automata

All the above

Find the false statement about calcium.

Needed for the formation of mitotic spindle

Used as calcium pectate in the middle lamella

Helps in photolysis of water during photosynthesis

None of the above

Choose the following statement which is false about magnesium

Not involved in the synthesis of D.N.A &R.N. A

It is a constituent of the ring structure of chlorophyll

Absorbed by plant in the form of mg^{2+} Ion

Activate carboxylase

i& ii

iii&iv

i,ii&iii

i&iv

Which is correct regarding Sulphur element

Cysteine and methionine have element 's'

Present in the thiamine & biotin

Present in ferredoxin

None of the above

i& ii

iii & ii

iv

i, ii&iii

Which microelement is required in more quantity than the other micronutrients?

Fe

Mn

Zn

B

57 Choose the correct answer

Potassium a. Synthesis of auxin

Boranb. opening & closing of stomata

Zinc c. Formation spindle apparatus during mitosis

Calcium d. pollen germination

Irone. formation of chlorophyll

Nickel f. Activate urease enzyme

1-b, 2-d, 6-f

3-a, 5-c, 2-f

4-c, 5-e, 1-f

4-c, 5-a, 2-e

58. Name cations and anions that maintain osmatic balance in cells

A. CL^-, Na^+, K^+

B. Zn^{2+}, Cu^{2+}, Fe^{3+}

C. Mg^{2+}, Ca^{2+}

D. None of the above

59. The element is said to be deficient when present

Above the critical concentration

Below the critical concentration

Equal to critical concentration

None of the above

60. Name the element whose symptoms of deficiency first appear in older leaves

Nitrogen

Potassium

Magnesium

All the above

61. Symptoms of deficiency first appear in young leaves due to

Sulphur

Calcium

Sulphur and Calcium

None of the above

62. Choose the correct answer

Zn	1) Bronzing in legumes
Cu	2) Heart rot in Beets
B	3) Mottled leaf
Mo	4) Mouse Ear in pecan
Cl	5) Die back in citrus
Ni	6) whip tail in cauliflower

i-3, ii-5, v-1, vi-4

ii-2, iv-6, i-3

ii-3, iii-1,v-4

i-5,ii-6,iv -3,iii-2

63. Choose the correct answer

Azotobacter	a) Free living microorganism
Rhodospirillum	b) Free living nitrogen fixing cyanobacteria
Anabaena, Nostoc	c) Free living nitrogen fixing aerobic organisms
Bacillus	d) anaerobic micro organisms

(i) -c, (ii) – d, (iii) -b, (iv) -a

(i) -b, (ii) – d, (iii) -c, (iv) -a

(i) -c, (ii) – a, (iii) -b, (iv) -d

(i) -d, (ii) – b, (iii) -a, (iv) -c

64. Name the essential elements present in nitrogenase enzyme.

Which type of essential elements are they?

Mo, N, Micronutrients

Fe, Mo, Micronutrients

N, Mg, Macronutrients

Fe, Mo, Macronutrients

65.

a) Assertion: Only certain prokaryotic species are capable of fixing nitrogen.

b) Reason: Nitrogenase enzyme is present in prokaryotes.

a is correct b is correct reason for b

a is correct b is wrong

a and b are wrong

None of the above

66.

$2NH_3 + 3O_2$ a + 2H b $2H_2o$

$2NO_2 + 0_2$ c d

Write c, b, d, a in order from the above

c b d a

Nitrobacter2 $NO_2$2 NO_3 Nitrosomonas

$2NO_2$ NitrobacterNitrosomonas,2 NO_3

Nitrosomonas$_{N2}$$NH_3$ Nitrobacter

Nitrosomonas 2 $NO_3$2NO_2Thiobacillus

67. Name the reaction in which Ammonia react with alfa- ketoglutaric acid to form glutomic acid

Ammonification

Transmination

Reduced amination

Nitrification

ANSWERS

FILL IN THE BLANKS

1.HYDROPONICS 2.J.V.SACHS3.ROOTS 4.MACRONUTRIENTS5.Mg IN CHOLOROPHYLL

6.Mg2+7.POTASSIUM 8.NITROGENASE & NITRATE REDUCTASE9.NICKEL

10.CRITICAL CONCENTRATION11.CHLOROSIS 12.DEATH OF TISSUES13.MANGANEESE

14.FLUX15.INFLUX 16.EFFLUX17.ZINC 18.K+,Cl-19.CALCIUM 20. IRON

21.Cl- 22.TOXIC 23.RHODOSPIRILLUM 24.FRANKIA 25.LEG-HAEMOGLOBIN

26.CELLS OF PERICYCLE 27.1:1 28.LEG-HAEMOGLOBIN 29.ASPARAGINE

30. XYLUM VESSELS

31. NITROGEN-INSECTS 32.IRON MAGNESIUM AND CALCIUM

33.SOIL 34.DUE TO PRESENCE OF NITROGENASE ENZYME 35.NITROGEN

36. NITROGEN FIXATION

37. NITROSOMONAS, NITROCOCCUS ,NITROBACTER 38.PSEUDOMONAS, THIOBACILLUS.

CHOOSE THE CORRECT ANSWER

39-C	40-B	41-A	42-B	43-C	44-B	45-B	46-D	47-A	48-A
49-D	50-C	51-A	52-A	53-D	54-D	55-D	56--A	57-A	58-B
59-A	60-D	61-C	62-A	63-A	64-B	65-A	66-A	67-C	

Padmasri Allaka

J.L. in Botany

SENIOR INTERMEDIATE WORK BOOK

BOTANY

UNIT-I: Plant Physiology

Chapter 4: Photosynthesis in Higher Plants

Key points of Photosynthesis in Higher Plants:

- **Photosynthesis** is a physico - chemical process by which they use light energy to drive the synthesis of carbohydrates.
- **Photosynthesis** is an enzyme regulated **anabolic process** of manufacture of organic compounds inside the chlorophyll containing cells from carbon dioxide and water with the help of sunlight as a source of energy**.**
- A simple equation of photosynthesis is as follows;

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2\uparrow$$

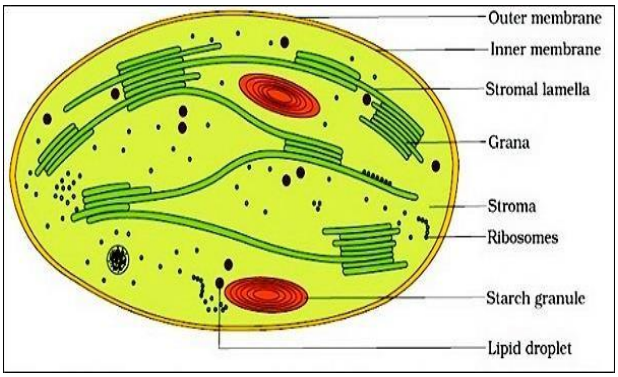
- **Photosynthesis is important due to two reasons:**
  1. It is the primary source of all food on earth.
  2. It is also responsible for the release of oxygen into the atmosphere.

Early experiments:

Joseph Priestley	Proved that plants purify air by taking CO_2 and releasing O_2. Plant used in experiment is **Mint.**
Jan Ingen Housz	Plants purify air only in the presence of sunlight. He showed that only the green parts of the plants that could release oxygen.
Julius Von Sachs	Provided evidence for the production of glucose during the growth of plants.
T.W. Engelmann	Using green alga –***Cladophora*** and suspension of aerobic bacteria and proved that blue and red lights are essential for photosynthesis. ***He was the first person worked on action spectrum***.
Cornelius Van Niel	Demonstrated that some bacteria use H_2S instead of H_2O in the process of photosynthesis.
F.F. Blackmann	Discovered two steps *i.e.,* light and dark reactions in photosynthesis. He further proposed the **'law of limiting factors'**.
Warburg	Performed flashing light experiment using green alga- ***Chlorella*** as a suitable material for the study of photosynthesis.

What is the site of photosynthesis?

- Chloroplasts are the actual sites of photosynthesis. The chloroplast envelope encloses a liquid proteinaceous matrix called **stroma.** The stroma is the site of **dark reaction** of photosynthesis.
- The lamellar system within the stroma forms flattened sac like lamellae called **thylakoids**. Thylakoids are stalked in some places to form **grana**. Light reaction occurs in grana.



Photosynthetic pigments:

- The main compounds involved in the conversion of light energy into chemical energy are the **photosynthetic pigments** that exist in the chloroplast.
- **Chlorophylls** are the green photosynthetic pigments
  Chlorophyll 'a' – blue green in the chromatogram
  Chlorophyll 'b'- yellow green
  Xanthophylls - Yellow
  Carotenoids - yellow to yellow-orange
- Chlorophyll is the major pigment responsible for trapping light. Other pigments like chlorophyll 'b', xanthophylls and carotenoids are called **accessory pigments**.
- Part of the spectrum used in photosynthesis has a wavelength between **400-700 nm** and is called **Photosynthetically active radiation** (PAR).
- The most efficient wavelengths of light effective in photosynthesis are those of **red light** and **blue light**. **Green light** is least effective in photosynthesis.

Light reaction:

"Light reaction is the process of photosynthesis that converts light energy into chemical energy and stored in the form of ATP and NADPH".

- Light reaction takes place in the **grana** of chloroplast.
- Light energy is utilized in both the photosystems I and II, present inside thylakoid membranes of the chloroplasts.
- The pigments are organised into two distinct light harvesting complexes (LHC) within the **photosystem I** (PS I) and **photosystem II** (PS II).
- The reaction centre is different in both the photosystems. In PS I, the reaction centre is called **P_{700}.** While in PS II, the reaction centre is called **P_{680}**.
- Synthesis of ATP molecules which occur inside the chloroplast during light reaction is known as **Photophosphorylation**.

Electron Transport:

- Electron transport in two photosystems (**PS I** and **PS II)** takes place in different steps.
- Electrons are transported from water to P_{680} (PS II) through photolysis of water.

Photolysis of water:

- The phenomenon of breaking up of water into hydrogen and oxygen under the influence of light is called **photolysis of water.**

$$2H_2O \longrightarrow 4H^+ + O_2 + 4e^-$$

- The water splitting complex **(OEC)** is associated with the PS II. Which is located on the inner side of the membrane of the thylakoid.
- One molecule of oxygen is evolved for every four electrons donated to P_{680}.
- The electrons released during photolysis of water are picked up by P_{680} reaction centre of photosystem II and follows **Z scheme** of non-cyclic and cyclic photophosphorylations.
- The electrons move from the PS II to b6/f (cytochrome complex) to the photosystem –I (PS-I) and reduce in form of energy.
- The electrons are re-energised in the photosystem-I and the electrons of high energy reduce $NADP^+$ into NADPH.
- In the process of non-cyclic photophosphorylation, the cytochrome uses the electron energy from photosystem-II to pump the ions of hydrogen from the lumen to stroma.
- **Assimilatory powers**: ATP and $NADPH_2$ are generated by the non-cyclic flow of electrons. These assimilatory powers help in the fixation of carbon dioxide during dark phase reaction.
- **Cyclic photoposphorylation** is performed by the photosystem-I only. This occur due to the cyclic flow of electrons in the stroma lamellae.
- The stroma lamellae membranes lack PS II as well as NADP reductase enzyme.
- The excited electron does not pass on to $NADP^+$ but is cycled back to the PS I complex through the electron transport chain.
- **In cyclic photoposphorylation,** the expelled electron passes through a series of carriers including P_{700}, FeS complex, ferredoxin (Fd), cyt b_6/f, and plastocyanin before returning to photocentre.
- The cyclic flow of electrons results only the synthesis of ATP, but not of $NADPH_2$.

Chemiosmotic Hypothesis:

- Chemiosmotic hypothesis was proposed by ***Peter Mitchell***.
- Chemiosmotic hypothesis stated that a proton motive force was responsible for driving the synthesis of ATP.
- Chemiosmosis requires a membrane, a proton pump, a proton gradient and ATPase.
- The **ATP synthase** or **ATPase** enzyme consists of two parts:
  1. **F_0** – embedded in the membrane and forms a transmembrane channel that carries out facilitated diffusion of protons across the membrane.
  2. **F_1** – protrudes on the outer surface of the thylakoid membrane on the side that faces the stroma.
- ATP synthase enzyme catalyses the formation of ATP.
- One molecule of ATP is formed when **$3H^+$** are passed through the ATP synthase complex.

$$ADP + Pi \xrightarrow{\text{ATP Synthase}} ATP$$

Where are the ATP and NADPH used?

- The products of light reaction are ATP, NADPH and O_2. Of these O_2 diffuses out of the chloroplast while ATP and NADPH are used to drive the processes leading to the synthesis of carbohydrates. This is the **Biosynthetic phase** of photosynthesis.
- **Biosynthetic phase (Dark reaction)** does not require the presence of light but require assimilatory power (**ATP + NADPH**) produced during the light reaction.
- It occurs in **stroma or matrix** of chloroplast.
- There are two main pathways for the biosynthetic or dark phase- **Calvin cycle (C_3 cycle)** and **C_4 cycle** (Dicarboxylic acid cycle).

Calvin cycle (C_3 pathway):

- **Calvin** represented different steps of dark reaction in the form of a cycle. Therefore, it is called as **Calvin cycle.**
- Carbon dioxide fixation in the presence of ATP and NADPH and its conversion to glucose, through a series of reactions, catalysed by specific enzymes is termed as **Calvin cycle.**
- Calvin cycle is divided into 3 phases:
  1. **Carboxylation**: CO_2 is fixed from an inorganic to an organic molecule
  2. **Reduction** : ATP and NADPH are used to reduce 3-PGA into G3P
  3. **Regeneration :** RuBP is regenerated
- **RuBisCO** is an enzyme which catelizes the fixing of atmospheric CO_2 during photosynthesis by catalizing the reaction between carbon dioxide and RuBP.
- The primary CO_2 acceptor in Calvin cycle is **RuBP**.
- 3-Phosphoglyceric acid **(3-PGA)** is the first stable product of photosynthesis. Hence, it is called as **C_3 cycle**.
- During the fixation of one molecule of CO_2 by C_3 plants, 3ATP and 2$NADPH_2$ are required.
- To produce a single molecule of glucose, 18 ATP and 12 NADPH are consumed.

C_4 cycle (Hatch-Slack Pathway):

- C_4 plants are found in tropical and sub-tropical regions.
- The leaves of C_4 plants possess special anatomy called ***kranz type***. The light dependent reactions and the Calvin cycle are physically separated. Light dependent reactions occurring in the **mesophyll cells** and the Calvin cycle occurring in the **bundle sheath cells**.

Why C4 plants are special?

- They have a special type of leaf anatomy, they tolerate higher temperatures, they show a response to high light intensities, they lack a process called photorespiration and have a greater productivity of biomass.
- **C_4 plants:** Monocots- *Zea mays, Sorghum, Panicum, Saccharum.*
  Dicots – *Amaranthus* and *Atriplex etc.*

What is 'kranz' anatomy?

- The word Kranz means **"wreath"** or **"ring"**. Kranz anatomy is a specialized structure in C_4 plants where the mesophyll cells are clustered around the bundle-sheath cells in a ring-like fashion.

- The chloroplasts in C_4 leaves are **dimorphic**.
  - i) The chloroplasts of mesophyll cells are of normal type.
  - ii) Chloroplasts of bundle-sheath cells are comparatively quite large size, without **grana or PS II**.
- **PEP carboxylase** enzyme occurs in mesophyll cells.
- C_4 cycle is performed in **mesophyll cells** while C_3 cycle is performed in the cells of **bundle sheath**.
- The primary CO_2 acceptor in C_4 cycle is phosphoenol pyruvic acid (PEP).
- The first stable compound formed in C_4 cycle is oxaloacetic acid (OAA).
- In C_4 plants, the photosynthetic yield is 2 to 3 times more than C_3 plants**.**

Crassulacean Acid Metablism (CAM):

- CAM cycle was observed in plants belonging to family **Crassulaceae**.
- In CAM plants, CO_2 fixation and calvin cycle are separated in time.
- CAM plants has only one kind of photosynthetic cells in which CO_2 is fixed during night and used to make glucose during day.
- Plants fix atmospheric CO_2 in dark and accumulate large amount of malic acid.
- In CAM plants, the vacuoles normally function as a site of accumulation of organic acid (malic acid).

Photorespiration:

- ***"The release of carbon dioxide in respiration in presence of light is called photorespiration".***
- The site of photorespiration is chloroplast. Peroxisome and mitochondria are required for completing the process.
- At high temperature, RuBP carboxylase functions as oxygenase.
- RuBisCO oxidises ribulose 1,5-bisphosphate to produce a 3-carbon phosphoglyceric acid and a 2-carbon phosphoglycolate.
- In C_4 plants, photorespiration does not occur. This is because they have a mechanism that increases the concentration of CO_2 at the enzyme site.

Factors affecting photosynthesis:

- Carbon dioxide is the major limiting factor for photosynthesis. Increase in concentration upto 0.05 percent can cause an increase in CO_2 fixation rates.
- At low light intensity the rate of photosynthesis is reduced. As the light intensity increases, the rate of photosynthesis also increases.
- When temperature is increased from minimum to optimum, the rate of photosynthesis doubles for every 10^oC rise in temperature.
- At a very high oxygen content the rate of photosynthesis begins to decline in all plants. The phenomenon is called **Warburg effect.**

Fill in the blanks with suitable answer:

1. A scientist was performed photosynthesis experiment on green plant. He supplied CO_2 and water at room atmosphere. But no photosynthesis was observed after certain period of time. The cause may be due to the absence of_____.
2. A plant in your garden avoid photorespiratory losses, has improved water use efficiency, show high rates of photosynthesis at high temperatures and has improved efficiency of nitrogen utilization. Based on the above characters you assign that is_____plant.
3. The half-leaf experiment where a part of the leaf is enclosed in a test tube containing some KOH soaked cotton was performed, which showed that_____ was required for photosynthesis.
4. In C_4 plants, photorespiration does not occur. This is because they have a mechanism that increases the concentration of_____at the enzyme site.
5. _____is the chemical where the energy is stored during the first phase of photosynthesis.
6. _____are the structures inside the plant cells that contain chlorophyll.
7. Photophosphorylation is the synthesis of_____from ADP and inorganic phosphate in the presence of light.
8. Photosynthetic pigments such as chlorophyll 'a', chlorophyll 'b', xanthophyll and carotene can be separated by_____technique.
9. In photosynthesis process,_____molecules of NADPH and_____ATP are required to reduce six molecules of carbon dioxide to glucose.
10. If we place a plant in white light, the plants use_____and_____light part of the spectrum for photosynthesis.
11. _____is a copper containing compound in the electron transport chain that accept the pair of electrons from the cytochrome b_6/f complex.
12. The number of water molecules required in the chemical reactions to produce one molecule of glucose during photosynthesis is_____.
13. There is an increase in the rate of photosynthesis with an increase in the concentration of_____.
14. Cornelius van Niel demonstrated that photosynthesis is essentially a_____ Reaction.
15. The decrease in yield of photosynthesis in the presence of red light becomes increased to normal when it is supplemented with blue light. This phenomenon is termed as_____.

Answer True or False

S.NO	Statement	True/ False
1	Sunlight is not needed during the Calvin cycle phase of photosynthesis.	
2	'Hill reaction' takes place in dark.	
3	Photosynthesis is responsible for the world's oxygen supply which is needed for animals to survive.	
4	All plants needed the same amount of sunlight to make enough food to be healthy.	
5	RuBisCO is the most abundant enzyme in the world.	
6	Carbon dioxide is the major limiting factor for photosynthesis.	
7	The C_3 plants respond to higher temperatures and show higher rate of photosynthesis.	
8	NADP reductase enzyme is located on the stroma side of the membrane.	
9	Chlorophyll is the major pigment responsible for trapping light.	
10	Cyclic photophosphorylation occurs when only light of wavelengths <680 nm are available for excitation.	
11	Hydrogen donor in Bacterial photosynthesis is CH_2O.	
12	Photolysis of water takes place in lumen of thylakoid.	
13	Photosynthetically active radiation is represented by the range of wave length of 500-680 nm.	
14	The first CO_2 acceptor in C_4 plant is phosphoenolpyruvate.	
15	Photo-oxidation of chlorophyll is called solarisation.	

Multiple Choice Questions: (LEVEL-1)

1. **Scientist who first time to explain that green plants purify the air by**			
a. C.V. Niel	b. J.V. Sachs	c. J. Priestly	d. J. Ingen Housz
2. **Chlorophyll absorbs**			
a. Blue light only	b. Red light only	c. Blue light & Red light	d. Green light
3. **Which pigment is absent in Chloroplast?**			
a. Xanthophyll	b. Chlorophyll 'a'	c. Anthocyanin	d. Carotene
4. **Photosynthesis is**			
a. Catabolic process	b. Anabolic process	c. Exothermic process	d. Exergonic process
5. **Photochemical reactions of Photosynthesis take place in**			
a. Frets	b. Stroma	c. Thylakoids	d. All of these
6. **Alga used by Calvin and his co-workers in their experiments on photosynthesis is**			
a. Spirogyra	*b. Chlorella*	*c. Chara*	*d. Euglena*

7. **The sequential energy changes in photosynthesis are**			
a. Electrical–Chemical	b. Light–Chemical	c. Light- Electrical	d. Chemical-Light
8. **'Hill's reaction takes place in'**			
a. Light	b. Dark	c. Dark & Light	d. Any time
9. **The first carbohydrate produced in the dark phase of photosynthesis is**			
a. Starch	b. PGA	c. Fructose	d. PGAL
10. **The role of Chlorophyll in photosynthesis is**			
a. Absorb light	b. Photolyse water	c. Both a & b	d. None of these
11. **Which of the following is not a C_4 Plant?**			
a. Zea mays	*b. Sorghum*	*c. Panicum*	*d. Digitalis*
12. **Ferredoxin is a component of**			
a. Hill reaction	b. P-680	c. PS- II	d. PS- I
13. **In Photosynthesis which one acts as electron acceptor?**			
a. Oxygen	b. NADPH	c. NADP	d. All of these
14. **The red drop phenomenon is due to the disruption of the photochemical activity of**			
a. PS- I	b. PS- II	c. PS- I & PS- II	d. Carotenoids
15. **The macro element present in Oxygen Evaluating Complex (OEC) is**			
a. Mn	b. Cl	c. Ca	d. Mg
16. **Which of the following is not required for Photolysis of water?**			
a. Light	b. water	c. oxygen	d. Manganese
17. **Fill question mark in photosynthesis reaction: $6CO_2 + ? \text{----------} > C_6H_{12}O_6 + 6H_2O + 6O_2$**			
a. $6H_2O$	b. $12H_2O$	c. $12CO_2$	d. $6H_2S$
18. **Which metal ion is a constituent of Chlorophyll?**			
a. Fe	b. Mg	c. Cu	d. Zn
19. **Which is the primary CO2 acceptor in C4 plants?**			
a. Pyruvic acid	b. RuBP	c. OAA	d. PEP
20. **Which of the following pigment appear like yellow green in the chromatogram?**			
a. Chlorophyll 'a'	b. Chlorophyll 'b'	c. Xanthophyll	d. Carotenoids
21. **Which of the following pigments are called accessory pigments?**			
a. Chlorophyll 'b'	b. Xanthophyll	c. Carotenoids	d. All of these
22. **The factor which is not limiting in normal conditions for photosynthesis is**			
a. Light	b. Water	c. Chlorophyll	d. Carbon dioxide
23. **Decreased rate of photosynthesis in high concentration of oxygen is referred to as**			
a. Pasteur effect	b. Emerson effect	c. Warburg effect	d. Richmon-Long effect
24. **Photosynthetic pigments in chloroplast are embedded in membrane of**			

a. Thylakoids	b. Matrix	c. Envelope of chloroplast	d. Stroma lamella
25. **In Chlorophyll molecule 'Mg' is situated in**			
a. Centre of porphyrin	b. Corner of porphyrin	c. In phytol tail	d. Both a and c
26. **The isotope of carbon used extensively for studies in photosynthesis is**			
a. C^{13}	b. C^{14}	c. C^{15}	d. C^{16}
27. **Which of the following element is not a part of chlorophyll?**			
a. Iron	b. Nitrogen	c. Carbon	d. Hydrogen
28. **Which of the following will show dimorphism of chloroplast?**			
a. Sugar cane	b. Rice	c. Wheat	d. Sugar beet
29. **Which is the most abundant plant pigment in the world?**			
a. Chlorophyll 'a'	b. Chlorophyll 'b'	c. Xanthophyll	d. Carotenoids
30. **How many types of Photosynthetic cells occur in C_4 plants?**			
a. One type	b. Two types	c. Three types	d. Four types
31. **Kranz anatomy is found in**			
a. Dicots	b. C_3-plants	c. C_4-plants	d. CAM plants
32. **Maximum absorption of light by chlorophyll 'a' occurs at**			
a. 480 nm	b. 580 nm	c. 680 nm	d. > 680 nm
33. **Which of the following is not a 4-carbon compound in C_4 plants?**			
a. PEP	b. OAA	c. Malic acid	d. Aspartic acid
34. **Scientist who was the first person worked on action spectrum is**			
a. J.V. Sachs	b. C.V. Niel	c. T.W.Engelmann	d. Robert Hill
35. **Oxygen released during photosynthesis comes from**			
a. CO_2	b. H_2O	c. Carbohydrate	d. O_3
36. **How many turns of Calvin cycle are required to make one molecule of glucose?**			
a. 3	b. 6	c. 12	d. 18
37. **In non-cyclic electron transport Plastoquinone (PQ) acts as**			
a. H^+ carrier	b. e^- carrier	c. Both a & b	d. H^+ donar
38. **Ultimate oxidizing agent of Z- scheme is**			
a. PS- I	b. PS- II	c. Cytochromes	d. $NADP^+$
39. **In Calvin cycle condensation of two trioses to yield a hexose molecule for storage occur in**			
a. Stroma	b. Cytosol	c. Grana	d. Both a & c
40. Impure air is purified in the presence of light and green plants was first said by			
a. J. Priestly	b. C.V. Niel	c. J.V. Sachs	d. Ingen Housz

Multiple Choice Questions: (LEVEL-2)

41. Photosynthesis is a			
a. Reductive, endergonic, catabolic process b. Reductive, exergonic, catabolic process		c. Reductive, endergonic, anabolic process d. Oxidative, exergonic, catabolic process	
42. Oxygen evolved in photosynthesis is			
a. Less than CO_2 consumed b. More than CO2 cnsumed		c. Equal to CO_2 consumed d. None of these	
43. The first event in photosynthesis			
a. Photolysis of water b. Synthesis of ATP		c. Photoexcitation of chlorophyll and ejection of electron d. Release of oxygen	
44. The correct molecular (Chemical) formula for chlorophyll 'a' is			
a. $C_{55}H_{70}O_5N_4Mg$	b.$C_{55}H_{72}O_5N_4Mg$	c.$C_{55}H_{70}O_6N_4Mg$	d.$C_{55}H_{72}O_6N_4Mg$
45. During photosynthesis			
a. CO_2 gets reduced and H_2O oxidised b. H_2O gets reduced and C_O2 oxidised		c. CO_2 and H_2O both get oxidised d. CO_2 and H_2O both get reduced	
46. Which of following proves that CO2 is essential for photosynthesis?			
a. Calvin's experiment b. Moll's experiment		c. Arnon's experiment d. Hill's experiment	
47. In dark reaction : $6CO_2 + A + 12\ NADPH + H^+ \longrightarrow C_6H_{12}O_6 + 6H_2O + B + 18H_3PO_4 + 12$ NADP **A and B are respectively**			
a. 6 ATP and 6 ADP b. 6ADP and 6 ATP		c. 18 ADP and 18ATP d. 18 ATP and 18 ADP	
48. In Calvin cycle, one molecule of glucose is formed from			
a. 6CO2 + 30ATP +12 NADPH b. 6CO2 +12ATP		c. 6CO2 + 18ATP + 12 NADPH d. 6CO2 + 18ATP + 30 NADPH	
49. The correct sequence of flow of electrons in the light reaction is			
a. PS- II, plastoquinone, cytochromes, PC, PS- I, ferredoxin b. PS- II, plastoquinone, PC, cytochromes, PS- I, ferredoxin c. PS- II, cytochromes, plastoquinone, PC, PS- I, ferredoxin d. PS- II, cytochromes, PC, plastoquinone, PS- I, ferredoxin			
50. Which of the following are formed in photosynthesis during light reaction?			
a. ATP, hydrogen and O_2 donor b. ATP, hydrogen donor and O_2		c. Hydrogen, O_2 and sugar d. ATP and sugar	
51. Which of the following is not correct?			
a. 5- carbon compound- RuBP b. 4- carbon compound- Malic acid		c. 3-carbon compound- PGA d. 2-carbon compound- Aspartic acid	
52. How many ATP and $NADPH_2$ are respectively produced in the process of photorespiration?			
a. 1 and 2	b. 0 and 0	c. 2 and 4	d. 4 and 6

53. Energy for attaching Phosphate to ADP in Photosystem – II comes from

a. Reduction of glucose
b. Oxidation of glucose
c. Proton gradient
d. Phosphorylation

54. Z-Scheme of electron transport explains

a. Cyclic photophosphorylation
b. Non-cyclic photophosphorylation
c. Oxidative phosphorylation
d. Substrate level phosphorylation

55. Assimilatory power required for the Biosynthetic phase of Photosynthesis in C_3 Plants

a. 18 ATP + 12 NADPH
b. 6 ATP + 12 NADPH
c. 12 ATP + 6 NADPH
d. 12 ATP + 12 NADPH

56. A pair of compounds formed due to enzyme Aldolase activity in C_3 plants are

a. Ribulose-1,5-bis phosphate and Sedoheptulose-1,7-bis phosphate
b. Fructose-1,6-bis phosphate and Sedoheptulose-1,7-bis phosphate
c. Ribulose-1,5-bis phosphate and Fructose-1,6-bis phosphate
d. Xylulose -5-phosphate and Ribose-5-phosphate

57. How many protons are accumulated in the lumen of thylakoid with release of one O_2 molecule during Non-cyclic Electron Transport System (ETS) are

a. 2 from water and 8 from stroma
b. 4 from water and 8 from stroma
c. 4 from water and 4 from stroma
d. 2 from water and 4 from stroma

58. Visible part of electromagnetic spectrum consists of radiations having wavelength in the range of

a. 300-900 nm
b. 400-800 nm
c. 200-760 nm
d. 390-760 nm

59. The thylakoids are removed and kept in a culture medium containing CO_2 and H_2O and then exposed to light, hexose sugars are not formed as end products because

a. CO2 assimilation cannot take place in light
b. CO2 assimilating enzymes are not present in it
c. Light trapping device is absent or not functioning
d. Pigments P-700 and P-680 are not linked

60. Photosynthesis consists of essentially two biological reaction systems one followed by the other. The second of these systems does which of the following

a. Fixes carbon dioxide
b. Traps light energy
c. Synthesises starch
d. Works only in the presence of light

61. In C_4 plants Calvin cycle

a. Occurs in mesophyll chloroplasts
b. Occurs in stroma of bundle sheath chloroplasts
c. Occurs in grana of bundle sheath chloroplasts
d. Does not occur as CO2 in fixed mainly by PEP and no CO2 is left for Calvin ycle

62. Identify the 'wrong' statement

a. Lamellae of grana have both PS- I and PS- II
b. Lamellae of stroma membranes lack of PS- II as well as NADP reductase enzyme
c. Cyclic photophosphorylation occurs in stroma lamellae
d. Cyclic photophosphorylation occurs when only light of wavelengths < 680 nm

63. In C_4 plants photorespiration does not occur because

a. C_4 plants grows in tropical regions
b. C_4 plants have a mechanism that increases the concentration of CO_2 at the enzyme site
c. RuBisCO enzyme is more active in bundle sheath cells
d. C_4 plants consisting dimorphic chloroplasts

64. The enzymes of dark reaction in C_4 plants are found in

a. Bundle sheath chloroplast
b. Mesophyll chloroplast
c. Both **a** and **b**
d. Cytosol

65. Photophosphorylation differs from oxidative phosphorylation in, as

a. It takes place in light
b. ATP formed
c. Cytochrome participates
d. All the above

