Telangana State Board of
INTERMEDIATE Education

BOTANY-II

BASIC LEARNING MATERIAL

For The Academic Year : 2021-2022

TELANGANA STATE BOARD OF INTERMEDIATE EDUCATION

BOTANY

Second Year

(English Medium)

BASIC LEARNING MATERIAL

ACADEMIC YEAR

2021-22

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PREFACE

The ongoing Global Pandemic Covid-19 that has engulfed the entire world has changed every sphere of our life. Education, of course is not an exception. In the absence and disruption of Physical Classroom Teaching, Department of Intermediate Education Telangana has successfully engaged the students and imparted education through TV lessons. In the back drop of the unprecedented situation due to the pandemic TSBIE has reduced the burden of curriculum load by considering only 70% syllabus for class room instruction as well as for the forthcoming Intermediate Examinations. It has also increased the choice of questions in the examination pattern for the convenience of the students.

To cope up with exam fear and stress and to prepare the students for annual exams in such a short span of time , TSBIE has prepared "Basic Learning Material" that serves as a primer for the students to face the examinations confidently. It must be noted here that, the Learning Material is not comprehensive and can never substitute the Textbook. At most it gives guidance as to how the students should include the essential steps in their answers and build upon them. I wish you to utilize the Basic Learning Material after you have thoroughly gone through the Text Book so that it may enable you to reinforce the concepts that you have learnt from the Textbook and Teachers. I appreciate ERTW Team, Subject Experts, who have involved day in and out to come out with the Basic Learning Material in such a short span of time.

I would appreciate the feedback from all the stake holders for enriching the learning material and making it cent percent error free in all aspects.

The material can also be accessed through our website**www.tsbie.cgg.gov.in.**

Commissioner & Secretary
Intermediate Education, Telangana.

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UNIT-I

CHAPTER 3

PLANT PHYSIOLOGY

ENZYMES

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. How are prosthetic groups different from co-factors?

Ans: **Prosthetic group :** In a holoenzyme organic co-factor that is tightly bound to the **apoenzyme is** called Prosthetic group.

Co-factors : In a holoenzyme non protein part is called co-factor. It could be a metal ion or an organic compound.

2. What is meant by feed back inhibition?

Ans: The end product of a chain of enzyme catalysed reactions inhibits the enzyme of the first reaction as part of homeostatic control of metabolism.

3. Why are "Oxido reductases" so named?

Ans: Because they can catalyse oxido reduction between two substrates These enzymes are called **oxydoreductases.**

4. Distinguish between apoenzyme and co factor?

Ans: **Apo enzyme :** The protein part of a holoenzyme

Co-factors : In a holoenzyme non protein part is called co-factor. It could be a metal ion or an organic compound.

5. What are competitive enzyme inhibitors? Mention one example.

Ans: The Inhibitors that closely resembles the substrate in its molecular structure and inhibits the activity of the enzyme, is known as **competitive inhibitors.**

E.g., Inhibition of succinic dehydrogenase by malonate which closely resembles the substrate succinate in structure.

6. What are non-competitive enzyme inhibitors? Mention one example.

Ans: These inhibiors has no structural similarity with the substrate and forms an enzyme inhibitor complex at a point other than its active site. Thus they make the enzyme inactive.

eg : Metal ions of copper, mercury, silver etc.

7. What do the four digits of an enzyme code indicate?

Ans: The Four Digits of the enzyme code indicates the following:

First digit - Major class of the enzyme.

Second digit - Sub class of the enzyme.

Third digit - Sub-subclass of the enzyme.

Fourth digit - Serial number of the enzyme in a perticular sub-sub class.

8. Who proposed 'Lock and Key hypothesis' and 'Induced fit hypothesis' ?

A. ❖ 'Lock and key hypothesis' was proposed by Emil Fisher (1884),

❖ Induced fit hypothesis was proposed by Daniel E. Koshland (1973).

9. Define Michaelis constant.

A. ❖ Substrate concentration required to cause half the maximal reaction rate is termed as Michaelis - Menten constant (Km).

❖ It is very important in determining enzyme substrate interaction.

SHORT ANSWER QUESTIONS (4 MARKS)

1. Write briefly about enzyme inhibitors.

A. The activity of enzyme is also sensitive to the presence of specific chemicals that bind to the enzyme. When the binding of the chemical shuts the enzyme activity, the process is called **inhibition** and the chemical is called an **inhibitor.**

Enzyme inhibitors are three types

a. competitive inhibitors

b. Non competitive inhibitors

c. Feed back Inhibitors

a. Competitive inhibitors: The inhibitors that closely resembles the substrate in its molecular structure and inhibits the activity of the enzyme, is known as **competitive inhibitors.**

E.g., Inhibition of succinic dehydrogenase by malonate which closely resembles the substrate succinate in structure.

b. Non competitive inhibitors: These inhibiors has no structural similarity with the substrate and forms an enzyme inhibitor complex at a point other than its active site. Thus they make the enzyme inactive.

eg : Metal ions of copper, mercury, silver etc.

c. Feed back Inhibitors: The end product of a chain of enzyme catolysed reactions inhibits the enzyme of the first reaction as part of homeostatic control of metabolism.

2. Explain different types of cofactors.

A. In a holoenzyme non protein part is called co-factor. It could be a metal ion or an organic compound.

Co-factors are three types. They are

a. Prosthetic groups

b. Co-enzymes

c. Metalions

a. Prostetic groups: These are the organic compounds that are tightly bound to the apo-enzyme. Ex : In peroxidase and catalase haem is the prosthetic group.

b. Co-enzymes: Co- enzymes are also organic compounds that are loosely bound to the apoenzyme

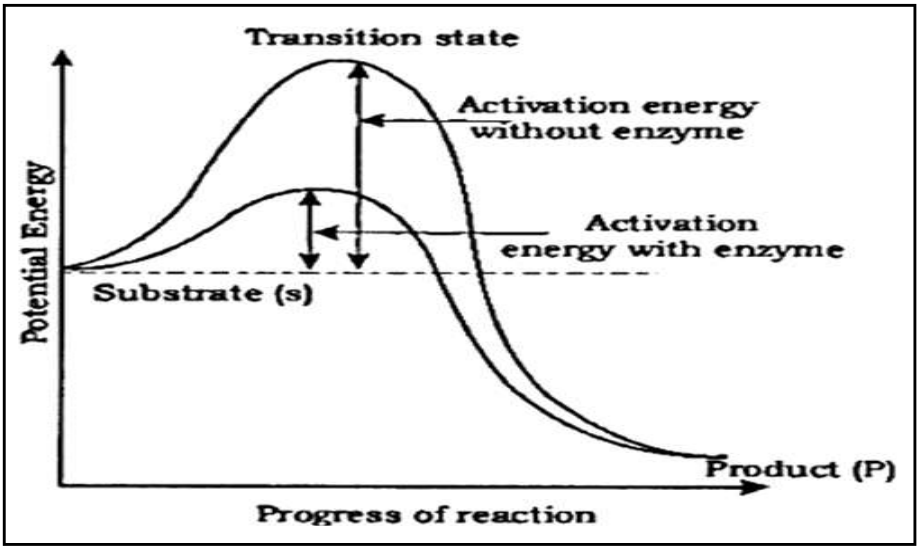
Eg : NAD, NADP.

c. Metalions : A number of enzymes require metal ions for their activity which form co ordination bonds with side chains at the active site and at the same time form one or more co ordination bonds with the sub strate e.g.: Zink is a cofactor in carboxypeptidase.

3. Explain the mechanism of enzyme action.

A.

- Each enzyme (E) has a substrate (S) binding site in its molecule so that a highly reactive enzyme substrate complex (ES) is produced.
- This complex is short lived and dissociates into its product (P) and the unchanged enzyme, with an intermediate enzyme product complex (EP)
- Energy that is required for a substrate to react in order to get converted into end product is called "Activation energy".
- This activation energy is available in different forms like heat, ATP etc.
- The formation of ES complex is essential for catalysis.
- Enzyme action can be explaind by two hypothesis
  1) Lock and key hypothesis by emil fisher
  2) Induced fit hypothesis by Daniel E. Koshland.



Enzyme action can be described in the following steps.

- ❖ First the substate binds to the active site of the enzyme, fitting into the active site.
- ❖ The binding of the substrate induces the enzyme to alter its shape, fitting more tightly around the substrate.
- ❖ The active site of the enzyme, now in close proximity to the substrate, breaks the chemical bonds of the substrate and the new - enzyme product complex is formed.
- ❖ The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of the substrate and runs through the catalytic cycle once again.

UNIT-I

CHAPTER 4

PLANT PHYSIOLOGY

PHOTOSYNTHESIS

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. Name the processes which take place in the grana and stroma regions of chloroplasts ?

Ans: Light phase occurs on grana, which leads to the formation of ATP & $NADPH_2$. Dark phase occurs in the stroma, leads to the formation of sugar.

2. Where does the photolysis of water occur ? What is its significance ?

Ans: **Photolysis of water** occurs in the lumen of thylakoids. During photo synthesis plants releases O_2 by this mechanism only.

$$H_2O \rightarrow 2H^+ + 2e^- + \frac{1}{2}O_2 \uparrow$$

$$2H_2O \rightarrow 4H^+ + 4e^- + O_2 \uparrow$$

3. How many molecules of ATP and NADPH are needed to fix a molecule of CO_2 in C_3 plants ? Where does this process occur ?

Ans: ❖ 3 molecules of ATP & 2 molecules of NADPH

❖ In the **stroma** of chlroplast.

4. Mention the components of ATP ase enzyme ? What is their location ? Which part of the enzyme shows conformational changes?

Ans: The ATPase enzyme consists of two parts : F_0 and F_1, Portions.

F_0 portion - It is embedded in the membrane of thylakoid

F_1 portion - It protrudes out on the outer surface of the thylakoid membrane, towards stroma.

F_1 portion of ATPase can shows conformational changes to produce ATP.

5. Distinguish between action spectrum and absorption spectrum ?

Ans: The graph showing rate of photosynthesis at different wave lengths of light is called **Action Spectrum.**

The graph showing light absorption by photosythetic pigments at different wave lengths is called **absorption spectrum**.

6. Of the basic raw materials of photosynthesis, what is reduced ? What is Oxidised ?

Ans: During photosynthesis mechanism CO_2 molecules are reduced and H_2O molecules are Oxidised.

7. Define the law of limiting factors proposed by Blackman ?

Ans: According to **Blackman** (1905) "If a process (like photosynthesis) is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the factor that is present in a relative minimum value".

8. What is the primary acceptor of CO_2 in C_3 plants ? What is the first stable compound formed in Calvin cycle ?

Ans: Ribulose bisphosphate (RuBP). It is a 5-carbon compound.

PGA (Phospho Glyceric Acid). It is a 3-carbon compound.

9. What is the primary acceptor of CO_2 in C_4 plants ? What is the first formed compound formed as a result of primary carboxylation in plants C_4 pathway ?

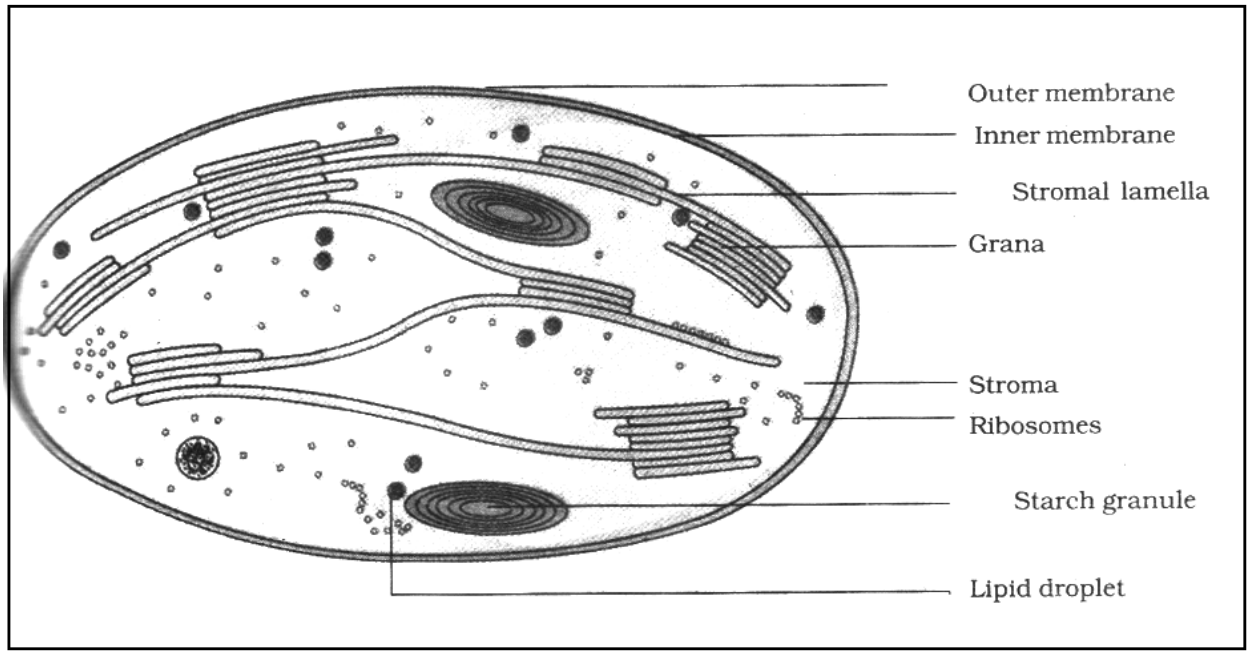
Ans: PEP (Phospho Enol Pyruvate), a 3-carbon compound.

Oxalo Acetic Acid (OAA), a 4-carbon compound.

SHORT ANSWER QUESTIONS (4 MARKS)

1. Draw a neat labelled diagram of chloroplast.

A.



2. Tabulate any eight differences between C_3 and C_4 plants / cycles.

A.

C_3 plants	C_4 plants
1. Occurs mostly in temperate plants and some tropical plants.	1. Occurs only in tropical and subtropical plants
2. Leaves do not show kranz anatomy	2. Leaves show kranz anatomy.
3. Chloroplast dimorphism is not present.	3. Chloroplast dimorphism is present.
4. Only calvin cycle occurs.	4. C_4 cycle in mesophyll cells and calvin cycle in bundle sheath cells takes place.
5. The primary CO_2 acceptor is RUBP in C_3 plants	5. The primary CO_2 acceptor is PEP in C_4 plants.
6. The first stable product is PGA in C_3 cycle	6. The first stable product is OAA in C_4 cycle
7. Less efficient in utilizing the spheric atmospheric CO_2	7. More efficient in utilizing the atmo- CO_2
8. Photorespiration is very high	8. Photo respiration is not detectable.

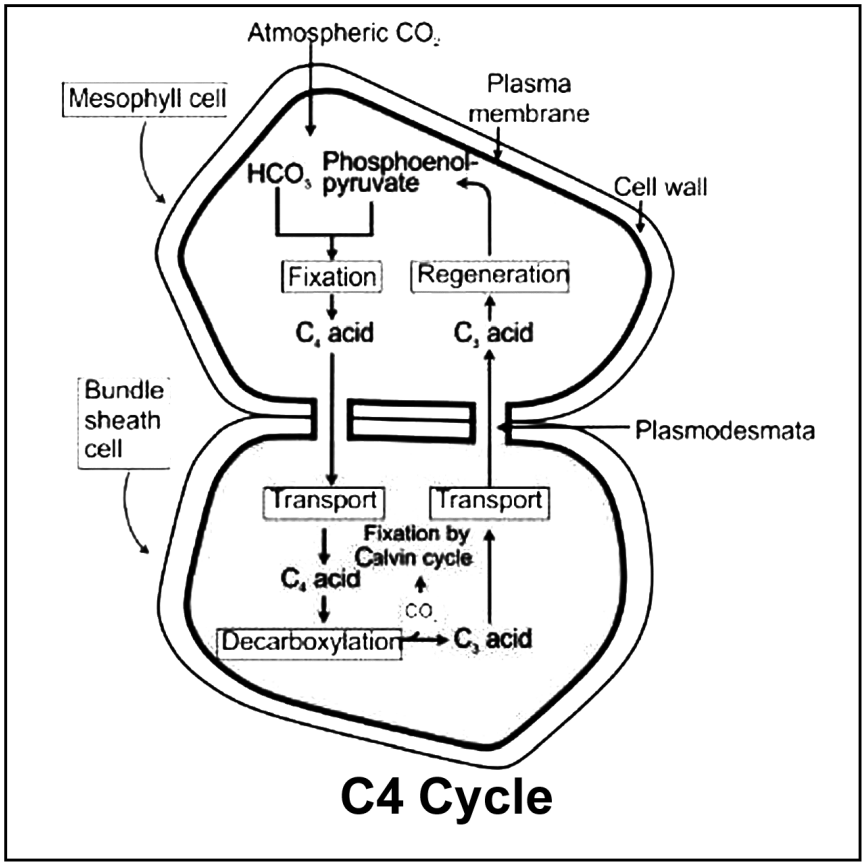
3. Describe C_4 pathway?

