Telangana State Board of
INTERMEDIATE Education

BOTANY-II

BASIC LEARNING MATERIAL

For The Academic Year : 2020-2021

TELANGANA STATE BOARD OF INTERMEDIATE EDUCATION HYDERABAD

INTERMEDIATE - SECOND YEAR

BOTANY

English Medium

BASIC LEARNING MATERIAL

(QUESTION AND ANSWERS)

Academic year 2020-2021

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 of Physical Classroom Teaching, Department of Intermediate Education Telangana has successfully engaged the students and imparted education through TV lessons. The actual class room teaching through physical classes was made possible only from 1st February 2021. 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 Public Examinations May 2021. 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, Medha Charitable Trust who have involved day in and out to come out with the, Basic Learning Material in such a short span of life.

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

The material can be accessed through our website www.tsbie.cgg.gov.in which is exclusively devoted to uploading the additional study material from time to time.

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 :** An organic co-factor that is tightly bound to the **apoenzyme.**

Co-factors : Non protein part of a **holoenzyme.** 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 catolysed reactions inhibits the enzyme of the first reaction as part of homeostatic control of metabolism.

3. Why are "Oxido reductases" so named?

Ans: Enzymes which catalyse oxydo reduction between two substrates are called **oxydoreductases.**

4. Distinguish between apoenzyme and co factor?

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

Co-factor : Non-protein part of a holoenzyme. It coud be a metal ion or an organic complex.

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

Ans: The inhibitor closely resembles the sub strate in its molecular structure and inhibits the activity of the enzyme, is known as **competitive inhibitor.**

E.g., inhibition of succinic dehydrogenase by malonate which closely resembles the sub strate 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 : Metalions of copper, mercury, silver etc.

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

Ans: The first digit of the enzyme code indicates the major class of the enzyme.

Second- Sub class

Third - Sub-subclass

Fourth - 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.**

Competitive inhibitor : The inhibitor closely resmbles the substrate in its molecular structure and inhibits the activity of enzyme. Due to its close structural similarity with the substarte, the inhibitor competes with the substrate for the substrate binding site of the enzyme, consequentyly, the substrate can not bind and as a result, the enzyme action declines.

Non-competitive enzyme inhibition : The inhibitor has no structural similarity with the substrate and forms and enzyme inhibitor complex at a point other than its active site, so that globular structure of the enzyme is changed. As a result catalysis cannot take place.

2. Explain different types of cofactors.

A. Three kinds of co-factors may be identified they are prostetic groups, co-enzymes and metalions.

Prostetic groups are organic compounds and are distinguished from other co-factors in that they are tightly bound to the apo-enzyme. Ex : In peroxidase and catalase hem is the prosthetic group.

Co-enzymes are also orgnic compounds but their association with the apo enzymes is only tansient, usually, occuring during the course of catalysis. Co-enzymes serve as co-factors in number of enzymes.

Eg : NAD, NADP.

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 from other 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

PLANT PHYSIOLOGY

CHAPTER 4

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 A.T.P. & $NADPH_2$. 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 thylacoids. 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: In C_3 plants, to fix one molecules of CO_2, 3 molecules of ATP & 2 molecules of NADPH are required this process occurs 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 prodes on the outer surface of the thylakoid membrane, towards stroma.

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

5. Distinguish between action spectrum and absorption spectrum ?

Ans: The graph showing light absorption of photosythetic pigments at different wave length is called **abosption spectrum**. The graph to showing rate of photosynthesis at different wave lengths of light is called **Action 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: The intial acceptor CO_2 in C_3 plants is Ribulose bisphosphate (RuBP). It is a 5-carbon compound. The first stable compound in C_3 pathway is PGA (Phospho Glyceric Acid). It is a 3-carbon compound.