66. During light reaction of photosynthesis, which of the following phenomenon is observed during cyclic phosphorylation as well as non-cyclic phosphorylation

a. Involvement of both PS- I and PS- II pigment systems
b. Formation of NADPH
c. Formation of ATP
d. Release of O_2

67. The enzymes that catalyse the dark reaction of carbon fixation are located

a. Outside the thylakoids
b. Inside the thylakoids
c. Cytosol
d. Both a and b

68. During fixation of one molecule of CO_2 by C3 plants , number of ATP and $NADPH_2$ required are

a. 2 ATP and 3 $NADPH_2$
b. 3 ATP and 2 $NADPH_2$
c. 6 ATP and 6$NADPH_2$
d. 6 ATP and 12 $NADPH_2$

69. The enzyme RuBisCO has

a. More affinity for CO_2, than for O_2
b. More affinity for O_2 than CO_2
c. Equal affinity for both
d. No affinity for both

70. Which of the following organelle does not participate photorespiration?

a. Peroxisomes | b. Mitochondria | c. Chloroplasts | d. Ribosomes

71. Quality of light refers to

a. Intensity of light
b. Frequency of light
c. Wavelength of light
d. Duration of light

72. Which of the following compound in the photosynthetic electron transport chain contains copper?

a. Cytochrome | b. Ferredoxin | c. Plastoquinone | d. Plastocyanin

73. *Chlorella* (an alga) is taken for photosynthesis experiment, instead of land plant because

a. It respires slowly
b. It photosynthesizes at a faster rate
c. Oxygen coming out from it can be collected on water
d. Oxygen easily absorbed from the external environment

74. Dark reaction in photosynthesis is called so because

a. It can occur in dark also
b. It does not directly depend on light energy
c. It cannot occur during day light
d. It occurs more rapidly at night

75. What is the sequence of carbon compounds formed during Calvin cycle?

a. $C_2 \longrightarrow C_3 \longrightarrow C_5 \longrightarrow C_7$
b. $C_4 \longrightarrow C_3 \longrightarrow C_5 \longrightarrow C_7$
c. $C_3 \longrightarrow C_6 \longrightarrow C_5, C_4 \longrightarrow C_7 \longrightarrow C_5$
d. $C_3 \longrightarrow C_6 \longrightarrow C_7, C_4 \longrightarrow C_2 \longrightarrow C_5$

76. Which two reactions occur during photo phosphorylation?

a. ATP is hydrolysed and NADPH is reduced
b. ATP is hydrolysed and NADPH is oxidised
c. ATP is synthesized and NADPH is oxidised
d. ATP is synthesized and NADPH is reduced

77. Warburg effect refers to

a. Decreased photosynthetic rate at very high O_2 concentration
b. Increased photosynthetic rate at very high O_2 concentration
c. Decreased photosynthetic rate at very low O_2 concentration
d. Increased photosynthetic rate at very low O_2 concentration

78. In the given equation, H_2A acts as_____and undergoes _____ respectively during photosynthesis in the presence of light

$2H_2A + CO_2 \longrightarrow 2A + CH_2O + H_2O$

a. Oxidising agent, oxidation
b. Reducing agent, reduction
c. Oxidising agent, reduction
d. Reducing agent, oxidation

79. Name the amino acid which acts as a mediator between OEC complex and P680* for transfer of electrons

a. Phenyl alanine
b. Tryptophon
c. Tyrosine
d. Methionine

80. Bundle sheath chloroplast of C_4 plants are

a. Large and agranal
b. Large and granal
c. Small and agranal
d. Small and granal

Match the following type Questions (LEVEL-3)

81. Match Column- Ⅰ with Column- Ⅱ and select the correct option from the codes given below

Column- Ⅰ	Column- Ⅱ
A. Chlorophyll a	1. Yellow
B. Chlorophyll b	2. Yellow-orange
C. Xanthophyll	3. Blue green
D. Carotenoids	4. Yellow green

a. A=3, B=4,C=1, D=2
b. A=3, B=1, C=4, D=1
c. A=4, B=3, C=2, D=2
d. A=4, B=2, C=3, D=1

82. Match Column- Ⅰ with Column- Ⅱ and select the correct option from the codes given below

Column- Ⅰ	Column- Ⅱ
A. Sunlight is essential for photosynthesis	1. J. Priestly
B. Provide evidence for production of glucose	2. C.V. Niel
C. Discovered oxygen	3. Jan IngenHousz
D. Photosynthesis is a light dependent reaction	4. J.V. Sachs

a. A=3, B=1,C=4, D=2
b. A=3, B=4, C=1, D=2
c. A=4, B=3, C=2, D=1
d. A=4, B=2, C=3, D=1

83. Match Column- Ⅰ with Column- Ⅱ and select the correct option from the codes given below

Column- Ⅰ	Column- Ⅱ
A. Grana	1. Cyclic photophosphorylation
B. Stroma	2. Releasing of O_2
C. Thylakoid lumen	3. Dark reaction
D. Stroma lamellae	4. Light reaction

a. A=3, B=4,C=1, D=2
b. A=3, B=1, C=4, D=1
c. A=4, B=3, C=2, D=1
d. A=4, B=2, C=3, D=2

84. Match Column- Ⅰ with Column- Ⅱ and select the correct option from the codes given below

Column- Ⅰ	Column- Ⅱ
A. 3-carbon compound	1. Glucose
B. 4-carbon compound	2. OAA
C. 5-carbon compound	3. Ribose
D. 6-carbon compound	4. PGA

a. A=3, B=4,C=1, D=2
b. A=3, B=1, C=4, D=1
c. A=4, B=3, C=2, D=2
d. A=4, B=2, C=3, D=1

85. Match Column-Ⅰ with Column-Ⅱ and select the correct option from the codes given below

Column-Ⅰ	Column-Ⅱ
A. PEP carboxylase	1. Forms transmembrane channel
B. RuBisCO	2. Stroma side of the membrane
C. ATPase	3. Abundant enzyme in the world
D. NADP reductase	4. Mesophyll cells

a. A=3, B=4, C=2, D=1
b. A=3, B=1, C=4, D=2
c. A=4, B=3, C=1, D=2
d. A=4, B=3, C=2, D=1

86. Match the following lists and select the correct option from the codes given below

List-Ⅰ	List-Ⅱ
A. Pheophytin	1. $PQH_2 \rightarrow PC$
B. Cytochrome b/f complex	2. P 680* to PQ^-
C. Plastocyanin	3. Unnamed substance A to $NADP^+$
D. Ferredoxin	4. Cytochrome b/f → P700*

a. A=2, B=1, C=4, D=3
b. A=3, B=1, C=4, D=2
c. A=4, B=3, C=2, D=1
d. A=2, B=4, C=1, D=3

87. Match the following lists and select the correct option from the codes given below

List-Ⅰ	List-Ⅱ
A. Calvin cycle	1. Sugarcane
B. Hatch-Slack cycle	2. Cactus
C. CAM cycle	3. Cotton
D. Glycolate cycle	4. Photorespiration

a. A=4, B=1, C=3, D=2
b. A=3, B=1, C=2, D=4
c. A=4, B=3, C=1, D=2
d. A=3, B=2, C=1, D=4

88. Match the following lists and select the correct option from the codes given below

List-Ⅰ	List-Ⅱ
A. Carboxylation	1. First step of reductive phase
B. Isomerization phase	2. First step of regeneration
C. Phosphorylation	3. Last step of reductive phase
D. Reduction and dephosphorylation	4. First step of Calvin cycle

c. A=4, B=1, C=2, D=3
d. A=3, B=1, C=2, D=4
c. A=3, B=2, C=1, D=4
d. A=4, B=2, C=1, D=3

89. Match the following lists and select the correct option from the codes given below

List- Ⅰ	List- Ⅱ
A. Chemiosmotic hypothesis	1. Robert Emerson
B. *Z* -Scheme	2. F.F. Blackman
C. Law of limiting factor	3. Peter Mitchell
D. Enhancement effect	4. Hill and Bendall

a. A=3, B=2, C=4, D=1
b. A=3, B=1, C=2, D=4
c. A=3, B=4, C=2, D=1
d. A=3, B=2, C=1, D=4

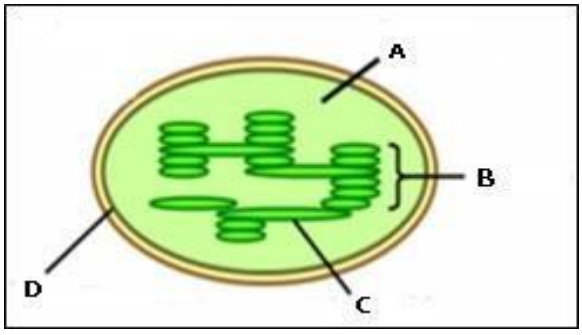
90. Match the following lists and select the correct option from the codes given below

List- Ⅰ	List- Ⅱ
A. ATP Synthase	1. PEP → OAA
B. RuBisCO	2. G-3P → Fructose 1,6- Bis Phosphate
C. PEPcase	3. RuBP → PGA
D. Aldolase	4. ADP → ATP

a. A=4, B=2, C=1, D=3
b. A=3, B=2, C=1, D=3
c. A=3, B=4, C=1, D=2
d. A=4, B=3, C=1, D=2

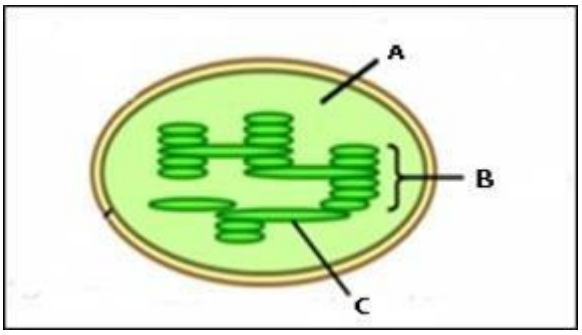
Diagram based Questions (LEVEL-4)

91. Identify the parts marked as A, B, C and D in the given the figure showing Chloroplast



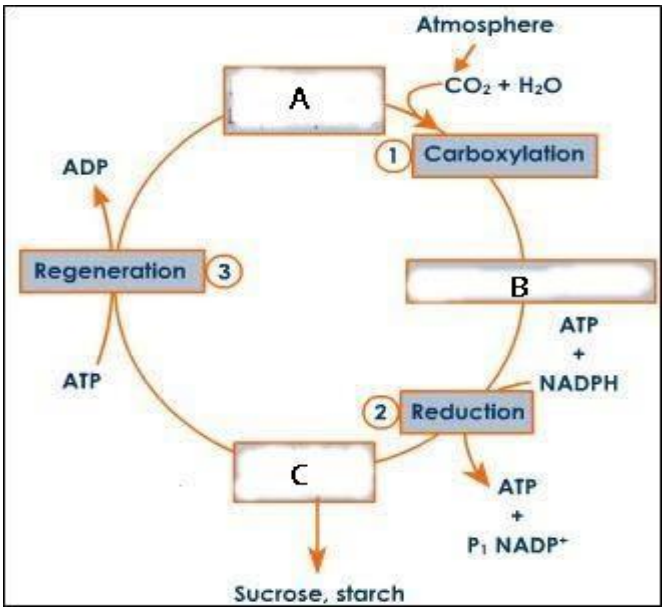
	A	B	C	D
a.	Stroma	Grana	Thylakoid	Inner membrane
b.	Grana	Stroma	Inner membrane	Thylakoid
c.	Thylakoid	Grana	Thylakoid	Inner membrane
d.	Stroma	Thylakoid	Grana	Inner membrane

92. Refer the given diagrammatic representation of the chloroplast and identify where different photosynthetic events A, B and C, occur in various parts of the chloroplast?



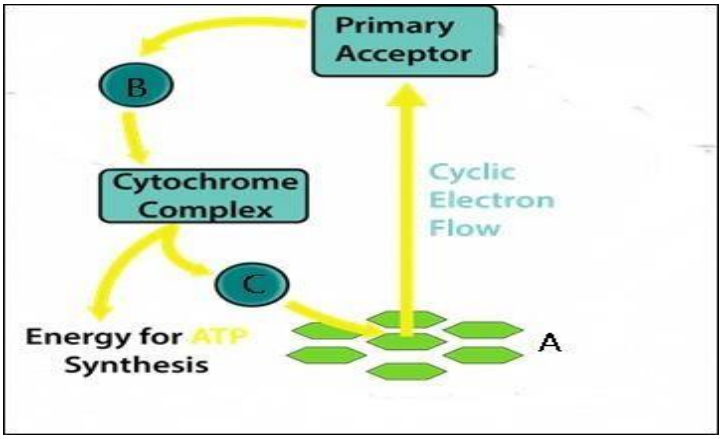
	A	B	C
a.	Light reaction	Dark reaction	Cyclic flow of electrons
b.	Dark reaction	Cyclic flow of electrons	Light reaction
c.	Dark reaction	Light reaction	Cyclic flow of electrons
d.	Light reaction	Cyclic flow of electrons	Dark reaction

93. In the given representation of Calvin cycle, identify A, B and C and select the correct option?



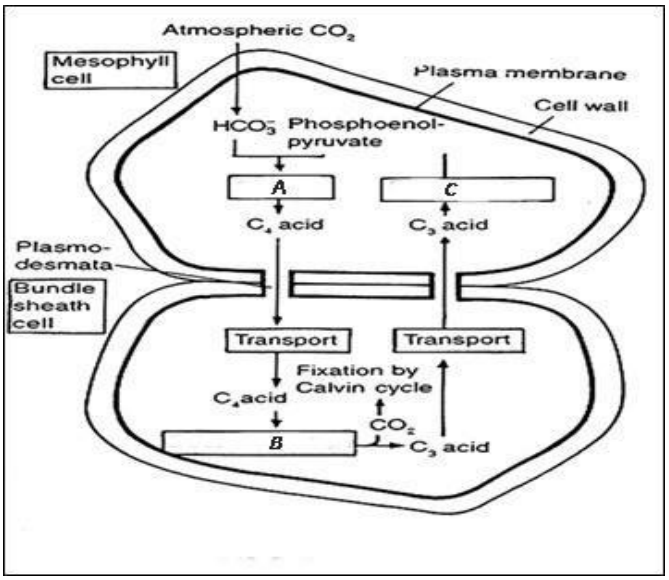
	A	B	C
a.	3 PGA	RuBP	Trios phosphate
b.	RuBP	3PGA	Trios phosphate
c.	RuBP	OAA	3PGA
d.	OAA	3PGA	RuBP

94. Study the given flow chart of cyclic photophosphorylation and select the correct answer for A, B and C.



	A	B	C
a.	PS- Ⅰ	Ferredoxin	Plastocyanin
b.	PS- Ⅱ	Ferredoxin	Plastocyanin
c.	PS- Ⅰ	Plastocyanin	Ferredoxin
d.	PS- Ⅱ	Plastocyanin	Ferredoxin

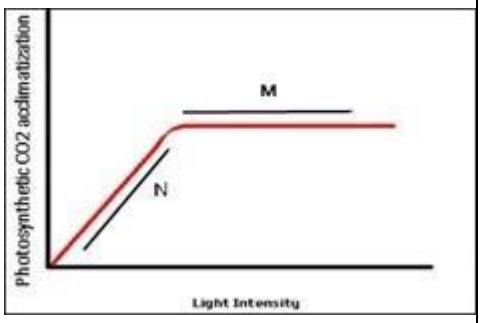
95. Given figure represents C_4 pathway. Select the suitable options for A, B and C.



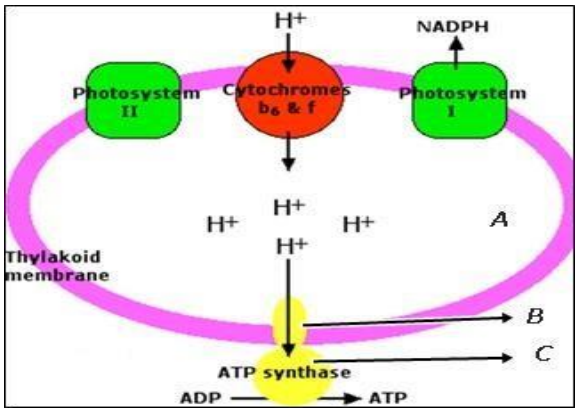
	A	B	C
a.	Decarboxylation	Reduction	Regeneration
b.	Fixation	Regeneration	Transamination
c.	Carboxylation	Reduction	Decarboxylation
d.	Fixation	Decarboxylation	Regeneration

96. A typical light response curve of photosynthesis is shown. The limiting factor/s for photosynthesis at M and N is/are

a. Light and CO_2 respectively
b. Temperature and CO_2 respectively
c. CO_2 and light respectively
d. Only CO_2



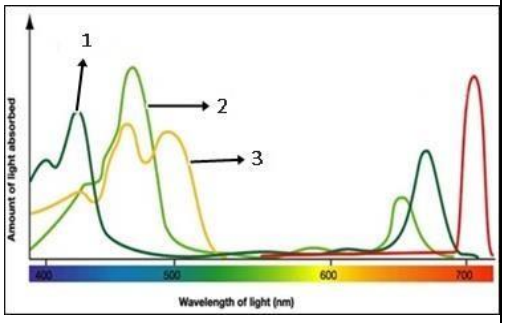
97. Identify the parts marked as A, B and C in the given figure showing ATP synthesis through Chemiosmosis.



	A	B	C
a.	Thylakoid lumen	F_0	F_1
b.	Thylakoid lumen	F_1	F_0
c.	Chloroplast lumen	F_0	F_1
d.	Chloroplast lumen	F_1	F_0

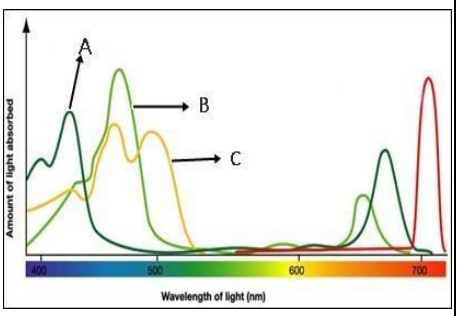
98. Absorption spectrum of chlorophyll – 'a' is shown by

a. 1
b. 2
c. 3
d. 1 and 2

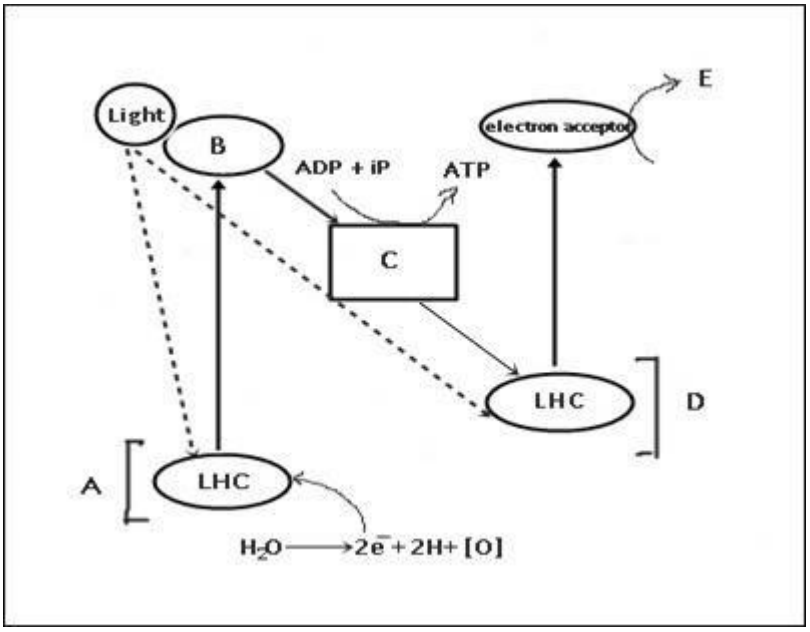


99. Absorption spectrum of photosynthetic pigments shown in the figure. Identify A,B and C and select the correct option.

	A	B	C
a.	Chlorophyll a	Carotenoids	Chlorophyll b
b.	Chlorophyll a	Chlorophyll b	Carotenoids
c.	Chlorophyll b	Chlorophyll a	Carotenoids
d.	Chlorophyll b	Carotenoids	Chlorophyll a



100. Identify A, B, C, D and E in given flow chart showing Z- scheme of light reaction



	A	B	C	D	E
a.	P_{700}	H^+ acceptor	e^- acceptor	P_{680}	$NADP^+$
b.	PS-I	e^- acceptor	e^- transport system	PS-II	NADPH
c.	PS-II	H^+ acceptor	e^- acceptor	P_{700}	NADPH
d.	PS-II	e^- acceptor	e^- transport system	PS-I	NADPH

ASSERTION AND REASON TYPE QUESTIONS (LEVEL-5):

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both (A) and (R) are true and (R) is the correct explanation of assertion
(b) If both (A) and (R) are true but (R) is not the correct explanation of (A)
(c) If (A) is true, but (R) is false
(d) If (A) and (R) are false

1. **Assertion:** In green plants oxygen is released during photosynthesis.
   Reason : In photosynthesis oxygen is released during photolysis of water
2. **Assertion :** In C_4 plants photorespiration does not occur
   Reason : C_4 plants have mechanism that increases the concentration of CO2 at the enzyme site.
3. **Assertion:** Grana lamellae have both PS I & PS II.
   Reason : Stroma lamellae lack pigment system II and NADPH reductase enzyme.
4. **Assertion :** Thylakoid lumen is the reservoir for protons.
   Reason : Thylakoid lumen is the site of photophosphorylation.
5. **Assertion:** The C_4 plants have a special type of leaf anatomy called Kranz anatomy.
   Reason : Chloroplasts of bundle sheath cells have grana and starch grains.
6. **Assertion:** CAM plants may show photorespiration.
   Reason : Dark reaction occurs during day time in CAM plants.
7. **Assertion :** The first product of CO_2 fixation in C_4 plants is OAA.
   Reason : Oxaloacetic acid is formed in agranal chloroplast.
8. **Assertion:** Manganese is important for Hill reaction.
   Reason : Photolysis of water occurs in the presence of manganese.
9. **Assertion:** C_4 pathway is more advanced than C_3 pathway.
   Reason : C_4 plants are better equipped to show high photosynthetic rates in drought Conditions.
10. **Assertion :** All plants are not photosynthetic
    Reason : Leaves are large in all types of plants

ANSWER KEY

Fill in the blanks

1. Light	6. Chloroplast	11. Plastocyanin
2. C4 plant	7. ATP	12. 12H20
3. CO2	8. Paper chromatography	13.CO2
4. CO2	9. 12, 18	14.Light dependent
5. ATP	10.Red, blue	15. Emerson' effect

True or False

Note: Correct statements are given in the brackets	
1	**True**
2	**False (**'Hill reaction' takes place in light)
3	**True**
4	**False (** Some species requires large amounts of sunlight and some require little amount**)**
5	**True**
6	**True**
7	**False (**The C_4 plants respond to higher temperatures and show higher rate of photosynthesis)
8	**True**
9	**True**
10	**False (** Cyclic photophosphorylation occur when light wave length >680 nm)
11	**False**
12	**True**
13	**False (** Hydrogen donor in Bacterial photosynthesis is H_2S)
14	**True**
15	**True**

Multiple Choice Questions (LEVEL-1)

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

Multiple Choice Questions (LEVEL-2)

41	c	46	b	51	d	56	b	61	b	66	c	71	c	76	b
42	c	47	d	52	b	57	b	62	d	67	a	72	d	77	b
43	a	48	c	53	c	58	d	63	b	68	b	73	c	78	d
44	b	49	a	54	b	59	b	64	a	69	a	74	b	79	c
45	a	50	b	55	a	60	a	65	a	70	d	75	c	80	a

Match the following type Questions (LEVEL-3)

81	a	82	b	83	c	84	d	85	c
86	a	87	b	88	d	89	c	90	d

Diagram based Questions (LEVEL-4)

91	a	92	c	93	b	94	a	95	d
96	c	97	a	98	a	99	b	100	d

Assertion and Reason Type Questions (LEVEL-5)

1	a	2	a	3	b	4	c	5	c
6	b	7	c	8	a	9	a	10	c

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RESPIRATION IN PLANTS

Mechanism of breakdown of food materials with in the cell to release energy, and the trapping of this energy for synthesis of ATP is called cellular respiration.

The complete combustion of glucose, which produces CO_2 and H_2O as end products, yields energy most of which is given out as heat.

The compounds that are oxidized during this process are known as **respiratory substrates.**

Usually **carbohydrates** are oxidized to release energy, but **proteins**, **fats** and even **organic acids** can be used as respiratory substrates, under certain conditions.

Calorific Value of protein, carbohydrate and fat:

The amount of heat liberated from complete combustion of 1g food in a bomb calorimeter (a closed metal chamber filled with O_2) is its gross calorific values.

The actual amount of energy released by combustion of 1g of food is the physiological value of food.

Features of Cellular respiration:

i) All the energy contained in respiratory substrates is not released free in to the cells orinasingle step.

ii) Energy is released in a series of slow step wise reactions controlled by enzymes, and it is trapped as chemical energy in the form of ATP. **(ATP acts as the energy currency of the cell)**

iii) Cellular respiration is an **amphibolic process.**

Reason: The carbon skeleton (Intermediates of respiration) produced during respiration is used as precursors for biosynthesis of other molecules in the cell.

iv) Cellular respiration is an **exergonic process.**

Reason: The breaking of C–C bonds of complex compounds through oxidation within the cells, leading to release of considerable amount of energy.

v) Cellular respiration is a **downhill process. Reason:** Oxygen is a strong electron acceptor.

DO Plants breathe?

Yes, plants require O_2 for respiration to occur and they also give out CO_2. Hence, plants have systems in place that ensure the availability of O_2. Plants, unlike animals, have no specialized organs for gaseous exchange but they have **stomata** and **lenticels** for this purpose.

There are **several reasons** why plants can get along without respiratory organs.

1) Each plant part takes care of its own gas-exchange needs. There is very little transport of gases from one plant part to another.

2) Plants do not present great demands for gas exchange.

Roots, stems and leaves respireatratesfar lower than animals do. **Only during photosynthesis are large volumes of gases exchanged** and, each leaf is well adapted to take care of its own needs during these periods. When cells photosynthesise, availability of O_2 is not a problem in these cells since O_2 is released within the cell.

3) The distance that gases must diffuse even in large, bulky plants is not great. Each living cell in a plant is located quite close to the surface of the plant.

Most cells of a plant have at least apart of their surface in contact with air. This is also facilitated by the **loose packing of parenchyma cells in leaves, stems and roots,** which provide an inter connected network of air spaces.

Types of respiration:

A) On the basis of type of respiratory substrates:

1) Floating respiration:

When carbohydrate or fats are oxidized inside the cell. Carbohydrates and fats are floating inclusions of cell thus, this is called floating respirations.

2) Protoplasmic respiration:

When protein is oxidized inside the cell. This occurs in starved cell. Protein is constituent of protoplasm thus, this is called protoplasmic respiration.

B) On the basis of presence or absence of O_2:

1) Aerobic

2) Anaerobic / Fermentation

Aerobic respiration: It is divided into following stages:

1) Glycolysis

2) Link reaction

3) Krebs cycle

4) Electron transport system and oxidative phosphorylation

1) Glycolysis

i) The term glycolysis has originated from the greek words, glycos for sugar and lysis for splitting.

ii) The scheme of glycolysis was given by Gustav Embden, Otto Meyerhof and J.Parnas. Thus it is often referred to as the EMP pathway.

iii) This process takes place inside cytoplasm of all living cells.

iv) Glycolysis is called common pathway because it is a common step between aerobic and anaerobic respiration.

v) Glycolysis is a chain process of ten chemical reactions, where 1, 3 and 10 reactions are irreversible.

vi) In this process, glucose undergoes partial breakdown / oxidation to form two molecule of pyruvic

acid. In plants this glucose is derived from sucrose (end product of photosynthesis) or from storage carbohydrates (starch).

vii) Sucrose is converted into glucose and fructose by the enzyme, invertase and these two monosaccharides readily enter the glycolytic pathway. Glucose is the favoured substrate for respiration.

Gross products of glycolysis	Net products of glycolysis
2 molecules of pyruvic acid (CHCO.COOH)	2 molecules of pyruvic acid (CHCO.COOH)
2 molecules of NADH	2 molecules of NADH
4 molecules of ATP	2 molecules of ATP

2) Link reaction / Gateway step / Transition reaction

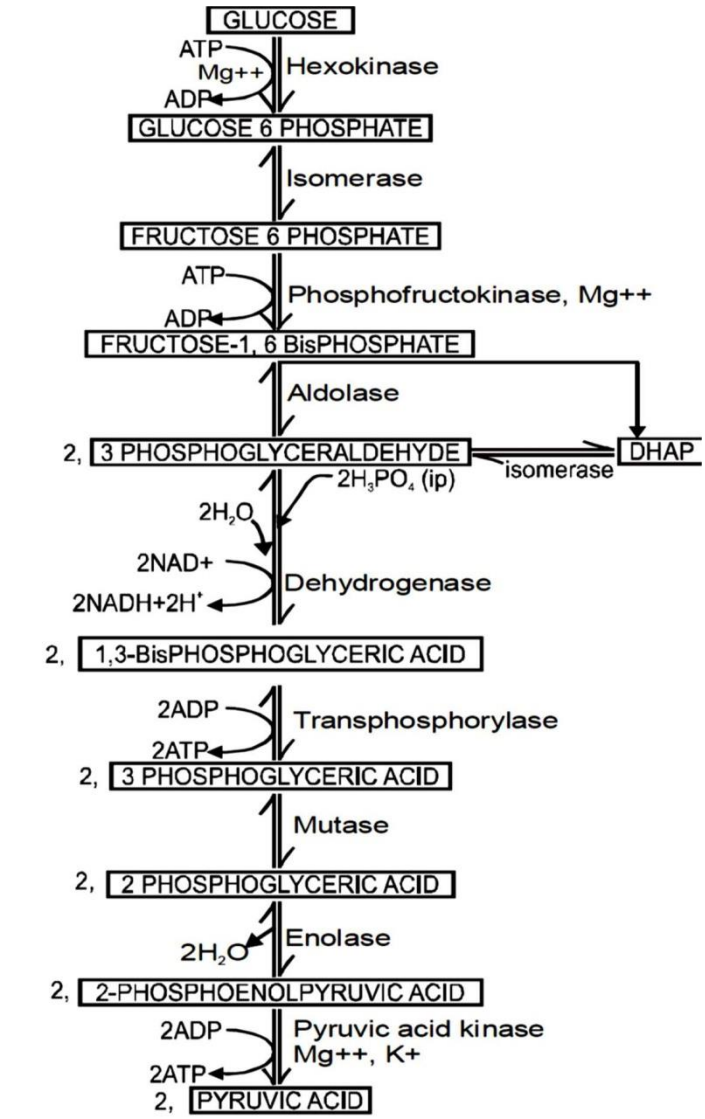
Pyruvate, which is formed by the glycolytic catabolism of carbohydrates in cytosol, after it enters mitochondrial matrix under goes oxidative decarboxylation by a complex set of reactions catalysed by pyruvate dehydrogenase.

This reaction require participation of several co-enzymes, including NAD and CoA.

$$\text{Pyruvic acid} + \text{CoA} + \text{NAD}^+ \xrightarrow[\text{Pyruvate dehydrogenase}]{Mg^{2+}} \text{Acetyl CoA} + CO_2 + \text{NADH}(H^+)$$

During this process, two molecules of NADH are produced from the metabolism of two molecules of pyruvic acid (produced from one glucose molecule during glycolysis).

The acetyl CoA is called connecting link between glycolysis and Krebs cycle.