A. Because the first stable compound is a four corbon compound, the pathway is termed as C_4 pathway and plants which undergo this pathway are called C_4 plants.

- C_4 cycle occurs in subtropical and tropical regions of world.
- The most distinguishable anatomical feature of a C_4 leaf is the presence bundle seath surrounding vascular bundles. This anatomical specialization of a C_4 leaf is called "Kranz anatomy".
- C_4 Plants example - maize, sorghum, sugarcane etc.
- C_4 Pathway operates in two photosynthetic cells : mesophyll and bundle sheath cells.
- The primary CO_2 acceptor is phosphoenol pyruvate (3-carbon) which accepts CO_2 in the form of HCO_3^- and is present in the mesophyll cells. The enzyme responsible for this fixation is PEP corboxylase.

  $PEP + HCO_3^- \longrightarrow$ Oxalo acetic acid (4C)
  (OAA)
- Oxalo acetic acid is formed in the mesophyll cells and then converted into malic acid.
- Malic acid transported to the bundle sheath cells.
- In the bundle sheath cells malic acid broken to release CO_2 and pyruvic acid.
- Malic acid $\longrightarrow$ Pyruvic acid + CO_2

- ❖ Purivic acid is transported back to the mesophyll, where it is converted to phsphoenol pyruvic acid (PEP) again to complete the cycle.
- ❖ The CO_2 released in the bundle sheath cells enters the C_3 cycle.
- ❖ Rubisco enzyme present in the bundle sheath cells.
- ❖ CO_2 utilized in the C_3 cycle and to synthesize glucose.



4. Describe in brief photorespiration.

A.
- ❖ Light dependent release of CO_2 and uptake of O_2 by the green plants is called as photorespiration.
- ❖ Photorespiration occurs only in C_3 plants.
- ❖ Photorespiration occurs in chloroplast, mitochondria and peroxysome.
- ❖ Rubisco catalyzes corboxylation and oxygenation reactions. So this is called Ribulose bisphosphate corboxylase oxygenase.
- ❖ The binding of CO_2 or O_2 with Rubisco is competitive and concentration of O_2 or CO_2 determines this reaction.
- ❖ In general Rubisco has a much greater affinity for CO_2 than for O_2.
- ❖ When the concentration of O_2 is high, Rubisco binds to oxgen and carries out photorespiration.
- ❖ In C_3 plants some O_2 does bind to Rubisco, and hence CO_2 fixation is decreased.

- ❖ O_2 binds with Rubisco produces one phosphoglycerate and one phosphoglycolate molecule, and is said to be photorespiration.
  $RUBP + O_2 \xrightarrow{Rubisco}$ Phosphoglycerate + Phosphoglycolate.
- ❖ In the photorespiratory pathway there is no synthesis of glucose and ATP or NADPH. But threre is a release of CO_2 with utilisation of energy. Therefore it is a wasteful process.
- ❖ 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.

LONG ANSWER QUESTIONS (8 MARKS)

1. In the light of modern reaserches, describe the process of electron transport, cyclic and non cyclic photo phosphorylation.

A. Photosynthetic pigments are present in the thylakoid membrane organised into two complex systems these are

1) Photo system I (PS I)
2) Photo system II (PS II)

- ❖ Light absorbed by the pigments of Antenna transfered to reaction centre.
- ❖ A special chlorophyll 'a' forms the reaction centre.

Electron transport :

- ❖ Electron transport is two types
  1) Non-cyclic electron transport
  2) Cyclic electron transport

1) Non-cyclic electron transport :

- ❖ Both PSI and PSII systems are involved in the non-cyclic electron transport.
- ❖ In the starting of photosynthesis, reaction centre of PSII (P_{680}) absorb the light and oxidised to loss of one electron.
- ❖ The electrons from the reaction centre of PS II (P_{680}) are transfered to pheophytin.
- ❖ Electrons transfer from pheophytin to plastoquinone (PQ), cytochrome, next plastocynin, Finally reaches to PS I.
- ❖ In the mean time, reaction centre of PSI (P_{700}) absorb the light and oxidised to loss of one electron.
- ❖ Transfer the electron from PSI to ferridoxin through different electron carriers.
- ❖ Passes the electron from ferridoxin to $NADP^+$ and converted to NADPH.
- ❖ In non-cyclic electron transport electrons transfer from PS II to PS I next NADP and converted to NADPH.

- ❖ In thylakoid membrane difference of redox potential in between the electron carriers induce the electron flow.
- ❖ In non-cyclic electron transport electrons move in a zig-zag manner (Z scheme)

2) Cyclic - electron transport :

- ❖ PS I only present in the stroma lamellae. In the stroma lamellae membranes lack the PS II as well as NADP reductase enzyme.
- ❖ In this method, electron transfer from PS I, does not pass on to $NADP^+$ but is cycled back to the PSI complex through the electron transport chain.
- ❖ PS I is only involved in the electron transport that is called cyclic electron transport.

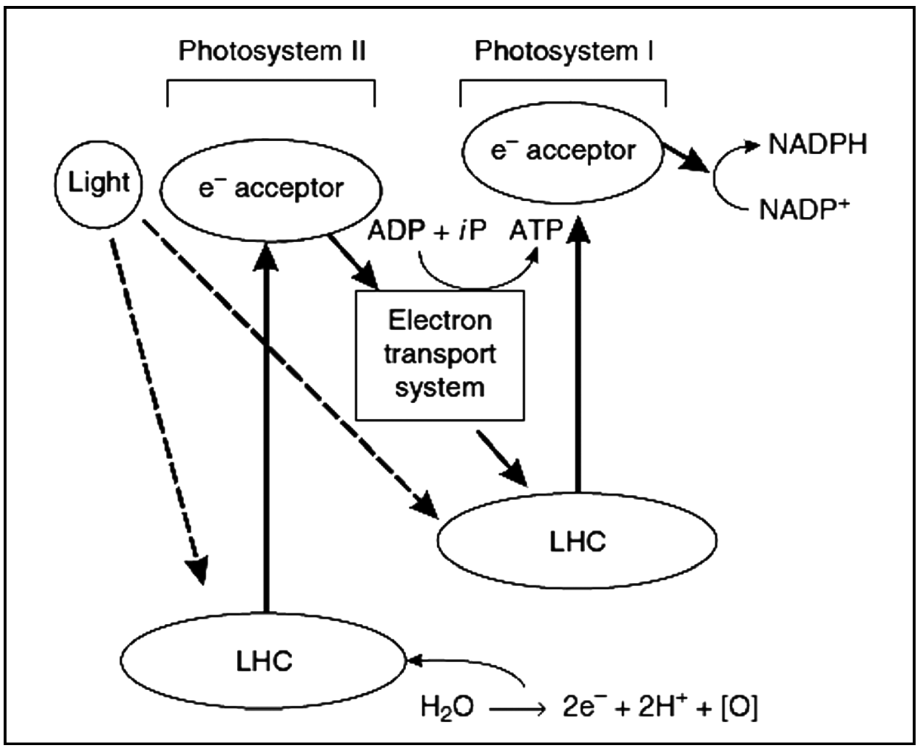
Photolysis of water :

- ❖ The splitting of water in the presence of light and the consequent evolution of oxygen is known as photolysis of water.
- ❖ Oxidised P_{680} accepts the electron by splitting of water for recruit the electron deficiency.
- ❖ Water is split into protons, electrons and oxygen.
- ❖ Oxygen evolving complex (OEC) is responsible for photolysis of water.
- ❖ Oxygen evolving complex is associated with the PS II, which is physically located on inner side of the membrane of the thylakoid.
- ❖ In this process, protons are released into the thylakoid lumen.

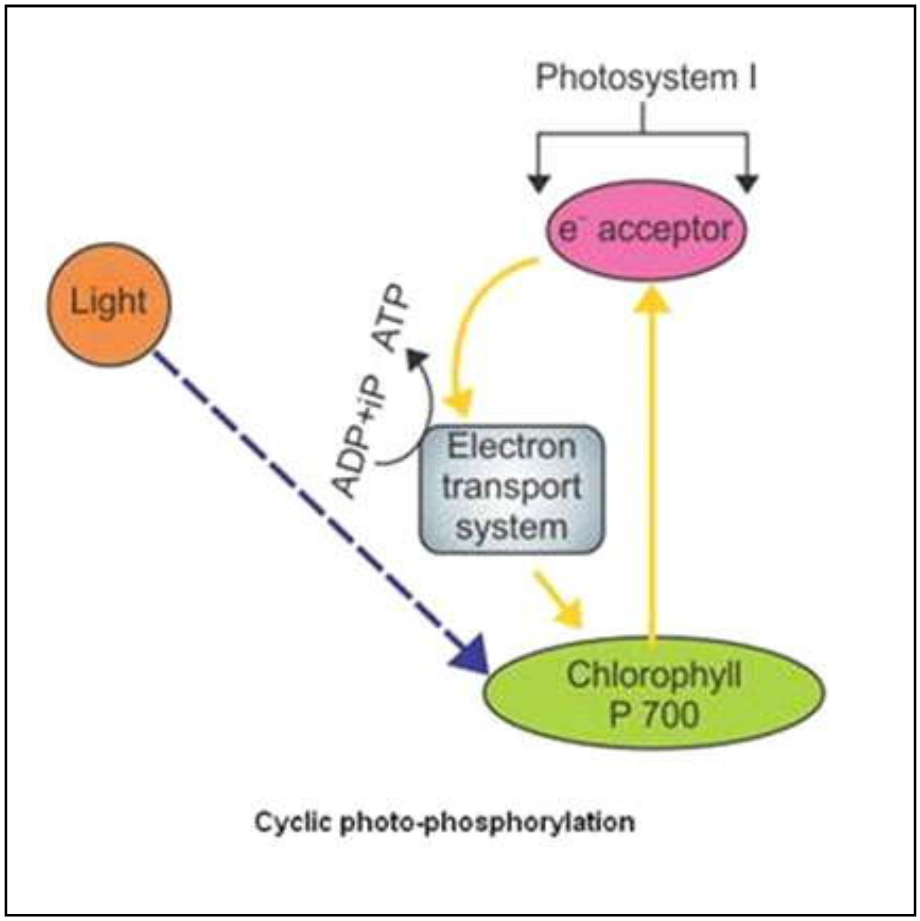
$$2H_2O \longrightarrow 4\,\bar{e} + 4H^+ + O_2$$

Photophosphorylation :

- ❖ Photophosphorylation is the synthesis of ATP from ADP and inorgonic phosphate in the presence of light.
- ❖ Both PSI and PS II systems are involved in the non - cyclic electron transport for the formation of ATP is called non-cyclic photophosphorylation.
- ❖ ATP and NADPH are synthesised by the non-cyclic electron transport.
- ❖ PSI system only involved in the cyclic electron transport for the formation of ATP is called cyclic photophosphorylation.
- ❖ ATP is only synthesised by cyclic electron transport but not of NADPH.
- ❖ Cylic photophosphorylation also occurs when only light of wavelengths beyond 680 nm are available for excitation.
- ❖ In green plants, cyclic photophosphorylation is an additional source of ATP required for chloroplast activities over and above that is required in the calvin cycle.



Non cyclic Photophosphorylation



Cyclic photo-phosphorylation

2. Explain calvin cycle.

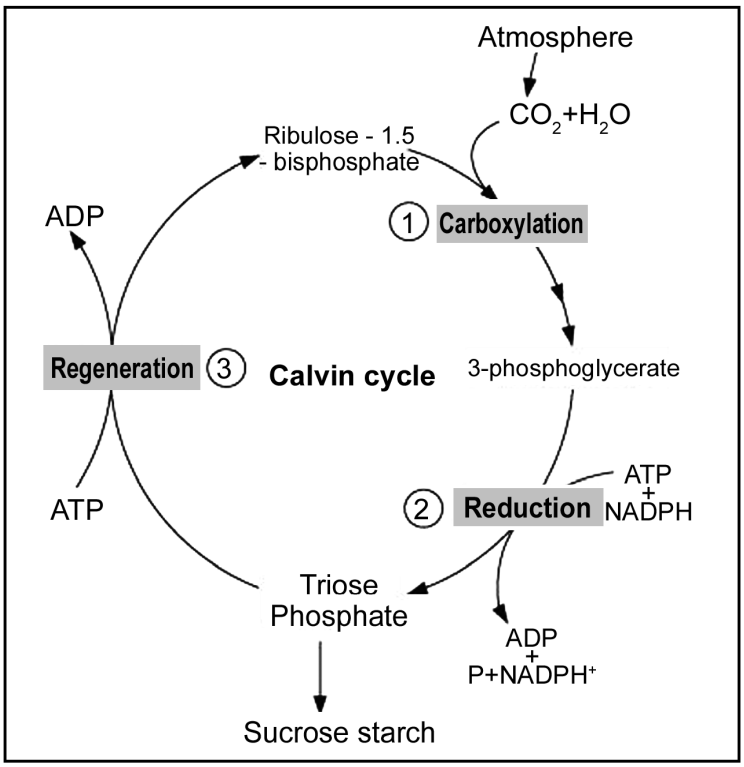
A. ❖ Melvin calvin and his co-workers conduct the experiments on chlorella and discovered this cycle, so it is called calvin cycle.

❖ In the corboxylation stage, primary stable compound PGA is formed. It contains 3 corbons, so this cycle is also called C_3 cycle.

❖ Calvin pathway occurs in all photosynthetic plants.

❖ Calvin cycle divides into three stages

1) Corboxylation 2) Reduction 3) Regeneration



1) Corboxylation :

❖ Corboxylation is the most crucial step of the calvin cycle.

❖ In this stage ribulose 1, 5 bis phosphate (Rubp) accepts CO_2 and forms one unstable compound, next stable 3-corbon compound PGA is formed.

❖ Corboxylation enzyme - Rubp corboxylase / oxygenase.
This enzyme is also called Rubsico

$$6RUBP + 6CO_2 + 6H_2O \xrightarrow{RUBSICO} 12\ PGA\ (3C)$$

2) Reduction :

❖ This is a two step reaction that leads to the formation of trioses (G-3p).

❖ The steps involve utilisation of 2 molecules of ATP For phosphorylation and two NADPH for reduction per CO_2 molecule fixed.

❖ The fixation of six molecules of CO_2 and 6 turns of the cycle are required for the removal of two molecules of triose (one glucose) from the pathway.

❖ Out of 12 G-3P, Two G-3P is exported into the cytosol for utilizing the synthesis of glucose. The remaining 10 G-3P are used to regeneration of 6 Rubp.

$$12\,PGA + 12\,ATP \xrightarrow{\text{Phosphoglycerokinase}} 12\,bis\,PGA + 12\,ADP$$

$$12\,bis\,PGA + 12\,NADPH \xrightarrow{\text{G-3P dehydrogenase}} 12\,G-3P + 12\,NADP + 12H_2PO_4$$

3) Regeneration : Regeneration of the CO_2 acceptor molecule Rubp is crucial, if the cycle is continue uninterrupted.