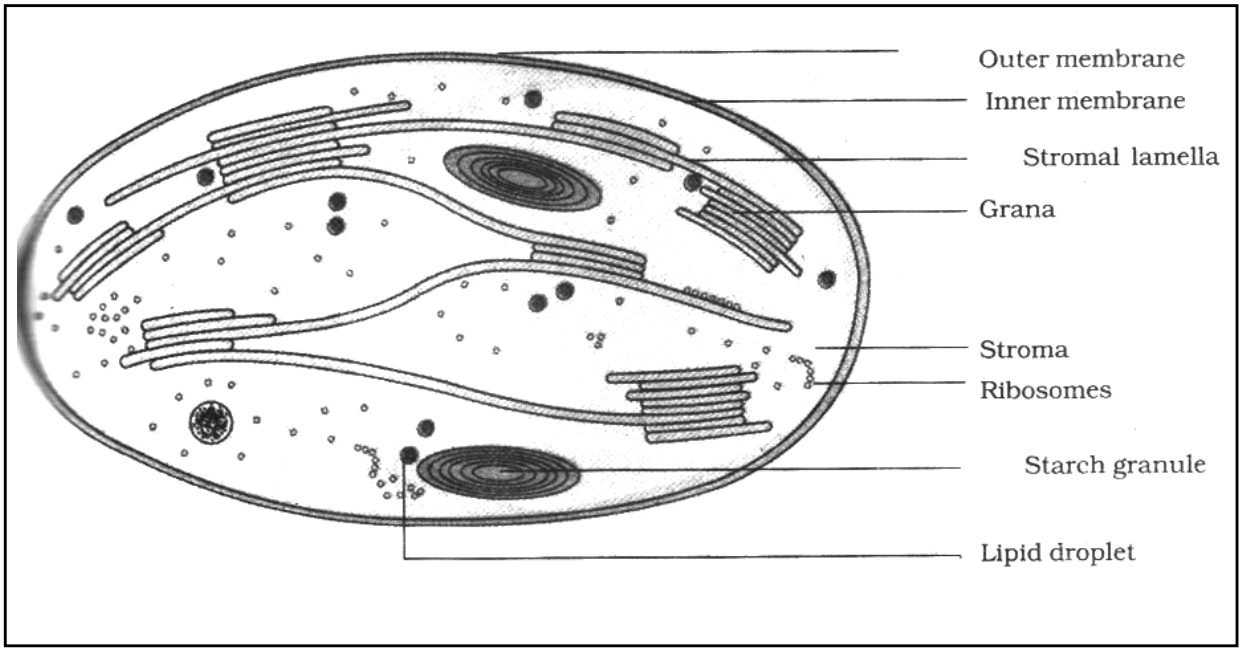
9. What is the primary acceptor of CO_2 in C_4 plants ? What is the first formed compound formed as a result of primary carboxylation in plants C_4 pathway ?

Ans: The primary acceptor of CO_2 in C_4 plants is PEP (Phospho Enol Pyruvate), a 3-carbon compound. The first formed compound as a result of primary carboxylation in mesophyll cells of C4 plants is Oxalo Acetic Acid (OAA), a-4 carbon compound. It is a dicarbocylic acid.

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.

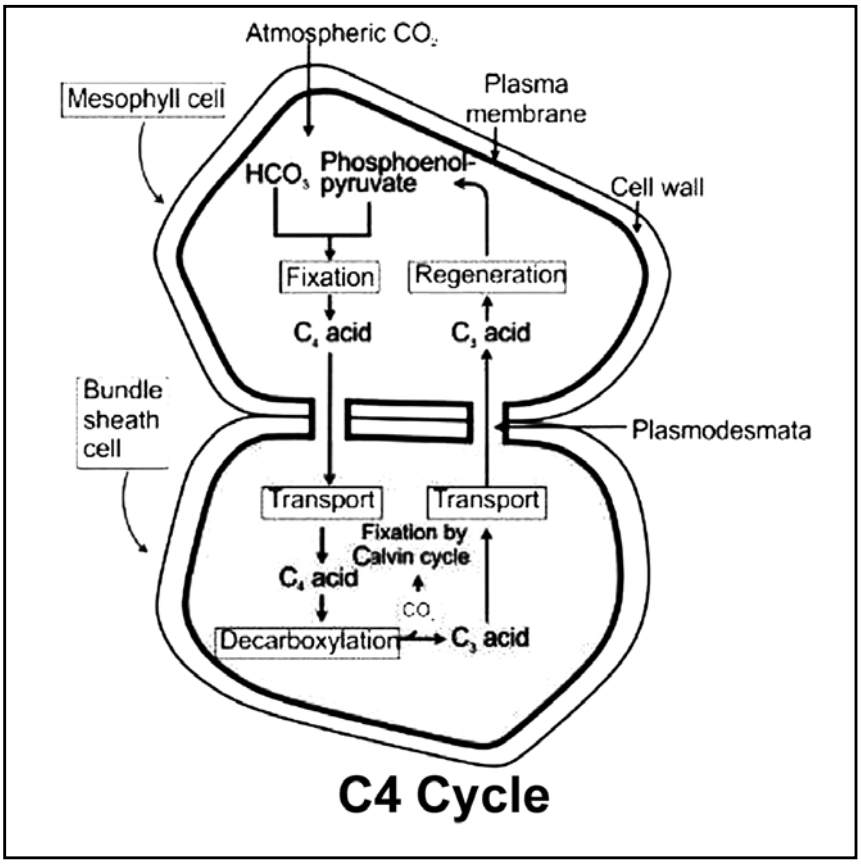
3. Describe C_4 pathway?

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 + $O_2 \xrightarrow{\text{Rubisco}}$ 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.