GLYCOLYSIS / EMP PATHWAY

3) Krebs Cycle

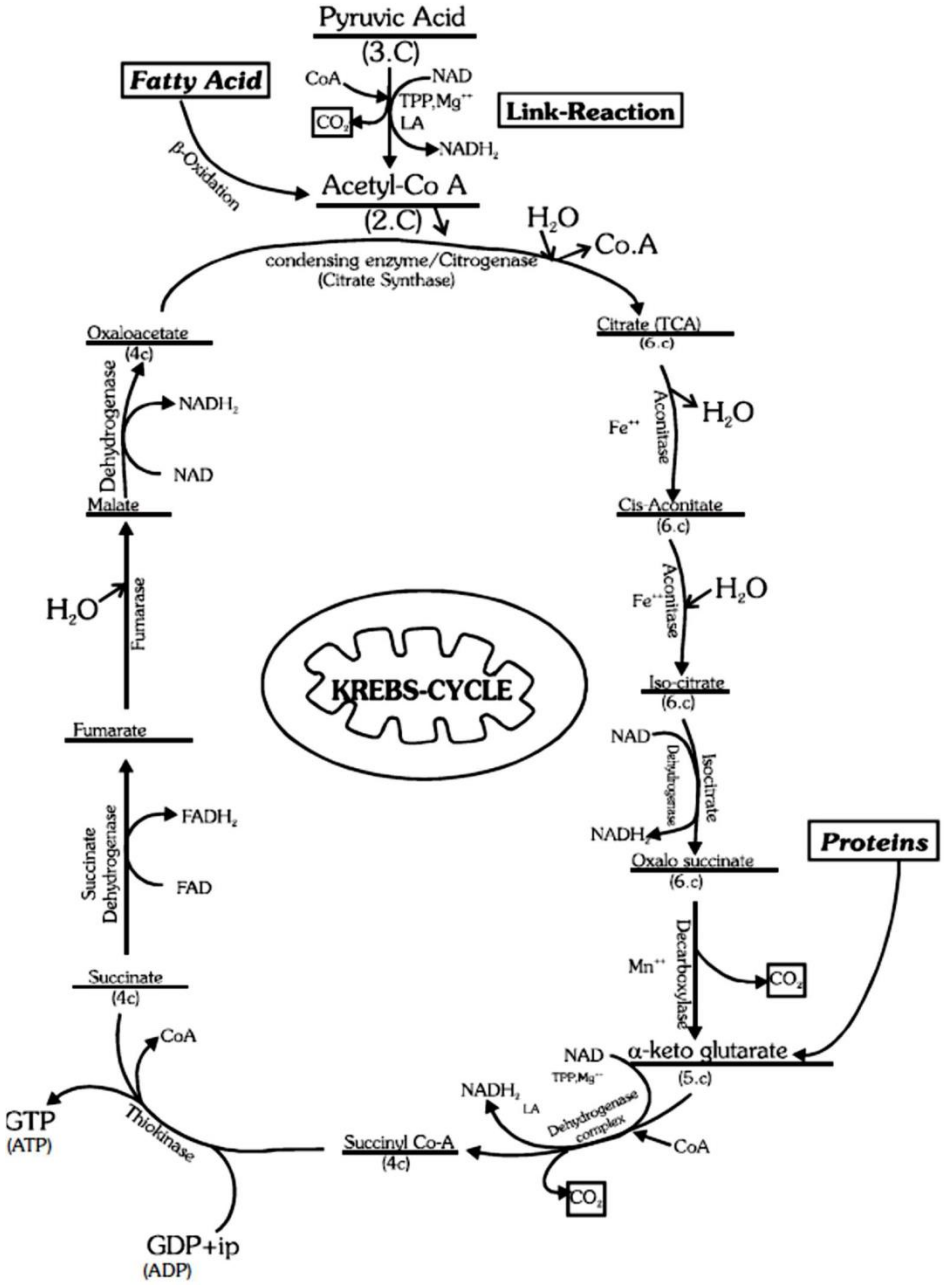
i) Named after the scientist Hans Krebs who first elucidated it. It is also called TCA (tricarboxylic acid) cycle or CA (citric acid) cycle.

ii) Krebs cycle occurs inside mitochondrial matrix of eukaryotic cells and cytoplasm of prokaryotic cells.

iii) One turn of Krebs cycle involve four dehydrogenation, two decarboxylation and one substrate level phosphorylation.

iv) OAA is considered as the first member of the cycle.

v) All enzymes of Krebs cycle are located inside mitochondrial matrix except succinate dehydrogenase (Marker enzyme), which is located in inner membrane of mitochondria.



4) ETS and oxidative phosphorylation (Terminal oxidation of NADH and $FADH_2$)

i) It is associated with release and utilization of the energy stored in $NADH+H^+$ and FADH.

ii) $NADH + H^+$ and $FADH_2$ are oxidized through the electron transport system (ETS) and the electrons are passed on to O_2 resulting in the formation of H_2O.

iii) ETS is present in the **inner mitochondrial membrane of eukaryotes** and **plasma membrane of prokaryotes.**

Electron carriers of ETS:

i) Flavins(FMN)

ii) FeS

iii) Quinone (Ubiquinone or Co-Q)

iv) Cytochromes $(Cyt\ b \rightarrow Cyt\ c_1 \rightarrow Cyt\ c \rightarrow Cyt\ a \rightarrow Cyt\ a_3)$

ETS is consists of four complexes and fifth complex is ATP synthase which is associated with ATP synthesis.

Name of complexes	Components of ETS	Inhibitors
Complex-I	FMN-NADH dehydrogenase	Rotenone & amytal
Complex-II	$FADH_2$ dehydrogenase /Succinate dehydrogenase	
Complex-III	Cytochrome b-Cyto c_1	antimycin
Complex-IV (Cytochrome C oxidase) Above four complexes are coupled with complex-V	Cyto. a, Cyto. a_3 and 2 Cu centres	cyanide, CO
Complex-V	ATP synthase/ATPase	Oligomycin

Special features of ETS:

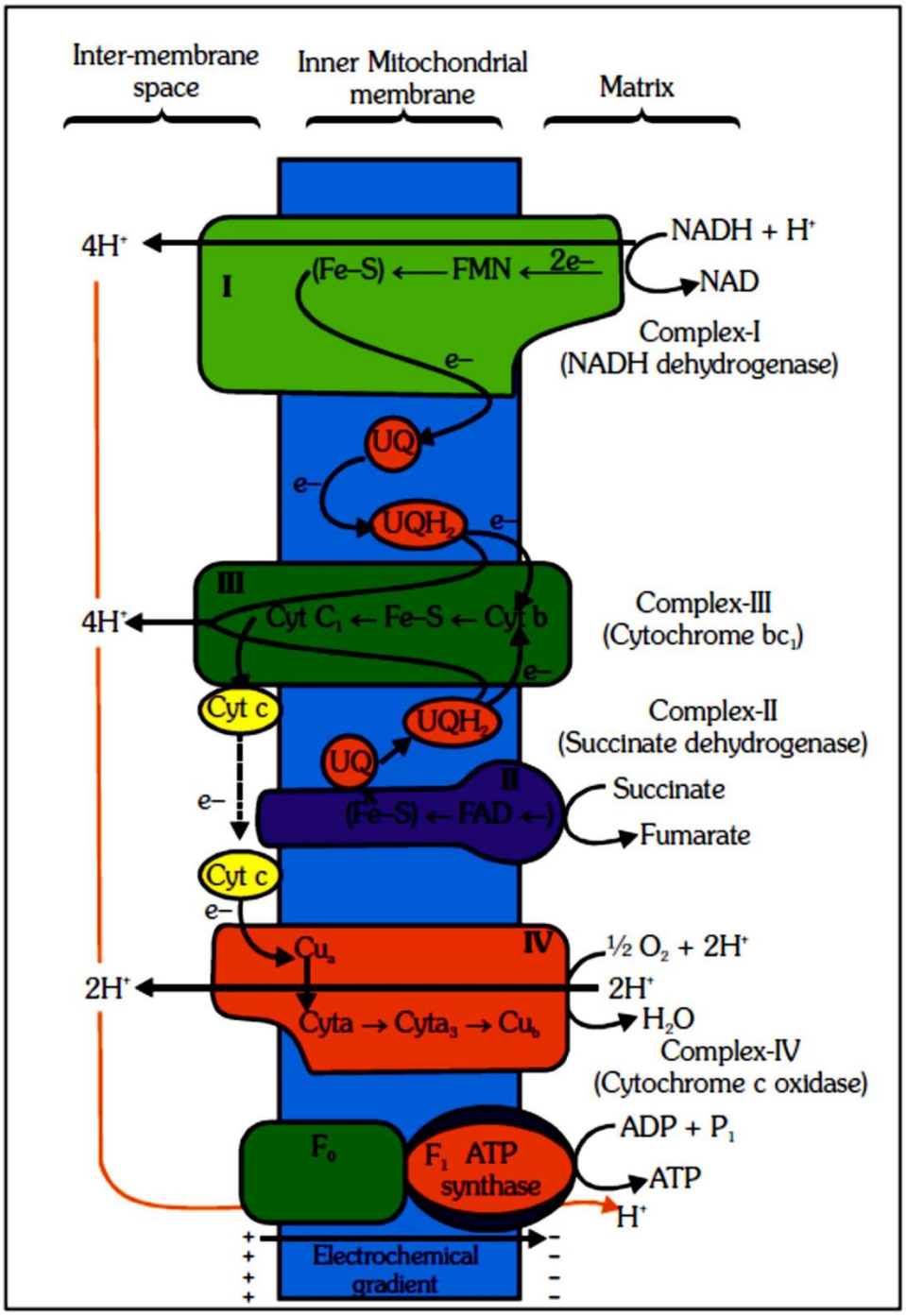
i) UQ (Co.Q) and Cytc are **mobile carrier** of ETS.

ii) Cytochrome C is a small protein attached to outer surface of the inner membrane and acts as a mobile carrier for transfer of electrons between **complex-III (cytochromebc$_1$) and complex-IV (cytochromec oxidase)**

iii) Every cytochrome has iron with variable $Fe^{+++} \rightleftharpoons Fe^{++}$. Thus , helpful in transfer of electrons

iv) The role of O_2 is limited to the terminal stage of the process. The presence of oxygen is vital. Since it drives the whole process by removing hydrogen from the system. Oxygen acts as the final hydrogen acceptor.

Cyanide inhibits the activity of cytochromec oxidase which catalyse the oxidation of cytochrome a_3 and reduction of oxygen. In mitochondria of some plants alternative oxidase system is present in which ETS continue seven in presence of cyanides. This type of respiration is known as **cyanide resistance respiration or alternate electron pathway.** eg. Spinach, *Pisum*

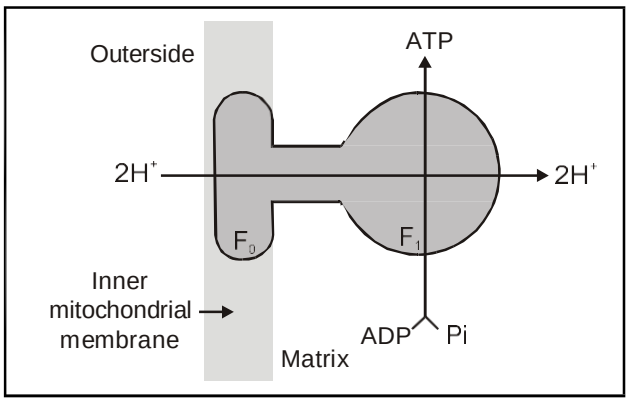


Oxidative phosphorylation (Chemi osmotic theory / Coupling theory)

i) During ETS of respiration CoQ (UQ) & FMN can releases H+ ions in perimitochondrial space and leads to differenctial H+ ion concentration across inner mitochondrial membrane. This differential H+ ion concentration across inner mitochondrial membrane leads to creation of proton gradiant (pH gradient) and Electrical potential (diffrence of charge). Both are collectively known as Proton motive force (PMF).

ii) PMF do not allow stay of H+ ions in Perimitochondrial space (PMS) so they return towards the

matrix through F_0part of ATPase selectively. Passage of 2H+ ions through F_0part or proton channel leads to synthesis of 1 ATP.



i) Cytosolic or extra mitochondrial or **glycolytic NADH** transported to ETS by **two type of shuttles (Only in eukaryotes)**:

a) **Glycerol phosphate shuttle Common shuttle system** eg.-all plants, nerves and muscles.

b) Malate aspartate shuttle Heart, liver and kidney etc.

ii) In **prokaryotes, shuttle mechanism is absent.** They **always get 38 ATP** from aerobic respiration of 1glucose.

iii) Oxidation of one molecule of NADH gives rise to 3 molecules of ATP, while that of one molecule of $FADH_2$ produces 2 molecules of ATP.

The respiratory balance sheet

It is possible to make calculations of the net gain of ATP for every glucose molecule oxidised; but **in reality this can remain only a theoretical exercise. These calculations can be made only on certain assumptions that:**

- There is a sequential, orderly pathway functioning, with one substrate forming the next and with glycolysis, TCA cycle and ETS pathway following one after another.
- The NADH synthesised in glycolysis is transferred into the mitochondria and undergoes oxidative phosphorylation.
- None of the intermediates in the pathway are utilised to synthesise any other compound.
- Only glucose is being respired – no other alternative substrates are entering in the pathway at any of the intermediary stages.

But **this kind of assumptions are not really valid in a living system;** all pathways work simultaneously and do not take place one after another; substrates enter the pathways and are withdrawn from it as and when necessary; ATP is utilised as and when needed; enzymatic rates are

controlled by multiple means. Yet, it is useful to do this exercise to appreciate the beauty and efficiency of the living system in extraction and storing energy. Hence, **there can be a net gain of 36 ATP molecules during aerobic respiration of one molecule of glucose.**

Theoretical energy calculation for complete oxidation of one glucose molecule:

Step	Number of turn	ATP synthesis through substrate level phosphorylation	ATP gain through oxidative phosphorylation	ATP consumed	Net gain
EMP pathway	1	4	6 or 4	2	8 or 6
Link reaction	2	0	6	0	6
Krebs cycle	2	2	22	0	24

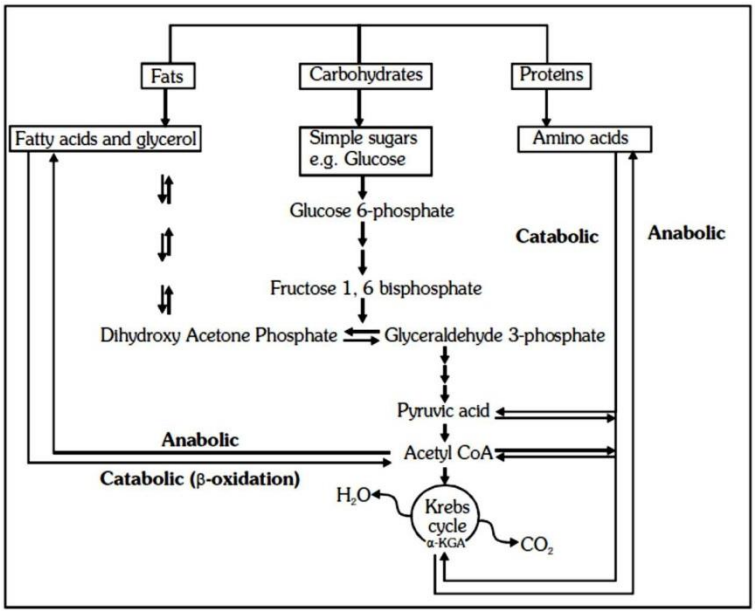
Amphibolic pathway

i) **Glucose is the favoured substrate for respiration. All carbohydrates are usually first converted into glucose before they are used for respiration.** Other substrates can also be respired, but then they do not enter the respiratory pathway at the first step.

ii) Fats would need to be broken down into glycerol and fatty acids first. If fatty acids were to be respired they would first be degraded to acetyl CoA and enter the pathway. Glycerol would enter the pathway after being converted to PGAL.

iii) The proteins would be degraded by proteases and the individual amino acids (after deamination) depending on their structure would enter the pathway at some stage within the Krebs cycle or even as pyruvate or acetyl CoA.

iv) Since respiration involves breakdown of substrates, the respiratory process has traditionally been considered a catabolic process and the respiratory pathway as a catabolic pathway. Fatty acids would be broken down to acetyl CoA before entering the respiratory pathway when it is used as a substrate. But when the organism needs to synthesise fatty acids, acetyl CoA would be withdrawn from the respiratory pathway for it. Hence, the respiratory pathway comes into the picture both during breakdown and synthesis of fatty acids. Similarly, during breakdown and synthesis of protein too, respiratory intermediates form the link. Breaking down processes within the living organism is catabolism, and synthesis is anabolism. Because the respiratory pathway is involved in both anabolism and catabolism, it would hence be better to consider the respiratory pathway as an amphibolic pathway rather than as a catabolic one.



v) Glycolysis is also known as oxidative anabolism or catabolic resynthesis, because it links with an anabolism of fats and amino acids. An intermediate PGAL issued for the synthesis of glycerol later forms fats or lipid. PGA issued for synthesis of Serine, Glycine, Cysteine. Alanine forms from pyruvate.

vi) Acetyl Co-A is common meeting point (connecting link) between fat, carbohydrate and protein metabolism.

Amphibolism of Krebs cycle–

1) Acetyl Co-A–Synthesis of fatty acids & GA (Gibberellic acid)

2) Succinyl CoA – Synthesis of chlorophyll, Cytochromes, Phytochromes

3) OAA & ∝- Keto glutaric acid–Synthesis of Amino acids.

4) OAA–Synthesis of Alkaloids.

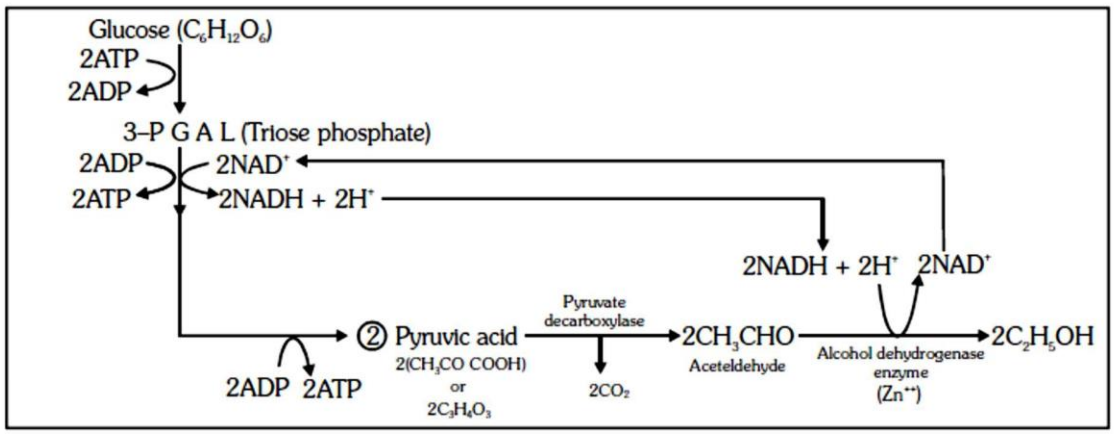
Anaerobic respiration / Fermentation

In fermentation not much energy is released; **less than seven percent** of the energy in glucose is released and not all of it is trapped as high energy bonds of ATP.

The processes are **hazardous,** either acid or alcohol is produced. **Yeasts poison themselves to death when the concentration of alcohol reaches about 13% percent.**

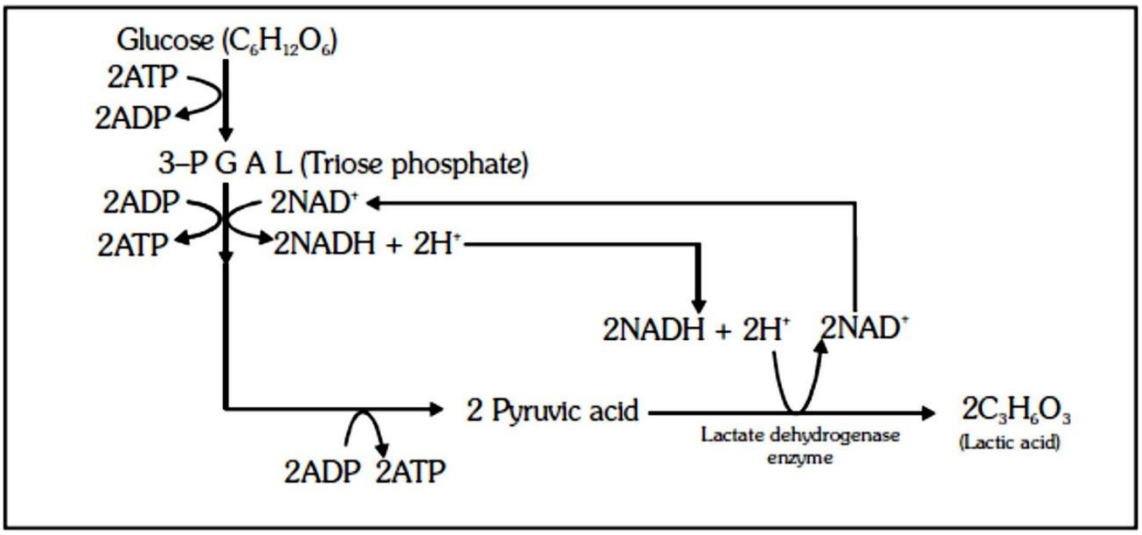
Fermentation is of two types:

A) Alcoholic fermentation: In this fermentation, say by yeast, the in complete oxidation of glucose is achieved under an aerobic conditions by sets of reactions where pyruvic acid is converted to CO_2 and ethanol. The enzymes, **pyruvate decarboxylase** and **alcohol dehydrogenase** catalyse these reactions.



A) Lactic acid Fermentation:

Some bacteria produce lactic acid from pyruvic acid. In animal cells also like in muscles during exercise, when oxygen is in adequate for cellular respiration pyruvic acid is reduced to lactic acid by **lactate dehydrogenase.**



Pasteur effect:

It is an **inhibitory effect** of oxygen on the fermentation process.

Explanation:

The effect can be easily explained; as the yeast being **facultative anaerobes** can produce energy using two different metabolic path ways.

i) While the oxygen concentration is low, the product of glycolysis, **pyruvate** is turned into **ethanol** and **CO_2** and the energy production efficiency is low (2 moles of ATP per mole of glucose).

ii) If the oxygen concentration grows, **pyruvate** is converted into **acetyl CoA** that can be used in the **citric acid cycle,** which increases the efficiency to 36 moles of ATP per mole of glucose.

Respiratory Quotient

The ratio of the volume of CO_2 evolved to the volume of O_2 consumed in respiration is called the respiratory quotient (RQ) or respiratory ratio.

$$RQ = \frac{Volume\ of\ CO_2\ evolved}{Volume\ of\ CO_2\ consumed}$$

The respiratory quotient depends upon the type of **respiratory substrate** used during respiration.

RQ = 1

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + 12H_2O + 686kcal$$

$$RQ = \frac{6CO_2}{6O_2} = 1.0$$

RQ = ∞

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2 + 59kcal$$

$$RQ = \frac{2CO_2}{Zero\ O_2} = \infty$$

RQ = Zero

In succulent plants due to availability of insufficient O_2 glucose oxide separtially and **RQ will be zero.**

$$2C_6H_{12}O_6 + 3O_2 \rightarrow 3C_4H_6O_5 + 3H_2O + Energy$$

Malic acid

RQ = Less than one

During complete oxidation of protein and fat

During **protoplasmic respiration**(In case of a **starved cell**)

In case of mixed diet

In case of **germinating fatty seeds.**

$$2\underset{Triplamitin}{C_{51}H_{98}O_6} + 145O_2 \rightarrow 102CO_2 + 98H_2O + Energy$$

$$RQ = \frac{102\ CO_2}{145\ O_2} = 0.7$$

When proteins are respiratory substrates the ratio would be about 0.8 or 0.9.

Pure proteins or fats are never used as respiratory substrates because before entering the respiratory path way they must be converted into such compounds which can enter into the glycolysis or link reaction or Krebs cycle at the irrespective stages.

RQ = More than one

During complete oxidation of **organic acids.**

In case of maturing fatty seeds.

$$2\underset{\text{Oxalic acid}}{(COOH)_2} + O_2 \rightarrow 4CO_2 + 2H_2O + Energy$$

RQ = 4.0

$$\underset{\text{Malic acid}}{C_4H_6O_5} + 3O_2 \rightarrow 4CO_2 + 3H_2O + Energy$$

$$2\underset{\text{Succinic acid}}{C_4H_6O_4} + 7O_2 \rightarrow 8CO_2 + 6H_2O + Energy$$

RQ = 1.14

Energy efficiency of cellular respiration :

$$ADP + iP \xrightarrow{8.1\,Kcal} ATP$$

Thus, 8.1Kcal energy trapped for each molecule of ATP formation. Therefore, during arobic respiration if total net gain is 36 ATP molecules then total trapped energy is 36×8.1=291.6Kcal.

Efficiency= $\frac{291.6}{686} \times 100 = 42.50\%$

During arobic respiration if total net gain is 38ATP molecules then total trapped energy is 38×8.1=307.8Kcal.

Efficiency= $\frac{307.8}{686} \times 100 = 44.86\%$

The total energy content of 1 molecule of glucose is 686 Kcal.

2. FILL IN THE BLANKS

1. The mechanism of breakdown of food materials within the cell to release energy is …….
2. The power houses of the cell …….
3. The energy currency in the cell ……
4. The compounds that are oxidized during the respiration ……..
5. The glycolysis takes place in ……
6. The connecting link between glycolysis and trek's cycle ……..
7. The end product in glycolysis …….
8. The net gain of ATP in Glycolysis ……..
9. The end products in yeast fermentation …….
10. The enzyme involved in lactic acid fermentation ……..
11. Net gain of ATP in anaenabic respiration …….
12. The tricarboxylic acid cycle takes place in ……..
13. The 5 carbon contatining compound in Kneb's cycle ……..
14. The electron transport system takes place in the..... of mitochondria
15. The simplest respiratory substrate is …….
16. The net gain of ATP during aerobic respiration is ……

17. The RQ value of carbohydrates is ……..
18. The oxidative phosphorylation takes place in ……
19. The mobile carrier involved in electron transport system is ……..
20. The pure proteins (or) fats are never used as ……..

3. TRUE OR FALSE

1. Green plants only can prepare their own food [ ]
2. Carbohydrates only act like respiratory substrate [ ]
3. Interior cells of woody plants are living and also perform respiration [ ]
4. Sucrose is monoacchride which is converted into glucose and fructose by invertase [ ]
5. Fate of pyruvic acid depends on the cellular need [ ]
6. In all organisms during anaerobic respiration pyruric acid forms acetaladehyde [ ]
7. During aerotric respiration pyruvic acid is transported from mitochoria into the cytoplasm [ ]
8. Tricarboxylic acid cycle is commonly called EMP pathway [ ]
9. In kerbs cycle all hydration and dehydration reactions are catalysed by aconitase [ ]
10. In aerobic respiration ultimate e^- acceptor is O_2 [ ]
11. Electrons from NADH produced the mitochondrial matrix and cytoplasm are oxidised by an NADH dehydrogenase [ ]
12. Cytochorne C is a small lipid attached to the outer surface of the inner membrane [ ]
13. UQ transfer e^- between complex I to II , I to III , II to III complexes [ ]
14. Oxidation of one molecule of $FADH_2$ of cytosolic $NADH_2$ gives rise to 2 molecule of ATP[ ]
15. In ATP synthacse PO is a peripheral membrance protein complex & F1 is an integral membrane protein compels [ ]
16. ATP gain from glycolysis in the presence of O_2 are 6ATP [ ]
17. Fats directly enter into respiratory pathway [ ]
18. Glycerol would enter the respiratory pathway after being converted to acetyl CoA [ ]
19. Pure proteins or fats are directly used as respiratory substrates [ ]
20. Release of energy from fats is less than carbohydrates [ ]

4. OBJECTIVE TYPE BITS

1. The simple respiratory substrate is

   1) Glucose 2) Protein 3) Fats 4) Lipids

2. Release of energy by breaking down of C-C bond of various organic molecules by oxidation process for cellular use is known as

   (1) Respiration (2) photorespiration (3) oxidative phosphorylation (4) combustion

3. Respiratory substrate are the organic substance which are..... during respiration to liberate energy

   (1) oxidised (2) reduced (3) both a and b (4) synthesised

4. The released energy obtained by oxidation is stored as

   (1) a concentration gradient across a membrane (2) ADP

   (3) ATP (4) NAD^+

5. Which specialized cell provides inter connectivity for air spaces?

   (1) Parenchyma (2) Chlorenchyma (3) Sclerenchyma (4) None of these

6. The main purpose of cellular respiration is to

   (1) Convert potential energy to kinetic energy (2) Convert kinetic energy to potential energy

   (3) Create energy in the cell

   (4) Convert energy stored in the chemical bonds of glucose to an energy that the cell can use

7. Phase common in aerobic and anaerobic respiration is

   (1) TCA cycle (2) glycolysis (3) glycogenolysis (4) ETS

8. Cyanide resistant pathway is

   (1) anaerobic respiration (2) aerobic respiration (3) both a and b (4) none of these

9. Glycolysis takes place in

   (1) all living cells (2) eukaryotic cells only

   (3) prokaryotic cells only (4) None of these

10. Sucrose is converted into

    (1) glucose and fructose (2) triose phosphate and pyruvic acid

    (3) oxlic acid and citric acid (4) citric acid pyruvic acid

11. Where is ATP synthesized in glycolysis?

    (1) when 1,3 di PGA is changed into 3PGA

    (2) When glucose is converted into glucose-9-phosphate

    (3) Both a and b

    (4) when 1,6 diphosphate is broken in triose phosphate

12. How many ATP molecules could maximally be generated from one molecule of glucose, if the complete oxidation of one mole of glucose to carbon dioxide and water yields 686kcal and the useful chemical energy available in the high energy phosphate bond of one mole of ATP is 12kcal?