❖ The regeneration steps require one ATP for phosphorylation to from Rubp

❖ G-3P and DHAP (Dihydroxy acetone phosphate) are isomers and the inter conversion is catalysed by triose phosphate isomerase

$$G-3P \xrightarrow{\text{Triose Phosphote isomerase}} DHAP$$

$$2G-3P + 2DHAP \xrightarrow{\text{Aldolase}} 2Fructose\,1,6-bisphosphate$$

$$2Fructose1,6\ bisphosphate \xrightarrow{\text{Fruetose 1,6 bis phosphatase}} 2\ Fructose\ 6-Phosphate + 2Pi$$

$$2Fructose-6-Phosphate + 2G-3P \xrightarrow{\text{Transketolase}} 2xylulose-5\,phosphate + 2erythrose-4-phosphlate$$

$$2erythrose-4-phosphate + 2DHAP \xrightarrow{\text{Aldolase}} 2Sedoheotulose\ 1,7\ bis\ Phosphate$$

$$2Sedoheptulose\ 1,7\ bis\ Phosphate \xrightarrow{\text{Sedoheptulose 1,7 bis Phosphatase}} 2Sedoheptulose\ 7\ Phosphate + 2Pi$$

$$2Sedoheptulose-7-Phosphate + 2G-3P \xrightarrow{\text{Transketolase}} 2Xylulose-5-P + 2ribose-5-P$$

$$4Xy\ lulose\ -\ 5\ -\ P \xrightarrow{\text{Ribulose - 5 - Phosphate epimirase}} 4\ Ribulose\ -\ 5\ -\ Phosphate$$

$$2Ribose-5-P \xrightarrow{\text{Ribose-5-Phosphate isomerase}} 2Ribulose-5-Phosphate$$

$$6Ribulose-5-Phosphate + 6ATP \xrightarrow{\text{Rubp Kinase}} 6Ribulose\ 1,5\,bis\ Phosphate + 6ADP$$

✤ To make one glucose through calvin cycle requires $6CO_2$, 18ATP and 12 NADPH

UNIT-I

PLANT PHYSIOLOGY

CHAPTER 5

RESPIRATION IN PLANTS

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. Different substrates get oxidised during respiration. How does respiratory quotient (RQ) indicate which type of substrate i.e., carbohydrate, fat or protein is getting oxidised ?

RQ = A/B

What do A and B stand for ?

What type of substrates have RQ of 1, < 1, > 1 ?

A. Respiratory Quotient (R.Q) = $\frac{\text{Volume of } CO_2 \text{ evolved}}{\text{volume of } O_2 \text{ consumed}}$

Here, A stands for = Volume of CO_2 evolved

B stands for = volume of O_2 consumed

If RQ value is 1 the Respiratory substrates are carbohydrates

If RQ values is < 1 the Respiratory substrates are Protiens & fats

If RQ values is > 1 the Respiratory substrates are Organic acids

2. What is the specific role of F_0 - F_1 particles in respiration ?

A. ❖ F_0 is an integral membrane protein complex that forms the channel through with protons cross the inner membrane.

❖ The F_1 headpiece is a peripheral membrane protein complex and contains the site for synthesis of ATP

3. When does anaerobic respiration occur in man and yeast ?

A. Anaerobic respiration occurs in the absence of oxygen.

Man : when oxygen is inadequate for cellular respiration, anaerobic respiration occurs which leads to muscle fatigue; (Pyruvic acid reduced to lactic acid)

Yeast : Incomplete oxidation of glucose occurs under anaerobic conditions, which leads to formation of alcohol. (Fermentaion)

4. What is the common pathway for aerobic and anaerobic respirations? Where does it take place ?

❖ Glycolysis

❖ Cytoplasm of the cell

5. What cellular organic substances are never used as respiratory substrates?

A. Pure proteins or fats are never used as respiratory substrates.

6. Why is the RQ of fats less than that of carbohydrates?

A. Fats are poorer in oxygen and the proportion of oxygen to carbon in fats is invariably less as compared to carbohydrate. Hence they require more oxygen for complete oxidation. Thus RQ is less than one for fats

7. What is meant by 'Amphibolic pathway' ?

A. ❖ The term Amphibolic pathway is used to signify **krebs cycle** (TCA cycle)

❖ As this cycle involves both in catabolism (Oxidation of fats, carbohydrates) and anabolism (α -ketoglutaric acid serves as substrate for the synthesis of amino acids) it is referred as amphibolic pathway.

8. Name the mobile electron carriers of the respiratory electron transport chain in the inner mitochondrial membrane.

A. ❖ Ubiquinone (between complex I&III, between complex II&III)

❖ Cylochrome 'C' (between complex III&IV)

9. What is the final acceptor of electrons in aerobic respiration ? From which complex does it receive electrons ?

A. ❖ O_2 is the ultimate final acceptor of electrons in aerobic respiration

❖ From complex IV (cytochrome C Oxidase) it receives electrons and gets reduced to water.

10. Do you know of any step in Kreb's cycle where there is a substrate level phosphorylation ? Explain.

A. In Kreb's cycle, Succinyl coenzyme A splits into succinic acid and co-enzyme A by the catalytic activity of 'Succinic thiokinase', where a ATP molecule is synthesized through substrate level phosphorylation.

$$\text{Succinyl CoA + ADP + Pi} \xrightarrow{\text{Succinic thiokinase}} \text{Succinic acid + CoA + ATP}$$

SHORT ANSWER QUESTIONS (4 MARKS)

1. Why is the respiratory pathway refered to as an amphibolic pathway? Explain?

❖ **Amphibolic pathway** is the one which is used for both breakdown (catabolism) and build-up (anabolism) reactions.

- ❖ **Respiratory pathway** is mainly a catabolic process which serves to by provide energy.
- ❖ The pathway produces a number of intermediates.
- ❖ Many of them are raw materials for building up both primary and secondary metabolites.
- ❖ Acetyl CoA is helpful not only in kerbs' cycle but it also raw material for synthesis of fatty acids, steroids, terpenes, aromatic compounds and carotenoids.
- ❖ 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 synthesize fatty acids, acetyl CoA would be withdrawn form the repiratory pathway for it.
- ❖ Hence, the respiratory pathway comes into the picture both during breakdown and synthesis of fatty acids.
- ❖ Breaking down processes within the living organisim is catabolism, and synthesis is anabolism.
- ❖ Because the respiratory prathway 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.

2. Write about two ATP yielding reactions of glycolysis.

A.
- ❖ 1,3 dPGA (disphosphoglyceric acid) looses phosphate group in the presence of phosphoglycerokinase to form 3-phosphoglyceric acid. ADP accepts phosphate group and gets converted to ATP.

$$\text{1,3 dPGA} + \text{ADP} \xrightarrow{\textit{phosphoglycerokinase}} \text{3-PGA} + \text{ATP}$$

- ❖ Phosphoenol pyruvic acid undergoes dephosphorylatio in the presence of pyruvic kinase results in the formation of pyruvic acid. ADP accepts phosphate group and gets converted to ATP.

$$\text{PEP} + \text{ADP} \xrightarrow{\text{Pyruvic kinase}} \text{Pyruvic acid} + \text{ATP}$$

3. The net gain of ATP for the complete aerobic oxidation of glucose is 36. Explain.

A. **1) Glycolysis :**

1. ATP produced by substrate by substrate level phosphorylation

Bisphosphoglyceric acid to phosphoglyceric acid	:	2 x 1 = 2 ATP
Phosphoenol pyruvic acid to pyruvic acid	:	2 x 1 = 2 ATP
ATP consumed : for the phosphorylation of glucose and fructose-6 phosphate	:	-2 ATP
Net gain of ATP	:	+2 ATP
2. ATP from NADH generated in glycolysis		:

	G-3-P to BPGA (2NADH, each worth 2ATP)	:	2x2 = 4 ATP
	ATP gain from glycolysis in the presence of 0_2	:	[a]6 ATP
2)	**Oxidative decarboxylation of pyruvic acid**		
	Pyruvic acid to acetyl COA		
	(2 NADH, each worth 3 ATP)	:	[b]2x3 = 6 ATP
3)	**Krebs cycle**		
	1. ATP produced in substrate level phosphorylation :		
	succinyl CoA to succinic acid	:	2 x 1 = 2 ATP
	2. ATP from NADH : Isocitric acid to Oxalosuccinic acid	:	2 x 3 = 6 ATP
	a Ketoglutaric acid to succinyl CoA	:	2 x 3 = 6 ATP
	Malic acid to Oxalocaetric acid	:	2 x 3 = 6 ATP
	3. ATP from FADH2 : Succinic acid to fumaric acid	:	2 x 2 = 4 ATP
	Toal ATP value of krebs cycle	:	[c]24 ATP
	Net gain of ATP in aerobic respiration per mole glucose		
	(a + b + c)	:	36 ATP

4. Define RQ. Write a short note on RQ.

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

$$RQ = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$$

- ❖ The respiratory quotient depends upon the type of respiratory substrate used during respiration.
- ❖ When carbohydrates are used as substrate and are completely oxidised, the RQ is 1, because equal amounts of CO_2 and O_2 are evolved and consumed, respectively.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$$

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

- ❖ Fats require more oxygen for complete oxidation thus RQ is less than one.
- ❖ Proteins require more oxygen for complete oxidation thus RQ is less than one.
- ❖ Organic acids require lesser oxygen for complete oxidation thus RQ is greater than one.
- ❖ In living organisms respiratory substrates are often more than one.
- ❖ Pure proteins or fats are never used as respiratory substrates.

5. Describe briefly the process of fermentation.

A.
- ❖ Enzymatic conversion of glucose to ethyl alcohol or Lactic acid by microbes under anaerobic conditions. This process is called fermentation.
- ❖ Anaerobic respiration performs some organisms. Ex : Bacteria, human muscles, yeast.
- ❖ Under anaerobic conditions lactobacillus bacteria converts pyruvic acid into lactic acid.
- ❖ Human muscles during exercise, when oxygen is inadequate for cellular respiration, pyruvic acid is reduced to lactic acid.
- ❖ In yeast, pyruvic acid is reduced to ethyl alcohol and CO_2.
- ❖ $$\text{Pyruvic acid} \xrightarrow{\text{Pyruvate decarboxylase}} \text{Acetaldehyde} + CO_2$$
$$\text{Acetaldehyde} + NADH + H^+ \xrightarrow{\text{Alcohol dehydrogenase}} \text{Ethyl alcohol} + NAD^+$$
- ❖ Anaerobic respiration results in the formation of only 2 ATP as its net gain.
- ❖ Also, the processes are hazardous - either acid or alcohol is produced.

6. Explain various complexs involved in electron transport system of respiration.

A. Five complexes are involved in electron transport system of respiration.

1. Complex - I (NADH Dehydrogenase)
- ❖ In this complex FMN is a prosthetic group.
- ❖ This complex transfer electrons from NADH to ubiquinone.

2. Complex - II (Succinic Dehydrogenase)
- ❖ In this complex FAD is a prosthetic group.
- ❖ This enzyme transfer electrons from succinate to ubiquinone.

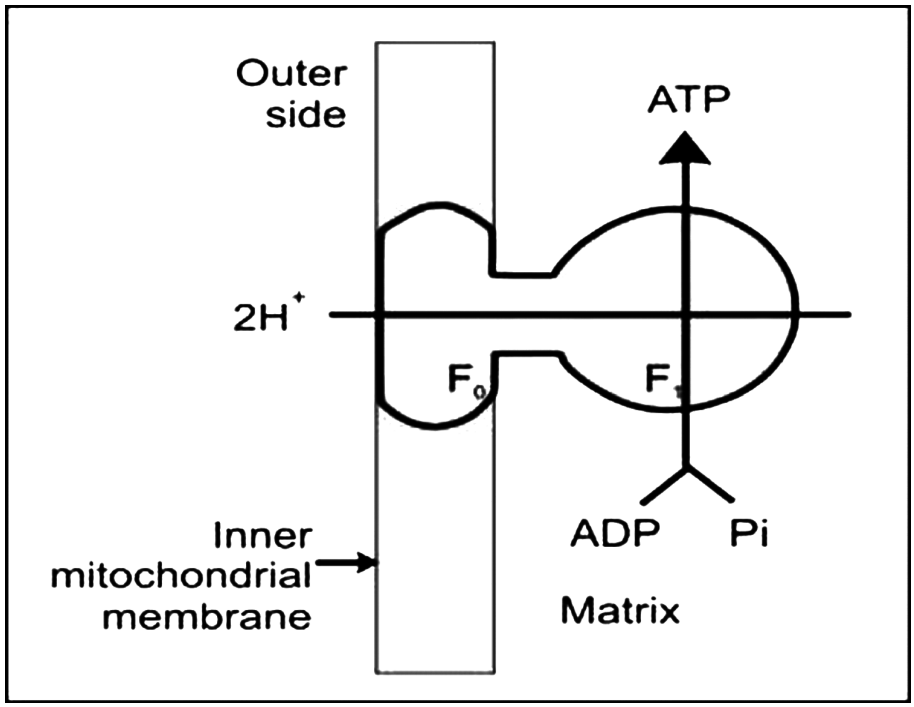
3. Complex - III (Cytochrome 'C' reductase)
- ❖ This complex tranfer electrons from ubiquinone to cytochrome 'C'.

4. Complex - IV (Cytochrome 'C' oxidase)
- ❖ This complex transfer electrons from cytochrome 'C' to molecular oxygen.

5. Complex - V (ATP synthase)
- ❖ This complex consists of two major components, F_0 and F_1
- ❖ F_0 is an integral membrane protein complex the forms the channel through which protons cross the membrane.
- ❖ F_1 head piece is a peripheral membrane protein complex and contains the site for synthesis of ATP.

7. Describe the structure of complex - V and explain the process of oxidative phosphorylation as explained by chemiosmotic hypothesis.

A.
- ATP synthase present in inner membrane of mitochondria and that participate in electron transport system of aerobic respiration is called complex - V.
- Complex V consists of two major components F_0 and F_1
- F_0 is an integral membrane protein complex that forms the channel through with protons cross the inner membrane.
- The F_1 headpiece is a peripheral membrane protein complex and contains the site for synthesis of ATP



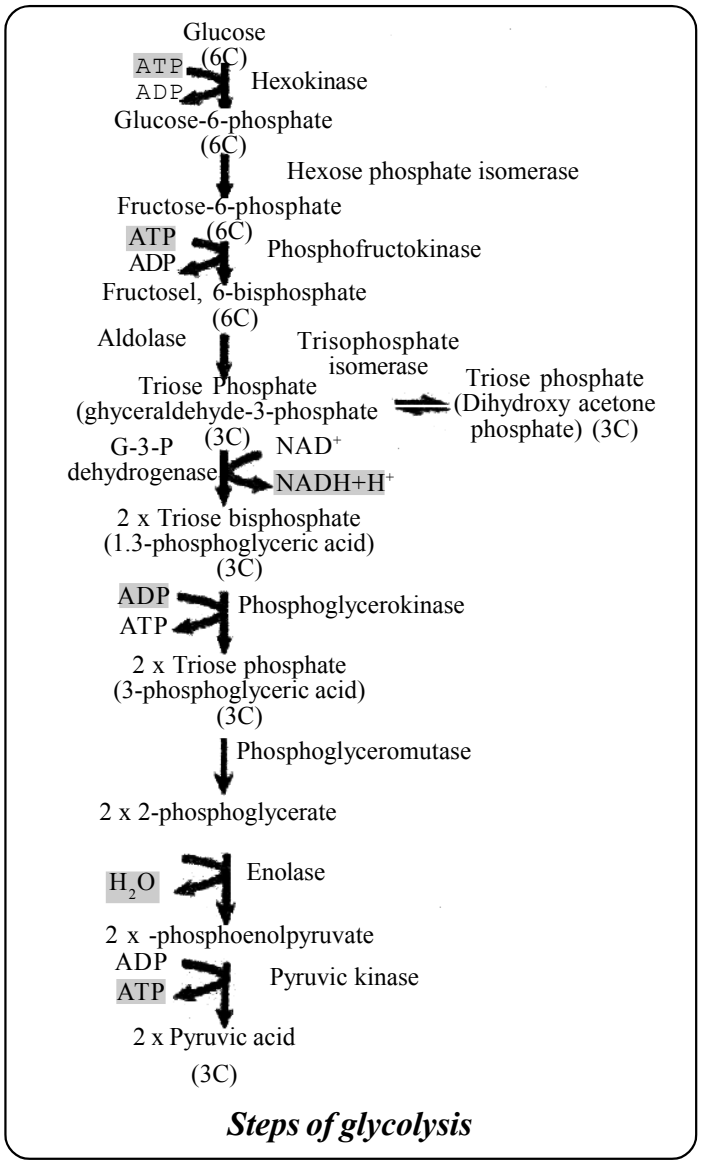
Oxidative phosphorylation :
- ATP synthesis is based on Peter Mitchell's chemiosmotic hypothesis.
- During passage of electrons from NADH and FADH to molecular oxygen, protons are transported into inner mitochondrial space from matrix of mitochondria.
- This established a proton gradient on either side of inner membrance.
- The protons reenter into matrix through ATP synthase.
- Then proton motive force created, this is used for synthesis of ATP from ADP and inorgonic phosphate.
- For each ATP produced, $3H^+$ passes through ATP synthase from the inner mitochondrial membrane to the matrix.