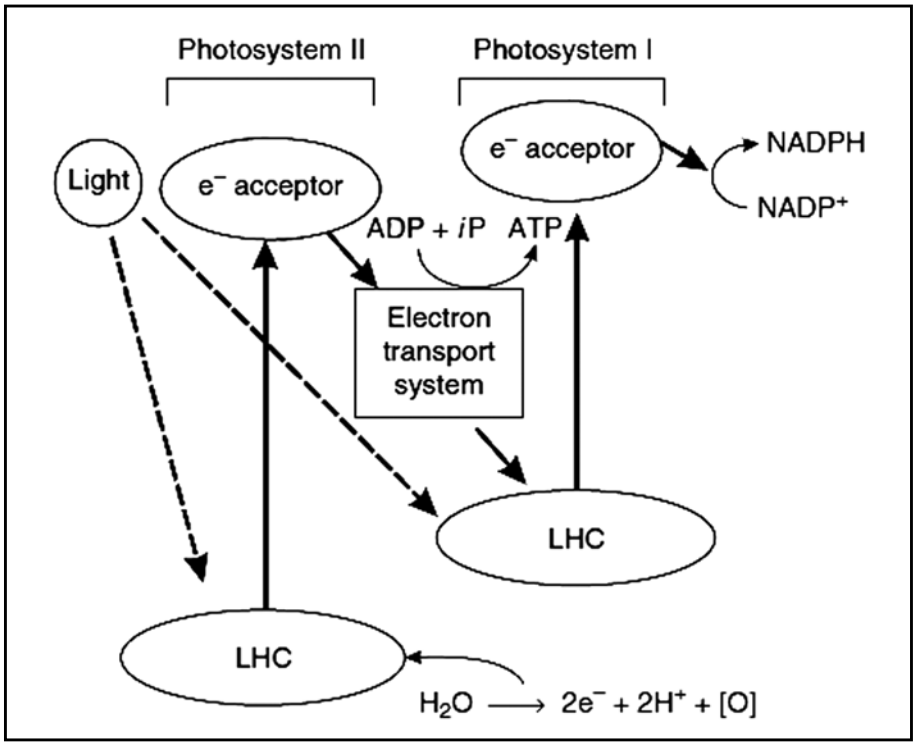
Photolysis of water :

- ✤ 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.



2. Explain calvin cycle.

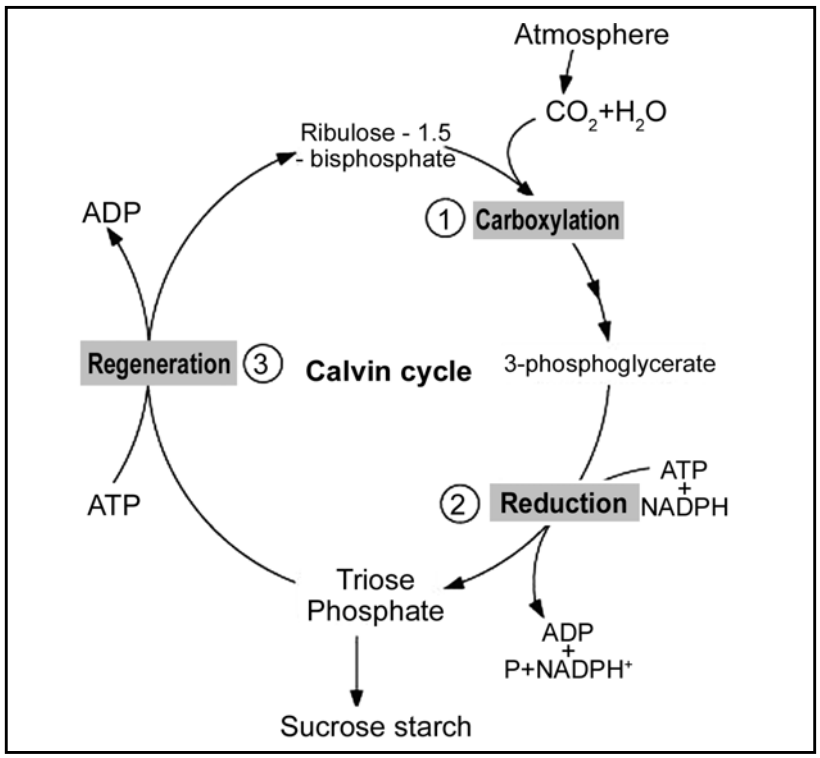
A. ✤ Melvin calvin and his co-workers conduct the experiments on chlorella and discovered this cycle, so it is called calvin cycle.

✤ 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.

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

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

- ✤ 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.