    (1) 2 (2) 30 (3) 57 (4) 1

13. Which of the following enzyme is responsible for formation of glucose from glucose-6-phosphate?
(1)Kinase (2) aldolase (3) Dehydrogenase (4) Phosphatase

14. Enzymes found attached to inner membrane of mitochondria instead of matrix is/are
(1) succinic dehydrogenase (2) cytochrome oxidase
(3) both a and b (4) malic dehydrogenase

15. Anaerobic respiration is also called as
(1) β- oxidation (2) termentation (3) oxidation (4) None of these

16. During anaerobic respiration in yeast
(1) H_2O and CO_2 are end- products (2) CO_2 ethanol and energy are end products
(2) CO_2 and H_2O are end products (4) CO_2 acetic acid and energy are end - products

17. In alcoholic fermentation
(1) There is no electron donor
(2) oxygen is the electron acceptor
(3) triose phosphate is the electron donor, while aceraldehyde is the electron acceptor
(4) triose phosphate is the electron donor, while pyruvic acid is the electron acceptor

18. Alcoholic fermentation takes place in the presence of
(1) maltase (2) zymase (3) amylase (4) inertase

19. Which of the following is used in the formation of alcohol?
(1) sucrose (2) Glucose (3) Galactose (4) Fructose

20. The reaction which is catalyzed by a protein that is not found in the matrix of mitochondria is
(1) Conversion of cyuvic acid to accetly
(2) oxidation ac……..
(3)
(4)

21. A competitive inhibitor of succinic dehydrogenase is
(1) malonate (2)

22. Aeobic respiration takes place in
(1) mitochondria (2) ribosome (3) Glogi body (4) both a and b

23. In oxidative decarboxylation, enzyme used to
(1) pyruvate decarboxyliase (2) pyruvate dehydrogenase
(3) pyruvate hydrogenase (4) pyruvate dehydrogenase

24. Connecting link between glycolysis and Kreb's cycle is
(1) acety CoA (2) pyruvic acid (3) CO_2 (4) None of these

25. Citric acid cycle is also known as
(1) Tricarboxylic acid cycle (2) oxidative decarboxylation
(3) fermentation cycle (4) both a and b

26. In citric acid cycle first step is

(1) Acetyl Co-A combines with oxaic acetic acid

(2) Acetyl Co-A combines with citric acid

(3) citric acid combines with oxalo acetic acid

(4) citric acid combines with malic acid

27. In which of the following reduction of NAD does not occur?

(1) Isocitric acid $\rightarrow \propto$

(2) Not clear Screen

3)

4)

28. In Kreb's cycle

(1) ATP is converted into ADP

(2) pyruvic acid is converted into CO_2 and H_2O

(3) glucose is converted into CO_2

(4) pyruvic acid is converted into ATP

29. The main purpose of electron transport chain is to

(1) Cycle $NADH+H^+$ back to NAD^+

(2) use the intermediate from TCA cycle

(3) breakdown pyruvic acid

(4) all of the above

30. Electron Transport system (ETS) occurs in

(1) inner mitochondrial membrane (2) outer mitochondrial membrane

(3) both a and b (4) not specific place

31. In mitochondria, enzyme cytochrome oxidase is present in

(1) outer membrane (2) perimitochondral

(3) inner membrane (4)matrix

32. Oxidative decarboxylation is

(1) pyruvic acid is oxidized to carbon dioxide

(2) pyruvic acid is subsidized to oxygen

(3) pyruvic acid is oxidized to oxygen

(4) pyruvic acid is subsidized to carbon dioxide

33. NADP, NAD and FAD are acceptors of

(1) phosphate (2) electrons (3) oxygen (4) hydrogen

34. Fate of pyruvic acid during aerobic respiration is

(1) lactic acid fermentation (2) alcoholic acid fermentation

(3) oxidative decarboxylation (4) oxidative phosphorylation

35. ∝- ketoglutarate acid, an intermediary compound of Kreb's cycle is a

(1) 5-carbon compound (2) 6-carbon compound

(3) 4-carbon compound (4) 3-carbon compound

36. In Kerb's cycle, GTP in formed in

(1) oxidative phosphorylation (2) substrate level phosphorylation

(3) photophosphorylation (4) decarboxylation

37. Correct sequence of electron acceptor of ATP synthesis is

(1)cty-aa_3,b,c (2)cyt-b,c,a,a_3 (3) cyt-b,c,a_3,a (4)cyt-c,b,a,a_3

38. Which one of the following is the terminal electron acceptor ?

(1)Molecular CO_2 (2) Molecular O_2 (3)Molecular H_2 (4)$NADPH_2$

39. Before entering into the respiratory pathway fats breakdown into

(1)fatty acid and glycerol (2)fatty acid and absorbic acid

(3)fatty acid and ascorbic acid (4) fatty acid and amino acid

40. When act as a respiratory substrate, which of the following would be broken down to acetyl Co-A?

(1)fatty acid (2)Protein (3)Carbohydrate (4) all of these

41. Break down process is also called

(1) catabolism (2) anabolism (3) both a and b (4) all of these

42. Plants need one of the following for ATP formation

(1) N and P (2) N and Cu (3) N and Ca (4) K

43. The respiratory quotient during cellular respiration would depend on the

(1)Nature of enzyme involved

(2) nature of the substrate

(3) amount of carbon dioxide released

(4) amount of oxygen utilised

44. Maximum amount of energy/ ATP is liberated on oxidation of

(1) Fats (2) proteins (3)starch (4)vitamins

45. The similarity between NAD^+ and $NADP^+$ is the

(1) Take up electron at a time (2) take up two protons at a time

(3) take up two electrons at a time (4) give up one protons at a time

46. $NADH_2$ FAD $FADH_2$ the given reaction occurs in

(1) heart cells (2)kidney cells (3)liver cells (4)nerve cells

47. RQ value of 4 may be expected for the complete oxidation of which one of the following?

(1) Glucose (2)Malic acid (3)Oxalic acid (4) Tartaric acid

48. In aerobic respiration, citric acid cycle takes place in

(1) cytosol (2)mitochondria (3)peroxisome (4) endoplasmic reticulum

49. In which part of mitochondria does ATP synthesis occur?

(1)F_1 (2) F_0

(3)Cristae (4) Inner membrane of mitochondria

50. Protein directly cannot be used as a respiratory substrate, it breaks down into

(1) amino acid (2) fatty acid (3) glycolytic acid (4) fumaric acid

Match the Following

1. Study the following lists

List – I (Substrate)	List – II (Undergoes)
A) 1,3bis PGA	I) Substrate for enolase
B) 2-PGA	II)Phosphorylation
C) Fructose'6-P	III) Oxidation
D) G3-P	IV) Dephosphorylation

(1)A-IV,B-I,C-II,D-III (2)A-IV,B-II,C-III,D-V

(3)A-V,B-I,C-IV,D-III (4)A-III,B-II,C-V,D-IV

2. Match the following with respect to aerobic respiration

List – I	List – II
A) First formed stable intermediate of Krebs cycle	I) SuccinylCo.A
B) Product of 2^{nd} oxidation reaction	II) ∝-Ketoglutaric acid
C) Product of 2^{nd} decarboxylation reaction	III) citric acid
D) Product of 2^{nd} oxidative decarboxylation reaction	IV) Isocitric acid
	V) Acetyl Co.A

(1) A-III,B-IV,C-II,D-I (2)A-III,B-V,C-II,D-I

(3) A-III,B-V,C-Iv,D-II (4) A-IV,B-V,C-II,D-I

3. Match the following

A) ∝-Ketoglutaric acid	I) Pyruvic
B) Connecting link	II) Succinic thiokinase
C) Oxidative decarboxylation	III) 5-Carbon compounds
D) Cleavage	IV) Fumerase
	V) Acetyl CoA

(1)A-V,B-II,C-IV,D-I (2)A-III,B-V,C-I,D-II

(3)A-III,B-V,C-II,D-I (4)A-v,B-II,C-IV,D-III

4. Match the following lists (with reference to Aerobic respiration)

List – I	List – II
A) Number of NADHs formed in Mitochondrion	I) 8
B) Number of CO2 liberated during glycolysis	II) 24
C) Number of ATP utilized	III) 2

D) ATP value of Krebs cycle — IV) 0

V) 3

(1) A-I,B-V,C-III,D-II (2) A-I,B-IV,C-II,D-V

(3) A-I,B-IV,C-III,D-II (4) A-I,B-III,C-II,D-V

5. Match the following with respect to ETS

Carrier	Composition
A) Complex I	I) cytochrome a
B) Complex III	II)$FADH_2$dehydrogenase
C) Complex II	III)NADH dehydrogenase
D) Complex IV	IV) Cytochrome c
	V) Cytochrome bc complex

(1)A-V,B-III,C-I,D-II (2) A-III,B-V,C-II,D-I

(3) A-III,B-IV,C-II,D-V (4) A-III,B-V,C-I,D-II

6. Match the following with respect to ETS

List – I	List – II
A) carries only protons	I) Complex IV
B) Carries only electrons	II) Complex V
C) Mobile electron carrier	III) Ubiquinone
D) Cytochrome C – oxidase	IV) Cytochrome – C
	V) Complex - I

(1)A-I,B-V,C-IV,D-III (2) A-II, B-III, C-IV, D-I

(3) A-II,B-IV,C-V,D-I (4) A-II,B-V,C-I,D-IV

7. Match the following with respect to aerobic respiration

List – I	List – II
A) No.of ATP formed due to oxidation of one Fructose bisphosphate	I) 6
B) No.of ATP formed due to oxidation of one Pyruvic acid	II) 12
C) No. of ATP formed due to oxidation of one Acetyl Co.A	III) 14
D) No.of ATP formed due to oxidation of one PEP	IV) 15
	V) 38

(1) A-IV,B-II,C-I,D-II (2)A-III,B-IV,C-II,D-I

(3) A-V,B-II,C-IV,D-I (4) A-V,B-IV,C-II,D-I

8. Match the following with respect to aerobic respiration

Substrate	Oxygen molecules used
A) One G-3-P oxidation	I)2 ½
B) One Glucose oxidation	II) 6
C) One Pyruvate oxidation	III) 2

D) One Acetyl Co.A oxidation — IV) 4

V) 3

(1)A-V,B-II,C-I,D-III — (2)A-IV,B-II,C-I,D-III

(3)A-V,B-IV,C-II,D-I — (4)A-V,B-I,C-II,D –III

9. Match the following

List – I	List – II
A) Respiration	I) Fermentation
B) CO2& ethyl alcohol as end products	II)ATP
C) Cellular currency	III) Biological oxidation
D) Removal of hydrogens	IV) Exergonic reaction
	V) Reduction

(1)A-IV,B-I,C-II,D-V — (2)A-III,B-II,C-V,D-IV

(3) A-IV,B-III,C-V,D-I — (4)A-IV,B-I,C-II,D-III

10. Match the following with respect to Respiratory Quotient

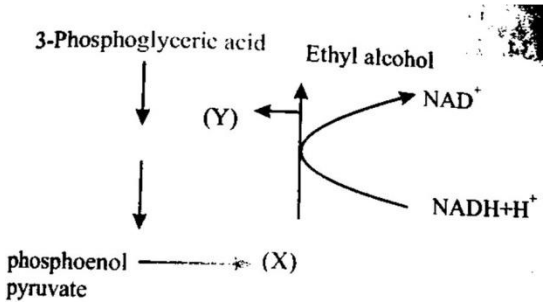
List – I	List – II
A) Lipids	I) one
B) Proteins	II) >1
C) Carbohydrates	III) 4
D) Organic acids	IV) 0.9
	V) Around 0.7

(1) A-V,B-IV,C-I,D-III — (2) A-IV,B-V,C-II,D-I

(3)A-V,B-IV,C-I,D-II — (4) A-III,B-IV,C-I,D-II

6. Diagram Based Questions

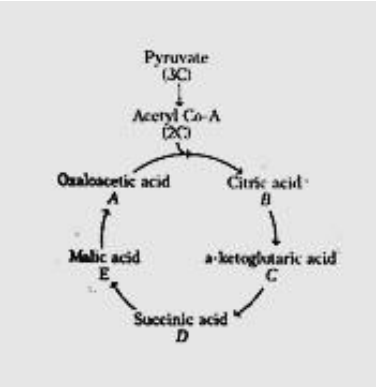
1. Identify the product marked by (X) and (Y) in the following pathway



(1) X-2 phosphoglycerate; Y- Acetyl CoA — (2) X- pyruvate; Y-CO2

(3) X- Phosphoenol pyruvate; Y- Lactic acid — (4) X-Phosphoenol pyruvate; Y- Acetyl CoA

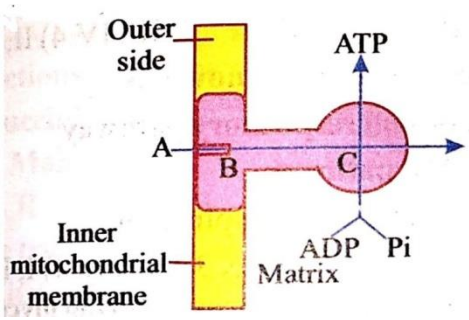
2. Choose the correct combination of labeling number of carbon compounds in the substrate molecules involved in citric acid cycle



(1) A-4C, B-6C,C-5C,D-4C,E-4C (2) A-6C, B-5C,C-4C,D-3C,E-2C

(3) A-2C, B-3C,C-4C,D-5C,E-6C (4) A-4C, B-5C,C-6C,D-4C,E-4C

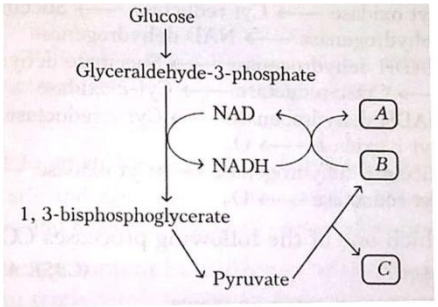
3. Given below the diagrammatic presentation of ATP synthesis in mitochondria. Identify A,B and C choose the correct option accordingly



(1) $A \square H^{\square}, B \square F_1, C \square F_0$ (2) $A \square 3H^{\square}, B \square F_0, C \square F_1$

(3) $\square 2H^{\square}, B \square F, C \square F_1$ (4) $\square 5H^{\square}, B \square F, C \square F_0$

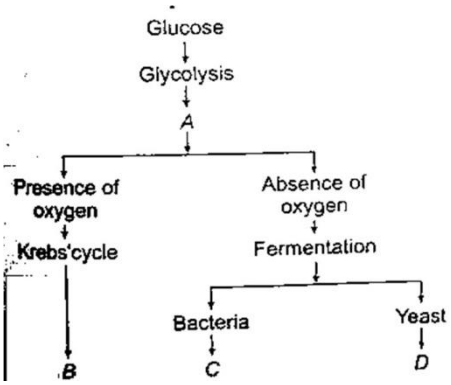
4. Choose the correct combination of labeling the molecules involved in the pathway of anaerobic respiration in yeast



(1) A-CO_2, B- ethanol, C- acetaldehyde (2)A-ethanol, B-acetaldehyde, C-CO_2

(3) A- ethanol, B- CO_2,C- acetaldehyde (4) A- acetaldehyde, B- CO_2, C-ethanol

5. The following is a simplified scheme showing the fate of glucose during aerobic and anaerobic respiration. Identify the end products that are formed at stages indicated as A,B,C and D. Identify the correct option from those given below.



(1) A-carbon dioxide and water , B-Pyruvic acid, C-Ethyl alcohol and carbon dioxide, D-Lactic acid

(2) A-Pyruvic acid, B-carbon dioxide and water,C-Ethyl alcohol and carbon dioxide, D-Lactic acid

(3) A-Pyruvic acid, B-carbon dioxide and water,C-Lactic acid, D-Ethyl alcohol and carbon dioxide

(4) A-Pyruvic acid, B-Ethyl alcohol and carbon dioxide, C-Lactic acid,D-carbon dioxide and water

7. Assertion and Reason type Questions

(1) Both A and R are true and R is the correct explanation of A

(2) Both A and R are true but R is not the correct explanation of A

(3) A is true but R is false

(4) A and R are false

1. A: In respiration ATP are synthesized

   R: ATP are utilized by cell to drive various metabolic functions such as respiration

2. A: In Glycolysis Oxygen is not used

   R: Glycolysis is not having oxidation reactions

3. A: The metabolic fate of Pyruvic acid (after glycolysis) depends on the cellular need.

   R: Pyruvic acid is the key product of glycolysis

4. A:Complete oxidation of one G-3P yields 19ATP

   R: Glucose splits into two molecules of pyruvic acid during glycolysis

5. A:NADH is oxidized to NAD^+ rather slowly in fermentation

   R: In fermentation oxidizing agent for NADH is not oxygen, rather it is acetaldehyde or pyruvic acid

6. (A) :Acetyl Co.A is popularly known as con-e- fleeting link between glycolysis and Krebs cycle

   (R) : Acetyl Co.A is formed from the end prod-uct of glycolysis and it starts the Krebs cycle.

7. (A) : The substrate for first decarboxylation in Krebs cycle is oxalosuccinic acid

   (R) : The substrate for oxidative decarboxylation of Krebs cycle is five carbon acid.

8. (A) : During $NADH_2$ oxidation protons of matrix reach the perimitochondrial space through inner membrane

   (R) : During ATP formation H^+ of perimitochondiral space reach matrix through F_0-F_1, particles.

9. (A) : Mitochondrial $NADH_2$ transport its electron to the UQ through the complex-I

(R) : Electrons of all the mitochondria) NADH + H^+ and $FADH_2$ first pass through this complex to UQ pool

10. (A) : R Q value varies with nature or the respiratory substrate

    (R) : The proportion of C - O is not the same in different respiratory substrates

11. (A) : Mitochondria are essential for aerobic respiration.

    (R) : In any living cell ATP synthase is present only in mitochondria

12. (A) : R Q of tripalmitin is less than 1

    (R): In Tripalmitin Carbon to oxygen ratio is very high

13. (A) : R.Q value of germinating rice grains is one

    (R) :Rice grains store food materials in their endosperm

14. (A) : R.Q value of fats is less than one

    (R) : Fats contain less O_2 and hence consume more O_2 during their oxidative breakdown

8. APPLICATION TYPE

1. No. of oxidations , SLP's decarboxylations respectively in glycolysis pathway are

   (1) 1,2,1 (2) 2,1,0 (3) 1,2,0 (4) 1,1,1

2. For every molecule of glucose during glycolysis, the ratio between pyruvic acid formed and net gain of ATP molecules formed by SWP is

   (1) 1:1 (2) 2:1 (3) 2:3 (4) 3:1

3. The ratio between net gain of ATP, no.of CO_2 liberated and number of ATP utilized during anaerobic respiration with alcohol fermentation is

   (1) 1:2:3 (2) 2:1:2 (3) 1:1:1 (4) 1:2:1

4. The ratio between oxidation reactions to decarboylation reactions in krebs cycle is

   (1) 4:1 (2) 2:3 (3) 2:1 (4) 1:1

5. Each turn of kreb's cycle yields

   (1) $3CO_2$, $2ATP$, $6NADH_2$, $2FADH_2$ (2) $2CO_2, 2ATP, 4NADH_2, 2FADH_2$

   (3) $3CO_2$, 2 ATP, $4NADH_2$, $2FADH_2$ (4) $2CO_2, 1ATP, 3NADH_2, 1FADH_2$

6. How many molecules of NADH+H+ are produceel from the oxidation of each molecule of $\propto$ - ketol glutanic acid under anaerobic conditions?

   (1) 9 (2) 8 (3) 3 (4) 2

7. What is the ratio of oxidation reaction in glycolysis and krebs cycle

   (1) 4:1 (2) 1:4 (3) 2:6 (4) 2:4

8. The ratio between 4- carbon , 5- carbon, 6-carbon compounds formed in Krebs cycle per one – acetyl co . A is

   (1) 3:2:5 (2) 5: 1:4 (3) 3:1: 5 (4) 6:1: 3

9. Number of ATP formed through ETS for the oxidation of each NADH of mitrochordrial matrix is

   (1) One (2) Two (3) Four (4) Three

10. Calculate the number of ATP produced for me Glyceraldehyde 3- phosphate molecule by the end of aerobic respiration through ETS only

(1) 20 (2) 16 (3) 15 (4) 15

11. Number of eletrons transported in ETS when one molecule of O_2 is reduced to water

(1) 2 (2) 8 (3) 6 (4) 4

12. In mitochondria , how many ATP are formed by oxidation of 1 mole of glucose during aerobic respiration

(1) 36 (2) 34 (3) 38 (4) 30

13. The no.of ATP produced from one molecule of cytosolic NADH $+H^+$ is

(1) 6 (2) 4 (3) 8 (4) 2

14. How many ATP are formed the ETS alone from glycolysis, oxidative decarboxylation of 2 mole of pyruvic acid and 2 acetyl COA respectively ?

(1) 6,4,20 (2) 4,6,8 (3) 4,6,22 (4) 4,6,24

15. Calculate the number of ATP produced per one G-3-P molecule by the end of aerobic respiration

(1) 20 (2) 19 (3) 15 (4) 18

9. Questions from previous NEET Exam

1. Conversion of glucose to glucose-6-phosphate, the first irreversible reaction of glycolysis, is catalysed by (2019)

(1) Phosphofructokinase (2) Aldolase

(3) Hexokinase (4) Enolase

2. Respiratory Quotient (RQ) value of tripalmitin is (2019)

(1) 0.09 (2) 0.9 (3) 0.7 (4) 0.07

3. Where is respiratory electron transport system (ETS) located in plants ? (2019)

(1) Mitochondrial matrix (2) Outer mitochondrial membrane

(3) Inner mitochondrial membrane (4) Intermembrane space

4. What is the role of NAD in cellular respiration? (2018)

(1) It functions as an enzyme. (2) It functions as an electron carrier.

(3) It is a nucleotide source for ATP synthesis.

(4) It is the final electron acceptor for anaerobic respiration.

5. Which of these statements is incorrect? (2018)

(1) Enzymes of TCA cycle are present in mitochondrial matrix.

(2) Glycolysis occurs in cytosol.

(3) Glycolysis operates as long as it is supplied with NAD that can pick up hydrogen atoms.

(4) Oxidative phosphorylation takes place in outer mitochondrial membrane.

6. Which statement is wrong for Krebs' cycle? (2017)

(1) There is one point in the cycle where FAD^+ is reduced to $FADH_2$.

(2) During conversion of succinyl CoA to succinic acid, a molecule of GTP is synthesised.

(3) The cycle starts with condensation of acetyl group (acetyl CoA) with pyruvic acid to yield citric acid.

(4) There are three points in the cycle where NAD^+ is reduced to $NADH^+ H^+$.

7. Which of the following biomolecules is common to respiration-mediated breakdown of fats, carbohydrates and proteins? (2016)

(1) Glucose-6-phosphate (2) Fructose 1, 6-bisphosphate

(3) Pyruvic acid (4) Acetyl CoA

8. Oxidative phosponorytation is (2016)

(1) Formation of ATP by transfer of phosphate group from a substrate to ADP

(2) Oxidation of phosphate group in ATP

(3) Addition of phosphate group to ATP

(4) Formation of ATP by energy released from electrons removed during substrate oxidation.

9. Specialised epidermal cells surrounding the guard cells are called (2016)

(1) Complementary cells (2) Subsidiary cells

(3) Bulliform cells (4) Lenticels

10. The number of substrate level phosphorylation in one turn of citric acid cycle is (NEET 2020)

1) Two 2) Zero 4) Three 4) One

KEY SHEET

2. FILL IN THE BLANKS

1. Cellular Respiration
2. Mitochondria
3. ATP
4. Respiratory substrates
5. Cytoplasm
6. Acetyl CoA
7. Pyruvic acid
8. 2ATP
9. Rthylalcohol and CO_2
10. Lactate dehydrohenase
11. 2ATP
12. Plastrix of the mitochondria
13. $\propto$ - Ketoglutaric acid
14. Inner membrane
15. Glucose
16. 36-ATP
17. 1(one)

18. F_0-F_1 particles
19. Cytochrome –C
20. Respiratory Substrates

3: TRUE OR FALSE

1) F	2) F	3) F	4) F	5) F	6) F	7) F	8) F	9) F	10) T
11) F	12) F	13) F	14) T	15) F	16) T	17) F	18) F	19) F	20) F

4. OBJECTIVE TYPE BITS

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

5. MATCHING TYPE

1) 1	2) 2	3) 2	4) 3	5) 2	6)	7) 4	8) 1	9) 4	10) 1

6. DIAGRAM BASED QUESTIONS

1) 2	2) 1	3) 2	4) 2	5) 3

7. ASSERTION AND RESONS

1) 3	2) 3	3) 2	4) 2	5) 3	6) 1	7) 4	8) 2	9) 3	10) 1
11) 3	12) 3	13) 2	14) 1						

8. APPLICATION TYPE QUESTIONS

1) 3	2) 1	3) 3	4) 3	5) 4	6) 4	7) 2	8) 2	9) 4	10) 2
11) 4	12) 2	13) 4	14) 3	15) 2					

9. PREVIOUS NEET QUESTIONS

1) 3	2) 3	3) 3	4) 2	5) 4	6) 3	7) 4	8) 4	9) 2	10) 4

SENIOR INTERMEDIATE WORK BOOK

BOTANY

UNIT-I PLANT PHYSIOLOGY

Chapter 6 Plant Growth and Development

Note to the students

1.*Please read the text book and go through the lines before you solve these small questions in the work book.*

2.*you may need to apply the knowledge given in the chapter' Plant Growth and Development' to solve some questions.*

3. Discuss the anwers and solutions with your friends and your lecturer.

4.The key concepts given abve may give you some clues in solving the below questions.

Key concepts of " Plant Growth and Development"

Growth

➢ Growth is an irreversible increase in size of an organism or its parts or even of an individual cell.
➢ Plants show growth throughout their life and have a capacity to show unlimited growth(indefinite) due to the presence of meristems at certain locations in their body.
➢ Meristems are a type of plant tissue consisting of undifferentiated cells that can continuous to divide and differentiate.
➢ The cells of the meristem have the capacity to self –perpetuate(continuous or ceaseless) o But the product looses the capacity to divide and such cells help to make up the plant body.
➢ Root apical meristem and shoot apical meristem responsible for growth in length or height of plant and referred it as Primary growth.
➢ Lateral meristems , cork cambium, vascular cambium responsible for growth in diameter of the plant body in dicotyledonous plants , gymnosperms and referred it as secondary growth.

➢ **Growth is Measurable**

➢ Growth when considered at cellular level is a consequences of increase in the amount of protoplasm. Increase in protoplasm is difficult to measure and hence certain relatable factors or parameters are used to measure growth .
➢ Increase in fresh and dry weight ➢ Increase in area, volume of fruits and leaves .Eg. cells in watermelon may increase in size by upto 3,50,000 times. ➢ Increase in length Eg. Root, shoot, growth of pollentube ➢ Increase in number of cells Eg. One single maize root apical meristem can give rise to >17,500 new cells per hour.
➢ Increase in surface area denotes growth in a dorsiventral leaf

Phases of Growth

- The period of growth is generally divided into three phases, namely,

1.Meristamatic phase
2.Elongation phase
3.Maturation phase

Growth rate

- The inceased growth per unit time is termed as growth rate. It can be expressed mathematically i.e**. arithmetic or geomaetrical**.
- In **arithmetic growth** , the following mitotic cell division ,only one daughter cell continues to divide , while othe differentiates and matures.
- On plotting the length of the organ against time, a **linear curve** is obtained.

L1 = Lo +rt
L1 = Length at time 't'
Lo = Length at time 'zero'
R = Growth rate / elongation per unit time.

- In **geometrical growth** –Both progeny cells following a mitotic cell division retain ability to divide and continue to do.
- Plot the parameters of growth against the time , a typical **sigmoid curve or S-shaped curve** is obtained.It is characteristic of living organism. The exponential growth is mathematically expressed as

$W1 = Wo\ e^{rt}$

W1 = Final size
Wo = Initial size at the beginging of the period
r =Growth rate
t = Time of the growth
e =Base of the natural logarithms

- Quantitate comaprisions between the growth of living system can be of two kinds.

1. Absolute growth
2. Relative growth

- **Absolute Growth Rate(AGR)-** Total growth per unit time and determined when the field of a plant or organ is to be calculated

AGR =Final size- initial size /time.

- **Relative Growth Rate(RGR)-** Growth of each per unit time and expressed per unit of the critical weight or volume

RGR =AGR/initial size * 100 (for %)
RGR =AGR/initial size (for points)

Conditions for growth

- **Water, oxygen, nutrients,temperature necessary conditions for growth.**
- **Water** useful in turgidity and also provides the medium for enzymatic activities needed for growth.
- **Oxygen** helps in releasing metabolic energy essential for growth activities**.**

- **Nutrients(**macro and micro essential elements) are required by plants the synthesis of protoplasm and act as source of energy.
- **Temperature –**Every plant has optimum temperature range best suited for its growth**.**
- **Environmental** signals such as light and gravity also affect ceartain phases and stages of growth.

Differentiation, Dedifferentiation and Redifferentiation

- **Differentiation**-Cells divide from root apical and shoot apical meristems and cambium differentiate and mature to perform specific functions.is termed as differentiation.
- **Dedifferentiation**- Living differentiated cells have lost capacity to divide, may regain capacity of division under certain conditions and it is called as dedifferentiation.

Eg. Interfascicular cambium and cork cambium.

- **Redifferentiation**- Meristems /tissues which have are able to produce cells that once again loose the capacity to divide but mature to perform specific functions. It is called redifferentiation**.**
- **Eg.**cambium, formation of secondary cortex, cork from cork cambium or

Secondary phloem and secondary xylem from vascular cambium.

Development

- The changes that takes place in a plant in its life cycle from its germination of seed to senescence are termed as development.
- **Plasticity** -Plants follow various pathways in response to environment or phases of life to form different kinds of structures. This ability is called plasticity.
- Eg. Heterophylly in cotton, coriander and larkspur (Delphinium)

Plant Growth Regulators(PGR)

Type of PGRs	**Name of the PGR**	**Derivatives of**	**Biosynthesis from**	**Functions**
Growth promotingPGRS	**Auxins**	**IAA**	**Tryptophan**	**Cell elongation**
	Gibberellins	**Terpenes**	**IPP(Isopentyl pyrophosphate)**	**Internode elongation**
	Cytokinins	**Adenine**	**Purine**	**Cell division**
Growth inhibitor PGRs	**Abscissic acid**	**carotenoids**	**IPP**	**Dormancy**
	Ethylene	**Gases**	**Methionine**	**Abscission**

Auxins:

History:

Charless Darwin and his son Francis Darwin conducts experiments on the colieoptiles of Canary grass, and stated that unilateral light was focused on the top of coleoptiles bending occurs towards light due to phototropic movements. It was concluded that the tip of the coleoptiles was the site of transmitable influence that caused the binding of the entire coleoptile. Auxins was isolated by F.W went from the tips of coleoptile of oat.

Physiological effects of auxins:

➢ **Auxins help to intiative root on stem cuttings**
➢ **Auxins promote flowering in pineapple like plants.**
➢ **Help to prevent fruit and leaf drop at early stage but promote the abscission of older mature leave and fruits.**
➢ **It causes apical dominanace in plants**
➢ **Auxins induces the parthenocarpic fruits. Eg; In Tomatoes.**
➢ **Auxins also controls xylem differentiation and help in cell division.**

Agricultural /Horticultural applications of auxins;

➢ Synthetic auxins like IBA, NAA and natural auixns like IAAwhen applied at low contrations induce root formation on stem cuttings. This method widely used for plant propagation in horticulture.
➢ 2,4-D (2, 4- Dichloro phenoxy acetic acid) are widely used as herbicides to kill dicotyledonous weeds. So it is used to prepare weed free lawan by gardeners

Physiological effects of Cytokinins:

➢ Promotes cell divison (root apices, developing shoot buds, young fruits)
➢ They help in production of new leaves
➢ They help to over come the apical dominance
➢ They promote nutrient mobilisation which help in the delay of leaf senescence

Physiological effects of ABA (Abscissic acid)

➢ ABA promtes abscission of leaves flowers, and fruits in plants
➢ ABA accelearates the senescence of leaves . ➢ It inhibits the seed and bud germination .
➢ It stimulates closure of stomata in epidermis and increases the tolearance of plants to various kinds of stresses. (stress hormone).

Physiological effects of Gibberellins:

- Gibberellins increasing in the length of axis is used to increase in the length of grapes stalk.

- They break seed dormancy
- They cause fruits like apple to elongate and improve their shape.
- They delay senescence and fruits can be left on the free for longer period to extend market period
- GA3 is used to speed up malting process in brewing industry.
- Spraying juvenile conifers with GA3 hastens maturity period leading to early seed production.
- They promote bolting (sudden internode elongation just prior flowering) in beet cabbages and many plants with rosette habit.

Physiological effects of Ethylene:

- Ethylene promotes senescence.
- Abscisson of plant organs, especially of leaves and flowers.
- Hastens fruit ripening in apples and tomatoes.
- Promotes root growth and root hair formation, thus helping plants to increase their absorption surface
- Promotes rapid inter node/petiole elongation in deep water rice plants.
- Intiate flowering in pineapples and mango.
- Accelerates female flowers in cucumber, there by increasing the yield.

Seed dormancy

- Germination of seeds - seedling comes out from the seed is called germination.
- Seed unable to germinate due to external and internal conditions.
- Quiescence –when the seed unable to germinate because of unfavourable external conditions for growth.
- Dormancy –When the seed fail to germinate due to unfavourable internal conditions, eventhough external conditions suitable.
- Dormancy of seeds may be due to hard seed coats (prevent uptake of oxygen or water) , chemical compounds(tomato).

➢ Dormancy caused by hard seed coat can be broken by Scarification, a method by which the hard seed coat is ruptured or weekened
➢ Some seeds able to germinate when exposed to low and temperatures. ➢ When daily temperatures alternate between high and low, The practice of layering the seeds during winter in layers of moist sand and peat is called stratification or prechilling.

Photoperiodism

➢ Photoperiodism- The flowering response of plants to periods of day/night is termed as photoperiodism. On the basis of photoperiodic response, plants are classified into following categories.
➢ 1.Long day plants- These plants flower , when they receive light more than their critical photoperiod. Eg. Spinach, beetroot.
➢ 2.Short day plants- These plants flower , when they receive light less than their critical photoperiod. Eg. Chrysanthemum, Euphorbia .
➢ 3.Day neutral plants- Flowering is not affected by photoperiod. ➢ Eg. Sunflower, cotton, tomato,cucumber .