1. Give an account of Glycolysis. Where does it occur? What are the end products? Trace the fate of these products in both aerobic and anaerobic respiration.

A. Brakedown of 1 molecule of glucose into 2 molecules of pyruvic acid is called **glycolysis**. It was given by Gustavo embden, Otto Mayerhof and J.Parnas so called EMP pathway.

Glucolysis occur in cytoplasm. Pyruvic acid, 2ATP, 2NADH+H are the end products in Glucolysis. Pyruvic acid, 2NADH+H are completely oxidized through TCA cycle, ETS pathway and produce 36 ATP molecules. In Anaerobic respiration, pyruvic acid is partially oxidized results in the formation of Ethyol alcohol and CO_2.

The path of glycolysis is as follows:



Steps of glycolysis

Reactions of Glycolysis:

1) **Phosphorylation:**

Glucose + ATP $\xrightarrow{\text{Hexokinase}}$ Glucose-6-phosphate +ADP

2) **Isomerisation:**

Glucose-6-phosphate $\xrightarrow{\text{Phosphohexose isomerase}}$ Fructose -6-phosphate

3) **Phosphorylation:**

Fructose -6-phosphate + ATP $\xrightarrow{\textit{phosphofructokinase}}$ Fructose 1,6 bis phosphate +ADP

4) **Cleavage:**

Fructose 1,6 bis phosphate $\xrightarrow{\textit{Aldolase}}$ DHAP+ Glyeroldyhyde 3 - phosphate

5) **Isomerisation:**

DHAP $\underset{\longleftarrow}{\xrightarrow{\textit{Triosephosphateisomerase}}}$ Glyeroldyhyde 3 - phosphate

6) **Oxidation:**

Glyeroldyhyde 3 - phosphate +NAD +Pi $\xrightarrow{\textit{G-3pDehydrogenase}}$ 1,3 bis PGA +NADH

7) **Dephosphorylation:**

1,3 bis PGA + ADP $\xrightarrow{\textit{Phosphoglycerokinase}}$ 3- Phosphoglyceric acid (3-PGA) +ATP

8) **Intramolecular shift:**

3- Phosphologyceric acid (3-PGA) $\xrightarrow{\textit{Phosphoglyceromutase}}$ 2 PGA (2-Phosphoglyceric acid)

9) **Dehydration:**

2- Phosphoglyceric acid $\xrightarrow{\textit{Enolase}}$ Phosphoenolpyruvic acid (PEP) $+H_2O$

10) **Dephosphorylation:**

Phospho enolpyruvic acid +ADP $\xrightarrow{\textit{Pyruvickinase}}$ Pyruvic acid + ATP

2. Explain the reactions of krebs cycle.

A. **Krebs cycle** also called as Tricarboxyllic acid cycle (TCA) occurs in the matrix of the mitochondria.

The final product of glycolysis is pyruvic acid. The pyruvic acid under goes oxidative decarboxyation and forms Acetyle COA

This Acetyle COA then enters into tricarboxylic acid cycle.

The T.C.A. starts with the condensation of acetyle group with OAA and water to yield citric acid.

The Reactions of krebs cycle are as follows :

1) **Condensation :**The acetyl CoA condenses with oxaloacetic acid and water to yield citiric acid in the presence of citrate synthetase and CoA is released.

OAA + A.CoA + Water $\xrightarrow{\textit{Citratesynthetase}}$ CA + Co. A

2) **Dehydration :** Citric acid looses water molecule to yield cisacontic acid in the presence of aconitase.

$$\text{Citric acid} \xrightarrow{Aconitase} \text{Cis-acontic acid} + H_2O$$

3) **Hydration :** A water molecule is added to cis aconic acid to yield isocitric acid in the presence of acontiase.

$$\text{Cis-aconitic acid} + H_2O \xrightarrow{Aconitase} \text{isocitric acid}$$

4) **Oxidation I :** Isocitric acid undergoes oxidation in the presence of dehydrogenase to yield oxalosuccinic acid

$$\text{Isocitric acid} + NAD+ \xrightarrow{Isocitratedehydrogenase} \text{oxalosuccinnic acid} + NADH + H^+$$

5) **Decarboxylation :** Oxlosuccinic acid undergoes decarboxylation in the presence of decarboxylase to form α -keto glutaric acid.

$$\text{Oxlosuccinic acid} \xrightarrow{oxalosuccinicdecarboxylase} \alpha \text{ - keto glutaric acid} + CO_2$$

6) **Oxidation II, decarboxylation :** α -keto glutaric acid undergoes oxidation and decarboxylation in the presence of dehydrogenase and condenses with co.A to form succinyl co.A

$$\alpha \text{ -keto glutaric acid} + NAD+ + \text{Co.A} \xrightarrow{\alpha ketoglutaricdehydrogenase} \text{succinyl co.A} + NADH + H+ CO_2$$

7) **Cleavage :** Succinyl co.A splits into succinic acid and co.A in the presence of thiokinase to from succinic acid. The energy released is utilized to from ATP from ADP and Pi.

$$\text{Succinyl co A} + ADP + Pi \xrightarrow{Succinicthiokinase} \text{Succinic acid} + ATP + \text{Co.A}$$

8) **Oxidation-III :** Succinic acid undergoes oxidation and forms Fumaric acid in the presence of succunic dehydrogenase.

$$\text{Succinic acid} + FAD \xrightarrow{succinicdehydrogenase} \text{Fumaric acid} + FADH_2$$

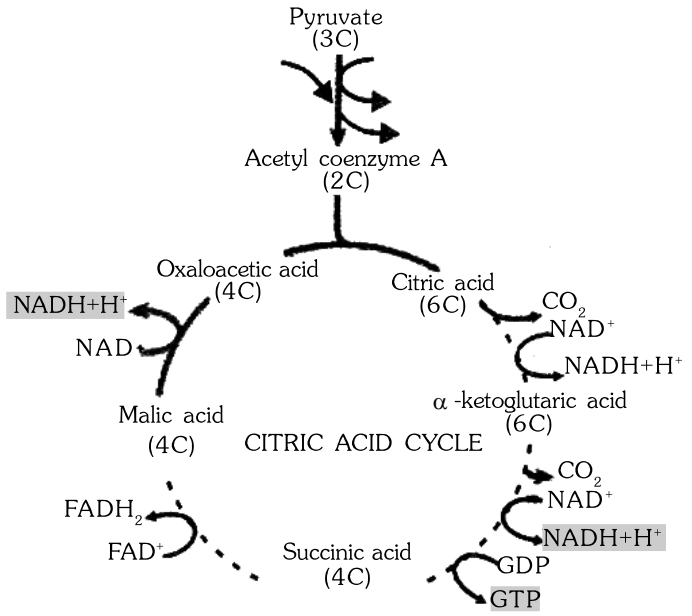
9) **Hydration :**

$$\text{Fumaric acid} + H_2O \xrightarrow{Fumerase} \text{Malic acid}$$

10) **Oxidation IV :**

$$\text{Malic acdi} + NAD^+ \xrightarrow{Malicdehydrogenase} \text{Oxaloacetic acid} + NADH + H^+$$

❖ Two molecules of pyruvic acid participated in krebs cycle formation of 8 NADH, 2 $FADH_2$, 2 ATP and 6 CO_2



The Citric acid cycle

UNIT-I

PLANT PHYSIOLOGY

CHAPTER 6

PLANT GROWTH AND DEVELOPMENT

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. What is the disease that formed the basic for the identification of gibberellings in plants ? Name the causative fungus of the disease.

Ans: **Bakane** (foolish seeding) disease in rice seedlings. It is caused by a fungal pathogen **Gibberella fujikuroi.**

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

Ans: Growing Apical bud inhibits the growth of Axilary buds is called **Apcial dominance**. It is caused by **auxins.**

3. What is meant by bolting ? Which hormone causes bolting ?

Ans: Sudden elongation of internodes prior to flowering is called **bolting.** It is caused by **Gibberellins.**

4. Define respiratory climatic. Name the PGR associated with it.

Ans: The rise in the rate of respiration during the ripening of fruits is known as **respiratory climatic.** The hormone responsible for this phenomenon is **ethylene.**

5. What is Ethephon ? Write its role in agricultural practices.

Ans: It is an **Ethylene** releasing chemical formulation. It hastens **fruit ripening** in tomatoes and apples and accelerates abscission in flowers and fruits. It promotes **female flowers** in **cucumbers,** there by increasing the yield.

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

Ans: ABA (Abscisic acid) is called **stress hormone.** ABA stimulates the closure of stomata in the epidermis and increases the tolerance of plants to various kinds of stresses.

SHORT ANSWER QUESTIONS (4 MARKS)

1. Write a note on agricultural / horticultural applications of auxins.

Ans:
1) Auxins like IBA, NAA, 2, 4-D, are the synthetic auxins extensively used in agricultural, horticultural practices.
2) IAA, IBA help to initiate rooting in stem cuttings, widely used for plant propagation in horticulture.
3) Promotes flowering in many plants Ex : pineapples.
4) Auxins promotes abscission of older mature leaves.
5) Auxins induce parthenocarpy. Ex : Tomatoes.

6) Synthetic Auxins like 2,4 D(2,4 Dichloro phenoxy Acetic Acid) is widely used to kill dicotyledonous weeds.

2. Write the physiological responses of Gibberellins in plants.

Ans: i) Gibberellins promote bolting for Ex : Beet, cabbage.
ii) They promote early seed production in conifers (When treated in young stage)
iii) They increase the length of grapes stalks.
iv) Gibberellins elongate and improve the shape in apples.
v) They speed up the malting process in brewing industry.
vi) In sugarcanes they increases the length of the stem.

3. Write any four physiological effects of cytokinins in plants.

Ans: 1) Cytokinins induces cell division.
2) They help produce new leaves, chloroplasts in leaves, lateral shoot growth and adventitious shoot formation.
3) Cytokinins help to overcome apical dominance.
4) They promote nutrient mobilization which helps in the delay of senescence.
5) Cytokinins help in the opening of stomata by increasing the concentration of k+ ions in guard cells.

4. What are the physiological processes that are regulated by ethylene in plants ?

Ans: 1) Ethylene promotes the **ripening of fruits,** by enhancing the respiration rate.
2) Ethylene promotes the **senescence** and **abscission of leaves and flowers.**
3) Ethylene promotes rapid **internode/petiole elongation** in deep water rice plants, It helps leaves/upper parts of the shoot to remain above water.
4) It also promotes **root growth** and **root hair formation**, thus helping plants to increase their absorption surface.
5) Ethylene is used to initiate flowering and for synchronizing fruit set in pine-apples.
6) It promotes female flowers in cucumbers, thereby increasing the yield.
7) Ethylene promotes triple response growth in dicot seedlings.

5. Which one of the plant growth regulators would you use if you are asked to

a) Induce rooting in a twig
b) Quickly ripen a fruit
c) Delay leaf senescence
d) Induce growth in axillary buds
e) 'Bolt' a rosette plant

f) Induce immediate stomatal closure in leaves

g) Overcome apical dominance h) Kill dicotyledonous weeds.

A. **a)** Auxins like IBA, NAA **b)** Ethylene
c) Cytokinins **d)** Cytokinins
e) Gibberellins **f)** Abscisic acid
g) Cytokinins **h)** Auxins-2, 4-D

LONG ANSWER QUESTIONS (8 MARKS)

1. List five natural plant growth regulators, write a note on discovery, physiological functions and agricultural / horticultural aplications of any one of them.

A. Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene

Auxins : Auxins was first isolated from human urine. Auxins are generally produced in growing apices of stems and roots.

The auxins was isolated by **F.W. Went** from the tip of coleoptiles of oat seedlings.

Physiological functions :

1) Apical dominance is caused by auxins
2) Auxins initiate rooting in stem cuttings.
3) Prevent fruit and leaf drop at early stages but promote the association of older mature leaves and fruits.
4) Auxins controls xylem differentiation and helps in cell division.
5) Auxins promote flowering e.g. pineapple
6) Auxins induces parthenocarpy e.g. tomato

Agricultural / Horticultural applications :

1) Auxins like IBA, NAA, 2, 4-D, are the synthetic auxins extensively used in agricultural, horticultural practices.
2) IAA, IBA help to initiate rooting in stem cuttings, widely used for plant propagation in horticulture.
3) Promotes flowering in many plants Ex : pineapples.
4) Auxins promotes abscission of older mature leaves.
5) Auxins induce parthenocarpy. Ex : Tomatoes.

UNIT-III

CHAPTER 9

GENETICS

PRINCIPLES OF INHERITANCE AND VARIATION

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. What is the cross between the F1 progeny and the homozygous recesive parent called? How is it useful ?

Ans:- Test Cross. It is analysed to predict the genotype of the test organism. (F_1 progeny)

2. Do you think Mendel's lawof inheritance would have been different if the characters that he chose were located on the same chromosome ?

Ans:- Yes, because the genes for characters located on the same chromosome may show the linkage. The linked genes will not shows independent assortment.

3. Who proposed the Chromosome Theory of Inheritance ?

Ans:- Sutton and Boweri

4. Define true breeding. Mention its significance.

Ans:- A true breeding line is one that have undergone continuous self-pollination shows the stable trait inheritance and expresions for several generations.

5. Explain the terms phenotype and genotype.

Ans:- **Genotype:-** It is the genetic make up of an Organism.

Phenotype :- The physical or external appearance of a character of an Organism.

6. What is point mutation ? Give an example ?

Ans:- **Point mutation :-** Mutations that occurs due to change in a single base pair of DNA.

Ex:- Sickle cell anemia.

7. What is the genotype of wrinkled phenotype of pea seeds ?

A. Genotype of wrinkled phenotype for pea seeds is rr. (Homozygous Recessive trait)

8. What will be the phenotypic ratio in the offsprings obtained from the following crosses

a) Aa x aa b) AA x aa c) Aa x Aa d) Aa x AA

Note : Gene 'A' is dominant over gene 'a'.

A. **a)** Aa × aa – P generation

Ⓐⓐ ⓐ – gamete

♀ A a

a | A a | a a

The progeny shows 1 : 1 ratio. (Test cross)

b) AA × aa – P generation

Ⓐ Ⓐ – gamete

A a

The progeny shows Aa hybrid. (Parental cross)

c) Aa × Aa – P generation

Ⓐⓐ Ⓐⓐ – gametes

♀ A a

A | A A | A a

a | A a | a a

The progeny shows 1 AA : 2 Aa : 1 aa genotypes, 3 : 1 phenotypic ratio ($F_1 \times F_1$)

d) Aa × AA – P generation

Ⓐⓐ Ⓐ Ⓐ – gametes

♀ A a

A | A A | A a

A | A A | A a

All the progeny shows dominant character. (Back cross)

9. In garden pea, the gene T for tall is dominant over its allele for dwarf. Give the genotypes of the parents in the following crosses.

a) tall x dwarf producing all tall plants.

b) tall x tall producing 3 tall and 1 dwarf plants.