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

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

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

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

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

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

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

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

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

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

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

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

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) = Volume of CO evolved

Here, A stands for = Volume of CO_2 evolved

B stands for = volume of O_2 consumed

Substrates having R.Q as 1 = carbohydrates (ex.Glucose)

Substrates having R.Q<1= Proteins & fats (ex.Tripalmitin)

Substrates having R.Q>1= Organic acids (ex.Malic acid)

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

A. 1. F_0-F_1 particles are called as **oxysomes** (smallest rotatary particles)

2. They play a major role in ATP synthesis.

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

A. Anaerobic respiration occurs in the absence of oxygen.

Yeast : Incomplete oxidation of glucose is achieved under anerobic conditions (Fermentaion)

Man : when oxygen is in adequate for cellular respiration, anerobic respiration occurs (Pyruvic acid reduced to lactic acid), leads to muscle fatigue;

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

A. 1. Glycolysis

2. Cytosol 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. 1. The term Amphibolic pathway is used to signify **krebs cycle** (TCA cycle)

2. As this cycle involves both in catalabolism (Oxidation of fats, carbohydrates) and anabolism

(-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. 1. Ubiquinone (between complex I&III, between complex II&III)

2. 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. 1. O_2 is the ultimate final acceptor of electrons in aerobic respiration

2. From complex IV it receives electronics & gets reduced to water.

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

A. D 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.

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

SHORT ANSWER QUESTIONS (4 MARKS)

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

A. **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 run the living system by providing 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 symthesize 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.

$$1,3\text{ - BisPGA} + ADP \xrightarrow{\text{Phosphoglycerokinase}} 3\text{ - PGA} + ATP$$

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

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

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 general in glycolysis	:	
G-3-P to BPGA (2NADH, each worth 2ATP)	:	2x2 = 4 ATP
Total ATP gain from glycolysis in the presence of 02	:	[(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 3 = 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.

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

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

- ✤ 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.

- ✤ It includes two reactions.

$$\text{Pyruvic acid} \xrightarrow{\text{Pyruvate decarboxylase}} \text{Acetaldehyde} + CO_2$$

$$\text{Acetaldehyde} + NADH + H^+ \xrightarrow{\text{Alcohol dehydrogenase}} \text{Ethyl alcohol} + NAD^+$$

- ✤ 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 (Succinate 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)

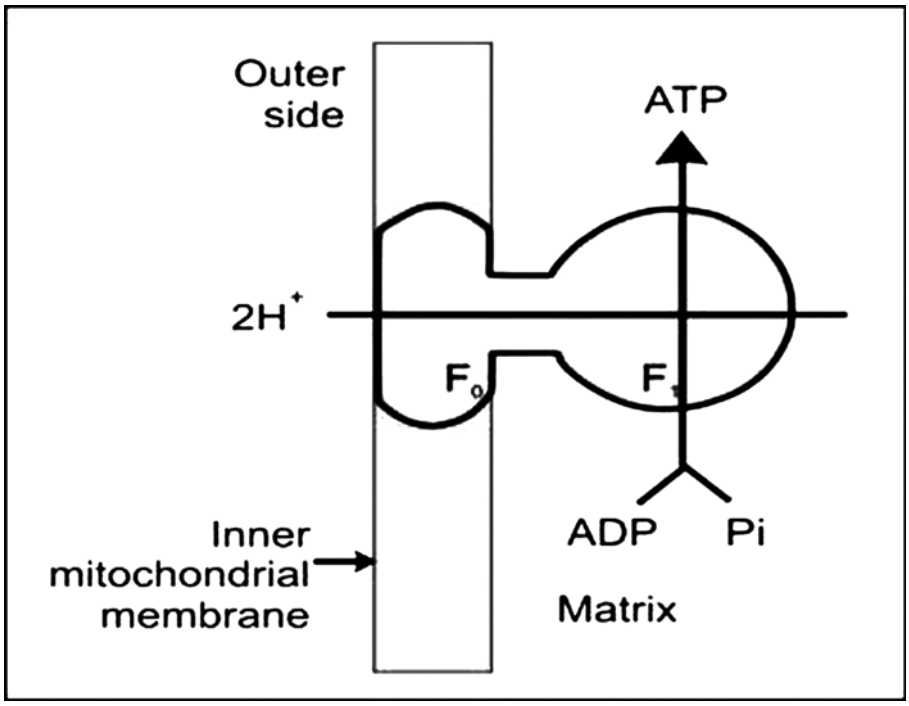
- ✤ This complex transfer electrons from cytochrome 'C' to molecular oxygen.

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.