Vernalization

➢ It is the method of inducing flowering in plants by pre-chilling treatment.
➢ The plants remain vegetative during warm season and when they receive low temperature during winter, they grow further and then bear flowers and fruits.
➢ It helps the plants to reach the vegetative maturity before reproduction can occur.
➢ Eg. Biennal plants- biennals are monocarpic plants that normally flower and die in the second season. In the first year exposed to cold treatment and stimulates a subsequent photoperiodic flowering response.

I. Match the words/sentences

Match the terms in column A with suitable terms in column B

A		B
1.Vernalisation	( )	a).foolishdisease
2.ABA	( )	b).synthetic auxin
3. Gibberella fujiokori	( )	c).Ripening fruits
4.IBA	( )	d).Low temperature
5.Ethylene	( )	e).senescence
6.2,4,-D	( )	f).Canary grass
7.Charles Darwin	( )	g). Herbicide
8.Dormancy of seed coat broken by	( )	h).Linear growth
9.Apical meristem	( )	i).Cytokinins
10. Opening of stomata	( )	j).Scarification

II. Carefully observe the following statements. Denote whether they are true/false.

11. Abscissic acid is a growth promoter

True/ False

12. Spraying of sugar cane of with Gibberellins increasing in the yield

True/ False

13..Cytokinins help in the delay of senescence.

True/ False

14. The process of layering the seeds during winter in layers of moist sand and peat is called stratification.

True/ False

15. cytokinins induces immediate stomata closure in leaves.

True/ False

16. Lateral meristems located at shoot and shoot apices.

True/ False

17. Ethylene promotes senescence and abscission of plant organs.

True/ False

18. Heterophylly in cotton,coriander due to plasticity.

True/ False

19. Increase growth per unit time is known as growth rate.

True/ False

20. Sudden elongation of internodes prior to flowering due to cytokinins.

True/ False

III. Fill in the blanks

Fill the following sentences with suitable words

Indole acetic acid, cytokinin, Growth , auxins. stress ,rosette, unfavourable, ethylene, Oxygen, gibberellins.

21. An irreversible increase in size of an organism or its parts or even of an individual cell is known as---------

22.IAA stands for----------

23. Dormancy of seeds broken by ----------

24. Abscissic acid (ABA) also acts as ---------- hormone

25. Induce rooting in a twig----------

26. Gibberellins induce stem elongation in--------- plants

27. Dormancy of seed due to---------- internal condition.

28.----------hormone responsible for enhancement of respiration during ripening of fruits.

29. overcome of apical dominance in plants by----------hormone.

30---------- helps in releasing metabolic energy essential for growth activities

IV. After reading the lesson try to explain the following very shor answer questions in one or two sentences each.

31. Define plasticity. Give an example.

---

32. What is the disease that formed the basis for the identification of gibberellins in plants? Name the causative fungus of the disease.

---

33. What is apical dominance?Name the growth hormone that causes it.

---

34. What is meant by bolting?which hormone causes bolting?

---

35. Define respiratory climactic.Name the PGR associataead with it.

36.What is ethephon?Write its role in agricultural practices.

37.Which of the PGRs is called stress hormone and why?

38.what do you understand by vernalizaation?write its significance.

---

39. Define the terms quiescence and dormancy.

40.Give an example for herbicides?

IV.After reading the text book try to answer these following questions on your own in one or a sentences.

41.Which hormone used to kill dicotyledonous weeds and prepare weed free lawns by gardener.

42.What is the technique that is widely applied in the tea plantation and hedge making to over come apical dominance?

43.Sugarcane stores carbohydrates as sugar in their stress. Which hormone spraying sugar cane crop to increases in the yield by much as 20 tonnes per acre.

---

44. Is the growth in plants definite or indefinite?

---

45. The search for natural substances with cytokinin like activites lead to the isolation of zeatin. What are the sources of zeatin?

---

46. The fruits can be left on the tree longer so as to extended the market period . Which hormone is used to speed up malting process in brewing industry.

47.Does Kinetin occurs naturally?

48.Ethylene is used to initiate flowering and for synchronising fruit-set in which plant and it also induces flowering in which plant?

49.While shoot apices modify themselves in to flowering prior to flowering. They by themselves cannot perceive photoperiods. Name the site of perception of light/dark duration

---

50.During secondary growth of plants which meristemsthat causes the increase in the girth of the organs of the plant?

.---

VI. Multiple choice questions

51.IAA is derived from

(a) Tryptophan (b)Tyrosine (c) Phenyalanine (d)None of these

52.Cell elongation in intermodal regionsof the green plants takes place due to

(a)Auxins (b) Cytokinins (c) Gibberellins (d) Ethylene.

53. Apical dominance is due to

(a) Auxins (b) Cytokinins (c) Gibberellins (d) Ethylene

54. Plants requiring exposure to light for less than critical period in order to flower is called

(a)Long day plants (b)Day plants (c) Intermediate day plant (d)Short day plants

55. Which of the following is a gaseous hormone?

(a) Ethylene (b) cytokinin (c)Both ethylene and auxi (d) ABA

56.The hormone present in liquid endosperm of coconut is

(a) Gibberellins (b)Cytokinins (c) Ethylene (d)Auxins

57.An example of short day plants is

(a) Wheat (b)Maize (c)Chrysanthemum (d)Radish

58. Seeds of some plants are unable to geminate even when external conditions are favourable . this is called

(a) Dormancy (b) Quiescence (c) Vivipary(d)Non –viability

59.Phototropism is due to hormone

(a) IAA (b) GA (c)2,4-D (d)Cytokinins.

60.Which one of the following plant is LDP

(a) Xanthium (b) Soyabean (c) Wheat (d) Tobacco

UNIT-I,Plant physiology, chapter - 6 Plant Growth and development

Key to I, II,III

1	d	11	True	21	Growth
2	e	12	True	22	Indole acetic acid
3	a	13	True	23	Gibberellins
4	b	14	True	24	Stress hormone
5	c	15	False	25	Auxins
6	g	16	False	26	Rosette
7	f	17	True	27	Unfavourable
8	j	18	True	28	Ethylene
9	h	19	True	29	Cytokinins
10	i	20	False	30	Oxygen

Key to IV

31.Plants follow various pathways in response to environment or phases of life to form different kinds of structures. This ability is called plasticity. Eg. Heterophylly in cotton, coriander,larkspur
32.Disease-Bakane (Foolish seedling)disease Causative fungus-Gibberella fujikuroi
33. Growing apical bud inhibits the growth of axillary buds is called apical dominance. Growth hormone-Auxins
34. Bolting- sudden elongation of internodes of the stem prior to flowering. Hormone –Gibberellins
35.Rise in rate of respiration during the ripening of the fruits is known as respiratory climactic. PGR name-Ethylene
36. Ethephon- Ethylene releasing chemical substance is called ethephon Role in agriculture-1. Ethephon hastens fruit ripening. 2. Accelerates abscission in flowers and fruits. 3. It promotes female flowers in cucumber there by increasing the yield
37. Stress hormone -Abscissic acid (ABA) ABA induces the closure of stomata in the epidermis and increases the tolerance of plants in various kinds of stresses.hence it is called Stress hormone
38.Vernalozation- It is the method of inducing flowering in plants by pre-chilling treatment.I t helps in shortening of the vegetative phase and early initiation . . Reproductive phase by aprevious cold treatment in plants. This process successfully used in many winter annuals and biennal plants
39.Quiescence: when the seed unable to germinate because of unfavourable external conditions for growth.

Dormancy –When the seed fail to germinate due to unfavourable internal conditions, eventhough external conditions suitable
40. 2, 4 –Dichlorophenoxy acetic acid(2,4-D)

Key to V

41. 2,4-D (2, 4 –Dichlorophenoxy acetic acid)
42. Decapitation (Removal of apical bud, results in the growth of axillary buds)
43. Gibberellins
44. indefinite
45. Corn kernels, and coconut milk
46. Gibberellins
47. Kinetin is a cytokinine and a degradation product of DNA. It does not occur naturally.
48. Pineapple and mango
49. Leaves
50. Lateral meristem, vascular cambium and cork cambium.

Key to VI

1.(a) 2.(a),3.(a),4.(d),5(a),6.(b),7.(c),8(a),9.(a),10.(c).

51	a	56	b
52	a	57	c
53	a	58	a
54	d	59	a
55	a	60	c

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UNIT – 7

KEY POINTS OF BACTERIA

Bacteria was identified firstly by " Anotony van Leuvea hock (1674) and term coined by Ehrenberg (1829).

- Louis Pasteur called them as "Chemical factories and he was considered as "Father of Bacteriology".
- Germ theory of diseases proposed by coach (1870)
- Bacterial existence is universal. These can live in all kinds of habits of temperatures, atmospheres , living and non-living.
- Size of Bacteria ranges from 2.0 to 5.0 length and breadth is 0.5 to 1.0 um.
- These are in various shapes like spherical, rod shape, comma and may be free or pairs or in colonial forms.
- Some bacteria can change their shape, according to their need of atmosphere and availability of food.
- Flagella can help to move.
- Flagella can arrange differently in various bacteria.
- The main genetic mankind is "Bacterial chromosome or additional to genophore
- Round, double stranded DNA molecules called plasmids.
- These plasmids can act as "Defensive mechanisms" to bacteria.
- These plasmids can be used as vectors in Genetic Engineering.
- Nutrition in bacteria is various kinds like photo autotropism, chemo auto tropism, chemo hetero tropism and photo hetero tropism.
- The reproduction in bacteria, vegitatively by binary fission and sexual reproduction also.
- Sexual reproduction kinds are conjugation, transformation and transduction.
- Exchange /or transfer of genetic mankind by touch or Direct contact is conjugation.
- Receiving of genetic mankind from atmosphere is transformation.
- Gene transfer through Backinophase is transduction.
- Bacteria act as Friends and Enemies to human.
- Some bacteria causes diseases in plants, animals and human also.
- Some bacteria helps in so many aspects to plants, animals and human.
- Some bacteria is useful in bio mining and some as bio-sensors.

I. Fill in the blanks.

1. Father of micro biological generated diseases is …….
2. The most useful bacteria to human beings is ……..
3. part of the bacteria is mostly used in modern genetic engineering technology.
4. Father of Bacteriology is …….
5. Biggest bacteria is ……

II. Matching – I

a) Rod shaped bacteria
b) Pleomorphic bacteria
c) Baggiota
d) Spiral shaped bacteria
e) Stephilo coccus
f) Filamentous bacteria
g) Irregularly arranged bacteria
h) Zubrioidae
i) Bacillus
j) Aceto bactor

III. Matching – II

a) Laderberg, Taturn
b) Streptococcus phenmoniae
c) Purification of Ganga river
d) Transduction
e) Photo heterotrophy
m) Lederberg & Grinder
n) Rhodo spirillum
o) Frederick Griffith
p) Dello vibrio
q) escheresia coli

IV. Multiple choice questions

1. Saprophytic bacteria
   a) Cromatium monos b) Bacillus c) Xanthomonos d) Rhodopseudo monos
2. Photo antotrophic bacteria
   a) Cromatium monos b) Bacillus c) Xanthomonos d) Rhodopseudo monos
3. Photo hetero trophic bacteria
   a) Cromatium monos b) Bacillus c) Xanthomonos d) Rhodopseudo monos
4. Chemo antotrophic bacteria
   a) Chlorobium, Nitrosomonas

b) Nitrosomonas, Rhodo spirillum
c) Nitrosomonas, Baggiota
d) Nitro bactor, Chlorobium

5. Crown gall disease in apple is caused by bacteria
   a) Xanthomonos orizae
   b) Xanthomonos aureopodic pv citri
   c) Agrobacterium tumifascience
   d) Phytopthora infestans

Reasoning/ Logical/ Thought provoking questions

1. Bacteria is a good friend to human. Explain
2. Bacteria is a friend and enemy to doctors . Comment & Explain.

NEET Questions :

1. What is chemotarcis ?
   a) Swimming towards bacteria
   b) Swimming away of bacteria
   c) Swimming towards or away of bacteria
   d) None of the above.

2. Which one of these has a Chinese letter arrangement
   a) Clostridium tetami
   b) Myobacterium tuberculosis
   c) Bacillus anthrasis
   d) Corena bacterium diphtheria

3. This is analogous to menosomes of bacteria
   a) Golgi of Eukaryotes
   b) Lysosomes of eukaryotes
   c) Motochondria of Eukaryotes
   d) None of the above

4. Which of these is exposed on the outer surface of a gram negative bacterious
   a) Braun Lipo protein
   b) An antiger of lipo polysaccharide
   c) Polysaccharide portion of lipo techoic acid
   d) Electron transport system components

5. Flagella of bacterium enables them to
   a) Reproduce
   b) Locomote
   c) Thrive in nutrient agar
   d) Adhere to tissue surface

6. Which of these is cocci occurring in single or pairs.
   a) Diplo cocci b) strepto cocci c) Tetra cocci d) None of the above

7. Cluster of flagella at a pole is called
   a) Petri trichous b) Mono trichous c) amphi trichos d) lopho trichous

8. Pencillin resistant bacteria
   a) Spiro chetes b) cyano bacteria c) mycoplasma d) bdello vibrioe

9. Gram positive bacteria cell wall
   a) Comprising many layers.
   b) Cell wall is thicker than the ' –' ve bacteria.
   c) Comprises of techoic acids
   d) All of the above.

10. The covalent bond between the cell walls of gram positive bacteria is
    a) Glycosidic bond
    b) -1, 4 glycosidic bond
    c) 1, 6 glycosidic bond
    d) Glycosidic bond

UNIT – 8

VIRUSES

KEY POINTS :

- Viruses are a unique group of 'biological entities' known to infect every type of cell.
- A virus particle contains a single type of nucleic acid/genetic material (DNA/RNA) and with protein
- Viruses maintain reproduction and mutations but do not exhibit most of the life processes.
- Viruses are "infectious particles"
- These are "obligate intracellular parasites"
- The study of viruses are known as 'virology'
- Russian scientist Iwanowski identified and confirmed this virus as "contagious living fluid "
- W. M. Stanley is a scientist who crystallized virus.
- Fraenkel Conrot (1956) confirmed that the genetic material of the TMV is RNA
- Classification regulating institution is 1CTV.
- The levels of classification in viruses are family, genus and species.
- Viruses range in size from 20 mm to 300 mm.
- The shapes of viruses are spherical, polyhedral or spiral.
- Viruses causes diseases like cold, hepatitis, chicken pox, influenza, herpes, warts, polio etc… in humans, chlorosis, mosaic, vein clearing, malformations and breaking of flowers in plants.
- The number of nucleofides in vivoid is 300 to 400.
- The capsule of virus is made up of glycol proteins.
- In viruses, the genetic information is in the form of (ds) DNA or (SS) DNA
- In general, viruses that infect plants have ss RNA , and viruses that infect animals have ds DNA
- The tobacco mosaic virus is about 300 mm long, 18 mm in diametric, with a molecular weight of 39 x 10^{6} daltons.
- The capsid is made up of 2,130 capsomers.
- Each capsomer is made up of 158 amino acids.
- The bacteriophase is distinguished as regions like head and tail.
- Bacteriophase can multiply by two alternative mechanisms i. e lytic and lysogenic cycles.

- Five steps involved in lytic cycle. They are attachment, penetration, biosynthesis, maturation & release.
- Lysis of host cell will not occur in lysogenic cycle,
- Cancer causing viruses are "oncogenic viruses".

I. Fill in the blanks :

1. One virus consisting of nucleic acid and ……
2. The scientist_____identified virus at first time.
3. Virus is a "contagious living fluid" identified scientist is _____.
4. "Viridae" is a term denotes the_____level of classification.
5. The spikes of viruses are made up of _____
6. _____forms the genome in viruses.
7. The number of amino acids in capsomere is _____
8. The enzyme_____helps to dissolve the cell wall and release of virious.
9. The breaking of flowers in tulip and beautiful in appearance causing virus is_____.
10. Causing portion/part of virus is_____which create "Mad cow disease" and Creutzfeldt – Jakob disease.

II. Multiple Choice Questions :

1. Viruses are
   a) Obligate intercellular parasites
   b) Facultative intracellular parasites
   c) Obligate intra cellular parasites
   d) Facultative inter cellular parasites.
2. gs virus containing nucleic acid , if containing , what is that
   a) RNA b) DNA c) DNA & RNA d) RNA/ DNA
3. In viruses, along with nuclei acid and protein cap, what kind of coverings can be
   a) Lipids, proteins
   b) proteins, carbohydrates
   c) Lipids, proteins and carbohydrates
   d) Proteins , carbohydrates and esters.
4. Viruses exhibiting characters.
   a) Mutations b) Reproduction c) Respiration d) Irritation

5. Steps involved in lytic cycle.
   a) Attachment, maturation, release bio synthesis
   b) Biosynthesis, maturation , attachment, release
   c) Attachment, biosynthesis, maturation , release
   d) Biosynthesis, attachment, maturation, release

6. The virus which attacks on Anabeane and Blue Green algae
   a) Bacteriophase b) Zoophase c) Cyanophase d) Influenza virus

7. LCTV means
   a) International Council of Television
   b) International Committee on tourist voice
   c) Indian Council of tobacco virus
   d) International Committee on taxonomy of viruses.

8. Number of nucleiotides in capsid.
   a) 6000 b) 6600 c) 6500 d) 6660

9. Diseases caused by viruses in human
   a) Rabis, AIDS , Rubella, Polio
   b) Rabis, Polio, Diptheria, Ciphilis
   c) Hepatitis, Pneumonia, Botulism, Tetanus
   d) T. B, polio, cholera and AIDS

10. Cancer causing viruses
    a) Herpis virus b) Tobacco mosaic virus
    c) Onco virus d) Small pox virus

Application based & thought provoking questions :

1. Gs virus is living or non living. Explain….
2. Gs small pox virus causing or Goddess related ?
3. We can fight with visible like animals and human, but we cant fight with invisible viruses. Why ?
4. Gs virus is Biological thing or Bio weapon ?
5. What are the measures, that you can take to control the viruses and its effect.

NEET QUESTIONS :

1. Cauliflower virus are group of viruses which have
   a) RNA b) D RNA c) DNA d) DNA

2. Protein of capsomeres are made up of
   a) Nucleic acid b) carbohydrates c) proteins d) amino acids

3. Term virion is used for
   a) Mycoplasm colony b) group of viruses c) Nostoc colony d) single virus

4. Which of the following is absent in virus
   a) Cell wall b) cell membrane c) cytoplasm d) all of the above

5. Each capsomere of TMV contain amino acids whose number is
   a) 158 b) 185 c) 815 d) 581

6. Dahlia mosaic virus has
   a) DNA b) RNA c) a & b d) None of these

7. Arthropod borne virus is
   a) Ribo virus b) Reo virus c) Arbo virus d) None of these

8. Which of the following is called filterable agent ?
   a) Bacteria b) virus c) fungi d) all of these

9. The first to isolate plant virus was
   a) W. M. Stanley b) E. C. Stackmann c) A. K. Smith d) Ivanovski

10. Algal viruses are known as
    a) Binal viruses b) Cyanophases c) Micophases d) Phycophases

Senior Intermediate Work Book
Botany
Unit –IV. MOLECULAR BIOLOGY

Chapter 10. MOLECULAR BASIS OF INHERITANCE

Note to the students:

1. ***Please read the text book and go through the lines before you solve these small questions in the work book.***
2. ***You may need to apply the knowledge given in the chapter "Molecular basis of Inheritance" to solve some questions.***
3. ***Discuss the answers and solutions with your friends and your lecturer***.
4. ***The key concepts given below may give you some clues in solving the given questions***.

Key concepts of 'Molecular basis of Inheritance':

➢ Study of macromolecules and their mechanism in living beings like gene replication, mutation and expression is called **Molecular Biology**.
➢ **Warren Weaver** coined the term molecular biology. **J.D. Watson** studied the effect of x-rays on bacteriophage multiplication and **F.H.C. Crick** studied the x-ray diffraction, "polypeptides and proteins.
➢ DNA and RNA are the two types of nucleic acids. DNA acts as genetic material and RNA acts as genetic material in some viruses.
➢ Study of complete nucleotide sequence of the human genome is called genomics.
The DNA:
➢ DNA stands for Deoxyribo nucleic acid. The length of DNA is varied in different organisms. Bacteriophage ∅ x 174 has 5,386 nucleotides, Lambda phage has 48,502 bp, *Escheritia coli* has 4.6 $x10^6$ bp, haploid human DNA has $3.3x10^9$ bp.
➢ DNA has two polynucleotide chains and each one has several nucleotides. Each nucleotide has 3 components like nitrogen base, pentose sugar and phosphate molecule.
➢ Nitrogen bases are of 2 types such as **purines** and **pyramidines**. Purines are double ringed namely Adenine (A), Guanine (G) whereas pyramidines are single ringed namely Cytosine (C), Thymine (T).
➢ Nitrogen base and sugar molecule is called nucleoside whereas nitrogen base, sugar molecule and phosphate is called nucleotide.
➢ Nitrogen base is linked to pentose sugar by **N-glycosidic bond** and phosphate group is linked to nucleoside by **phosphodiester bond**.
➢ A polymer ends with free phosphate group is called as 5' end and a polymer ends with hydroxyl group is called 3' end. Back bone is formed due to sugar and phosphates but nitrogen bases are linked with sugar molecules.
➢ Acidic nature of DNA was identified by **Friedrich Meischer** (1869) and named it as **nuclein**.
➢ Chemical analysis was carried out by **Chargaff.** The amount of purines is always equals to pyramidines is called **Chargaff's rule (A+G = T+C)**.
➢ Presence of hydrogen bonds in between the 2 polynucleotide chains was proposed by **Pauling.**

- **Watson and Crick** (1953) proposed **double helix model of DNA**. *ds*DNA has two polynucleotide chains and they are antiparallel to each other.
- Sugar-phosphate-sugar forms the back bone of each strand in the DNA molecules. Sugar and phosphate are bounded by Phosphodiester bond.
- Purines are attached to pyramidines by weak **hydrogen bonds**.
- Adenine (A) is always bonded to Thymine (T) by two hydrogen bonds and similarly Guanine (G) is always bonded to cytosine (C) by three hydrogen bonds. Hence ds DNA appears like a helical stair case.
- The diameter of DNA is **20 A^0** and each turn measures **34 A^0 or 3.4 nm** which contains 10bp and distance between two successive base pairs is **3.4 A^0 or 0.34 nm.**

Packaging of DNA helix:

- The length of mammalian DNA is 2.2 meters and contains $6.6x10^9$bpx$0.34x10^{-9}$ m / bp.
- DNA containing region of prokaryotic cell is called nucleoid. Prokaryotic DNA lacks chromatin organization and referred to as **genophore**.
- In eukaryotes the negatively charged DNA is wrapped around the positively charged histone octamer and appears as **"beads on string"** are known as **nucleosomes**. The chromatin Contains 200 bp of DNA double helix around a core of histone octamer such as two molecules of H_2A, H_2B, H_3 & H_4.
- H_1 histone molecule lies outside the nucleosome core and seals the two turns of DNA. DNA that contains between two successive nucleosomes is called **Linker DNA**.
- Lightly stained chromatin is called **euchromatin** but densely stained chromatin is called **heterochromatin.** Euchromatin is genetically active and hetero chromatin is genetically inactive.

The Search for Genetic Material:

- **Frederick Griffith** (1928) worked on ***Streptococcus pneumoniae*** with mice and proved that rough (R) strain had been transformed by the heat killed smooth (S) strain bacteria. Hence **rough strains (avirulent) transformed into smooth strains (virulent).**
- Avery, Mac Leod and Mc Carty discovered that proteases and RNases did not affect transformation but DNases inhibited transformation and concluded that, the DNA is genetic material.

The genetic material is DNA:

- Hershey and Chase (1952) worked on bacteriophages.
- Viruses grown in presence of radioactive phosphorus contained radioactive DNA but not radio-active protein because DNA contains phosphorus but protein lacks phosphorus.
- Bacteria infected with viruses that had radioactive DNA were radioactive proved that DNA is the genetic material that is passed from virus to bacteria.

Properties of Genetic Material (DNA versus RNA):

- RNA has 2'-OH group at every nucleotide which makes it labile and degradable. It is catalytic, more reactive and mutate fast.
- Presence of Thymine in place of Uracil gives additional stability to DNA. DNA is structurally is more stable, less reactive and mutate less.

Differences between DNA and RNA:

DNA	RNA
1. DNA stands for deoxyribo nucleic acid	1. RNA stands for ribonucleic acid
2. Two polynucleotide chains are present hence it is double stranded	2. One polynucleotide chain is present hence it is single stranded

3. Nucleotides are Numerous	3. Nucleotides are few
4. Deoxy ribose sugar ($C_5H_{10}O_4$) is present	4. Ribose sugar ($C_5H_{10}O_5$) is present
5. Thymine (T) present and Uracil (U) absent	5. Thymine (T) absent and Uracil (U) present
6.Mostly genetic material	6.Mostly non genetic material
7. Replication occurs	7. Replication does not occurs
8. DNA is one type	8. RNA is of 3 types such as *m* RNA, *r* RNA, and *t* RNA
9. Base pairing is A=T and G≡C	9. Base pairing is A=U and G≡C
10. Indirectly involved in protein synthesis	10. Directly involved in protein synthesis

RNA World:
➢ RNA acts as first genetic material as well as catalyst.
➢ RNA enzymes are known as Ribozymes. RNA is reactive and unstable.
➢ DNA has evolved from RNA with chemical modifications and made it more stable.
REPLICATION:
➢ Duplication of DNA molecule is called replication. It was explained by Watson and Crick (1953).
➢ Two strands of DNA could separate by helicase and produce template strands to synthesize complementary strands.
➢ Replication can be done by DNA polymerase and ligase enzymes. The daughter DNA molecules have one parental and newly synthesized strand. Hence this type is called semi conservative DNA replication.
The Experimental Proof:
➢ **Meselson and Stahl** (1958) worked on ***Escheritia coli*.**
➢ They grew *E. coli* in a medium containing $^{15}NH_4Cl$ (heavy isotope of nitrogen) as nitrogen source and proved the semi conservative replication of DNA.
➢ **Taylor** (1958) experimentally proved **semiconservative replication** in ***Vicia faba*** by using radio active thymidine.
The Machinery and the Enzymes:
➢ The enzyme required for DNA replication is DNA polymerase. Human diploid genome has 6.6 x 10^9bp.
➢ *E. coli* genome has 4.6 x 10^6bp and complete the replication within 38 minutes. The average rate of polymerisation has to be 2000bp/s.
➢ The two strands of DNA cannot be separated throughout its length and replication occur with in a small opening called as replication fork.
➢ DNA polymerases catalyse polymerization in 5'-3' direction only.
➢ Replication is continuous (leading strand) in template strand with polarity 3'-5'while replication is discontinuous (lagging strand) in other template strand with polarity 5'-3'.
➢ Discontinuously synthesized DNA fragments are called ***Okazaki fragments*** and later joined by **DNA ligases**.
➢ A particular region in ***E. coli*** DNA where the replication starts is called origin of replication (***Ori***).

Genetic Code:

- Transfer of genetic information from a polymer of nucleotides to a polymer of amino acids is called genetic code.
- **George Gamow** stated that the 4 bases in DNA can be code for **21 amino acids**.
- CODE IS TRIPLET: Code is made up of 3 nucleotides and formed from four nitrogen bases U, C, A, G. It generates 64 codons.
- CODE IS UNIVERSAL: UUU codes for phenyl alanine and UCU codes for serine in all organisms from bacteria to human beings.
- CODE IS UNAMBIGUOUS: One codon codes for only one amino acid, hence it is unambiguous and specific.
- CODE IS COMMALESS: Codon is read in m RNA in a continuous fashion. There are no punctuations.
- CODE IS DEGENERATE: Some amino acids are coded by more than one codon.

  e.g.: Serine is coded by many codons like UUU, UCC, UCA, UCG.
- STARTING CODONS: AUG is a protein initiation codon and codes for methionine amino acid.
- TERMINATION CODONS: UAA, UAG, UGA are protein termination codons which do not code for any amino acid.

Mutations and Genetic Code:

- Sudden heritable changes is called mutations. Addition or deletion of one or two bases changes the reading frame of genetic code is called **Point mutations**. e.g.: Sickle cell anaemia
- Addition or deletion of three or multiple bases changes the reading frame of genetic code is called **Frame shift mutations**.

t-RNA- The Adapter molecule:

- t- RNA stands for transfer RNA. It is also called s-RNA.
- The primary structure of t-RNA is an inverted L shape but secondary structure is Clover – leaf shape.
- t- RNA has 3 loops one has anti codon loop, other has T-loop identifies ribosomes and other has D-loop identifies enzymes.
- Amino acid attached to the 3'- end of t-RNA. t-RNAs are specific for each amino acid. But there are no t-RNAs for stop codons.

Transcription:

- The copying of genetic information from one strand of DNA into RNA is called transcription.
- Transcription Unit: It has 3 regions like Promoter, the structural gene and a terminator.
- DNA strand which has polarity 3'-5' acts as template strand and opposite strand which has polarity 5'-3' acts as coding strand.
- The promoter is located towards 5' end of the coding strand and terminator is located towards 3' end of coding strand.
- A segment of DNA coding for a polypeptide chain is called cistron. Cistron is **monocistronic in eukaryotes** and **polycistronic in prokaryotes**.
- Coding sequences are called **exons** and noncoding sequences are called **introns**.
- In bacteria, there are 3 types of RNA such as m-RNA (messenger RNA), t-RNA (transfer RNA) and r-RNA (ribosomal RNA).
- m- RNA provides template, t-RNA reads genetic code and brings amino acids, r-RNA plays catalytic role in translation.
- RNA polymerase binds to the promoter and initiates transcription is called chain initiation. Nucleoside triphosphates as substrate and polymerises in a template based on complementarity is called chain elongation. Removal of m-RNA and RNA polymerase from cistron is called chain termination.
- RNA polymerase is associated with initiation factor is sigma (***σ***) and termination factor is rho (**ρ**).

➢ In eukaryotes, RNA polymerases are of 3 types. RNA polymerase I transcribes 28s, 18s and 5.8s rRNAs. Polymerase II transcribes *hn*RNA and Polymerase transcribes t-RNA, 5s r-RNA and *sn* RNAs.
➢ In *hn*RNA introns are removed by splicing. Addition of methyl guanosine triphosphates at 5' end of *hn*RNA is called capping and addition of adenylate residues at 3' end of *hn*RNA is called tailing. After splicing, capping and tailing *hn*RNA is converted into m-RNA.
Translation:
➢ Polymerisation of amino acids to form a polypeptide chain according to genetic message present in mRNA.
➢ m- RNA has starting codons (AUG) and stop codons (UAA, UAG, UGA). Ribosomes moves from codon to codon along the m-RNA.
➢ Amino acids are added one by one and joined by peptide bonds in presence of **peptidyltransferase** to form polypeptide chain.
Regulation of Gene Expression:
➢ In eukaryotes gene regulation could be at 4 levels like Transcriptional level, Processing level, Transport of m-RNA from nucleus to cytoplasm and Translational level. But in prokaryotes there is no levels hence transcription and translation occurs simultaneously.
➢ *Escheritia coli* requires β–galactosidase to hydrolyse lactose into galactose and glucose.
➢ Prokaryotes has regulatory proteins can act both positively activators and negatively repressors. Promoter is regulated by proteins called as operators. Operator region is adjacent to promoter and its action in inhibited by repressor protein.
The *Lac* Operon:
➢ Lac Operon was explained by Jacob and Monad. It consists of one regulatory gene (i gene derived from inhibitor), promoter (p) and operator (o) and 3 structural genes (z, y, a).
➢ 'i' gene codes for repressor, 'z' gene codes for β–galactosidase enzyme, 'y'gene codes for permease enzyme and 'a' gene codes for transacetylase enzyme.
➢ When lactose is supplied to growth medium of bacteria due to absence of glucose, lactose enters into bacterium by the action of **permease**.
➢ In the absence of inducer, repressor protein produced by 'i' gene binds to the operator and prevents the formation of RNA polymerase from operon.
➢ In the presence of an inducer, repressor protein is inactivated by inducer.
➢ Regulation of *Lac* Operon by active repressor is referred to as **negative regulation** and regulation of *Lac* Operon by inactive repressor is referred to as **positive regulation**.