A. a) T T (Tall) x t t (dwarf) → T t (all tall plants) (parental cross).

b) T t (Tall) x T t (Tall) → 3 tall and 1 dwarf plant (F_1 x F_1)

	T	t
T	TT tall	Tt tall
t	Tt tall	tt dwarf

SHORT ANSWER QUESTIONS (4 MARKS)

1. Mention the advantages of selecting pea plant for experiment by Mendel.

A. 1 It is an annual plant that has well defined characteristics.

2 It can be grown and crossed easily.

3 It has bisexual flowers containing both female and male parts.

4 It can be self fertilized coveniently.

5 It has a short life cycle and produces large number of offsprings.

2. Differentiate between the following :

a) Dominant and Recessive

b) Homozygous and Heterozygous

A. **a) Dominant & Recessive :-**

Dominance is the phenomenon where a character is expressed phenotypically in both homozygotes and heterozygotes

Recessive :- The character which is not expressed phenotypically in heterozygous condition.

b) Homozygous & Heterozygous :-

Homozygous :- Individual having two similar or identical alleles for a single character. Hence it will produce only one kind of gametes with reference to a gene.

Heterozygous :- An individual having two different alleles for a single character. Consequently it will produce two different type of gametes with reference to a gene.

3. Explain the law of Dominance using a monohybrid cross.

A. The cross where parents differ in a single charater is called monohybrid cross. Height of the stem (a single character) has two contrasting trails i.e. Tall & Dwarf.

When a pure-breed tall(TT) plant is crossed with pure - breed dwarf(tt) plant; All the F_1 plants are Tall (Tt). Tallness (T) is dominant over Dwarfness(t). Hence All the F_1 Plants (Tt) are tall (Heterozygous tall).

When two alleles for a single chracter are ocuuring in heterozygous condition, the allele that expreses its character is the dominant allele, the other allele is the recessive allele.

When F_1 Plants (Tt) are self-pollinated the F_2 generation appears as follows.

Tall (TT) x Dwarf (tt) — Parent generation

T t — Gametes

Tall

Tt — F_1 generation

F_1 generation selfing T t x T t — gamete

— F_2 generation

♀ \ ♂	T	t
T	TT Tall	Tt Tall
t	Tt Tall	tt Dwarf

The phenotypic ratio is 3 Tall: 1 Dwarf.

The genotypic ratio is 1 TT, 2Tt, 1 tt.

Based on his observation on monohybrid crosses, Mendel proposed Law of Dominance.

Law of Dominance :

1 Characters are controlled by discrete units called factors.

2 Factors occur in pairs.

3 In a dissimilar pair of factors pertaining to a character one member of the pair dominates (dominant) the other (recessive).

4. Define and design a test -cross.

A. 1) The cross between F_1 Progeny and their homozygous recessive parent is called Test - cross.

2) Test cross is used to test whether an individual is homozygous (pure) or heterozygous (hybrid).

3) A monohybrid test cross gives a phenotypic ratio of 1:1

Monohybrid Test cross

F_1 Plant

Tt

Tall

T t

Homozygous recessive parent plant

tt

Dwarf

t t

	t	t
T	Tt tall	Tt tall
t	tt dwarf	tt dwarf

5. Explain the Co-dominance with example.

A. **Co-dominance :** It is the phenomenon in which both the alleles are equally dominant and so the character of both alleles is well expressed equally in next generation. So the F_1 generation resembles both parents.

1 Examples are different types of red blood cells that determine ABO blood grouping in human beings and seed coat pattern and size in lentil plants.

Ex.1. seedcoat pattern in lentil plant (Lens culinaris)

In Lentil, the seed coat shows two variants like, seeds with spots(having few big

irregular patches), seeds with dots (having several circular spots).

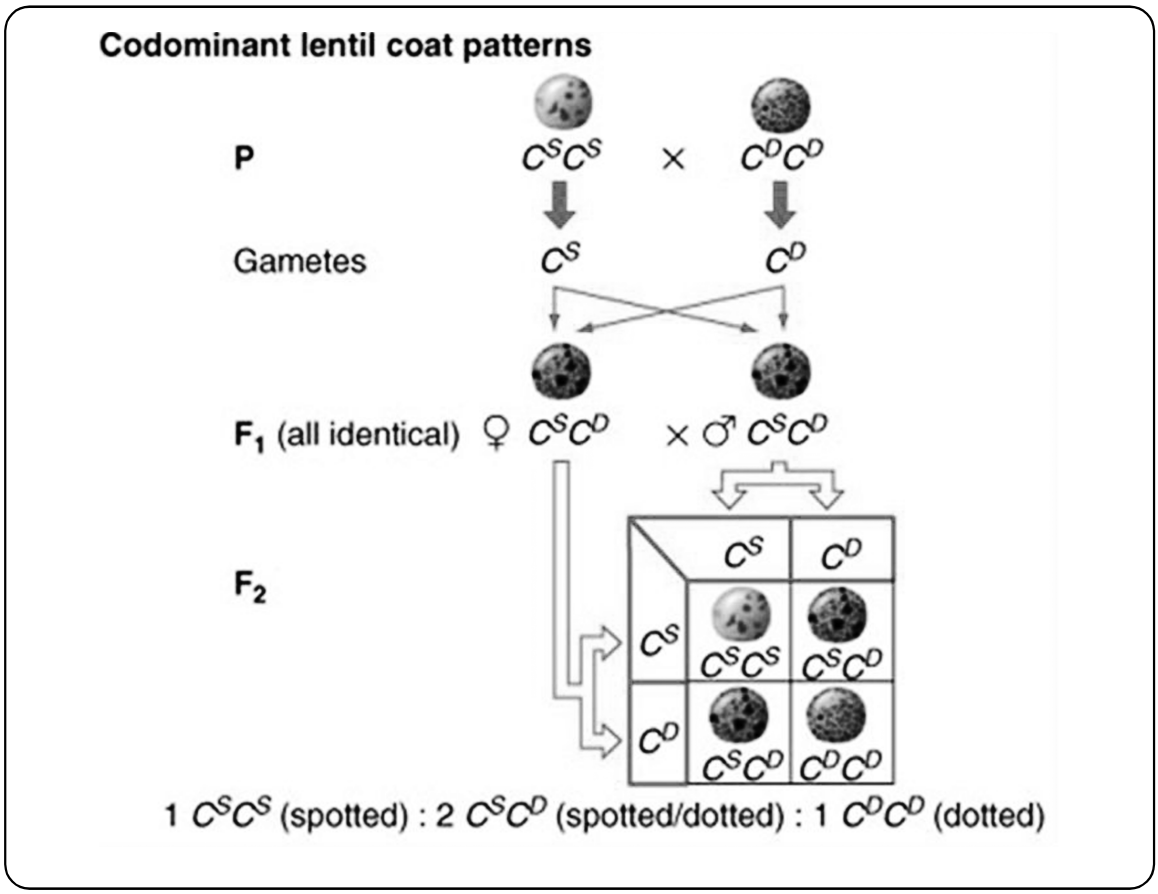
The alleles for spotted seedcoat are $C^S C^S$

The alleles for dotted seedcoat are $C^D C^D$

When a pure -breading plant containing spotted seeds ($c^S c^S$) crossed a pure breeding plant containing dotted seeds $C^D C^D$ produces the F_1 plants with both spots and dots on the seed coat ($C^S C^D$)

Here, the allele for C^S and allele for C^D both are expressed equally and hence the seed coat shows both spots and dots. ie. Neither C^S nor C^D are dominant or recessive. This phenomenon is called co-dominance

When F_1 plants are self-pollinated the F_2 generation appears as follows:



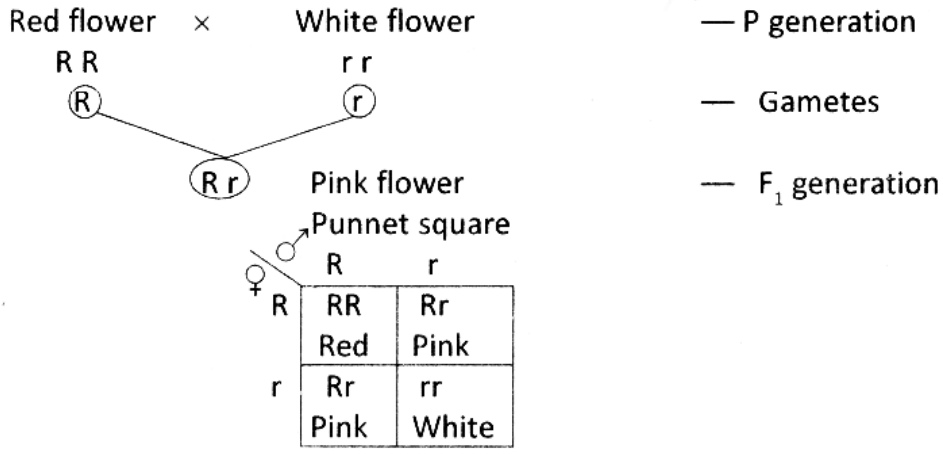
The Phenotypic ratio of F_2 progeny is 1:2:1

The Genotypic ratio F_2 progeny is 1:2:1

6. Explain the Incomplete dominance with example.

A. **Incomplete dominance :** It is the phenomenon in which neither of the genes is completely dominant or completely recessive. As a result the hybrid shows intermediate character, for example the inheritance of flower colour in the dog flower. (Snapdragon or Antirrhinum sp). The cross between true breeding (homozygous) red flower plant (RR) and true breeding (homozygous) white flower plant (rr), produces the

F_1 plants with Pink Flowers (Rr). When F_1 plants are self pollinated the F_2 generation appears as follows:



The phenotypic ratio of F_2 generation is 1:2:1

The genotypic ratio of F_2 generation is 1:2:1

- The phenotypic ratio deviates from Mendelian monohybrid ratio of 3 : 1 to 1: 2 : 1 (Red flower -1, Pink flowers - 2, White flower -1)
- Since the heterozygous / hybrid shows a different phenotype, phenotypic, genotypic ratio remains the same as 1:2:1.

7. Write a brief note on chromosomal mutations and gene mutations.

A. **Chromosomal mutations :-** Any change in the number or in structure of chromosomes leads to mutations. Such mutations are called chromosomal mutations.

i) Chromosomal mutations that occurs due to Structural changes are of 4 types:- They are

a) Deletion :- A part of chromosome is broken or lost

b) Duplication:- A particular part of chromosome is repeated.

c) Inversions:- A broken part of chromosome reattached to the original chromosome in reverse order.

d) Translocation:- A broken part of chromosome is attached to a non-homologous chromosome.

ii) Chromosomal mutations due to Numerical changes:- These are two types

a) Euploidy :- Change in the number of complete sets of chromosomes.

It is of the following types

Monoploidy (x): Having only one set of chromosomes. (genome)

Diploidy (2x): Having two sets of chromosomes. (two genomes)

Triploidy (3x) Having three sets of chromosomes. (three genomes)

Tetraploidy (4x): Having four sets of chromosomes. (four genomes)

Polyploidy (∞ x) It is the condition where the organisms containing more than two sets of chromosomes or genomes (i.e triploidy, tetraploidy, pentaploidy, hexaploidy.....etc.)

b) Aneuploidy:- Presence of one or two chromosomes extra or less over the normal chromosomal number.

Ex:- Monosomy (2n-1), Trisomy (2n+1)

Nullisomy (2n-2), Tetrasomy (2n+2)

II) Gene mutation (or) point mutation :-

Any change that occurs in the chemical structure of gene leads to mutation called Gene mutation (or) point mutation.

It may arise due to change in a single nucleotide or nucleotide pair of a functional gene.

Ex. Sicke cell anemia.

8. Define Law of Segregation and Law of Independent Assortment.

A. **Law of Segregation (or) Law of Purity of gametes :**

"The two alleles of gene when present together in a heterozygous state donot fuse or blend in any way but remain distinct and segregate during meiosis or in the formation of gametes so that each meiotic product or gamete will carry only one of them."

Law of Independent Assortment :-

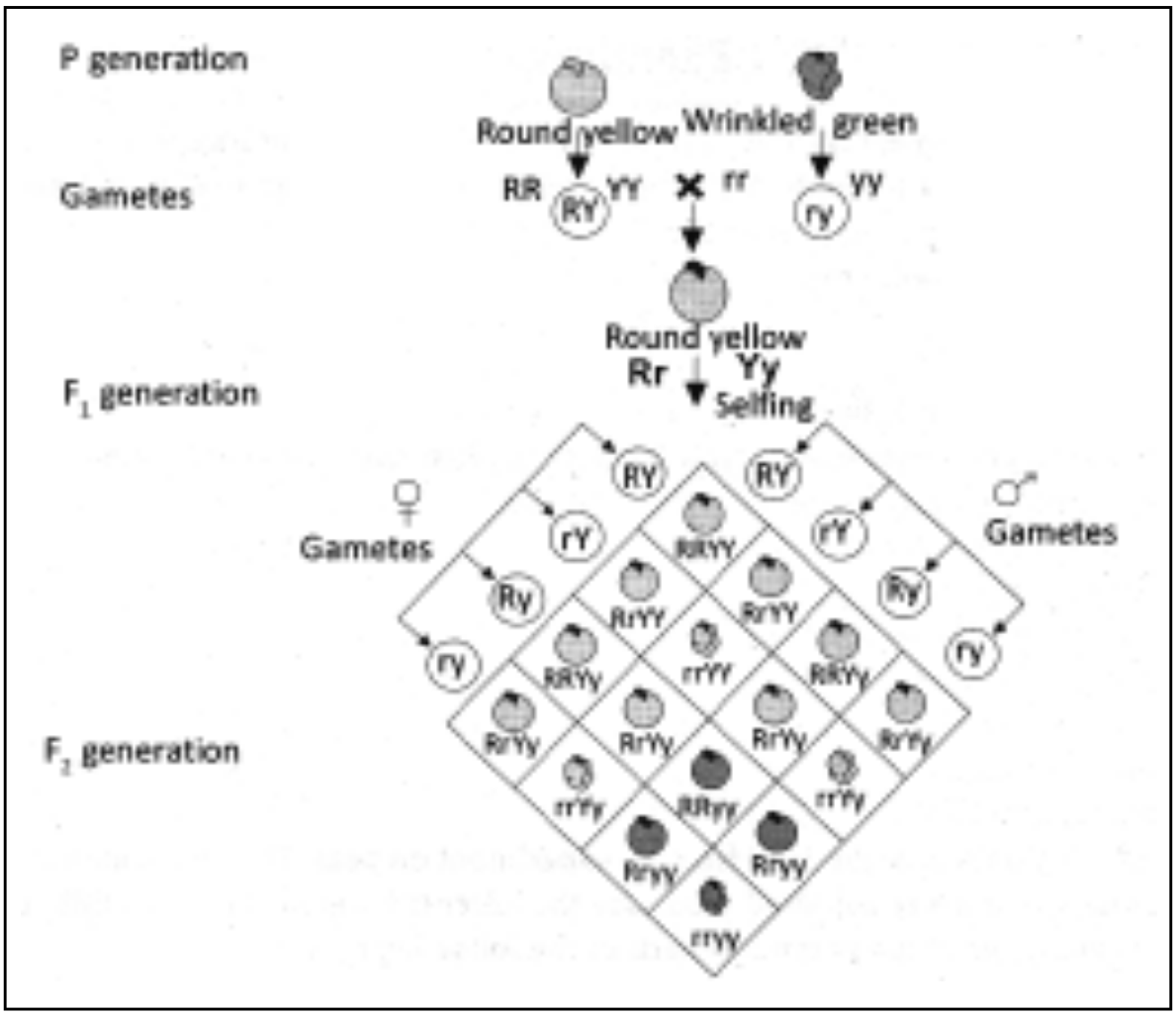
"When two pairs of traits are comibined in a hybrid, segregation of one pair of character is independent of other pair of character."

LONG ANSWER QUESTIONS (8 MARKS)

1. Explain the dihybrid cross with the help of punnet square board by taking contrasting traits, seed colour and seed shape.

A.
- ❖ The crossing of two plants that differ in two pairs of contrasting traits is called dihybrid cross.
- ❖ Yellow colour of seed (YY) is dominant over green colour (yy), similarly round shape of seed (RR) is dominant on wrinkled seed shape (rr).
- ❖ When a pure -breed pea plant that has yellow coloured, round shaped seeds was crossed with another pure- breed pea plant that has green coloured, wrinkle shaped seeds (parental cross).