LONG ANSWER QUESTIONS (8 MARKS)

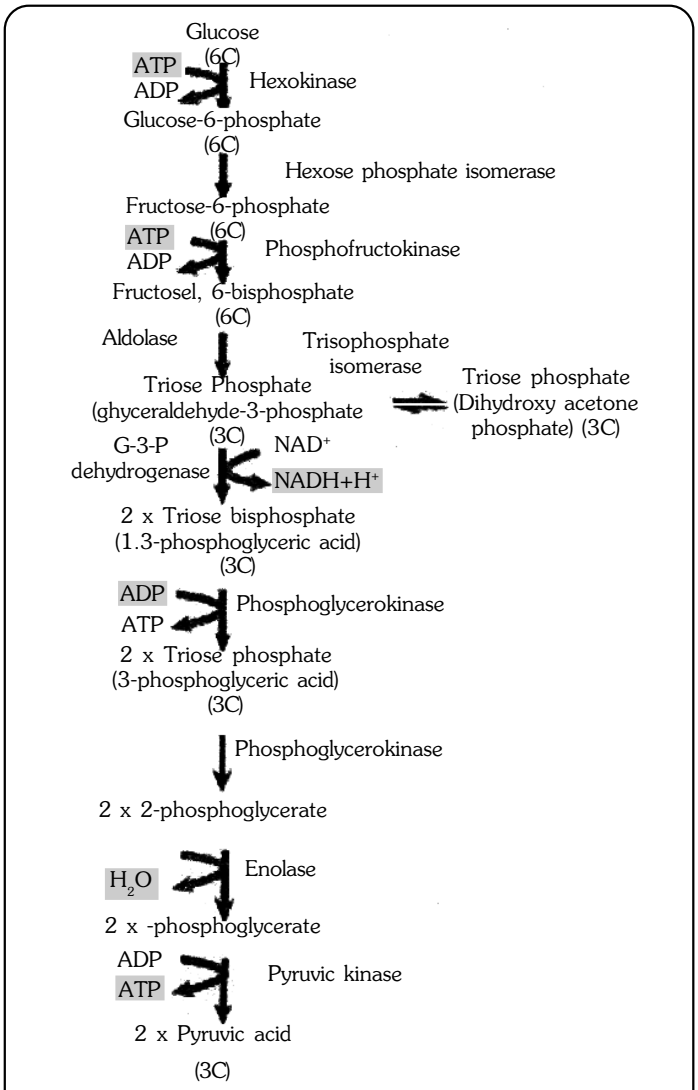
1. Give an account of Glycolysis. Where does it occur? What are the end products? Trace the fate of these products in both aerobic and anaerobic respiration.

A. Glucose is brokedown 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, 2NADPH+H are the end products in aerobic respiration. Pyruvic acid, 2NADPH+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.

ATP is utilised at two steps: first in the conversion of glucose into glucose 6-phosphate and second in the conversion of fructose 6-phosphate to fructose 1,6-bisphosphate.

The fructose 1, 6-bisphosphate is split into dihydroxyacetone phosphate and 3-phosphoglyceraldehyde (PGAL). We find that there is one step where NADH + $H^+$is formed from NAD^+; this is when 3-phosphoglyceraldehyde (PGAL) is converted to 1, 3-bisphosphoglycerate (BPGA). Two redox-equivalents are removed (in the form of two hydrogen atoms) from PGAL and transferred to a molecule of NAD^+. PGAL is oxidised and with inorganic phosphate to get converted into BPGA. The conversion of BPGA to -phosphoglyceric acid (PGA) is also an energy yielding process; this energy is trapped by the formation of ATP. Another ATP is synthesised during the conversion of PEP to pyruvic acid.



Steps of glycolysis

2. Explain the reactions of krebs cycle.

A. **Krebs cycle** occurs in the matrix of the mitochondria.

The final product of glycol sis pyruvic acid after oxidative decarboxyation forms Ace tyle COA

This Acetyle COA then enters a cyclic pathway, tricarboxylic acid cycle, commonaly called krebs cycle on the name of the scientist Sir Hans Krebs

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

The Reactions are as follows :

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

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

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

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

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

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

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

$$Isocitric\ acid + NADP+ \xrightarrow{dehydrogenase} oxalosuccinnic\ acid + NADPH + H^+$$

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

$$Oxlosuccinic\ acid \xrightarrow{decarboxylase} a\ keto\ glutaric\ acid + CO_2$$

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

$$a\text{-}kero\ glutaric\ acid + NADP+ + Co.A \xrightarrow{dehydrogenase} succinyl\ co.A + NADPH + H+ CO_2$$