* * *

I – Fill in the blanks using the words given below:

Eukaryotes, Ligases, Warren Weaver, 20 A^0, Watson and Crick, 4.6 x10^6 bp, genophore, N-glycosidic bond, AUG, *Streptococcus pneumonia,* Exons, 38 minutes, poly G (guanine), peptidyl transferase, rho (ρ) factor

1. The term molecular biology was coined by …….
2. The number of nitrogen bases present in *Escheritia coli* is …….
3. Bond present between pentose sugar and nitrogen base …….
4. Who proposed double helix model of DNA …….
5. The width of DNA helix is …….
6. All prokaryotic DNA does not contains chromatin organization called as …….

7. Transformation experiments were conducted by Frederick Griffith and he worked on…….
8. In genetic code the starting codon is …….
9. What is the time required to complete replication in *Escheritia coli* is …….
10. The DNA fragments were joined by …….
11. The coding or expressible genes present in *m*RNA called as …….
12. Mono cistronic DNA found in the organisms like …….
13. The factor responsible for termination of polypeptide chain is …….
14. In the processing of *hn*RNA into *m*RNA, the capping can be aided by ……
15. All amino acids present in protein molecule are linked by …….

II– Read the following statements and tick the right answer:

16. The number of nucleotides present in the ds DNA of *Escherichia coli*
4.6 x 10^6bp / 5.6 x 10^6bp
17. The nitrogen bases common to DNA and RNA are
T, A and U / G, A and C
18. Each histone Core is wrapped by how many turns of DNA
Two / three
19. How many types of nitrogen bases are found in nucleic acids?
Four / five
20. If a length of DNA has 45, 000 base pairs, how many complete turns will the DNA molecule take?
4,500 / 45,000
21. In their Semiconservative experiment Meselson and Stahl used
N^{15} / S^{35}
22. Molecular glue or gum is
DNA Polymerase / DNA Ligase
23. This RNA brings the amino acids and reads the genetic code
tRNA / *hn*RNA
24. Reverse transcription is depicted as
RNA→DNA →Protein / RNA→ Protein→ RNA
25. The "Lac operon" concept studies by Jacob and Monad in *E. coli* is applicable for all
Prokaryotes and all eukaryotes / Prokaryotes
26. In *ds* DNA the $\frac{A+G}{T+C}$ = 1 existence was first reported by
Meischer and Franklin / Chargaff
27. Which of the following organisms does not follow the central dogma of molecular biology
HIV / Bacteria
28. A *ds* DNA molecule consists of 200 nucleotides with 20% adenine. What is the number of hydrogen bonds in that molecule?
260 / 360
29. In most of the Operons, the position of Operator gene is in between
P – gene and z - gene / P – gene and A - gene
30. Doubling of DNA generally occurs in
Meiosis / Inter phase

III – Carefully observe the following statements. Denote whether they are true or false:

31. DNA is dependent on RNA for synthesis of proteins
True / False
32. Genetic code is non universal
True / False
33. Nitrogen bases of complementary strand is similar to that of *m*RNA

True / False

34. Lactose is an inducer of lac operon
True / False
35. Structural genes of lac operon of *E. coli* are regulated genes
True / False
36. AUG, GUG and CUG are commonly called as termination codons
True / False
37. In eukaryotes during post transcriptional changes, capping and tailing takes place in cytoplasm
True / False
38. DNA polymerization is always proceeds in 5'→3' direction
True / False
39. RNA can code for DNA as well as protein simultaneously
True / False
40. Purines are always pairs with pyramidines
True / False
41. Mice developed resistance to virulent strains
True / False
42. Discontinuously synthesized DNA fragments are called *Okazaki* fragments
True / False
43. DNA is chemically less reactive when compared to RNA
True / False
44. In bacteria transcription and translation takes place at different sites
True / False
45. Retro viruses have RNA genome and evolve faster
True / False

IV - Match the items in List – A with the items in List-B:

	List – A		**List – B**
46.	RNA polymerase – I	**: [ ]**	1. methionine
47.	RNA polymerase – II	**: [ ]**	2. initiation codon in prokaryotes
48.	RNA polymerase – III	**: [ ]**	3. Segment of DNA specifying a polypeptide
49.	AUG	**: [ ]**	4. transcription of t-RNAs
50.	GUG	**: [ ]**	5. segment of DNA undergo recombination
51.	Cistron	**: [ ]**	6. binds to repressor
52.	Recon	**: [ ]**	7. transcription of *hn*RNAs
53.	Muton	**: [ ]**	8. transcribed by regulator gene
54.	Operon	**: [ ]**	9. transcription of r-RNAs
55.	Inducer	**: [ ]**	10. segment of DNA undergo mutation
56.	Repressor	**: [ ]**	11. genetic unit with structural genes and operator
57.	Operator	**: [ ]**	12. nicking of the DNA strand
58.	Helicase	**: [ ]**	13. target for attachment of repressor
59.	Topoisomerase	**: [ ]**	14. clover leaf model of t-RNA
60.	R. Holley	**: [ ]**	15. unzip DNA strands

V-After reading the text book try to answer these simple questions on your own in one word or a sentence:

61. Who carried out in vitro synthesis of DNA?
……

62. Who was the first to discover the reverse central dogma?

……

63. Define Transposons or jumping elements?
……

64. Name any five viruses which have RNA as the genetic material?
……

65. What are the components of nucleotide?
……

66. What is meant by point mutation or gene mutation?
……

67. What is the percentage of other nitrogen bases if DNA molecule has 30% of thymine?
……

68. Write the codons which code for amino acid phenyl alanine?
……

69. What is the molecular formula of deoxy ribose sugar?
……

70. Who coined the term nucleosome?
……

VI- After reading the lesson try to explain the following concepts in one or two sentences each:

71. What are heterochromatin and euchromatin? Which of the two is transcriptionally active?
……
……

72. Explain the terms exons and introns?
……
……

73. What do you know about capping and tailing?
……
……

74. Define stop codon and give the examples?
……
……

75. Who proved that DNA is genetic material? What is the organism they worked on?
……
……

76. Write the sequence of complementary strand to the template strand of DNA whose sequence is 3'---AATGCAGCTATTAGG---5'?
……
……

77. Write the sequence of m RNA strand to the template strand of DNA whose sequence is 3'---AATGCAGCTATTAGG---5'?

……
……

78. Write the function of DNA polymerase?

……
……

79. Define nucleosome?

……
……

80. What is meant by charging of t-RNA?

……
……

VII – Multiple choice questions:

81. In a DNA strand the nucleotides are linked together by [ ]
    1. Glycosidic bonds 2. Phosphodiester bonds
    3. Peptide bonds 4. Hydrogen bonds
82. A nucleoside differs from a nucleotide. It lacks the [ ]
    1. Base 2. Sugar 3. Phosphate group 4. Hydroxyl group
83. Both deoxy ribose and ribose belongs to a class of sugars called [ ]
    1. Trioses 2. Hexoses 3. Pentoses 4. Polysaccharides
84. The fact that purine base always paired through hydrogen bonds with a pyramidine base leads to the DNA double helix [ ]
    1. Antiparallel nature 2. Semiconservative nature
    3. Uniform width throughout DNA 4. Uniform length in all DNA
85. The net electric charge on DNA and histones is [ ]
    1. Both positive 2. Both negative
    3. Negative and positive respectively 4. Zero
86. The promoter site and the terminator site for transcription are located at [ ]
    1. 3' (down stream) end and 5' (upstream) end, respectively of the transcription unit
    2. 5' (upstream) end and 3' (down stream) end, respectively of the transcription unit
    3. 5' (upstream) end
    4. 3' (down stream) end
87. Which of the following statements is the most appropriate for sickle cell anaemia [ ]
    1. It cannot be treated with iron supplements 2. It is a molecular disease
    3. It confers resistance to acquiring malaria 4. All of these
88. One of the following is true with respect to AUG [ ]
    1. It codes for methionine only
    2. It is also an initiation codon
    3. It codes for methionine in both prokaryotes and eukaryotes
    4. All of these
89. The first genetic material could be [ ]
    1. Protein 2. Carbohydrates 3. DNA 4. RNA
90. With regard to mature mRNA in eukaryotes [ ]
    1. Exons and introns do not appear in the mature RNA
    2. Exons appear but introns do not appear in the mature RNA
    3. Introns appear but exons do not appear in the mature RNA

4. Both exons and introns appear in the mature RNA

91. Who among the following scientists had no contribution in the development of the double helix model for the structure of DNA [ ]
    1. Rosalind Franklin 2. Maurice Wilkins
    3. Erwin Chargaff 4. Meselson and Stahl

92. Which of the following steps in transcription is catalyzed by RNA polymerase [ ]
    1. Initiation 2. Elongation
    3. Termination 4. All of these

93. Control of gene expression takes place at the level of [ ]
    1. DNA replication 2. Transcription
    3. Translation 4. None of these

94. The RNA polymerase holoenzyme transcribes [ ]
    1. Promoter, structural gene and the terminator region
    2. Promoter, and the structural gene
    3. Structural gene and the terminator regions
    4. Structural gene only

95. If the base sequence of a codon in mRNA is 5'-AUG-3', the sequence of t-RNA pairing with it must be [ ]
    1. 5'-UAC-3' 2. 5'-CAU-3' 3. 5'-AUG-3' 4. 5'-GUA-3'

96. The amino acid attaches to the tRNA at its [ ]
    1. 5'-end 2. 3'-end 3. Anticodon site 4. DHU loop

97. To initiate translation, the m RNA first binds to [ ]
    1. Smaller ribosomal sub-unit 2. Larger ribosomal sub-unit
    3. Whole ribosome 4. No such specificity exists

98. In *E. coli* the lac operon gets switched on when [ ]
    1. Lactose is present and it binds to repressor
    2. Repressor binds to operator
    3. RNA polymerase binds to the operator
    4. Lactose is present and it binds to RNA polymerase

99. What would be the length of DNA containing 10000 base pairs [ ]
    1. 68000 A^0 2. 34000 A^0 3. 10000 A^0 4. 100 A^0

100. Which is correct sequence according to increasing molecular weight [ ]
    1. tRNA-DNA-r RNA 2. tRNA-rRNA-DNA
    3. rRNA-DNA-t RNA 4. DNA-tRNA-rRNA

101. The smallest type of RNA is [ ]
    1. tRNA 2. *m*RNA 3. rRNA 4. Genetic RNA

102. DNA is genetic material was proved by [ ]
    1. Watson and Crick 2. Hershey and Chase
    3. Griffith 4. Sutton and Boveri

103. Sum of all the genes in a population is called [ ]
    1. Genotype 2. Gene pool 3. Gene factor 4. Genome

104. *m*RNA in prokaryotes is usually [ ]
    1. monocistronic 2. polycistronic 3. Monokaryotic 4. Replicative

105. Which is an example of Teminism [ ]
    1. DNA→ RNA →Protein 2. RNA→ DNA →m RNA→ Protein
    3. DNA →RNA →Protein→ DNA 4. None of these

VIII – Check if you can answer some questions from previous APEAMCET papers:

106. Choose the correct statement (2019)
    A. DNA is chemically more reactive and structurally stable compared to RNA
    B. Catalytic RNA is known as Ribozymes

C. DNA can directly code for the synthesis of protein, whereas RNA dependent on DNA for protein synthesis
D. Presence of 5-methyl uracil in the DNA also confers stability
The correct answer is:
1. B, D 2. B, C 3. A, B 4. C, D

107. Assertion (A): During transcription both the strands of DNA are copied
Reason (R): If both strands act as template DNA would code for RNA molecule with different sequence (2019)
1. Both A and R are correct and R is the correct explanation of A
2. Both A and R are correct and R is not the correct explanation of A
3. A is correct but R is not correct
4. A is not correct but R is correct

108. DNA molecule which has the highest number of hydrogen bonds (2018)

1. A A G A G C G T
   | | | | | | | |
   T T C T C G C A

2. A G A A G C T T
   | | | | | | | |
   T C T T C G A A

3. G C G A A A G G
   | | | | | | | |
   C G C T T T C C

4. A A T T A C G C
   | | | | | | | |
   T T A A T G C G

109. The number of nucleotides on the m RNA, ATP utilized, peptide bonds formed, translocations and ribosomes required to synthesize a polypeptide with 500 amino acids (2018)
1. 1500, 499, 500, 500 & 500 2. 1503, 500, 499, 499 & 1
3.1503, 500, 499, 500 & 1 4. 1500, 499, 499, 500 & 499

110. A protein has been synthesized according to the sequence of nucleotides presented below. Identify the correct sequence of nucleotides of DNA that help in transcription of the protein
AUG ACG GCA GAC AGA UGA (2017)
1.TAC TGC CGT CTG TCT ACT 2. ATG AGC GCA GCA GGT TGA
3.UAC UGC CGU CUG UCU ACU 4. ATG ACG GCA GAC AGT TGA

111. A scientist has selected a *ds*DNA molecule with 1700 A^0 length for his experiment and deleted 20 coils from the total DNA length. In the remaining molecule 20% of Adenine is present. The ratio among the following is (2017)
A. Total number of nucleotides deleted before conducting experiment
B. Number of Guanins present in the experimented molecule
C. Number of Thymines present in the experimented molecule
1. 20 : 9 : 6 2. 20: 6 : 9 3. 10: 9 : 6 4. 10 : 6 : 9

112. Select the correct statement (2016)
A. H1 histone molecule lies inside the nucleosome core and seals the two turns of DNA
B. Acrocentric chromosome has one extremely short and one very long arm
C. The association between positively charged DNA and negatively charged histone allows for meaningful DNA packaging inside the nucleus
D. A few chromosomes have non-staining secondary constrictions at a constant location and gives the appearance of a small fragment called the satellite
1. A, C 2. B, C 3. B, D 4. C, D

113. TAC AAA GGG TTT CAA CCC – if it is the sequence of nucleotides in a DNA strand, then predict the sequence of amino acids found in a protein formed from it (2016)
1. Proline, phenyl alanine, lysine, methionine, glycine, valine
2. Methionine, phenyl alanine, glycine, valine, lysine, proline
3. Valine, glycine, proline, lysine, phenyl alanine, methionine
4. Methionine, phenyl alanine, proline, lysine, valine, glycine

114. Assertion (A) : Transcription unit is often monocistronic in eukaryotes and polycistronic in prokaryotes
Reason (R) : Exons do not appear in mature RNA, introns appear in mature RNA (2015)
1. Both A and R are correct and R is the correct explanation of A
2. Both A and R are correct and R is not the correct explanation of A
3. A is correct but R is not correct
4. A is not correct but R is correct

115. In insertional inactivation of β –galactosidase gene, the bacteria in white colonies have (2015)
1. Non – recombinant plasmid 2. Recombinant plasmid
3. No plasmid 4. Linear foreign DNA

IX – Check if you can answer some questions from previous NEET papers:

116. Match the following genes of the Lac operon with their respective products (2019)

A. i gene	I. β –galactosidase
B. z gene	II. permease
C. a gene	III. Repressor
D. y gene	IV, transacetylase

Select the correct option:

	A	B	C	D
1.	II	III	I	IV
2.	I	II	III	IV
3.	IV	III	II	I
4.	III	I	IV	II

117. Purines found both in DNA and RNA are (2019)
1. Cytosine and thymine 2. Adenine and thymine
3. Adenine and guanine 4. Guanine and cytosine

118. The experimental proof for semi-conservative replication of DNA was first shown in a (2018)
1. Bacterium 2. Fungus 3. Plant 4. Virus

119. All of the following are part of an operon except (2018)
1. An operator 2. Structural gene 3. An enhancer 4. A promoter

120. The final proof for DNA as the genetic material came from the experiments of (2017)
1. Hershey and Chase 2. Avery, MacLeod and Mc Carty
3. Hargobind Khorana 4.Griffith

121. Spliceosomes are not found in cells of (2017)
1. Fungi 2. Bacteria 3. Animals 4. Plants

122. The equivalent of a structural gene is (2016)
1. Muton 2. Operon 3. Cistron 4. Recon

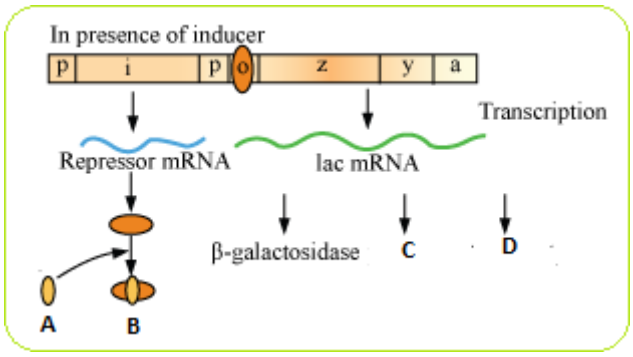
123. Taylor conducted the experiments to prove semi conservative mode of chromosome replication on (2016)
1. *Vinca rosea* 2. *Vicia faba* 3. *Drosophila melanogaster* 4. *E. coli*

124. Balbiani rings are the sites of (2015)
1. Polysaccharide synthesis 2. RNA and protein synthesis
3. Lipid synthesis 4. Nucleotide synthesis

125. Which one of the following is not applicable to RNA (2015)
1. Heterocyclic nitrogen bases 2. 5'phosphoryl and 3' hydroxyl ends
3. Complementary base pairing 4. Chargaff's rule

X – Diagram based questions:

126. Identify the different parts of the *Lac* operon

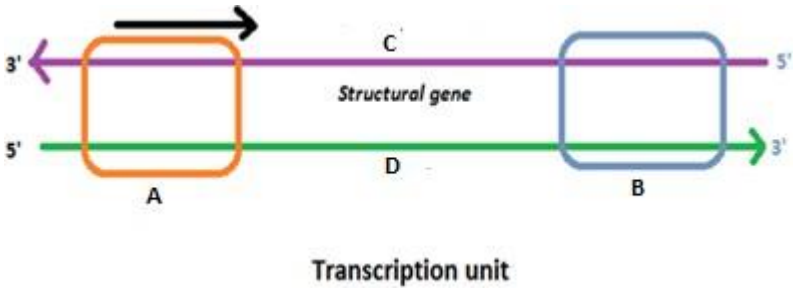


1. A. inducer, B. inactive repressor, C. permease, D. transacetylase
2. A. inactive repressor, B. transacetylase , C. permease , D. inducer
3. A. permease, B. inducer , C. inactive repressor , D. transacetylase
4. A. transacetylase, B. inducer , C. permease , D. inactive repressor

127. Identify the various parts of the bacterial transcription

1. A. Rho factor, B. 5'-end , C. RNA polymerase, D. 3'-end
2. A. 3'-end, B. Rho factor, C. 5'-end , D. RNA polymerase
3. A. 5'-end, B. 3'-end, C. RNA polymerase , D. Rho factor
4. A. 3'-end, B. RNA polymerase , C. Rho factor, D. 5'-end

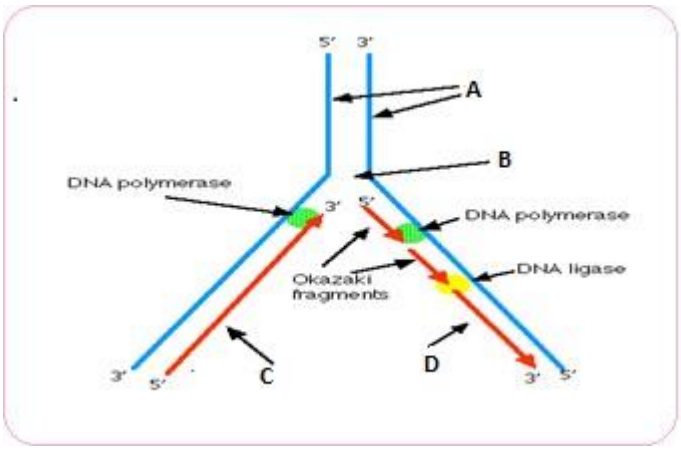
128. Identify the different parts of the transcription unit



Transcription unit

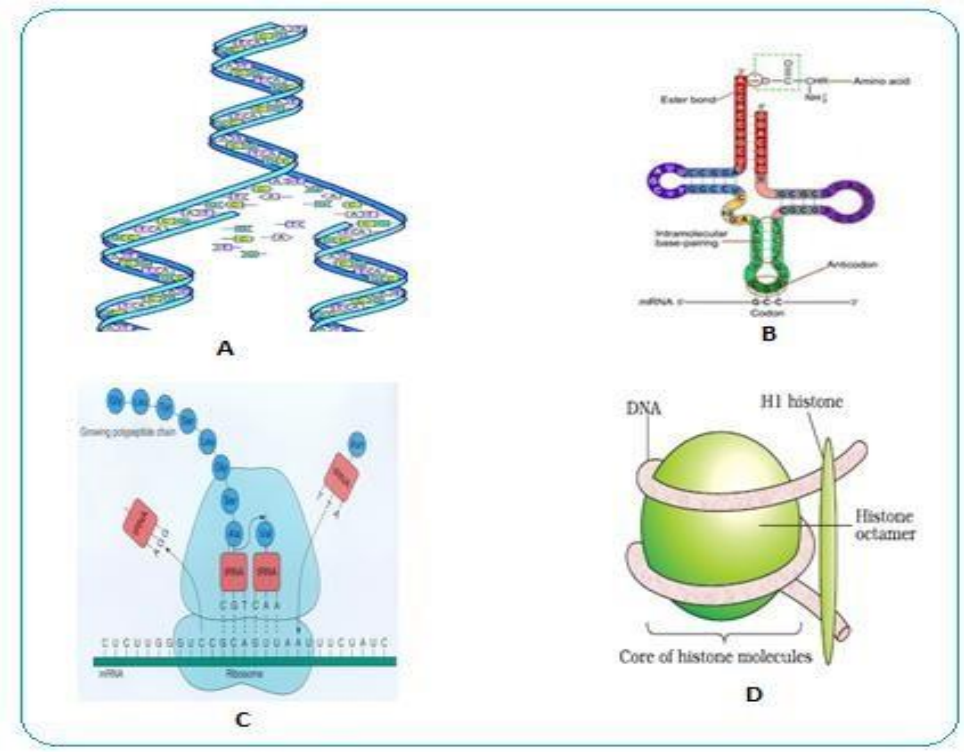
1. A. coding strand , B. Promotor , C. terminator , D. template strand
2. A. template strand, B. coding strand , C. Promotor , D. terminator
3. A. terminator , B. template strand , C. coding strand , D. Promotor
4. A. Promotor, B. terminator, C. template strand, D.coding strand

129. Identify the various parts of the replication fork



1. A. replication fork , B. template strand , C. lagging strand, D. leading strand
2. A. template strand, B.replication fork, C.leading strand, D.lagging strand
3. A. leading strand , B. lagging strand , C. template strand , D. replication fork
4. A. lagging strand , B. replication fork , C. leading strand , D. template strand

130. Identify and name the different diagrams of A, B, C and D



1. A. protein translation , B. DNA replication , C. nucleosome, D. t-RNA moleciule
2. A. DNA replication, B. t-RNA moleciule, C. protein translation, D.nucleosome
3. A. t-RNA moleciule , B. nucleosome, C. DNA replication , D. protein translation
4. A. protein translation , B. t-RNA moleciule , C. nucleosome, D. DNA replication

Unit –IV. MOLECULAR BIOLOGY

Chapter 10. MOLECULAR BASIS OF INHERITANCE

KEY –I:

01) **Warren Weaver**	02) **4.6 x10^6 bp**	03)**N-glycosidic bond**
04) **Watson and Crick**	05) **20 A^0**	06) **genophore**
07) ***Streptococcus pneumoniae***	08) **AUG**	09) **38 minutes**
10) **Ligases**	11) **Exons**	12) **Eukaryotes**
13)) **rho (ρ) factor**	14) **poly G (guanine)**	15) **peptidyltransferase**

KEY –II:

16) **4.6 x 10^{6}bp**	17) **G, A and C**	18) **two**
19) **five**	20) **4,500**	21) **N ^{15}**
22) **DNA Ligase**	23) **t – RNA**	24) **RNA→DNA →Protein**
25) **Prokaryotes**	26) **Chargaff**	27) **HIV**
28) **260**	29) **p – gene and z – gene**	30) **Inter phase**

KEY –III:

31) **True**	32) **False**	33) **False**
34) **True**	35) **True**	36) **False**
37) **False**	38) **True**	39) **False**
40) **True**	41) **False**	42) **True**
43) **True**	44) **False**	45) **True**

KEY –IV:

46) **9**	47) **7**	48) **4**
49) **1**	50) **2**	51) **3**
52) **5**	53) **10**	54) **11**
55) **6**	56) **8**	57) **13**
58) **15**	59) **12**	60) **14**

KEY –V:

61) Kornberg
62) Temin and Baltimore
63) DNA sequences that move from one place to another place in the genome
64) TMV, HIV, Bacteriophage, Polio virus, Influenza virus
65) Nitrogen base, pentose sugar, phosphate group
66) Mutations occurs due to change in single base pair of DNA molecule
e.g.: sickle cell anaemia
67) Adenine (A) – 30%, Guanine (G) – 20%, and Cytosine – 20%
68) UUU, UUC
69) $C_5H_{10}O_4$
70) Oudet

KEY –VI:

71) Dark colored chromatin is called heterochromatin and light colored chromatin is called euchromatin. In genetical transcription heterochromatin is inactive and euchromatin is active.
72) The functional or expressible genes present in *m*RNA are called exons whereas nonfunctional or non expressible genes present in *hn*RNA are called introns.
73) The capping and tailing occurs in heterogenous RNA (*hn*RNA). In capping methyl guanosine triphosphate or *poly G* is added to 5' end and in tailing adenylate residues or *poly A* (200-300) is added to 3' end of mRNA.

74) The codon which do not codes any amino acid or terminates protein synthesis are called stop codons. e.g.: UAA, UAG, UGA.
75) Hershey and Chase. They worked on Bacteriophages.
76) complementary strand sequence is : 5'---TTACGTCGATAATCC---3'
77) *m*RNA strand sequence is : 5'---UUACGUCGAUAAUCC---3'
78) DNA polymerase is useful in synthesis of nucleotide sequence in 5'-3' direction which is complementary to template strand.
79) In eukaryotes the negatively charged DNA is wrapped around the positively charged histone octamer and appears as "beads on string" are known as nucleosomes. The chromatin contains 200bp of DNA.
80) Amino acids are attached to tRNA molecule by using Adenosine tri phosphate (ATP).

KEY –VII - X:

81) **2**	82) **3**	83) **3**	84) **3**	85) **3**
86) **2**	87) **4**	88) **4**	89) **4**	90) **2**
91) **3**	92) **2**	93) **2**	94) **3**	95) **1**
96) **2**	97) **1**	98) **1**	99) **2**	100) **2**
101) **1**	102) **2**	103) **2**	104) **2**	105) **2**
106) **1**	107) **4**	108) **3**	109) **2**	110) **1**
111) **1**	112) **3**	113) **4**	114) **3**	115) **2**
116) **4**	117) **3**	118) **1**	119) **3**	120) **1**
121) **2**	122) **3**	123) **2**	124) **2**	125) **4**
126) **1**	127) **3**	128) **4**	129) **2**	130) **2**

*** * ***

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SENIOR INTERMEDIATE WORK BOOK BOTANY

Unit -V Biotechnology

Chapter 11 Biotechnology: Principles and processes

Note to the students:

1. Please read the text book and go through the lines before you solve these small questions in the work book.

2. You may need to apply the Knowledge given in the chapter "Biotechnology: Principles and processes" to solve some questions.

3.Discuss the answers and solutions with your friends and your lecturer.

4.The key concept given above may give you some clues in solving the below questions.

Concepts of "Biotechnology: Principles and processes"

- Biotechnology deals with techniques of using live organisms or enzymes from organisms to produce products and processes useful to humans.
- For example, in vitro fertilisation leading to a 'test-tube' baby, synthesising a gene and using it, developing a DNA vaccine or correcting a defective gene, are all part of biotechnology.
- The definition given by EFB is as follows: 'The integration of natural science and organisms, cells, parts thereof, and molecular analogues for products and services.
- This means biotechnology is a science which utilizes properties and uses of micro-organisms or exploits cells and the cell constituents at the industrial level for generating useful products essential to life and human welfare.

11.1 Principles of Biotechnology

Among many, the two core techniques that enabled birth of modern biotechnology are:

Genetic engineering:

Tissue culture:

The conceptual development of the principles of genetic engineering

- The techniques of genetic engineering which include creation of recombinant DNA, use of gene cloning and gene transfer, allows us to isolate and introduce only one or a set of desirable genes without introducing undesirable genes into the target organism.
- The multiplication of any alien piece of DNA in an organism it needs to be a part of a chromosome(s) which has a specific sequence known as 'origin of replication'. This can also be called as cloning or making multiple identical copies of any template DNA.

The construction of an artificial recombinant DNA molecule

- The construction of the first recombinant DNA emerged from the possibility of linking a gene encoding antibiotic resistance with a native plasmid (autonomously replicating circular extra- chromosomal DNA) of *Salmonella typhimurium*.
- Stanley Cohen and Herbert Boyer accomplished this in 1972 by isolating the antibiotic resistance gene by cutting out a piece of DNA from a plasmid which was responsible for conferring antibiotic resistance.
- The cutting of DNA at specific locations became possible with the discovery of the so-called 'molecular scissors'– restriction enzymes.
- The linking of antibiotic resistance gene with the plasmid vector became possible with the enzyme DNA ligase, which acts on cut DNA molecules and joins their ends.
- This makes a new combination of circular autonomously replicating DNA created in vitro and is known as recombinant DNA.

Tools of Recombinant DNA Technology: Genetic engineering or recombinant DNA technology can be accomplished only if we have the key tools,

Restriction Enzymes

- In the year 1963, the two enzymes responsible for restricting the growth of bacteriophage in *Escherichia coli* were isolated. One of these added methyl groups to DNA, while the other cut DNA. The later was called restriction endonuclease.
- The first restriction endonuclease–Hind II, whose functioning depended on a specific DNA nucleotide sequence was isolated and characterised.
- Besides Hind II, today we know more than 900 restriction enzymes that have been isolated from over 230 strains of bacteria each of which recognise different recognition sequences.
- Restriction enzymes belong to a larger class of enzymes called nucleases. These are of two kinds; exonucleases and endonucleases.
- Exonucleases remove nucleotides from the ends of the DNA whereas, endonucleases make cuts at specific positions within the DNA.
- Each restriction endonuclease recognises a specific palindromic nucleotide sequences in the DNA. For example, the following sequences reads the same on the two strands in 5' 3' direction. This is also true if read in the 3' 5' direction.

  5' —— GAATTC —— 3'

  3' —— CTTAAG —— 5'

- Restriction enzymes cut the strand of DNA a little away from the centre of the palindrome sites, but between the same two bases on the opposite strands. This leaves single stranded portions at the ends. There are overhanging stretches called sticky ends on each strand.
- When cut by the same restriction enzyme, the resultant DNA fragments have the same kind of ‘sticky-ends’ and, these can be joined together (end-to-end) using DNA ligases.

- Restriction endonucleases are used in genetic engineering to form ‘recombinant’ molecules of DNA, which are composed of DNA from different sources/genomes.

Cloning Vectors

- The DNA used as a carrier for transferring a fragment of foreign DNA into a suitable host is called vector. Vectors used for multiplying the foreign DNA sequences are called cloning vectors.
- Commonly used cloning vectors are plasmids, bacteriophages, cosmids (*cos* site of phage incorporated into a plasmid) and artificial chromosomes.
- Apart from natural vectors, artificially restructured plasmids like pBR322 (after Boliver and Rodriguez) pUC19, 101 (after University of California) are popularly used.
- The following are the features that are required to facilitate cloning into a vector.

(i)Origin of replication (ori): This is a sequence from where replication starts and any piece of DNA when linked to this sequence can be made to replicate within the host cells.