- The genotypes of parents are RRYY (Round, Yellow) and rryy (wrinkled, green). The gametes produced by those parents i.e., (RY) and (ry) unite on fertilization to produce the F_1 hybrid, RrYy.
- All the Progeny of F_1 generation found to have yellow coloured and round shaped seeds.



Phenotypic ratio: round yellow : round green : wrinkled yellow : wrinkled green

9 3 3 1

- The F_1 hybrid plants produce 4 types of gametes. ie RY, rY, Ry, ry. On self pollination of F_1 plants, F_2 progeny was obtained. It was found that 3/4 th of F_2 plants have yellow seeds and l/4th have green seeds. The same was the case for other trait (seed shape), so 3/4th of progeny were round and 1/4 wrinkled. The two traits segregated as in Monohybrid cross.
- In F_2 progeny the phenolypic ratio was 9 : 3 : 3 :1 for Round - yellow : Round - green : wrinkled - yellow : wrinkled - green.

UNIT-IV

MOLECULAR BIOLOGY

CHAPTER 10

MOLECULAR BASIS OF INHERITANCE

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. Distinguish between heterochromatin and euchromatin. Which of the two is transcriptionalty active ?

A. **Euchromatin :** The chromatin that is loosely packed and stains light is called as chromatin.

Heterochromatin : The chromatin that is more densely packed and stains dark is called as heterochromatin.

Euchromatin is transcriptionally active.

2. Who proved that DNA is genetic material ? What is the organism they worked on ?

A.
- ❖ Alfred Hershey and Martha Chase (1952)
- ❖ They worked with viruses that infect bacteria, bacteriophages.

3. What is the function of DNA polymerase ?

A.
- ❖ DNA polymerase uses a DNA template to catalyze polymerization of deoxynucleotides.
- ❖ It is highly efficient and catalyzes polymerization in only one direction (5'→ 3') .

4. What are the components of a nucleotide ?

A.
- ❖ A pentose sugar (ribose or deoxyribose)
- ❖ A nitrogenous base
- ❖ Phosphate group

5. Given below is the sequence of coding strand of DNA in a transcription unit 5' - AATGCAGCTATTAGG - 3'

Write the sequence of a) its complementary strand b) the mRNA

A. write the sequence of

a) Its complementary strand : 3' - T T A C G T C G A T A A T C C - 5'

b) the mRNA : 3'- U U A C G U C G A U A A U C C - 5'

6. Name any three viruses which have RNA as the genetic material.

A. TMV (Tobacco Mosaic Virus) QB bacteriophage, HIV (Human Immuno defficiency Virus)

7. What are the components of a transcription unit ?

A. (1) A Promoter (2) The structural gene (3) A terminator.

8. What is the difference between exons and introns ?

A. **Exons :** The coding sequences or expressed sequences are defined as exons. Exons are said to be those sequences that appear in mature or processed RNA.

Introns : The non coading sequences in split genes of eukaryotes that interrupts exons. Those sequences that do not appear in mature RNA.

9. What is meant by capping and tailing ?

A. Addition of methyl guanosine triphosphotes to the 5" - end of hn RNA is called capping.

Addition of adenylate residues (Adenine) at 3"- end of hnRNA is called tailing

10. What is meant by point mutation ? Give an example.

A. The mutation that occurs in a single base pair of a gene is called Point mutation.

Point mutation in the gene for beta globin chain (in human haemoglobin) that results in the change of amino acid residue glutamate to valine. It results in a diseased condition called **sickle cell anemia.**

11. What is meant by charging of tRNA ?

A. Amino acids are activated in the presence of ATP and linked to thier cognate tRNA - this process called charging of tRNA.

12. What is the function of the codon-AUG ?

A. AUG has dual functions it codes for methionine and also acts as the intiator codon.

13. Define stop codon. Write the codons.

A. The codons UAA, UAG, UGA are the stop codons. These codons provide the signal to stop protein synthesis and hence they are called stop codons.

14. What is the difference between the template strand and a coding strand in a DNA molecule ?

Template strand : The transcribed RNA has 5'-3' polarity it is transcribed in 5'-3' direction on the 3' -5' strand of DNA which is called template strand because it acts as a template for RNA synthesis.

Coding strand : The 5'-3' strand or complementary strand of DNA is called coding strand becuase the sequence of nitrogenous base in this strand is similar to that of RNA.

15. Write any two differences between DNA and RNA.

A.

DNA	RNA
1) The sugar molecule in DNA is deoxyribose	1) The sugar molecule in RNA is ribose
2) Thymine is present	2) Uracil is present

16. In a typical DNA molecule, the proportion of Thymine is 30% of the N bases. Find out the percentages of other N bases.

A. Adenine = 30%
Guanine = 20%
Cytocine = 20%

17. The proportion of nucleotides in a given nucleic acid are : Adenine 18%, Guanine 30%, Cytosine 42%, and Uracil 10%. Name the nucleic acid and mention the number of strands in it.

A. RNA
It is a single stranded.

SHORT ANSWER QUESTIONS (4 MARKS)

1. Define transformation in Griffith's experiment. Discuss how it helps in the identification of DNA as genetic material.

A. Transformation is uptake of naked DNA fragments from the surrounding environment and the expression of that genetic information in the recipient cell.

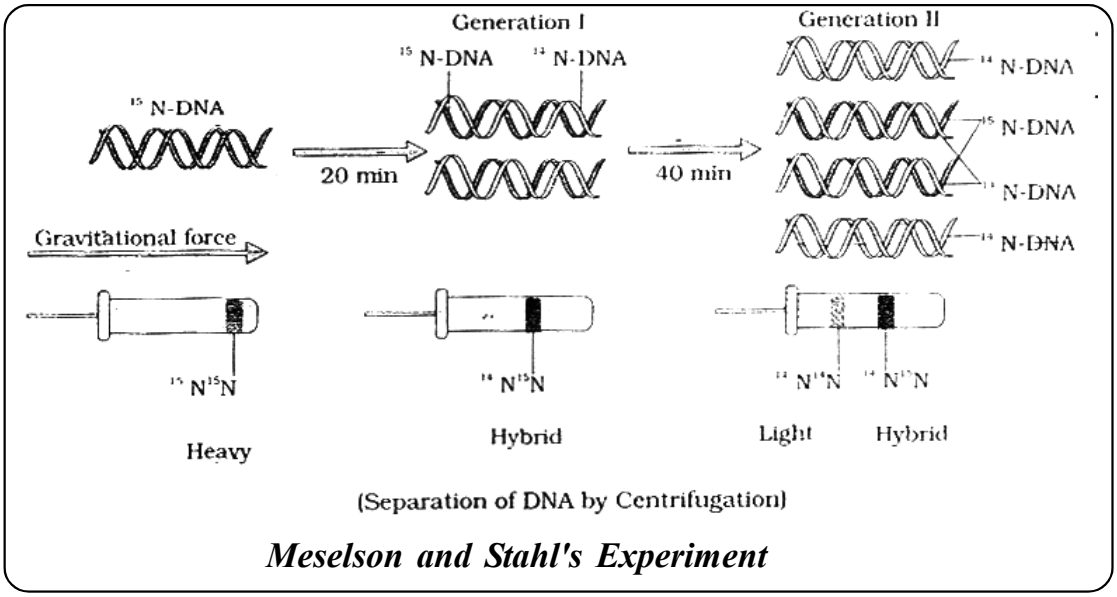
- **Griffiths** transformation experiments conducted on Streptococcus pneumonia.
- He found that there are two strains of this bacteria.
- S-type (smoth walled) and R-type (rough)
- S-type is capsulated and virulent while R-type is non capsulated and non-virulent.
- He conducted his experiment in the following four stages.
  i) He injected living S-type bacteria in mice, mice died.
  ii) He injected living R-type bacteria in mice, mice survived.
  iii) He injected heat killed S-type bacteria, mice did not died.
  iv) He injected the mixture of heat killed S-type and live R-type and the mice died of pneumonia.
- Some 'transforming principle' transferred from the heat killed S strain, had enabled the living R Strain to synthesise a smooth polysaccharide coat and become virulent Strain.
- Later that transformed principle was confirmed as the genetic material only i.e DNA

2. Discuss the significance of heavy isotope of nitrogen in Meselson and Stahl's experiment.

A. Meselson and Stahl performed an experiment using E.coli to prove that DNA replication is semi conservative.

- They cultured E.coli of bacteria in a culture medium cantaining heavy isotopes of Nitrogen (15_N)

- ❖ After these bacteria had replicated for several generations in that medium redioactive 15_N became incorporated in both the strands of the DNA.
- ❖ This heavy DNA can be distinguished from the Normal DNA by centrifugation in cesium chloride density gradient.
- ❖ When these bacteria with 15_N were transfered in cultural medium containing 14_N isotopes, it was found that DNA seperated from fresh generation of bacteria possessed one strand heavier than the other.
- ❖ The heavier strand represented the parental strand and lighter one was the new one syntesized from the culture indicating semicanservative mode of DNA replication.



Meselson and Stahl's Experiment

3. A single base mutation in a gene may not always result in loss or gain of function. Do you think the statement is corect? Defend your answer.

A. No, the statement is not correct.

Mutations also arise due to change in a single base pair of DNA. This know as **point mutation.**

- ❖ A classical example of point mutation is a change of single base pair in the gene for beta globin chain (in human haemoglobin) that results in the change of amino acid residue glutamate to valine.
- ❖ It results in a diseased condition called **sickle cell anemia.**

4. How many types of RNA polymerases exist in cells ? Write their names and functions.

A. There are three types of RNA polymerases in the nucleus. They are

1. RNA polymerase I: It transcribes rRNAs (28S, 18S, 5.8S)

2. RNA polymerase II: It transcribes the precursor of mRNA the hetrogenous neclear RNA (hnRNA)
3. RNA polymerase III: It is responsible for transcription of tRNA, 5sr RNA and sn RNAs (small nuclear RNAs)

5. What are the contributions of George Gamow, H.G. Khorana, Marshall Nirenberg in deciphering the genetic code ?

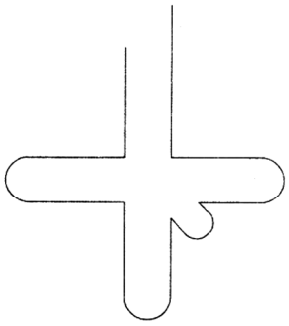
A. **George Gamow :** He suggested that in order to code for all the 20 amino acids, the code should be made up of three nucleotrides. This was a very bold proposition, because a permuation and combination of 4^3 would generate 64 codons, generating many more codons than required.

H.G. Khorana : He developed a chemical method in synthesizing RNA molecules with defined combinations of bases (homopolymers such as UUU and copolymers such as UUC, CCA)

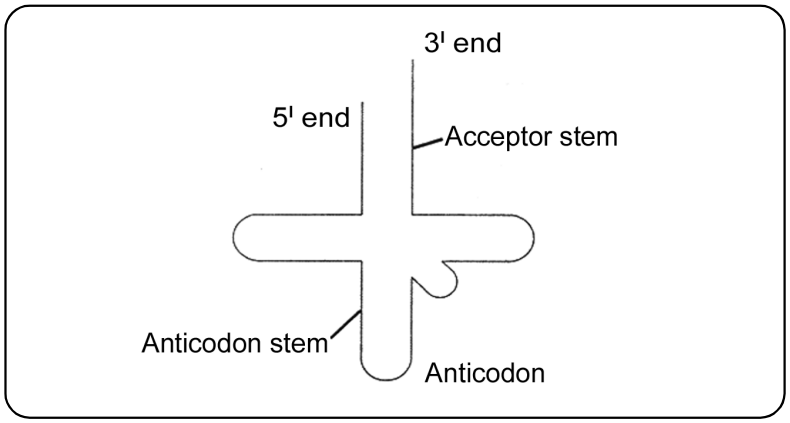
Marshall Nirenberg : Marshall Nirenberg made cell free system for protein synthesis. It finally helped the code to be deciphered.

6. On the diagram of the secondary structure of tRNA shown below label the location of the following parts :

a) Anticodon **b) Acceptor stem** **c) Anticodon stem**
d) 5' end **e) 3' end**

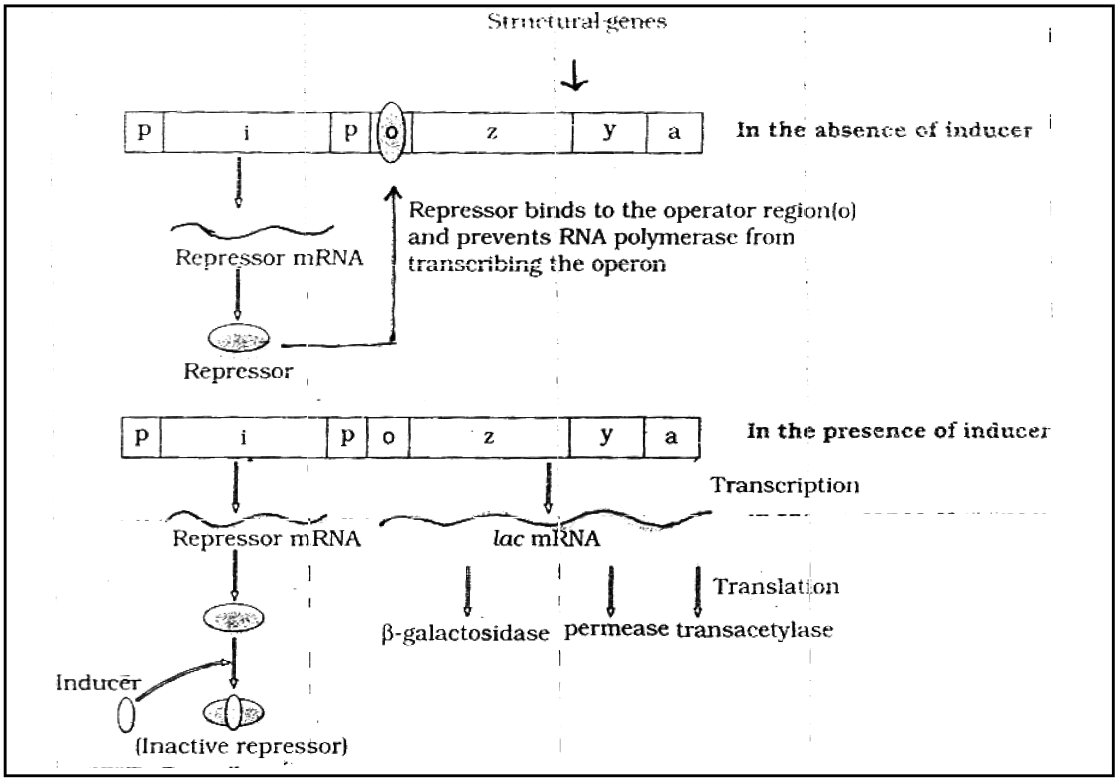


A.



7. Draw the schematic / diagrammatic presentation of the lac operon.

A.



8. What are the differences between DNA and RNA ?

A.

DNA	RNA
1.DNA acts as the genetic material in all the living organisms (except some viruses)	1. RNA is not the genetic material (except a few viruses)
2.Most of the DNA found in the nucleus and some in cell organelles.	2. Only a small amount of RNA is found in nucleus, majority of it present in cytoplasm.
3.It is Double strandard	3. It is single strandard
4. Deoxyribose sugar is present	4. Ribose Sugar is present
5. Four types of nitrogenous bases are adenine, guanine, thymine and cytosine	5. Four types of nitrogenous bases are adenine, guanine, uracil and cytosine
6.purines and pyramidines are in 1:1 ratio	6. No such proportion between purine and pyramidine.