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

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

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

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

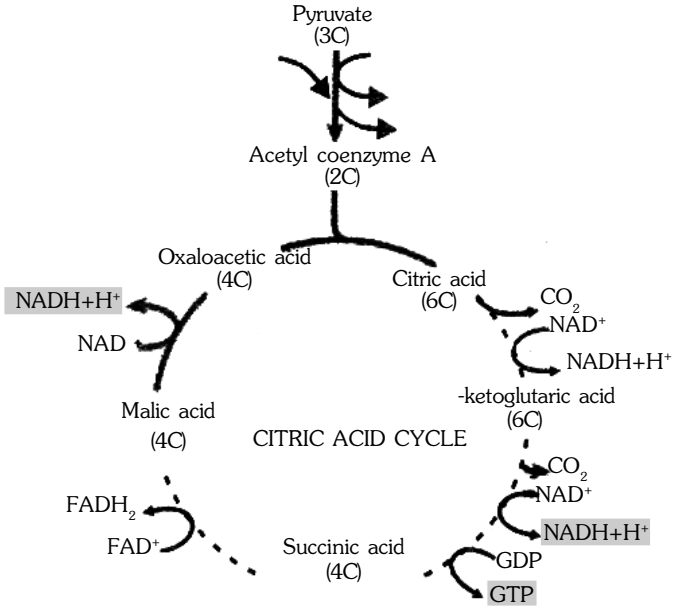
9) **Hydration :**

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

10) **Oxidation IV :**

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

✤ 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 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: A B C (Abscisic acid) is called **stress hormone.** A B A 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 induce parthenocarpy. Ex : Tomatoes.
5) Used as herbicides (2,4-D) 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 causes internodal elongation.

iv) Delay of senescence

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.

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.**

2) Ethylene promotes the **senescence** and **abscission of leaves and flowers.**

3) Ethylene promotes rapid **internode/petiole elongation** in deep water rice plants.

4) It also promotes **root growth** and **root hair formation**, thus helping plants to increase their absorption suface.

5) Ethylene is used to initiate flowering (mango) and for synchronizing fruit set in pineapples.

6) It promotes female flowers in cucumbers, thereby increasing the yield.

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 **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 groveling apices stems and roots.

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

Physiological functions :

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

Agricultural / Horticultural applications :

1) Used for initiate rooting in stem cuttings
2) Auxins are used as weedysides
3) Used for productions of seed less fruits
4) The knowledge of apical dominance is widely applied in tea plantations.

UNIT-III

GENETICS

CHAPTER 9

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.

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 inherit and do not follow the law of independent assortment of Mendel.

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 having 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 individuals.

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

6. What is point mutation ? Give an example ?

Ans:- **Point mutation :-** Mutations also arise due to change in a single base pair of DNA. This is known as point mutation.

Ex:- Sickle cell anemia.

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

A. 1 Wrinkled character of seed in pea is a recessive trait.

2 Hence genotype of wrinkled phenotype for pea seeds is rr.

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

(A)(a) (a) – gamete

♀	A	a
a	A a	a a

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

b) AA × aa – P generation

(A) (a) – gamete

A a

The progeny shows Aa hybrid. (Parental cross)

c) Aa × Aa – P generation

(A)(a) (A)(a) – 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

(A)(a) (A)(A) – gametes

♀	A	a
A	A A	A a
A	A A	A a

All the progeny shows dominant character. (Back cross) 1:1

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) 1:2:1.

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. Mendel observed that in F_1 hybrids the character of tallness dominated or supress the dwarf character. The character which is expressed in F_1 generation is called dominant trait and that which remained unexpressed is called recessive trait.

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).

The law of dominance is used to explain the expression of only one of the parental characters in a monohybrid cross in the F_1 and the expression of both in the F_2. It also explains the proportion of 3 : 1 obtained at the F_2.

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

T t — Gametes

Tall

Tt — F_1 generation

F_1 ♀ ♂

	T	t
T	TT Tall	Tt Tall
t	Tt Tall	tt Dwarf

T t x T t — gamete

T t T t — F_2 generation

The phenotypic ratio is 3 Tall: 1 Dwarf.

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

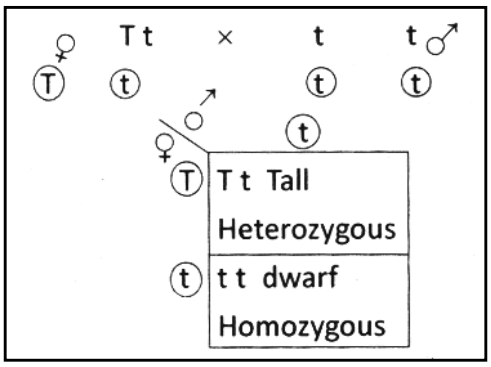
4. Define and design a test -cross.

A. 1) When the F_1 individuals are crossed with the recessive parent or organism similar in phenotype and genotype to the recessive parent, it 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