(ii) **Selectable marker:** In addition to ‘ori’, the vector requires a selectable marker, which helps in identifying and eliminating non-transformants and selectively permitting the growth of the transformants.

(iii) **Cloning sites:** In order to link the alien DNA, the vector needs to have very few, preferably single, recognition sites for the commonly used restriction enzymes.

(iv) **Vectors for cloning genes in plants and animals:** The tumor inducing (Ti) plasmid of *Agrobacterium tumifaciens* has now been modified into a cloning vector which is no more pathogenic to the plants Similarly, retroviruses have also been disarmed and are now used

to deliver desirable genes into animal cells.

Competent Host (For Transformation with Recombinant DNA)

Since DNA is a hydrophilic molecule, it cannot pass through cell membranes. In order to force bacteria to take up the plasmid, the bacterial cells must first be made 'competent' to take up DNA.

Processes of Recombinant DNA Technology

Isolation of the Genetic Material (DNA)

- In majority of organisms this is deoxyribonucleic acid or DNA. In order to cut the DNA with restriction enzymes, it needs to be in pure form.
- This can be achieved by treating the bacterial cells/plant or animal tissue with enzymes such as lysozyme (bacteria), cellulase (plant cells), chitinase (fungus). This is followed by the dissolution of all the biological membranes within a cell by detergent lysis.
- Other molecules can be removed by appropriate treatments and purified DNA ultimately precipitates out after the addition of chilled ethanol. This can be seen as collection of fine threads in the suspension.

Cutting of DNA at Specific Locations

- Restriction enzyme digestions are performed by incubating purified DNA molecules with the restriction enzyme, at the optimal conditions for that specific enzyme.
- Agarose gel electrophoresis is employed to check the progression of a restriction enzyme digestion.

Separation and isolation of DNA fragments:

- The cutting of DNA by restriction endonucleases result in the fragments of DNA. These fragments can be separated by a technique known as gel electrophoresis.
- The DNA fragments separate (resolve) according to their size through sieving effect provided by the agarose gel.
- The separated DNA fragments can be visualised only after staining the DNA with a compound known as ethidium bromide followed by exposure to UV radiation.
- The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece. This step is known as elution.
- The DNA fragments purified in this way are used in constructing recombinant DNA by joining them with cloning vectors.

Insertion of isolated gene into suitable vector:

- To isolate a plasmid the bacterial cell is treated with lysozyme to digest the cell wall. Then the bacterial cell is subjected to centrifugation to separate the plasmid.
- After having cut the source DNA as well as the vector DNA with a specific restriction enzyme, the cut out 'gene of interest' from the source DNA and the cut vector with space are mixed and ligase is added. This results in the preparation of recombinant DNA.

Amplification of Gene of Interest using PCR

- PCR stands for Polymerase Chain Reaction. In this reaction, multiple copies of the gene (or DNA) of interest is synthesised in vitro using two sets of primers and the enzyme DNA polymerase.
- Repeated amplification is achieved by the use of a thermostable DNA polymerase (isolated from a bacterium, Thermus aquaticus), which remain active during the high temperature induced denaturation of double stranded DNA.

Insertion of Recombinant DNA into the Host Cell/Organism

- There are several methods of introducing the ligated DNA into recipient cells. Recipient cells after making them 'competent' to receive, take up DNA present in its surrounding.
- This is, done by treating them with a specific concentration of a divalent cation, such as calcium, which increases the efficiency with which DNA enters the bacterium through pores in its cell wall.
- In a method known as micro-injection, recombinant DNA is directly injected into the nucleus of an animal cell.
- In another method, suitable for plants, cells are bombarded with high velocity micro-particles of gold or tungsten coated with DNA in a method known as biolistics or gene gun.
- And the last method uses 'disarmed pathogen' vectors, which when allowed to infect the cell, transfer the recombinant DNA into the host.

Selection of Transformed host cells:

selectable marker, insertional inactivation, colony hybridization,

Obtaining the Foreign Gene Product

- In almost all recombinant technologies, the ultimate aim is to produce a desirable protein. Hence, there is a need for the recombinant DNA to be expressed.
- The cultures may be used for extracting the desired protein and then purifying it by using different separation techniques.
- Small volume cultures cannot yield appreciable quantities of products. To produce in large quantities, the development of bioreactors. A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions (temperature, pH, substrate, salts, vitamins, oxygen).

- The most commonly used bioreactors are Simple stirred-tank bioreactor, Sparged stirred-tank bioreactor.

Downstream Processing

- After completion of the biosynthetic stage, the product has to be subjected through a series of processes before it is ready for marketing as a finished product.
- The processes include separation and purification, which are collectively referred to as downstream processing.

I – Fill in the blanks using the words given below:

Colony hybridization, gene amplification, thermostable, nucleases, velocity, desirable, restriction enzymes, bright orange, phosphodiester, chilled ethanol

1. Restriction enzymes belong to a large class of enzymes_____.
2. Restriction endo nucleases break the_____bonds of DNA.
3. _____is one of the techniques for DNA finger printing.
4. In gene gun method cells are bombarded with high_____micro particles of gold or tungsten.
5. _____are also called as molecular scissors.
6. Gene specific probes are used in_____for selection of transformed host cells.
7. Purified DNA ultimately precipitates out after the addition of_____.
8. Repeated amplification is achieved by the use of a_____DNA polymerase such as Taq polymerase.
9. In almost all recombinant DNA technologies, the ultimate aim is to produce _____protein.
10. On an agarose gel DNA fragments appear as_____coloured bands after staining.

II – Read the following statement and tick the right answer.

11. First discovered restriction endo nuclease

    Eco RI / *Hind* II

12. Bacterial cell walls are digested by treating with

    Lysozyme / Chitinases

13. Artificially synthesized plasmids are

    Cosmid / pBR322

14. Agarose is a natural polymer extracted from

    Sea weeds / Bacteria

15. Feature required to facilitate cloning into a vector.

    High molecular weight / Selectable marker

16. In isolation the separated DNA can be removed by

    Spooling / Elusion

17. Multiplication of the alien piece of DNA in an organism is not possible unless it becomes a part of

    Origin of replication / Cloning sites

18. If any protein encoding gene is expressed in a heterologous host is

    Purified protein / Recombinant protein

19. The technique involves the growth of only desired microbe/ eukaryotic cell in large quantities for the manufacture of biotechnological products is

    Tissue culture / Genetic engineering

20. The specific recognition sequence of Eco RI for staggered cutting

    3’-GAATTC-5’ / 5’-GAATTC-3’

III – Carefully observe the following statements. Denote whether they are True or False.

21. Gene gun method is used to transfer recombinant DNA into animals.

22. First artificial DNA molecule was constructed using plasmids from Salmonella typhimurium.

23. Plasmids are derived from fungi.

24. Insertional inactivation is a method of isolation of genetic material.

25. In gel electrophoresis technique the smaller the fragments size, the farther away it moves.

26. We cannot see pure DNA fragments in the visible light without staining.

27. Retroviruses are used as vectors for cloning genes in animals.

28. The normal E. coli cells have resistance towards ampicillin and tetracycline.

29. In recombinant DNA technology the source DNA and the vector DNA should be digested with different restriction enzymes.

30. The dissolution of all the cell membranes are done by detergent lysis.

IV – Match the items in Section A with the items in Section B.

Section A		Section B
31. Isolation of genetic material	[ ]	a. probe
32. cutting of DNA	[ ]	b. bioreactor
33. annealing	[ ]	c. marketing
34. selection of transformed host	[ ]	d. gel electrophoresis
35. staggered cuttings	[ ]	e. cellulases
36.separation of DNA fragments	[ ]	f. PCR
37. downstream process	[ ]	g. restriction nucleases
38. insertion of r-DNA into the host	[ ]	h. cosmid
39. production of desired protein	[ ]	i. palindromic sequence
40. cloning vector	[ ]	j. gene gun method

V – After reading the text book try to answer these simple questions on your own in one word or a sentence.

41. Probe:

42. Gel elusion:

43. Restriction enzyme digestion:

44. Exonucleases:

45. Stage meiosis a recombinant DNA is made:

46. PCR:

47. Downstream processing:

48. Taq polymerase:

49. Sticky ends:

50. Competent host:

VI – After reading the lesson try to explain the following questions in one or two sentences.

51. Define Biotechnology given by EFB.

Ans: _____

52. what is meant by Chimaeric DNA?

Ans: _____

53. What modification is done on the Ti plasmid of Agrobacterium tumefaciens to convert it into a cloning vector?

Ans: _____

54. While doing PCR, 'denaturation' step is missed. What will be its effect on the process?

Ans: _____

55. What is meant by origin of replication?

Ans: _____

56. What is a plasmid DNA?

Ans: _____

57. Do eukaryotic cells have restriction endonucleases?

Ans: _____

58. What is the significance of adding proteases at the time of isolation of genetic material?

Ans: _____

59. Besides better aeration and mixing properties, what other advantages do stirred tank bioreactors have over shake flasks?

Ans: _____

60. Decide the ratio between ester bonds and hydrogen bonds that are broken in each palindromic sequence of a DNA when treated with Eco RI during the formation of sticky ends?

Ans: _____

VII – Multiple choice questions.

61. Which of the following is not a part of Biotechnology? [ ]

a. test tube baby

b. synthesising a gene

c. developing a fruit

d. correcting a defective gene

62. The process not included in the Genetic Engineering technique is [ ]

a. creation of recombinant DNA

b. gene cloning

c. gene transfer

d. multiplication of undesirable characters

63. Which of the following is used as one of the tools for recombinant DNA technology? [ ]

a. proteases

b. restriction enzymes

c. ribonucleases

d. chitinases

64.which statement is wrong about the conventional naming Eco RI [ ]

a. 'E' comes from genus name

b. 'co' comes from species name

c. 'R' means restriction enzyme

d. 'I' means the Roman number

65. The correct sequence of reactions involved in PCR are [ ]

a. Denaturation, Annealing and Extension

b. Extension, Denaturation and Annealing

c. Denaturation, Extension and Annealing

d. Extension, Annealing and Denaturation

66. The DNA fragments separated on an agarose gel can be visualised after staining with [ ]

a. Safranine

b. Acetocarmine

c. Ethidium bromide

d. phenolphthalein

67. Recombinant DNA can be forced into host cell by [ ]

a. incubation and heat shock

b. polymerase chain reaction

c. gel electrophoresis

d. transformation

68. Tumor inducing (Ti) plasmids are modified into cloning vectors, they are derived from the pathogen [ ]

a. Salmonella typhimurium

b. Thermus aquaticus

c. Escherichia coli

d. Agrobacterium tumefaciens

69. In insertional inactivation, recombinant DNA is inserted within the coding sequence of the enzyme [ ]

a. Endonuclease

b. β-galactosidase

c. Ribonuclease

d. Protease

70. A cloning vector has two antibiotic resistance genes for tetracycline and ampicillin. A foreign DNA was inserted into the tetracycline gene. Non- recombinants would survive on the medium containing [ ]

a. tetracycline but not ampicillin

b. ampicillin but not tetracycline

c. both tetracycline and ampicillin

d. neither tetracycline nor ampicillin

VII – Check if you can answer some questions from previous NEET (AIPMT) and EAMCET papers.

71. Which one is a true statement regarding DNA polymerase used in PCR?[AIPMT 2012]

(1) It is isolated from a virus

(2) It remains active at high temperature

(3) It is used to ligate introduced DNA in recipient cells

(4) It serves as a selectable marker

72. For transformation, micro-particles coated with DNA to be bombarded with gene gun are made up of [AIPMT-2012]

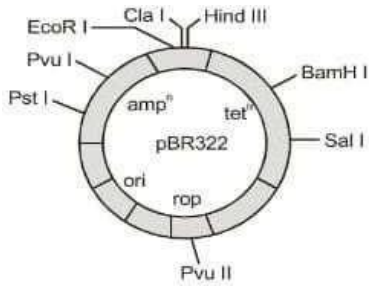
(1) Silicon or Platinum

(2) Gold or Tungsten

(3) Silver or Platinum

(4) Platinum or Zinc

73. The figure below is the diagrammatic representation of the E. coli vector pBR322. Which one of the given options correctly identifies its certain component(s)? [AIPMT-2012]



(1) *Hind* III, *Eco* RI-selectable markers

(2) ampR, tetR-antibiotic resistance genes

(3) ori-original restriction enzyme

(4) rop-reduced osmotic pressure

74. Biolistic (gene-gun) is suitable for [AIPMT-2012]

(1) Disarming pathogen vectors

(2) Transformation of plant cell

(3) Constructing recombinant DNA by joining with vectors

(4) DNA finger printing

75. In genetic engineering, the antibiotics are used [AIPMT-2012]

(1) As selectable markers

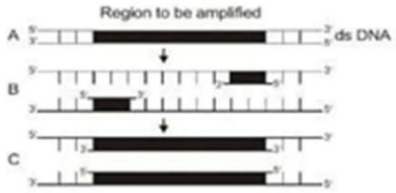
(2) To select healthy vectors

(3) As sequences from where replication starts

(4) to keep the cultures free of infection

76. The figure below shows three steps (A, B, C) of Polymerase Chain Reaction (PCR). Select the option giving correct identification together with what it represents?

[AIPMT-2012]



(1) B-Denaturation at a temperature of about 98ºC separating the two DNA strands

(2) A-Denaturation at a temperature of about 50ºC

(3) C-Extension in the presence of heat stable DNA polymerase

(4) A-Annealing with two sets of primers

77. Which one of the followoing is not correctly matched for the organism and its cell wall degrading enzyme? [NEET-2013]

(1) Plant cells - Cellulases

(2) Algae - Methylases

(3) Fungi - Chitinases

(4) Bacteria - Lysozyme

78. DNA fragments generated by the restriction endonucleases in a chemical reaction can be separated by [NEET-2013]

(1) Polymerase chain reaction

(2) Electrophoresis

(3) Restriction mapping

(4) Centrifugation

79. The colonies of recombinant bacteria appear white in contrast to blue colonies of non-recombinant bacteria because of [NEET-2013]

(1) Insertional inactivation of alpha–galactosidase in non-recombinant bacteria

(2) Insertional inactivation of alpha–galactosidase in recombinant bacteria

(3) Inactivation of glycosidase in recombinant bacteria

(4) Non-recombinant bacteria containing beta-galactosidase

80.Which vector can clone only a small fragment of DNA? [AIPMT-2014]

(1) Bacterial artificial chromosome

(2) Yeast artificial chromosome

(3) Plasmid

(4) Cosmid

81. Commonly used vectors for human genome sequencing are [AIPMT-2014]

(1) T-DNA

(2) BAC and YAC

(3) Expression Vectors

(4) T/A Cloning Vectors

82. The DNA molecule to which the gene of interest is integrated for cloning is called [ReAIPMT-2015]

(1) Carrier

(2) Transformer

(3) Vector

(4) Template

83. The cutting of DNA at specific locations became possible with the discovery of [ReAIPMT-2015]

(1) Ligases

(2) Restriction enzymes

(3) Probes

(4) Selectable markers

84. Which of the following is not a feature of the plasmids? [NEET- 2016]

(1) Single-standard

(2) Independent replication

(3) Circular structure

(4) Transferable

85. The taq polymerase enzyme is obtained from [NEET- 2016]

(1) Pseudomonas putide

(2) Thermus aquaticus

(3) Thiobacillus ferroxidans

(4) Bacillus subtilis

86. Which of the following is a restriction endonuclease? [NEET- 2016]

(1) RNase

(2) *Hind* II

(3) Protease

(4) DNase I

87. Stirred-tank bioreactor have been designed for [NEET(Phase-2)- 2016]

(1) Purification of product

(2) Addition of preservatives to the product

(3) Availability of oxygen throughout the process

(4) Ensuring anaerobic conditions in the culture vessel

88. A foreign DNA and plasmid cut by the same restriction endonuclease can be joined to form a recombinant plasmid using [NEET(Phase-2)- 2016]

(1) *Eco* RI

(2) *Taq* polymerase

(3) Polymerase III

(4) Ligase

89. Which of the following is not a component of downstream processing? [NEET(Phase-2)- 2016]

(1) Separation

(2) Purification

(3) Preservation

(4) Expression

90.Which of the following restriction enzymes produce blunt ends? [NEET(Phase-2)- 2016]

(1) *Sal* I

(2) *Eco* RV

(3) *Xho* I

(4) *Hind* III

91. A gene whose expression helps to identify transformed cells is known as [NEET- 2017]

(1) Selectable marker

(2) Vector

(3) Plasmid

(4) Structural gene

92. DNA fragment are [NEET- 2017]

(1) Positively charged

(2) Negatively charged

(3) Neutral

(4) Either positively or negatively charged depending on their size

93. The DNA fragments separate on an agarose gel can be visualised after staining with [NEET- 2017]

(1) Bromophenol blue

(2) Acetocarmine

(3) Aniline blue

(4) Ethidium bromide

94. Which one of the following represents a palindromic sequence in DNA? [AIPMT-2012]

(1) 5'-GAATTC-3'
3'-CTTAAG-5'

(2) 5'-CCAATG-3'
3'-CAATCC-5'

(3) 5'-CATTAG-3'
3'-GATAAC-5'

(4) 5'-GATACC-3'
3'-CCTAAG-5'

95. What is the criterion for DNA fragments movement on an agarose gel during gel electrophoresis? [NEET- 2017]

(1) The larger the fragment size, the farther it moves

(2) The smaller the fragment size, the farther it moves

(3) Positively charged fragments move farther end

(4) Negatively charged fragments do not move

96. The correct order of steps in Polymerase Chain Reaction (PCR) is [NEET- 2018]

(1) Extension, Denaturation, Annealing

(2) Annealing, Extension, Denaturation

(3) Denaturation, Annealing, Extension

(4) Denaturation, Extension, Annealing

97. Which one of the following equipment is essentially required for growing microbes on a large scale for industrial production of enzymes? [NEET- 2019]

(1) BOD incubator

(2) Sludge digester

(3) Industrial oven

(4) Bioreactor

98. DNA precipitation out of a mixture of biomolecules can be achieved by treatment with [NEET- 2019]

(1) Isopropanol

(2) Chilled ethanol

(3) Methanol at room temperature

(4) Chilled chloroform

99.Choose the correct sequence of steps in PCR [EAMCET-2018]

(1) Annealing, Denaturation, Extension, Amplification

(2) Amplification, Annealing, Denaturation, Extension

(3) Denaturation, Annealing, Extension, Amplification,

(4) Denaturation, Amplification, Extension, Annealing,

100. Genetically transformed host cells can be selected by [EAMCET-2018]

i, Antibiotic resistant gene

ii, Radioactive ds DNA having complementarity to the whole length of desired gene

iii, Coding sequence of β-galactosidase

iv, Radioactive ssDNA having complementarity to at least one part of desired DNA

v, Radioactive dsRNA having complementarity to the whole length of desired DNA

(1) i, ii, v

(2) ii, iii, v

(3) i, ii, iii, v

(4) i, iii, iv

101. Match the following. [EAMCET-2018]

List-I	List-II	List-III
A) Hind III	i) Agarose gel	I) Six base pairs

B) pBR322	ii) Agrobacterium	II) Selectable marker
C) T-DNA	iii) Ampicillin	III) Elusion
D) DNA	iv) Recognition sequence	IV) Transgenic plants

	A	B	C	D
(1)	iv, I	i, III	iii, II	ii, IV
(2)	iv, I	iii, II	i, III	ii, IV
(3)	iv, I	iii, II	ii, IV	i, III
(4)	i, III	ii, IV,	iii, II	iv, I

102. Match the following lists [EAMCET-2019]

List-I	List-II
A) Ampicillin resistance	I) Chitinase
B) Transfer r-DNA through infection	II) Insertional inactivation
C) Disruption of fungal cell wall	III) Selectable marker
D) Insertion of r-DNA in the coding Sequence of enzyme	IV) Chimeric DNA V) Disarmed pathogen vector

	A	B	C	D
(1)	III	I	V	II
(2)	III	V	I	II
(3)	I	II	III	IV
(4)	I	III	II	V

103. The ratio of genes for protein involved in plasmid replication rop codes, Ori, restriction sites, Antibiotic resistance genes present in E. coli. Cloning vector pBR322 is

[EAMCET-2019]

(1) 1:1:5:1

(2) 1:7:1:2

(3) 1:2:1:7

(4) 1:1:7:2

104. Find the wrong statements [EAMCET-2019]

(A) TO cut DNA with restriction enzyme it needs to be pure form, free from RNA, Protein, Polysaccharides and lipids

(B) RNA can be removed by protease enzyme

(C) DNA separated as suspension can be removed by spooling

(D) DNA can be precipitated by adding warm ethanol

(1) A, B

(2) C, D

(3) A, C

(4) B, D

105. Sequence of strategies involved for the isolation of gene of interest from a plant cell during the process of rDNA technology [EAMCET-2018]

A) Dissolution of biological membranes

B) Enzymatic digestion of cell wall

C) Precipitation of DNA

D) Removal of DNA by spooling

(1) B, C, A, D

(2) C, A, B, D

(3) B, A, C, D

(4) C, B, A, D

106. The core techniques enabled modern biotechnology [EAMCET-2018]

A) Change the phenotype of host organism by genetic engineering

B) Chemical engineering process of vaccine production by tissue culture

C) Manufacture of specific products from eukaryotic cells in bioreactor

D) Altering the chemistry of genetic material by tissue culture

(1) B, C, D

(2) A, C, D

(3) A, B, D

(4) A, B, C

107. Enzymes used for isolation of DNA from Bacterial cell [EAMCET-2017]

I) Lysozyme

II) Cellulase

III) Chitinase

IV) Protease

V) Ribonuclease

VI) Endonuclease

(1) I, IV, V

(2) II, V, IV

(3) I, II, IV, VI

(4) I, III, IV, V

108. Key tools of r- DNA technology are [EAMCET-2017]

I) Molecular scissors

II) pBR322

III) Gene gun

IV) Bioreactor

(1) I, III

(2) I, IV

(3) I, II

(4) II, III

KEY for I to VIII

1	Nucleases	11	*Hind* -II	21	F	31	e
2	Phosphodiester	12	Lysozyme	22	T	32	g
3	Gene amplification	13	pBR322	23	F	33	f
4	Velocity	14	Sea weeds	24	F	34	a
5	Restriction enzyme	15	Selectable marker	25	T	35	i
6	Colony hybridization	16	Spooling	26	T	36	d
7	Chilled ethanol	17	Origin of replication	27	T	37	c
8	Thermostable	18	Recombinant protein	28	F	38	j
9	Desirable	19	Tissue culture	29	F	39	b
10	Bright orange	20	5’-GAATTC-3’	30	T	40	h

41. A probe is a small fragment of single standard DNA or RNA which is tagged with a radioactive molecule and is complementary to at least one part of the desired DNA.

42. It is a technique of extracting separated bands of DNA from agarose gel.

43. The process of cutting DNA with restriction enzyme is called restriction enzyme digestion.

44. The restriction enzymes which remove nucleotides from the ends of the DNA are called as exonucleases.

45. In meiosis recombinant DNA is made in pachytene stage.

46. PCR stands for Polymerase Chain Reaction. A reaction where multiple copies of the gee of interest are synthesised in vitro using two sets of primers and the enzyme DNA polymerase.

47. The processes including separation, purification of biosynthetic product before marketing are collectively referred to as downstream processing.

48. Taq polymerase is a thermostable DNA polymerase isolated from a bacterium, *Thermus aquaticus* used for repeated amplification in Polymerase Chain Reaction.

49. Single stranded strings of nucleotides that extends from the ends of a fragment of double-stranded DNA.

50. Microbial cells which are capable of taking in DNA molecules from outside and thereby undergo transformation.

51. The integration of natural science and organism, cells, parts thereof, and molecular analogues for products and services.

52. Chimaeric DNA or recombinant DNA are artificially synthesized DNA. It is formed after having cut the source DNA as well as the vector DNA with the same restriction enzyme, the cut 'gene of interest' from the source DNA and the cut vector are mixed with ligase enzyme.

53. The tumor inducing (Ti) plasmid of Agrobacterium tumefaciens has been modified into a cloning vector such that it is no more pathogenic to plants but is still able to use the mechanism to deliver genes of our interest into a variety of plant.

54. The denaturation step is carried out in the PCR to separate the template DNA into single strands so that the primers can bind to the target region and initial extension. If denaturation step is missed primers do not bind to the templet DNA amplification does not occur.

55. Origin of replication is a sequence from where replication starts. Any piece of DNA when linked to this sequence can be made to replicate within the host cell.

56. Small, circular, double standard DNA molecule present in the bacterial cytoplasm in addition to the bacterial chromosome is called as plasmid. The plasmid DNA have the ability to replicate within the bacterial cell, hence are used as cloning vectors.

57. NO, eukaryotic cells do not have restriction endonucleases. This is because the DNA of eukaryotes is highly methylated by a modified enzyme called methylase.

58. Proteases can remove the proteins present inside the cell. If the proteins are not removed during isolation of DNA, they could interfere in further processes of genetic engineering.

59. Stirred tank bioreactor has an agitator system, an oxygen delivery system, a foam control system, a temperature control system, pH control system and sampling ports system so that small volumes of the culture can be withdrawn periodically.

60. Eco RI recognizes palindromic sequence 5'-GAATTC- 3' on the DNA and cuts in between G and A on each of the two strands of the double helix in their sugar-phosphate backbone. So, the ratio between ester bonds and hydrogen bonds broken during the formation of sticky ends is 1:2.

61	c	71	2	81	2	91	1	101	3
62	d	72	2	82	3	92	2	102	2
63	b	73	2	83	2	93	4	103	4
64	c	74	2	84	2	94	1	104	4
65	a	75	1	85	2	95	2	105	3
66	c	76	3	86	2	96	3	106	4
67	a	77	2	87	3	97	4	107	1
68	b	78	2	88	4	98	2	108	3
69	d	79	4	89	4	99	3		
70	c	80	3	90	1	100	4		

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Senior intermediate WorkBook
Botany
Unit-V-Biotechnology

Chapter 12-Biotechnology and It's applications

Key concepts of Biotechnology and It's applications

Introduction

Biotechnology has a wide range of applications such as therapeutics, diagnostics, genetically modified crops for agriculture, processed food, bioremediation, waste treatment and energy production

Three critical areas of research in biotechnology:

- Providing the best catalyst usually a microbe or pure enzyme
- Creating optimal conditions through engineering for the catalyst to act
- Downstream processing to purify the protein/organic compound

Applications in Agriculture

Green revolution: It is a substantial and dramatic increase in agricultural production.

Norman Borlaug's efforts led to green revolution, so he is named as father of green revolution.

The term "green revolution" coined by William Gaud in 1968.

In India Dr. Swaminathan introduced this by using improved varieties, chemical fertilizers, pesticides, improved irrigational facilities etc., but for farmers in the developing world, agrochemicals are too expensive and they show effect on environment

With the advent of genetic engineering and biotechnologyGene revolution came into existence.

Genetically modified organisms are produced by altering genes through manipulation in plants, bacteria, fungi and animals.

Genetic modification has following advantages in addition to the production of high yielding and disease resistant varieties

A) Make crops more resistant to abiotic stresses (cold, drought, salt, heat) and pests.
B) Reduce the use of chemical pesticides
C) Reduce post- harvest loses
D) Increases efficiency of mineral usage of plants
E) Enhances nutritional value of food eg: Vitamin A enriched rice

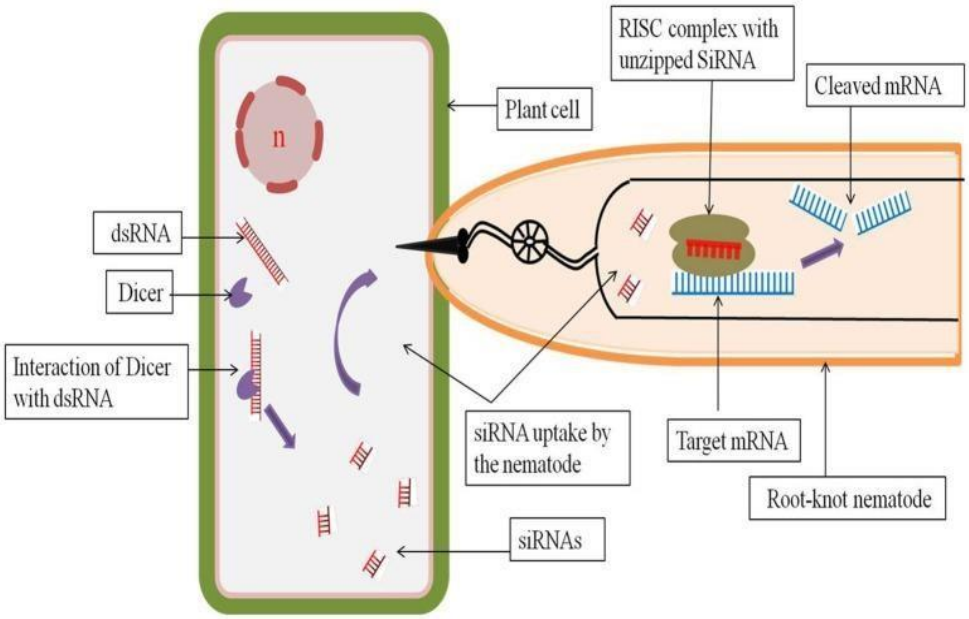
Insect resistant plants:

Bt cotton:

- Specific Bt toxin genes were isolated from bacteria named Bacillus thuringiensis and incorporated into cotton plants.
- These 'Cry" genes codescrystalline proteins which become active only after entering the insect gut due to alkaline pH of the gut.
- There it binds to epithelial cells, create pores and kills insects like coleopterans (beetles), lepidopterans (tobacco bud worm, armyworm) & dipterans (flies, mosquitoes).
- The proteins encoded by the genes cry IAc and cry IIAb control cotton bollworms and cry I Ab controls corn borer

Pest resistant plants:

- A nematode Meloidegyne incognitia infects Tobacco roots.
- A cellular defence mechanism in eukaryotes named RNAiis used to produce pest resistant plants.
- Using Agrobacterium tumifaciens vectors the nematode specific genes were introduced in to the host plant
- This double stranded RNA produces sense and antisense RNA in the host cell(produced due to transposons-mobile genetic elements, virus with RNA genome) and they form double stranded RNA as they are complementary to each other, these are cut by the dicer protein and form si RNA's (short interspersed) or micro RNA's which are 20-25 bplong.
- When nematode infects tobacco plant these complementary RNA's enter in to the parasite, one of the strand (guide strand)selected by protein agrounate and incorporates in RISC (RNA induced silencing complex), then guide strand attach to the nematode RNA, inhibiting translation (m-RNA silencing).



Other applications of Biotechnology:

The recombinant DNA technology helps for the mass production of safe and more effective therapeutic drugs.

- **Human Insulin**: It is genetically engineered insulin with the help ofbacteria.
- In 1983, Eli Lilly, an American company prepared two DNA sequences corresponding to A and B chains of human insulin and introduced into plasmids of E.coli to produce many copies of chains separately, then extracted and combined by disulphide bonds to form human insulin.
- **Gene Therapy**:It is to correct hereditary diseases by using molecular diagnosis like r-DNA technology, Polymerase chain reaction and Elisa linked Immuno-sorbent Assay(ELISA), so that we can diagnose diseases early.
- **ELISA**: Antigen-Antibody interaction that helps to detect antigens inthe blood or antibodies against pathogen in an infected person.
- **DNA finger printing**: It helps in forensic searches like criminal searching, solving parental disputes.

Transgenic Plants:

- Papaya resistant to ring spot virus, Bt cotton to insects, tomato to Pseudomonas bacteria, Potato to Phytopthera fungi.
- Flavr savr tomato is bruise resistant.
- Taipei-Golden rice rich in Vitamin A and prevents blindness.
- Brassica napus, male sterile plants useful to eliminate the process of emasculation during hybridisation
- Round-up ready Soyabean is herbicide tolerant, Basmati rice tolerant to abiotic stress.

Molecular Farming:

Plants are used as biofactories or bio-reactors for obtaining commercially useful plants, specialised medicines and antibodies on a large scale.