9. Write the important features of Genetic code.

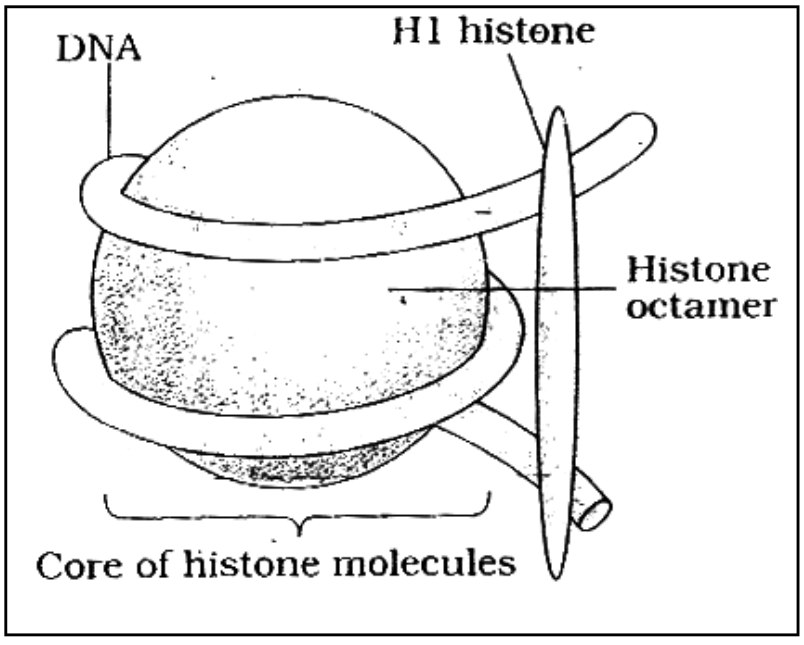
A. 1) The codon is triplet.

2) The functional codons are 61 codons, that codes for amino acids and 3 codons do not code for any amino acids, hence they function as stop codons. (UAA, UAG, UGA)
3) One codon codes for only one amino acid, hence it is **unambiguous** and **specific.**
4) Some amino acids are coded by more than one codon, hence the **code is degenerate.**
5) The codons are read in mRNA in a contiguous fashion there are **no punctuations.**
6) **The code is nearly universal:** for example from bacteria to human UUU would code for phenyl alanine.
7) AUG has dual functions, It codes for **methionine**, and also acts as the **intiator codon.**

10. Write briefly on nucleosomes?

Ans. Histones are organised to form a unit of eight molecules called **histone octamer. ($2xH_{2A}$, $2xH_{2B}$, $2xH_3$, $2xH_4$).**

- ❖ The negatively charged DNA is wrapped around the positively charged histone octamer to form a structure called nucleosome.
- ❖ A typical nucleosome contains 200bp of DNA helix.
- ❖ Nucleosomes constitute the repeating unit of a structure in nucleus called **chromatin.**
- ❖ The nucleosomes in chromatin are seen as beads-on-string.
- ❖ Part of DNA which joins two nucleosomes is called linker DNA.



Nucleosome

UNIT-V

BIOTECHNOLOGY

CHAPTER 11

BIOTECHNOLOGY : PRINCIPLES AND PROCESSES

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. Define Bio-technology ?

Ans:- "Biotechnology is a science which utilizes properties and use of micro organisms or exploit cells and the cell constituents at the industrial level for generating useful products essential to life and human welfare."

2. What are molecular scissors ? Where are they obtained from ?

Ans:- **Restriction enzymes** are also called as "molecular scissors". They are useful to cut the DNA at specific locations. They obtained usually from bacteria.

3. Name any two artificially restructured plasmids ?

Ans:- P^{BR} 322, (after Boliver and Rodriquez),
P^{UC} 19,101 (after university of California).

4. What is E.coRI? How does it function ?

Ans:- E.coRI is a restriction enzyme obtained from a bacterium Escherichia coli.
This enzyme specifically recognises the 5'-GAATTC-3' sites on the DNA and cut it between G and A.

5. What are the cloning vectors ? Give example ?

Ans:- Vectors used for multiplying the foreign DNA sequences are called **cloning vectors.**
ex: Plasmids, bacteriophages and Cosmids

6. What is recombinant DNA ?

Ans:- Recombinant DNA formed by the integration of gene of interest within a suitable vector.
Both source DNA and vector DNA are cut with same restriction enzyme and are joined with ligase to make recombinant DNA.

7. What is Polindromic sequence ?

Ans:- The polindrome in DNA is a sequence of base pairs that reads same on the two strands when orientation of reading is a kept the same.
For example, the following sequences read the same on the two stands in 5' → 3'
This is also true if read in the 3' → 5' direction
5' GAATTC 3'
3' CTTAAG 5'

8. What is full form of PCR ? How is it usefull in bio-technology ?

Ans:- PCR stands for Polymerase Chain Reaction. In this process, multiple copies of the gene (or DNA) of interest is synthesised by using a computerized machine called Thermocycler.

9. What is down stream processing ?

Ans:- Downstream processing is a method of separation and purification of foreign gene products after the completion of the biosynthetic stage. The product is subjected to various processes in order to separate and purify the product.

10. How does one visualige DNA on an agargel ?

Ans:- The separated DNA fragments can be visualized after staining the DNA with a compound known as ethilium bromide followed by exposure to UV radiation.

11. How can you differentiate between exonucleases and endonucleases ?

Ans:- Exonuclease remove nucleotides from the ends of the DNA .
Endonucleases make cut at specific positions with in the DNA.

SHORT ANSWER QUESTIONS (4 MARKS)

1. Write short notes on restriction enzymes.

A.
- ❖ Restriction enzymes are extracted from bacteria.
- ❖ Restriction enzymes are also called molucular scissors.
- ❖ First Recognized restriction endonuclease is Hind II.
- ❖ 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 functions by `inspecting' the length of a DNA sequence. Once it finds its specific recognition sequence, it binds to the DNA and cuts each of the two strands of the double helix at specific points in their sugar-phosphate backbones.
- ❖ Each restriction endonuclease recognises a specific palindromic nucleotide sequence in the DNA.
- ❖ The palindrome in DNA is a sequence of base pairs that reads same on the two strands when orientation of reading is kept the same.

  5' GAATTC 3'

  3' CTTAAG 5'
- ❖ Commonly most restriction enzymes cut the two stands of DNA double helix at different locations. Such a cleavage is generally termed as staggered cut.
- ❖ Restriction enzymes cut the stand of DNA a little away from the centre of the

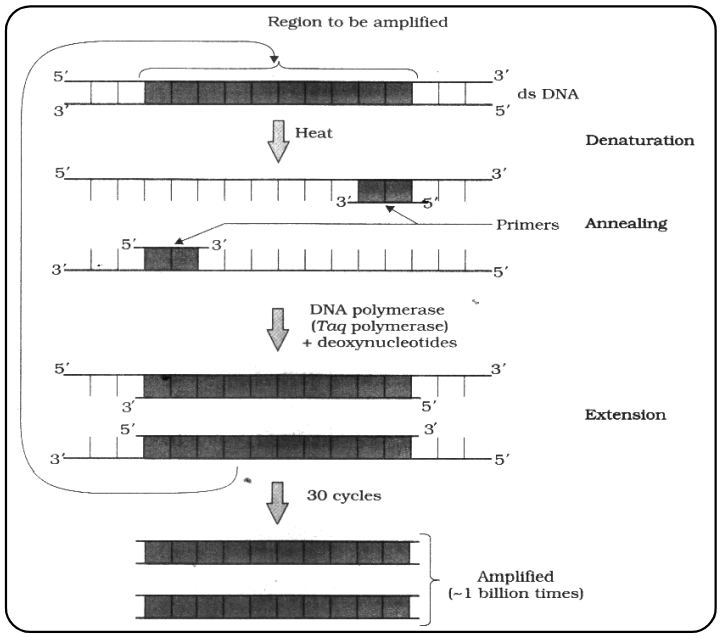
palindrome sites, but between the same two bases on the opposite strands.

- ❖ EcoRI recognizes 5' GAATTC 3' sites on the DNA and cuts it between G and A.
- ❖ Restriction endonucleases are used in genetic engineering to forms `recombinant' molecules of DNA, which are composed of DNA from different sources/ genomes.

2. Give an account of amplification of gene of interest using PCR.

A. PCR stands for polymerase chain reaction.

- ❖ In this reaction, multiple copies of the Gene(DNA) of Interest are synthesised ` invitro' using two sets of primers and the enzyme DNA polymerase.
- ❖ The enzyme extends the primers, using the nucleotides provided in the reaction and the genomic DNA as template.
- ❖ If the process of replication of DNA is repeated many times, the segment of DNA can be amplified to approximately billion times.
- ❖ Each repeated amplification is achieved by the use of thermostable DNA poly merase (TAQ polymerase), Which remain active even during the high tem perature induced denaturation of double stranded DNA.
- ❖ The amplified fragment, if deserved can now be used to ligate with a vector for further cloning.



Polymerase chain reaction (PCR) : Each cycle has three steps: (i) Denaturation; (ii) Primer annealing; and (iii) Extension of primers

3. What is a bio-reactor? Describe briefly the stirring type of bioreactor?

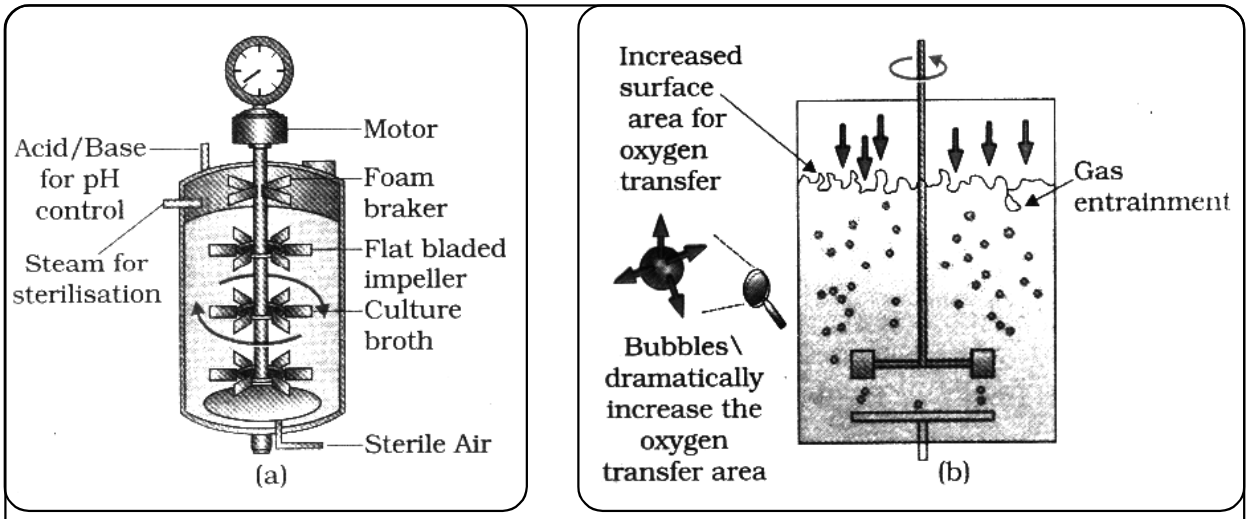
A. Bioreactors are large vessels in which raw materials are biologically converted into specific products, individual enzymes, etc., using microbial plant, animal or human cells. A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions.

Sterring type of Bio-reactor :- A stirred tank reactor is usually cylindrical or with a curved base to facilitate the mixing of the reactor contents.

❖ The stirrer facilitates even mixing and oxygen availability throughout the bio-reactor.

❖ Alternatively air can be bubbled through the reactor.

❖ The bioreactor has an agitator system, an oxygen delivery system, a foam control system, a temperature and PH control system and sampling ports. So that small volumes of culture can be withdrawn periodically



(a) Simple stirred-tank bioreactor;
(b) Sparged stirred-tank bioreactor through which sterile air bubbles are sparged

4. What are the different methods of insertion of recombinant DNA into the host cell?

A. There are several methods of introducing the r- DNA into host cells.

Heat shock medhod : Recombinant DNA can be forced into such cells by incubating the cells with recombinant DNA on ice, followed by placing them briefly at 42^0c and then putting them back on ice. This enables the bacteria to take up the r-DNA.

Micro Injection :- In this method r-DNA is directly injected into the nucleus of an animal cell.

Gene gun Method :- This method is used for plants. cells are bombarded with high velocity micro particles of gold or tungsten coated with DNA.

Disarmed `pathogen' vector method :- This method uses discarmed ptahogen vectors, which when allowed to infect the cell, transfer the recombinant DNA into the host.

LONG ANSWER QUESTIONS (8 MARKS)

1. Explain briefly the various processes of recombinant DNA technology?

A. 1. Isolation of genetic material (DNA)
2. Cutting of DNA at specific locations
3. Isolation of a desired DNA fragment
4. Insertion of isolated DNA into a suitable vector
5. Introduction of recombinant DNA into the host
6. Selection of the transformed host cells.
7. Obtaining the foreign gene product.

1. Isolation of Genetic Material (DNA) :-

- The first step in the isolation of genetic material from a cell is the digestion of the cell wall
- The cell wall is digested by treating the bacterial cells/plants tissue with enzymes such as lysozyme(bacteria), cellulase (plant cells)chitinase (fungus) etc. This is followed by the dissolution of all the biological membranes within a cell by detergent lysis.
- The RNA can be removed by treatment with ribonuclease whereas proteins can be removed by treatment with protease.
- Purified DNA ultimately precipitates out after the addition of chilled ethanol.

2. Cutting of DNA at specific Locations :-

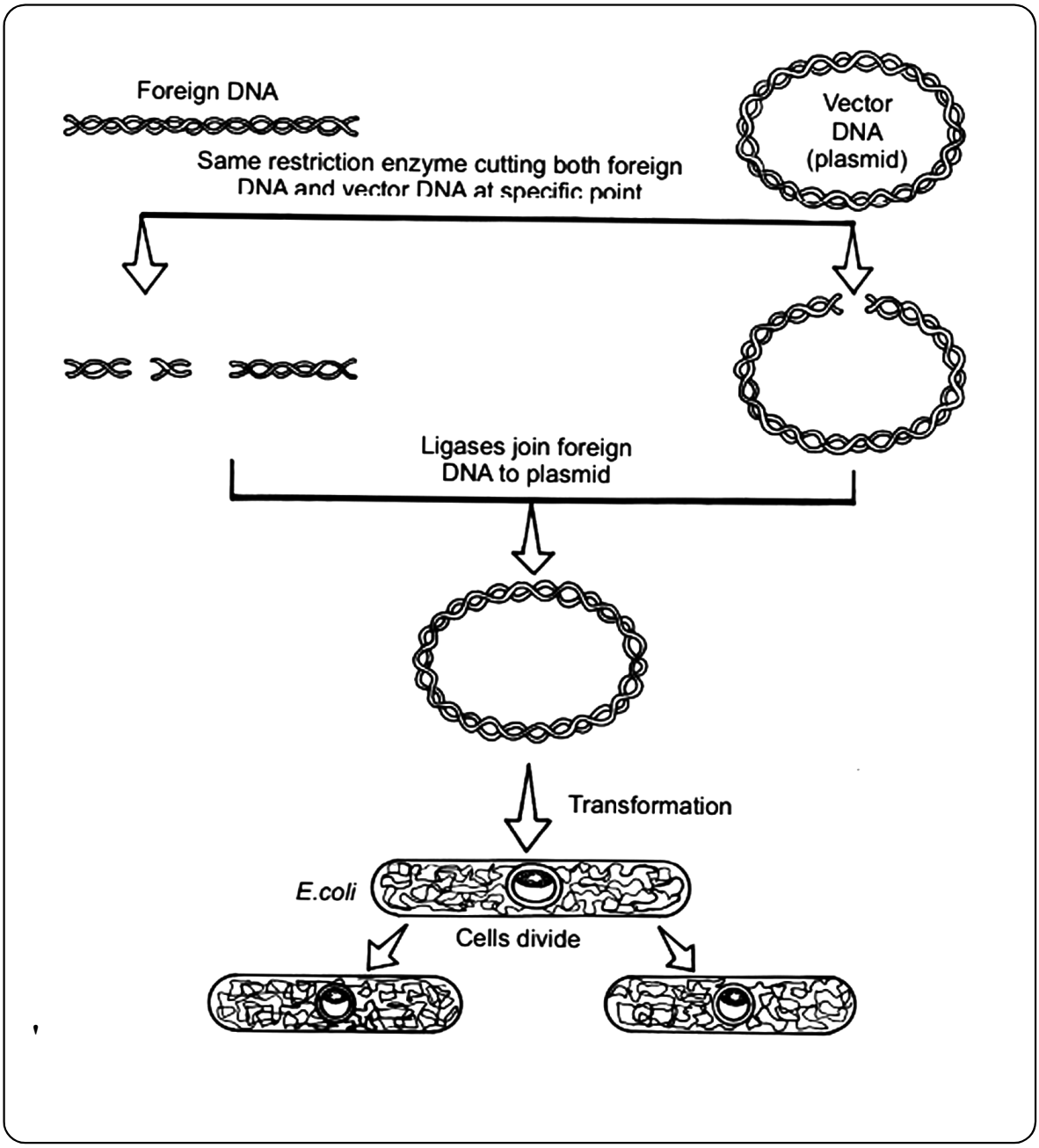
- The purified DNA is cut into a number of fragments by restriction endonucleases.
- It is performed by incubating purified DNA molecules with the restriction enzyme at the optimal conditions.