5. Explain the Co-dominance with example.

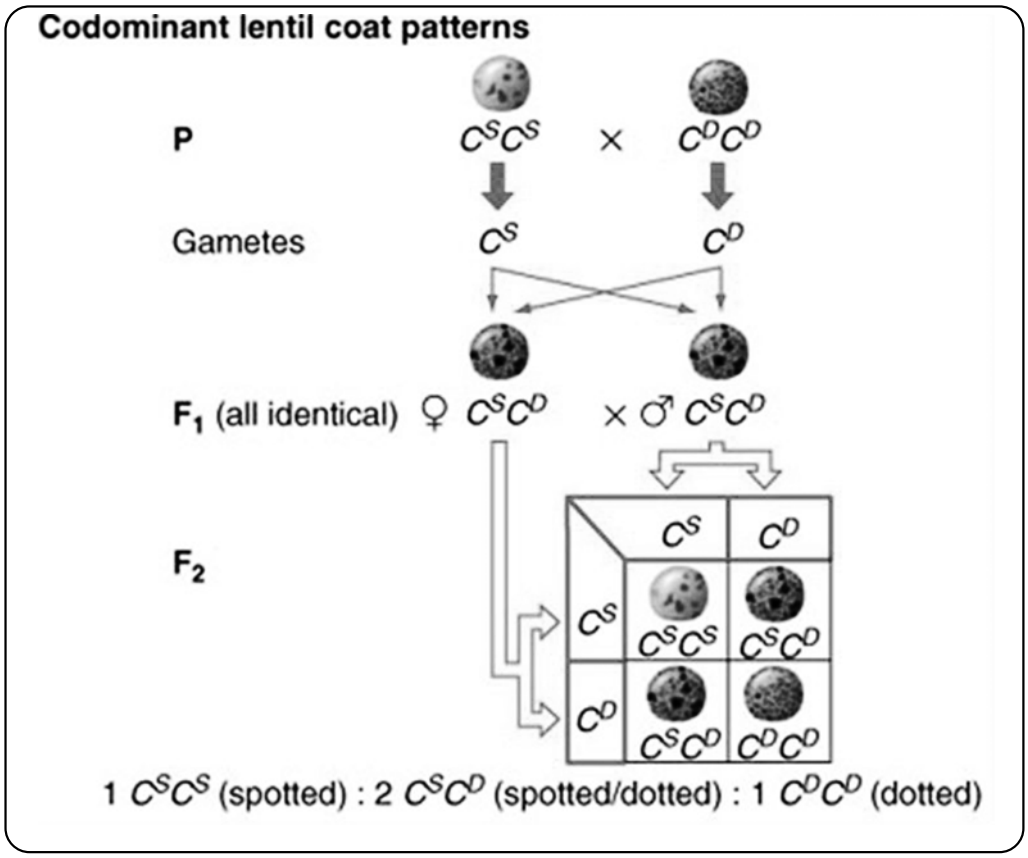
A. **Co-dominance :** It is the phenomenon in which both the genes are equally dominant and so the character of both genes is well expressed in next generation. So in F_1 generation resembles both parents.

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.

2 Lentil is a major grain legume (pulse) crop in N.America.

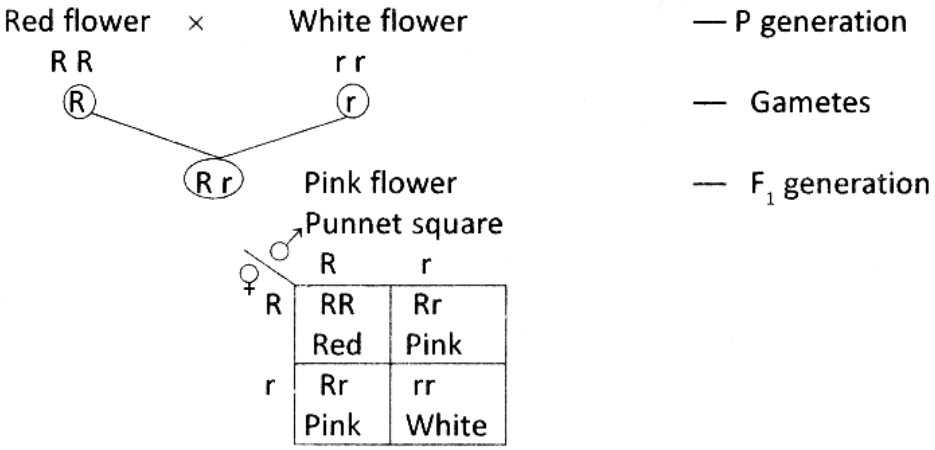
3 A cross between pure-breeding spotted (having a few big irregular patches) lentils and pure breeding dotted (having several small circular dots) lentils produce heterozygotes that are both spotted and dotted.

4 Thus it shows the phenotypic features of both parents, which means that neither the spotted nor the dotted allele is dominant or recessive to the other.



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 (RR) and true breeding (homozygous) white flower plant (rr), the F_1 (R r) was pink.



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)
2. since the heterozygous / hybrid shows a different phenotype genotype ratio remains the same as Mendelian ratio 1:2:1.

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

A. **Chromosomal mutations :-** Any change in the number or structure of chromosomes is called chromosomal mutation

i) Structural changes:- During prophase I of meiosis, homologous regions of chromosomes so many changes in structure in order to form pairs or bivalents. These structural changes are 4types. 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 re attached to th original chromosome in reverse order.