- Bio safety and Ethical issues:
- Fear of transferring allergins and toxins to humans and animals.
- Risk of changing fundamental nature of vegetables
- Harmful effect on biodiversity and environment
- Risk of gene pollution
- Changes in natural evolutionary pattern.

GEAC: Genetic engineering Approval Committee, it takes decisions regarding the viabitlity of GM research and safety of introducing GM organisms.

Patents: Certain companies are being granted patents for products and technologies that make use of genetic materials, plants and other biological resources that are identified, developed and used by farmers and indigenous people of a specific region or country.

Basmati rice which has unique aroma and flavour has 27 documented varieties in India, which has reference in ancient texts, folklore and poetry in India.

American company got patent rights on Basmati in 1997 which allowed to sell a new variety of Basmati in US and abroad,

Patents could restrict other people selling Basmati

Several attempts have been made to patent uses, products and processes based on Indian traditional herbal medicines such as turmeric, neem etc.

Bio piracy- Use of bio- resources by multinational companies and other organisations without proper authorization from the countries and people concerned or without compensatory payment.

- Developing and under developed world is rich in biodiversity and traditional knowledge about bio resources.

- Inadequate benefit sharing, injustice between developed and developing countries.

- The Indian parliament recently cleared the second amendment of Indian patents bill to deal with these issues.

Fill in the Blanks using the words given below

Biopiracy, Gene revolution, Bt-toxic gene, Meloidegyne incognitia, DNA finger printing, Taipei, Cry I Ab, Norman Borlaug, GMO, Basmati rice

1. Plants, bacteria, fungi and animals whose genes have been altered by manipulation are called _____.
2. Transgenic golden rice which is rich in vitamin A is_____.
3. _____is the father of green revolution.
4. _____gene controls corn borer.
5. _____were isolated from Bacillus thuringiensis and incorporated into cotton plants.
6. In 1997, an American company got patent rights on_____through the US patent and Trademark office.
7. Advent of Genetic engineering and Bio technology helped in increasing food production, reduced use of chemical fertilizers and pesticides lead to_____
8. We can solve parenting disputes, find criminals easily with the help of_____.
9. The use of bio-resources by multinational companies without proper authorization from the countries and people concerned is known as_____.
10. RNAi is observed in tobacco plants infected with _____

Ans: 1. GMO 2. Taipei 3. Norman Borlaug 4. Cry IAb 5. Bt toxin genes 6.Basmati rice 7. Gene revolution 8. DNA-finger printing 9. Bio-piracy 10. Meloidegyne-incognitia

Multiple Choice Questions

1. The gene that controls cotton bollworm
   a) Cry I Ac b) Cry II Ab c) Cry III Ab d) Both a &b
2. The condition that causes the solubility of the crystalline protein in the insects that infect Bt cotton
   a) Alkaline pH of the gut b) Acidic pH of the trachea c) Acidic pH of the gutd) Alkaline pH of the trachea
3. RNA interference (RNA:) is called gene silencing because
   a) Processing of mRNA is blocked b) transcription of mRNA is blocked c) translation of mRNA is blocked by complementary RNA d) translation of mRNA is blocked by proteins
4. Which of the following revolutions help in tripling the food supply
   a) Green revolution b) blue revolution c) both a & b d) gene revolution
5. The genetically modified(GM) brinjal in India has been developed for
   a) Insect resistance b) enhancing shelf life c) food processing d) drought resistance
6. BT toxin kills the insects by
   a) Blocking the nerve conduction b) damaging the surface of trachea c) creating pores in mid gut d) creating pores in tracheal system
7. Bt in popular Bt cotton stands for
   a) Bacillus tomentosa b) Bacillus thuringiensis c) Bio piracy d) Biotechnology
8. In Insulin, chain A & B are linked together by
   a) H bond b) glycosidic bond c) disulphide bond d) peptide bond
9. Which of the following risks are not associated with genetically modified foods?
   a) Toxicity in human beings b) antibiotic resistance in microorganisms c) formation of super weeds d) allergic reactions in body
10. How many recombinant therapeutics have been approved for human-use world over.
    a) 30 b) 28 c) 29 d)31

Ans: 1-d;2-a;3-d;4-d;5-a;6-c;7-b;8-c;9-b;10-a

Match the following

1) ELISA	a) helps in forensic science
2) DNA finger printing	b) antigen-antibody interaction
3) Early diagnosis of	

pathophysiology c) production of antibiotics, vitamins and other chemicals at low cost

4) Microbes d) PCR & r-DNA

Ans: 1-b; 2-a; 3-d;4-c

1) Brassica napus a) Resistant to Phytopthera fungi
2) Round up ready Soyabean b) Ring-spot disease resistant
3) Potato c) Pseudomonas resistant
4) Papaya d) Male sterile
5) Tomato e) Herbicide tolerant

Ans: 1-d; 2-e;3-a; 4-b; 5-c

1) Cellular defence a) Transposans
2) Complimentary RNA b) Vector for pest resistant Tobacco plant
3) Agrobacterium c) Bio safety
4) GEAC d) RNAi

Ans: 1-d; 2-a; 3-b; 4-c

1) C-DNA's a) Unauthorised utilisation of bio-resources
2) Human insulin b) Vaccines
3) Bio-piracy c) PCR
4) Detection of very low concentration of virus/bacteria d)E.coli

Ans: 1-b; 2-d; 3-a; 4-c

Previous competitive exam questions

1. Which of the following transgenic protein products has been used to treat emphysema?
   a) α-1-antitrypsin b) α-Lactalbumin c) cry protein d) C-peptide
2. How many varieties of rice have been estimated to be present in India?
   a) 2,000 b) 20,000 c) 200,000 d) 2,000,000
3. The first clinical gene therapy was given for treating? [AIPMT 2012]
   a) Diabetes mellitus b) chicken pox c) rheumatoid arthritis d) adenosine deaminase deficiency
4. Consumption of which one of the following foods can prevent the kind of blindness associated with vitamin 'A' defiency? [AIPMT 2012]
   a) Golden rice b) Bt-Brinjal c) flavr savr tomato d) canolla
5. The first human hormone produced by recombinant DNA technology is [AIPMT 2014]
   a) Insulin b) Estrogen c) thyroxin d) progesterone
6. An analysis of chromosomal DNA using the southern hybridisation technique does not use [AIPMT 2014]
   a) Electrophoresis b) blotting c) autoradiography d) PCR
7. The introduction of T-DNA into plants involves [Re-AIPMT-2015]
   a) Allowing the plant roots to stand in water b) infection of the plant by Agrobacterium tumefaciens c) altering the pH of the soil then heat-shocking the plants d) exposing the plants to cold for a brief period
8. The crops engineered for glyphosate are resistant/tolerant to [AIPMT-2015]
   a) Herbicides b) fungi c) bacteria d) insects

9. Which kind of therapy was given in 1990 to a four- year old girl with adenosine deaminase (ADA) deficiency? [NEET(Phase-2)-2016]
   a) Gene therapy b) chemotherapy c) immunotherapy d) radiation therapy
10. Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of [Re-AIPMT-2015]
   a) Vitamin A b) vitamin B c) vitamin C d) omega 3

Ans: 1- a; 2-c; 3-d ;4-a; 5-a; 6-d; 7-b; 8-a; 9-a; 10-a

Two marks questions

1. What is RNA interference (RNAi)
2. What is a Cry protein?
3. What is DNA finger printing?
4. Where is PCR used now a days routinely?
5. What are transgenic plants?

1. It is a cellular defence mechanism in which complementary RNA molecule prevents translation of another RNA molecule, thus preventing the expression of a gene.
2. It is a toxic protein that is produced by bacteria Bacillus thuringiensis that kills certain insects. Cry IAc and Cry II Ab produces toxins that kills cotton boll worm; CryI Ab controls corn borer
3. It is a type of recombinant therapy that helps in forensic science in the search of criminals and also solving parentage disputes etc.
4. PCR is now routinely used to detect in early diagnosis of diseases, detects HIV in suspected AIDS patients. It is being used to detect mutations in genes in suspected cancer patients too. It is a powerful technique to identify many other genetic disorders.
5. Plants with desirable characters created by gene transfer method from different species

True or False

1. A nematode Meloidegyne incognitia infects the leaves of tobacco plants ( )
2. RNA silencing involves the inhibition of translation of nematode mRNA ( )
3. The source of complementary RNA in cellular defence mechanism could be from virus having DNA genomes ( )
4. RNAi takes place in all prokaryotes as amethod of cellular defence ( )
5. Ti plasmid of Agrobacterium tumefaciens is widely used as an effective vector for obtaining transgenic plants. ( )
6. There are 27 documented varieties of Basmati rice in India
7. M.S. Swaminathan is the father of green revolution ( )
8. Downstreaming process is used to purify protein( )
9. Several attempts have also been made by American company to patent uses, products of Neem & Ocimum plants
10. Changing of fundamental nature of vegetablesis not a bio-safety issue of genetically modified plants ( )

Ans: 1-F;2-T;3-F;4-F;5-T;6-T;7-F;8-T;9-F;10-F

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Senior Intermediate Workbook

BOTANY

UNIT – VI: PLANTS, MICROBES AND HUMAN WELFARE

Chapter -13: Strategies for Enhancement in Food Production

KEY POINTS

- Biological principles as applied to animal husbandry and plant breeding have a major role in increasing the food production

PLANT BREEDING

- Only limited food can be produced for humans and animals by traditional farming.
- The Green Revolution was largely dependent on plant breeding techniques
- Plant breeding is purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.
- Conventional plant breeding has been practiced since the beginning of human civilization.
- Classical plant breeding involves crossing or hybridization of pure lines.
- With advancements in genetics, molecular biology and tissue culture, plant breeding is now increasingly being carried out by using molecular genetic tools.
- Main steps in breeding a new genetic variety of a crop are
    1. Collection of variability: Genetic variability is the root of any breeding program.
    2. Evaluation and selection of parents.
    3. Cross hybridization among the selected parents: The desired characters have to be combined from two different plants (parents) through emasculation, bagging, artificial pollination and rebagging.
    4. Selection and testing of superior recombinants: This step yields plants that are superior to both the parents.
    5. Testing, release and commercialization of new cultivars.
- Green Revolution lead to some Indian hybrid crops of high yielding varieties like Wheat and Rice, Sugarcane, Millets.
- Wheat semi dwarf varieties: Sonalika and Kalyan Sona in 1963,
- Rice Semi-dwarf varieties from IR-8 and Taichung Native-1 in 1966 and the later Jaya and Ratna are developed in India.
- Sugarcane: A hybrid was developed between Saccharum Barberi of North India and Saccharum Officinarum of South India.
- Millets: Hybrid maize, Jowar and Bajra are high yielding varieties resistant to water stress.

PLANT BREEDING FOR DISEASE RESISTANCE

- Fungal, bacterial and viral pathogens affect the yield of cultivated crop species.

- Methods of breeding for disease resistance: Breeding is carried out by conventional breeding techniques or by mutational breeding.
- Mutation is the process by which genetic variations thus creating a new character or trait not found in the parental type. Such new character is used as a source in Mutation breeding. Example – Parbhani Kranti (bhindi)

PLANT BREEDING FOR DEVELOPING RESISTANCE TO INSECT PESTS

- Insect resistance in host crop plants may be due to morphological, biochemical or physiological characteristics.

PLANT BREEDING FOR IMPROVED FOOD QUALITY

- **Biofortification** which aims at breeding crops is the most practical means to improve public health and to overcome hidden hunger.
- Examples include ATLAS-66, a wheat variety containing high protein content and GOLDEN RICE, a rice variety which has 5 times as much Iron and β-carotene containing rice variety.

SINGLE CELL PROTEIN (SCP)

- One of the alternate sources of protein for animal and human nutrition is SCP.
- Microbes are being grown on an industrial scale as a source of good protein.
- Algae, Fungi and Bacteria are used in SCP production
- Spirulina can be grown easily on waste materials to produce large quantities of protein rich food, incidentally also reducing environmental pollution called as **bio-remediation**

TISSUE CULTURE

- The technology to provide fast and efficient systems for crop improvement is called tissue culture.
- **Totipotency** is the capacity to generate a whole plant from any cell.

- Steps involved in tissue culture are:
    1. Explant that is, any part of the plant is taken out and its surface sterilization through detergent.
    2. Preparation of nutrient medium and its sterilization through auto-clave (15mins, 121^{o} C and 15 pounds of pressure)
    3. Inoculation in an aseptic environment.
    4. Incubation in laminar airflow chamber for 3-4 weeks.
        a. Undifferentiated mass of cells thus produced is called Callus.
        b. Formation of shoots or roots is called Organogenesis.
        c. Embryo like structures developed from callus called Somatic Embryo genesis. Such embryos are called embryoids, developed from Somatic tissue and so are referred to as Somatic embryos.
    5. The plantlets are developed from either organogenesis or Somatic embryoids.
    6. Acclimatization of plantlets to environment.

- Micro-propagation – The production of large number of plants in a very short time and limited space through tissue culture is called ***Micro-propagation***. Such plants are genetically identical to the original or source plant. Hence they are called ***Soma clones.***
- Another application of tissue culture is recovery of healthy plants from deceased plants by culturing the **meristem** in vitro from apical and axillary parts which is free of virus to obtain virus free plants.
- Isolated single cells or protoplasts (naked cells) from plants after digesting their cell walls can be fused to get hybrid protoplasts are called **Somatic Hybrids.** And such process is called **somatic hybridization.**
- Somatic Hybridization technique provides the opportunity for bypassing the conventional breeding barriers through direct transfer of cytoplasmic and nuclear genomes to plant cells. A popular example is pomato obtained from tomato and potato.

;

I. MULTIPLE CHOICE QUESTIONS

1. In research fields, evaluation of new cultivars is done by
    a. Ideal fertilizer application
    b. Irrigation
    c. Other crop management practices.
    d. All the above.
2. Modification and adjustment of an organism to any change in local environment is called
    a. Quarantine
    b. Selection
    c. Introduction
    d. Acclimatization
3. Undesirable cross pollination can be prevented during hybridization by
    a. Emasculation
    b. Bagging
    c. Re-bagging
    d. Artificial pollination
4. How many growing seasons are required for testing of materials before release and commercialization of new cultivars
    a. 3
    b. 4
    c. 2
    d. 5
5. Root cause of any breeding program is
    a. Genetic similarity in the population
    b. Genetic variability in the population
    c. Hetero zygosity of an individual plant
    d. Homo zygosity of an individual plant
6. Percentage of Gross Domestic Product (G.D.P) on agriculture in India is
    a. 36%
    b. 63%
    c. 33%

d. 66%

7. Heterosis is
    a. Presence of two or more traits
    b. Induction of mutations
    c. Appearance of spontaneous mutation
    d. Superiority of their parents
8. Two semi dwarf rice varieties of I.R – 8 and Tai Chung Native - 1 derivatives were introduced in the year
    a. 1956
    b. 1966
    c. 1976
    d. 1986
9. Which of the following is generally used to induce artificial mutations in crop plants?
    a. Alpha
    b. X-Rays
    c. UV Rays
    d. Gamma rays

10. Himagiri variety developed by hybridization and selection for disease resistance against rust
    a. Wheat
    b. Maize
    c. Sugarcane
    d. Chilli
11. Brown rust of Wheat is caused by:
    a. Bacteria
    b. Virus
    c. Fungi
    d. Aphids
12. Conventional breeding is often constrained by the availability of limited number of disease resistance genes that are present in
    a. Crop varieties or wild relatives
    b. Crop relatives or wild varieties
    c. Wild relatives or mutants
    d. Wild varieties or mutants.

13. In Mung bean, following disease resistance was induced by mutational breeding
    a. Leaf mosaic virus and red rot
    b. Curl blight and black rot
    c. Yellow mosaic virus and powdery mildew
    d. Brown rust and late blight
14. Meristem culture was successfully practiced in
    a. Banana
    b. Sugarcane
    c. Potato
    d. All the above
15. Parbhani Kranti, a new resistant variety for yellow mosaic virus developed from wild variety of
    a. Mung bean

b. Bhindi
c. Chilli
d. Tobacco.

16. The seeds of plants growing wildly placed in our garden are referred to as
    a. Plant introduction
    b. Domestication
    c. Hybridization
    d. Acclimatization
17. Which of the following are not Prokaryotic, Heterotrophic SCP organisms?
    a. Chlorella
    b. Torula yeast
    c. Methylo philus
    d. Brevi bacterium
18. Lack of essential micro nutrients in diet lead to
    a. Increase the risk for disease
    b. Reduce life span
    c. Affect mental abilities
    d. All the above
19. The transfer of ex-plant onto the sterilized nutrient culture medium is called
    a. Inoculation
    b. Incubation
    c. Acclimatization
    d. Sterilization
20. Proliferating undifferentiating mass of cells is known as
    a. Embryoids
    b. Plantlets
    c. Somaclones
    d. Callus
21. Algal SCP among the following
    a. Acetabularia
    b. Candida
    c. Anabaena
    d. Spirulina
22. Economically important plants produced through Somaclones
    a. Banana
    b. Eucalyptus
    c. Teak
    d. All the above
23. Although the plant is infected with virus which part of the plant is free of virus
    a. Apical meristem
    b. Axillary meristem
    c. None of the above
    d. Both of the above
24. Virus free plants can be obtained through in Vitro culture of
    a. Anthers
    b. Ovaries
    c. Leaf
    d. Meristem
25. Digestion of cell walls in somatic hybridization

a. Cellulase and pectinase
b. Chitinase
c. Both (a) and (b)
d. None of the above.

26. The technique in production of large number of plants in a very short time and limited space is called
    a. Vegetative propagation
    b. Micro propagation
    c. Somaclonal variation
    d. Gene mutation
27. Somatic embryos obtained from Callus are called
    a. Embryos
    b. Embryoids
    c. Seeds
    d. Clones.
28. The rice variety introduced in India from Philippines is
    a. Sonora
    b. TN -1
    c. IR – 8
    d. Sonalika
29. Torula Yeast and Baker's Yeast are used as SCPs' obtained from
    a. Candida utilis
    b. Saccharomyces cerevisiae
    c. Both A &B
    d. None of the above
30. Classical plant breeding is not associated with
    a. Crossing of pure lines
    b. Production of plants with desirable traits
    c. Hybridization followed by artificial selection
    d. Domestication
31. Examples for high yielding varieties resistant to water stress developed in India:
    a. Wheat and Sugarcane
    b. Jowar & Bajra
    c. Maize and Rice
    d. Both A & B
32. Green Revolution made it possible through plant breeding, to
    a. Produce disease resistant varieties
    b. Produce high yielding variety for food production to the extent of exporting it
    c. Both A &B
    d. None of the Above
33. Somatic hybridization is achieved through
    a. Conjugation
    b. Grafting
    c. Protoplast fusion
    d. Recombinant DNA
34. Pusa swarnim, a variety belongs to:
    a. Cauliflower
    b. Chilli
    c. Mustard
    d. Wheat

35. Which of the following cannot be obtained by basal medium?
    a. Plantlets from mature embryo
    b. Seedling from seed
    c. Plantlets from Callus
    d. Callus from ex-plant
36. In organ culture by growing which plant part do we get haploid plants:
    a. Anther
    b. Ovary
    c. Meristem
    d. Embryo
37. Germ plasm collection can include collection of
    a. Whole plant
    b. Seeds
    c. Vegetative propagates
    d. All of the above
38. Rhizogenesis and Caulogenesis are initiated by
    a. Auxins andCytokinins
    b. Auxins andgibberellin
    c. Gibberellin and Cytokinins
    d. Cytokinins and Zeatin
39. In tissue culture, synthetic seeds are coated with:
    a. Colchicin
    b. Sodium Chloride
    c. Sodium Algenate
    d. Auxins
40. Conventional plant breeding differs from classical plant breeding in this respect
    a. Involves hybridization
    b. Has been practiced since ages
    c. Involves domestication
    d. (b) and (c)
41. "Karan Rai" is another name of which of the Brassica variety
    a. Pusa Shubhra
    b. Pusa Swarnim
    c. Pusa Komal
    d. Pusa Sada Bahaar
42. If leaf bit is used as ex-plant, surface sterilization of the ex-plant is done with
    a. Liquid detergent
    b. Sodium hypo chloride
    c. Mercuric chloride
    d. Distilled water
43. Statements unrelated to "emasculation during hybridization experiments"
    a. It is required for female parent with bisexual self-pollinated flowers
    b. It avoids undesired cross-pollination
    c. It is not required for male parent
    d. It is not required in female parents with unisexual flowers and male sterile female parent
44. The somatic embryos with one set of chromosomes can be obtainedthrough
    a. Embryo culture
    b. Endosperm culture
    c. Shoot tip culture

d. Pollen grain culture

45. 33 % of India's GDP comes from
    a. Agriculture
    b. Industries
    c. Small scale cottage industries
    d. Exports
46. The scientific process by which the crop plants are enriched with certain desirable nutrients called
    a. Crop protection
    b. Plant breeding
    c. Bio-remediation
    d. Bio-fortification

II. FILL IN THE BLANKS

47. Mutations are induced in plants artificially by_____ radiations.
48. For evaluation and selection of parents in hybridization, _____ are to be created.
49. The state of uniformity/ homozygosity can be obtained when_____for several generations.
50. Examples for high yielding and disease resistant semi dwarf wheat in India are_____.
51. The better yield in semi-dwarf rice varieties in India are _____and _____.
52. People suffer from micro nutrient, protein and vitamin deficiencies are called _____.
53. _____is high-protein wheat variety used as a donor for improving cultivated wheat.
54. Iron and β – carotene are five times rich in_____.
55. King of green vegetables is_____.
56. To produce 1kg of meat by animal farming requires _____kg of grain.
57. Alternate sources of proteins for animal and human nutrition is_____.
58. Growing of microbes like Spirulina on waste materials as a source of good protein in SCP production also incidentally reduces environmental pollution which is also called as_____.
59. _____technology was developed for fast and efficient system for crop improvement.
60. The capacity to generate a whole plant from a cell is called_____.
61. Plants produced that are genetically identical to the original or source plant are called _____.
62. When isolated protoplasts from two different varieties of plants of desirable character are fused, then such hybrids are called _____
63. Somatic hybrid obtained from tomato and potato is_____.
64. In autoclave for sterilization of medium the required conditions are_____time, _____temperature,_____pressure.
65. Biological Principles applied to increase food production are_____and_____.
66. Classical plant breeding involves crossing of_____.
67. Purposeful manipulation of plant species is called_____.
68. Purposeful manipulation of genes is called _____.

III. REASONING AND ASSERTION

69. A: Bio fortification is the most practical means to improve public Health.
    R: Which aims at breeding crops with Higher levels of Vitamins & Minerals.
    a. Both A & R are True, R is correct explanation of A.
    b. Both A & R are True, R is not correct explanation of A.
    c. A is True, but R is False.
    d. Both A & R are False.

70. A: 250 gms of microorganisms produces 25 Tons of protein.
R: High rate of Bio mass production & growth.
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

71. A: Shoots or roots may be produced through process called organogenesis.
R: The ex- plants or callus cultured on different concentrations of carbon source.
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

72. A: Male sterile plants can be used directly as female parents without emasculation
R: In male sterile plants, Anthers do not produce active and fertile pollen.
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

73. A: Formation of Embryoids from callus is called true embryogenesis
R: Embryoids develop from Ovules
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

74. A: Somatic hybrids can be obtained by Protoplast fusion.
R: Endosperm can be obtained by Triple fusion.
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

75. A: Any part of Plant taken out and grown in test tube under sterile conditions in Nutrient Medium.
R: Ex- plants are plants obtained through tissue culture.
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

76. A: Genetic variations provide raw material for selection
R: Genetic variations are differences in the genotypes of the individuals
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

77. A: Hybridization is mating between two or more different lines
R: Hybridization is not a common method of creating genetic variation
a. Both A & R are True, R is correct explanation of A.
b. Both A & R are True, R is not correct explanation of A.
c. A is True, but R is False.
d. Both A & R are False.

78. A: In plant breeding, decrease in hetero zygosity reduces the performance of cross-pollinated crops.

R: Decrease in hetero zygosity enhances the performance of self-pollinated crops.

a. Both A & R are True, R is correct explanation of A.

b. Both A & R are True, R is not correct explanation of A.

c. A is True, but R is False.

d. Both A & R are False.

79. A: Emasculation of bisexual flowers of female parent is a prerequisite for artificial crossing.

R: There is a possibility of self-pollination in bisexual flowers which can be avoided by removing of stamens.

a. Both A & R are True, R is correct explanation of A.

b. Both A & R are True, R is not correct explanation of A.

c. A is True, but R is False.

d. Both A & R are False.

80. A: Parbhani Kranti was developed by mutational breeding

R: Mutation is the only method to develop disease resistant plants

a. Both A & R are True, R is correct explanation of A.

b. Both A & R are True, R is not correct explanation of A.

c. A is True, but R is False.

d. Both A & R are False.

81. A: Emasculation and bagging are not required if dioecious plants are selected as parents in hybridization

R: Dioecious plant species produce male and female flowers on the same plants

a. Both A & R are True, R is correct explanation of A.

b. Both A & R are True, R is not correct explanation of A.

c. A is True, but R is False.

d. Both A & R are False.

82. A: Somatic hybridization technique provides the opportunity for bypassing the conventional breeding barriers through direct transfer of Cytoplasmic and nuclear genomes to plant cells

R: Some plants show physical or chemical incompatibilities in normal sexual crosses

a. Both A & R are True, R is correct explanation of A.

b. Both A & R are True, R is not correct explanation of A.

c. A is True, but R is False.

d. Both A & R are False.

IV. MATCH THE FOLLOWING

83. Match the crop variety with their resistance to diseases:

a.	Pusa sadabhar	1.	Black Rot
b.	Pusa swarnim	2.	Bacterial Blight
c.	Pusa Subhra	3.	Leaf Curl
d.	Pusa Komal	4.	White Rust

A (a-4, b-3, c-1, d-2); B (a-3, b-4, c-1, d-2);

C (a-2, b-3, c-4, d-1); D (a-2, b-1, c-4, d-3)

84. Match the following based on the morphological and biochemical characters of certain plants leads to insect resistance of host crop plants:

a. Hairy Leaves in cotton	1. Resistant to stem sawfly
b. Hairy Leaves in Wheat	2. Resistant to cereal leaf beetle
c. Solid Stems in Wheat	3. Resistant to maize stem borers
d. Smooth leaves and nectar less in Cotton	4. Resistant to Jassids
e. High Aspartic acid, Low nitrogen and sugar content in maize.	5. Resistant to ball worms

A (a-2, b-4, c-1, d-3, e-5); B (a-3, b-1, c-5, d-2, e-4);

C (a-4, b-2, c-1, d-5, e-3); D (a-5, b-2, c-4, d-1, e-3)

85. Match the following:

a. Bitter Gourd	1. Vitamin A
b. Lablab	2. Protein
c. Pumpkin	3. Iron & Calcium
d. Spinach	4. Vitamin C

A (a-2, b-1, c-3, d-4); B (a-3, b-1, c-4, d-2);

C (a-4, b-3, c-1, d-2); D (a-4, b-2, c-1; d-3)

86. Match the following:

a. Inoculation	1. Isolated protoplasts
b. Micro Propagation	2. Plantlets from tissue culture
c. Somatic hybrids	3. Transfer of ex plants
d. Soma clones	4. Mass production of Plants Invitro

A (a-2, b-4,c-1,d-3); B (a-3, b-1,c-4,d-2);

C(a-3, b-4,c-1,d-2); D (a-4, b-3,c-1, d-2)

87. Match the following:

a. Sodium Hypochloride	1. Dis infectant
b. Sodium Algenate	2. Caulogenesis
c. Low Cytokinin to Auxin	3. Synthetic seeds
d. Low Auxin to Cytokynin	4. Rhizo genesis

A (a-1, b-4,c-2,d-3); B (a-2, b-1, c-4,d-3);

C (a-1, b-3, c-4,d-2); D (a-3,b-1, c-4, d-2)

88. Match the following:

a. Brassica	1. Pusa Komal
b. Wheat	2. Himagiri
c. Okra	3. Pusa Gaurav
d. Cowpea	4. Pusa Sawani

A (a-3, b-2, c-4, d-1); B (a-1, b-3, c-2, d-4);

C (a-2, b-4, c-1, d-3); D (a-2, b-3, c-4, d-1)

89. Match the following:

a. Hybridization	1. Progeny remains same for any number of Generations
b. Clonal Selection	2. Incorporation of new characters
c. Mutation Breeding	3. More number of Dominant genes
d. Heterosis	4. Creation of new character

A (a-3, b-4, c-1,d-2); B (a-2, b-1,c-4,d-3);

C (a-4,b-3, c-2, d-1); D (a-3,b-4,c-2,d-1)

V. TRUE OR FALSE

90. Saccharum barberi had thicker stems and higher sugar content_____
91. Creation of Pure lines is the pre requisite for selection of parents in the process of hybridization._____.
92. Saccharum officinarum grown in south India _____.
93. Acclimatization is the transfer of ex- plants into nutrient culture medium in anseptic condition _____.
94. The greater the genetic variability in a population, the better are the results of selection_____.
95. In pure lines, characters remain stable for several generations_____.
96. New characters cannot be incorporated through hybridization_____.
97. Pure lines are obtained from homozygous parents by cross-pollination _____.
98. The name of the Norman Borlug is associated with Yellow Revolution_____.
99. Synthetic Seeds contain sexual Embryos_____.
100. Shoot Tip culture is the production of virus infected Plants _____.

VI. ARRANGE IN CORRECT SEQUENCE

101. Events observed in Artificial Hybridization program
   a) Re-bagging
   b) Selection of parents
   c) Bagging
   d) Dusting the pollen on stigma
   e) Emasculation
   f) Collection of pollen from male plant
102. Events involved in Culturing of tissues and production of plantlets
   a) Transfer to field
   b) Surface sterilization of the ex-plant
   c) Incubation in the laminar airflow chamber
   d) Sterilization of nutrient medium in auto-clave
   e) Inoculation of ex-plant into the sterilized nutrient medium
   f) Organogenesis
   g) Callus
103. Steps in plant breeding a new genetic variety of crop are
   a) Selection and testing of superior recombinants
   b) Evaluation and selection of parents.
   c) Testing, release and commercialization of new cultivars
   d) Cross-hybridization among the selected parents.
   e) Collection of variability

104. Steps in Somatic Hybridization
   a) Isolation of single cells or proto plasts from plants after digesting the cell walls through enzymes like cellulase and pectilase.
   b) Fusion of naked protoplasts
   c) Transfer of cytoplasmic and nuclear genomes
   d) Formation of somatic hybrids
   e) Culture to form a novel plant
105. correct sequence for conventional method of breeding for disease resistance
   a) Testing and releasing of new varieties
   b) Hybridization of selected parents
   c) Screening of Germ plasm for resistance sources
   d) Selection of evaluation of the hybrids

ANSWER KEY

I. MULTIPLE CHOICE QUESTIONS

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

II. FILL IN THE BLANKS

47. Gamma	52. Hidden Hunger	57. Single cell protein or SCP	62. Somatic hybrids	67. Plant breeding
48. Purelines	53. Atlas-66	58. Bio remediation	63. Pomato	68. Genetic Engineering
49.Selfpollinated	54. Golden Rice	59. Tissue Culture	64. 15 mins, 121˚C, 15 Pounds	
50. Sonalika and Kalyansona	55. Chenopodium or Bathua	60. Totipotency	65. Animal Husbandry, Plant breeding	
51. Jaya and Ratna	56. 3-10 KG	61. Somaclones	66. Purelines	

III. REASONING AND ASSERTION

69.a	73.d	77.c	81.c
70.a	74.b	78.c	82.a
71.c	75.c	79.a	
72.a	76.b	80.a	

IV. MATCH THE FOLLOWING

83.b	87.c
84.c	88.a
85.d	89.b
86.c	

V. TRUE OR FALSE

90.F	93.F	96.F	99.F
91.T	94.T	97.F	100.F
92.T	95.T	98.F	

VI. ARRANGE IN CORRECT SEQUENCE

101. b-e-c-f-d-a
102. b-d-e-c-g-f-a
103. e-b-d-a-c
104. a-c-b-d-e
105. c-b-d-a

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