3. Isolation of desired DNA fragment :-

- The cutting of DNA by restriction endonucleases results in the fragments of DNA. These fragments can be separated by a technique known as **gel electrophoresis.**
- The separated DNA fragments can be visualised only after staining the DNA with a compound known as ethilium bromide followed by exposure to UV radiation.
- Finally the desired DNA fragments are selected by a southern blotting technique.

4. Insertion of isolated DNA into a 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 the same restriction enzyme, the cut'gene of interest' from the source DNA and the cut vector are mixed and ligase is added. This results in the formation of **recombinant DNA (rDNA) or chimaeric DNA.**



- ❖ PCR is a method widely used to rapidly make multiple copies of the gene (DNA) of interest.

5. Introduction of Recombinant DNA into the Host Cell

There are several methods of introducing the r- DNA into host cells.

Heat shock medhod : Recombinant DNA can be forced into such cells by incubating the cells with recombinant DNA on ice, followed by placing them briefly at 42^0c and then putting them back on ice. This enables the bacteria to take up the r- DNA.

Micro Injection :- In this method r-DNA is directly injected into the nucleus of an animal cell.

Gene gun Method :- This method is used for plants. cells are bombarded with high velocity micro particles of gold or tungsten coated with DNA.

Disarmed `pathogen' vector method :- This method uses discarmed ptahogen vectors, which when allowed to infect the cell, transfer the recombinant DNA into the host.

6. Selection of Transformed host Cells :

Two methods are used for selection of the transformed host cells.

a. Selectable marker gene
b. Colony hybridization

a. Selectable marker gene : So, if a recombinant DNA bearing gene for resistance to an antibiotic (e.g., Amplicillin) is transferred into E. coli cells, the host cells become transformed into amplicillin-resistant cells.

- ❖ If we spread the transformed cells on agar plates containing amplicillin, only transformants will grow untransformed recipient cells will die.
- ❖ Due to the ampicillin resistance gene, one is able to select a transformed cell in the presence of ampicillin. The ampicillin resistance gene in this case is called a **selectable marker.**

b. Colony hybridization :

- ❖ In this method gene specific probes are used. A probe is a small fragment of single stranded DNA or RNA which is tagged with radio-active molecule and is complimentary to atleast one part of the desired DNA.

7. Obtaining the Foreign Gene Product :-

- ❖ In almost all recombinant DNA technologies the ultimate aim is to produce a desirable protein. There is a need for the recombinant DNA to be expressed. The foreign gene gets expressed under appropriate conditions.
- ❖ After having cloned the gene of interest and having optimised the conditions to induce the expression of the target protein, one has to consider producing it on a large scale.

- ❖ Production of large quantities of proteins and enzymes requires the use of bioreactors.

2. Give a brief account of the tools of recombinant DNA technology.

A. The tools of recombinant DNA technology:

1.Restriction enzymes

2.Ligases

3.Cloning Vectors

4.Host organism

1.Restriction enzymes:

- ❖ Restriction enzymes are extracted from bacteria.
- ❖ Restriction enzymes are also called molucular scissors.
- ❖ First Recognized restriction endonuclease is Hind II.
- ❖ 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 functions by `inspecting' the length of a DNA sequence. Once it finds its specific recognition sequence, it binds to the DNA and cuts each of the two strands of the double helix at specific points in their sugar-phosphate backbones.
- ❖ Each restriction endonuclease recognises a specific palindromic nucleotide sequence in the DNA.
- ❖ The palindrome in DNA is a sequence of base pairs that reads same on the two strands when orientation of reading is kept the same.

  5' GAATTC 3'

  3' CTTAAG 5'
- ❖ Commonly most restriction enzymes cut the two stands of DNA double helix at different locations. Such a cleavage is generally termed as staggered cut.
- ❖ Restriction enzymes cut the stand of DNA a little away from the centre of the palindrome sites, but between the same two bases on the opposite strands.
- ❖ EcoRI recognizes 5' GAATTC 3' sites on the DNA and cuts it between G and A.
- ❖ Restriction endonucleases are used in genetic engineering to forms `recombinant' molecules of DNA, which are composed of DNA from different sources/ genomes.

2. Ligases :

- DNA Fragments can be joined together using DNA ligases.
- These are also called molecular gums.

3. 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 and artificial chromosomes etc.
- Plasmids are extra chromosomal circular DNA molecules found in all bacterial species.
- The advantage of a plasmid is that it is very easy to isolate and reintroduce into the host

The cloning vectors possess the following features:

Origin of replication: A cloning vector should possess an origin of replication so that it can self-replicate inside the host cell.

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. Presence of more than one recognition sites within the vector will generate several fragments, which will complicate the gene cloning

Selectable marker: It should have a selectable marker with an antibiotic resistance gene that facilitates screening of the recombinant organism.

Low Molecular weight: It should be small in size, so that it can easily integrate into the host cell.

Vectors for cloning genes in plants and animals: In Plants Agrobacterium tumifaciencesTi plasmid are used as vectors. In Animals retroviruses are used as vectors.

4. Host organism

- Competent host for transformation with recombinant DNA is required as tool.

UNIT-V

BIOTECHNOLOGY

CHAPTER 12

BIOTECHNOLOGY AND ITS APPLICATIONS

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. Give different types of *cry genes* and pests which are controlled by the proteins encoded by these genes.

A. ❖Genes cry I Ac and Cry II Ab control the cotton bollworms.

❖Genes cry I Ab control corn borer.

2. Can a disease be detected before its symptoms appear ? Explain the principle involved.

A. ❖Yes

❖Recombinant DNA technology, PCR, ELISA are some of the techniques that serve the purpose of early diagnosis.

❖Very low concentration of bacteria or virus Can be detected by amplification of their nucleic acid by PCR.

3. What is GEAC and what are its objectives ?

A. ❖GEAC means **Genetic engineering approval committee.**

❖It will make decissions regarding the validity of GM research and the safety of introducing GM organisms for public services.

4. Name the nematode that infects the roots of tobacco plants. Name the strategy adopted to prevent this infestation.

A. ❖Meloidegyne incognitia.

❖RNA interference (RNAi)

5. For which variety of Indian rice, has a patent been filed by a USA company?

A. 1. Basmati rice.

2. An American company crossed Indian Basmati with a semi dwarf variety and claimed a US patent in 1997 as an invention.

6. Give one example for each of transgenic plants which are suitable for food processing and those with improved nutritional quality.

A. 1. Transgenic tomato 'Flavr Savr'

2. Transgenic golden rice

7. What is green revolution? Who is regarded as Father of green revolution?

A. ❖Substantial and dramatic increase in agricultural production was termed as green revolution

❖Norman Borlaug

SHORT ANSWER QUESTIONS (4 MARKS)

1. List out the beneficial aspects of transgenic plants.

A. Beneficial aspects of transgenic plants are:

1. Transgenic crop plants having resistance to pathogens and pests.
   Ex:- Bt. cotton is resistant to insect.
   Transgenic papaya is resistant to papaya ring spot virus.
2. Transgenic plants suitable for food processing technology
   Ex:- Transgenic tomato `Flavr savr'
3. Transgenic plants with improved nutritional value.
   Ex:- Transgenic golden rice.
4. Transgenic plants useful for hybrid seed production :
   Male sterile plants of Brassica napus will eliminate the problem of manual emasculation and reduce the cost of hybrid seed production.
5. Trangenic plants tolerant to abiotic stresses caused by chemicals, cold, drought, salt, heat etc.
   Ex:- Basmati variety of rice was resistant against biotic and abiotic stresses.
   Roundup ready soyabean, is herbicide tolerant.

2. What are some bio-safety issues concerned with genetically modified crops?

A. Bio safety issues concerned with genetically modified crops are:

1. There is fear of transferring allergins or toxins to humans and animals as side effects.
2. There is a risk of changing the fundamental nature of vegetables.
3. They may pose a harmful effect on biodiversity and have an adverse impact on environment.
4. There is a risk of gene pollution that leads to create super-weeds which may be fast-growing than the crops and may be resistant to weedicides.
5. They may bring about changes in natural evolutionary pattern.

3. Give a brief account of Bt. Cotton.

A. Some strains of Bacillus thuringiensis produce proteins that kill certain insects such as lepidopterans, coleopterans and dipterans.

1. B. thuringiensis forms protein crystals. These crystals contain a toxic insecticidal protein.
2. The Bt toxin proteins exists as inactive protoxins but once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilises the crystals.
3. The activated toxin binds to the surface of midgut epithelial cells and creates pores that cause cell swelling and lysis leading to death of an insect.
4. Specific Bt toxin genes were isolated from Bacillus thuringiensis and incorporated into several crop plants such as cotton.
5. Most Bt toxins are insect group specific.
6. The toxin is coded by a gene named `cry'. For example, the proteins encoded by the genes cryIAc and CryIIAb control the cotton bollworms, and cryIAb controls corn borer.

4. Give a brief account of Pest resistant plants.

1. A nematode Meloidegyne incognitia infects the roots of tobacco plants which reduces the production of tobacco.
2. RNAi takes place in all eukaryotic organisms as a method of cellular defence. This method involves silencing of a specific mRNA due to a complementry RNA molecule that binds to and prevents translation of the mRNA(silencing).
3. The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements(transposons) that replicate via an RNA intermediate.
4. Using Agrobacterium vectors, nematode-specific genes were introduced into the host plant.
5. The introduction of DNA was such that it produceed both sense and anti-sense RNAs in the host cells.
6. These two RNAs being complementary to each other formed a double stranded RNA(dsRNA) that initiated RNAi and thus, silenced the specific mRNA of the nematode.
7. The consequence was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plant therefore got itself protected from the parasite.

UNIT-VI PLANTS, MICROBES AND HUMAN WELFARE

CHAPTER 14

MICROBES IN HUMAN WELFARE

VERY SHORT ANSWER QUESTIONS (2 MARKS)

1. Why does 'Swiss cheese' have big holes. Name the bacteria responsible for it.

A. Swiss cheese have big holes due to the production of large amount of carbon dioxide (C02) by the bacterium named **Propioni bacterium sharmanii.**

2. What are fermentors?

A. **Fermentors** are big vessels in which microbes are grown in large numbers on an industrial scale.

3. Name a microbe used for statin production. How do statins lower blood cholesterol level?

A. ❖Monascus purpureus.

❖The statins lower blood cholesterol level by competitively inhibiting the enzyme which is responsible for synthesis of cholesterol.

4. Why do we prefer to call secondary waste water treatment as biological treatment?

A. Secondary treatment removes the dissolved organic matter by the use of biological agents and hence, known as biological treatment. This is achieved by microbes which can consume and degrade the organic matter.

5. What is Nucleopolyhedrovirus is being used for now a days?

A. **Nucleopolyhydro** viruses are used as biological control agents.
They attack insect and other orthropods. These species - specific narrow spectrum insecticides have no negative impact on other organisms.

6. Write the most important characteristic that *Aspergillus niger, Clostridium butylicum* and *Lactobacillus share.*

A. These are organic acid producers.
Aspergillus niger produces Citric acid, Clostridium butylicum produces Butyric acid while Lactobacillus share produces Lactic acid.

7. Name any two genetically modified crops.

A. ❖Bt cotton

❖Bt brinjal.

8. Name any two industrially important enzymes.

A. (i) Lypase

(ii) Pectinases and Proteases.

9. Name an immunosuppressive agent. From where it is obtained ?

A. ❖Cyclosporin A

❖Trichoderma polysporum (Fungus)

10. What is the group of bacteria found in both the rumen of cattle and sludge of sewage treatment?

A. Methanogens - *Methanobacterium*

11. Name the scientists who were credited for showing the role of penicillin as an antibiotic.

A. 1. Alexander Fleming

2. Ernest Chain

3. Howard Florey.

SHORT ANSWER QUESTIONS (4 MARKS)

1. How do mycorrhizal fungi help the plants harbouring them?

A. ❖The symbiotic association of fungi with plants is known as mycorrhizae.

❖Many members of the genus Glomus form mycorrhiza.

❖The fungal symbiont in these associations facilitates absorption of phosphorus by the plant from the soil.

❖Plants having such associations shows other benefits such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.

2. What is the chemical nature of biogas? Explain the process of biogas production.

A. a. Biogas comprises methane (CH_4), carbondioxide (CO_2), traces of hydrogen sulphide (H_2S) and moisture.

b. Biogas is generated by the decomposition of excreta or dung of cattle (commonly called as gobar) domestic waste material, industrial and agriculture sewage due to the activity of anaerobic bacteria present in them.

Biogas formation from activated sludge :

1. A small part of activated sludge is pumped back into the aeration tank to serve as inoculum.
2. The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters.
3. In large tank anaerobic bacteria called methogens digest the bacteria and fungi of the sludge
4. During the digestion the bacteria produce a mixture of gases like CO_2, CH_4 and H_2S which forms biogas.

3. What are biofertilisers? Write a brief note on them.

A. The organisms that enrich the nutrient quality of the soil are called as biofertilisers.The main sources of biofertilisers are bacteria, fungi and cyanobacteria.

Bacteria:

❖Rhizobium bacteria shows symbiotic association in the nodular roots of legumi nous plants. They fix atmospheric nitrogen into organic forms, which is used by the plant as a nutrient.

❖Other Free-living bacteria can also fix atmospheric nitrogen, thus enriching the nitrogen content of the soil.

examples: *Azospirillun* and *Azotobacter*

Cyanobacteria :

❖Cyanobacteria fix atmospheric nitrogen.

❖In paddy fields cyanobacteria sarve as an important biofertiliser.

❖They add organic matter to the soil and increase its fertility

Ex. Nostoc, Anabaena

Fungi :

❖The symbiotic association of fungi with plants is known as mycorrhizae.

❖Many members of the genus Glomus form mycorrhiza.

❖The fungal symbiont in these associations facilitates absorption of phosphorus by the plant from the soil.

❖Plants having such associations shows other benefits such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.

LONG ANSWER QUESTIONS (8 MARKS)

1. Write brief essay on microbes in sewage treatment.

A. ❖ Large quantities of waste water are generated every day in cities and towns. This waste water is also called sewage.

❖ Municipal waste-water which contains large amounts of organic matter and microbes.

❖ Before disposal, sewage is treated in sewage treatment plants (STPs) by the heterotrophic microbes to make it less polluting.

Sewage treatment is carried out in two stages.

Primary treatment –

These treatment steps basically involve physical removal of large and small particles.

Initially, floating debris is removed by sequential filtration and then the grit are removed by sedimentation.

All solids that settle form the primary sludge, and the supernatant forms, the effluent.

The effluent from the primary settling tank is taken for secondary treatment.

Secondary treatment or biological treatment-

After the primary treatment of sewage water, primary effluent is passed into large aeration tanks, where it is constantly agitated mechanically and air is pumped into it.

This allows vigorous growth of useful aerobic microbes into flocs

While growing, these microbes consume the major part of the organic matter in the effluent. This significantly reduces the BOD or Biochemical Oxygen Demand of the effluent.

BOD refers to the amount of oxygen that would be consumed if all the organic matter in one litre of water is oxidised by bacteria. The sewage water is treated till the BOD is reduced.

The effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment and the sediment is called **activated sludge**.

A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum.

The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge digesters** where anaerobic bacteria digest the bacteria and the fungi in the sludge.

During digestion, bacteria produce a mixure of gases such as methane, hydrogen sulphide and carbon dioxide which form biogas.

The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.