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

ii) Numerical changes:- These are two types

a) Euploidy :- Genomes containing chromosomes which are multiple of some basic numbers.

Ex:- Monoploids (x) one genome
Diploids (2x) two genome
Triploids (3x) three genome
Polyploids (x) many genomes

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

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

II) Gene mutation (or) point mutation :-

It occurs in a very small segmant of DNA molecule. i.e., a single Nucleotide (or) nuclotide pair.

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. ⁕ Mendel crossed two pea (Pisum sativum) plants that differed in two pairs of phenotypic traits, that is said to be a dihybrid cross.

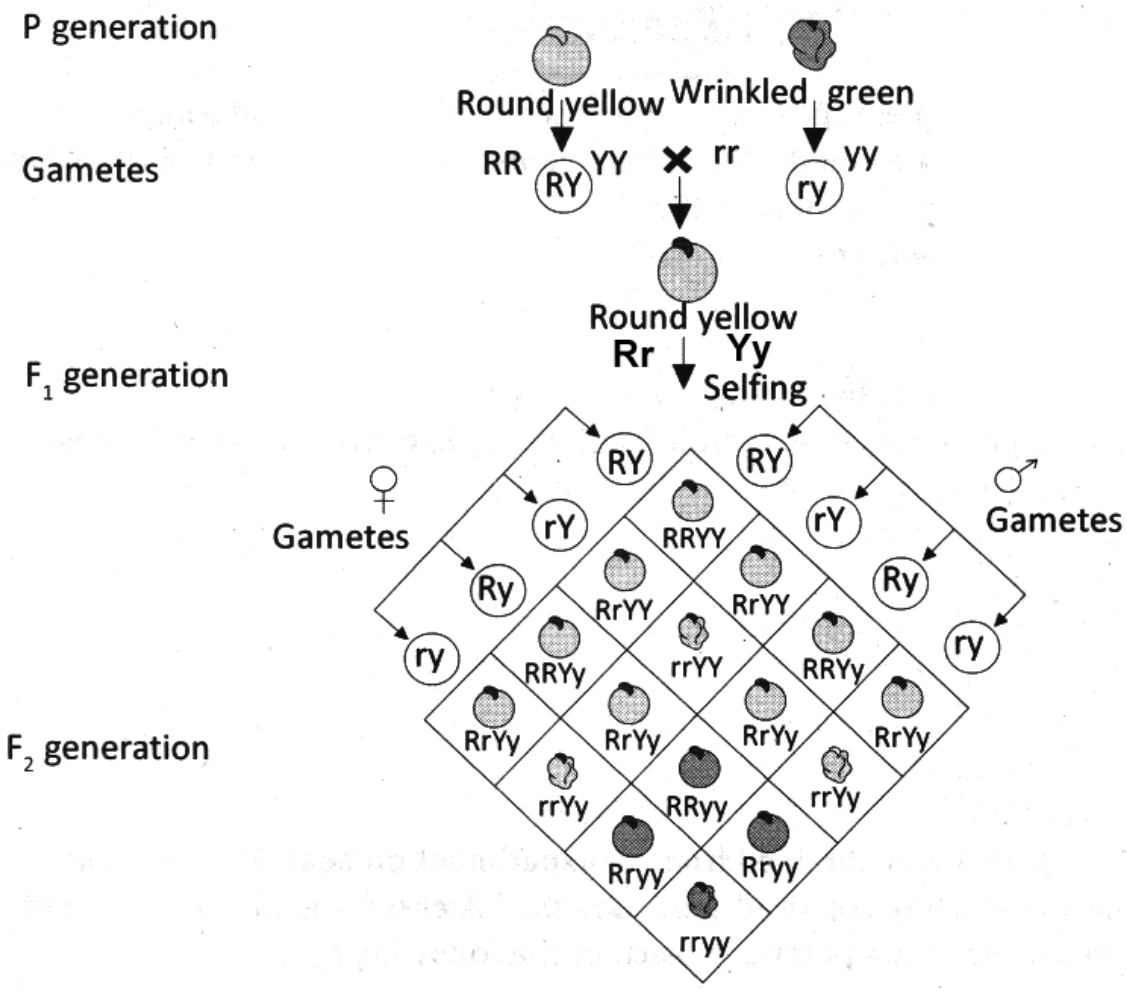
⁕ He crossed a pea plant that has yellow coloured, round shaped seeds with another pea plant that has green coloured, wrinkle shaped seeds (parental cross).

⁕ The resulting progeny (F_1 generation) found to have yellow coloured and round shaped seeds,

⁕ This clearly indicates that yellow colour of seed is dominant evergreen colour similarly round shape of seed is dominant on wrinkle shape.

⁕ He presumed that genotypic symbols for dominant yellow and recessive green seed colors as 'Y' and 'y' respectively. Similarly the genotypic symbols of *round* and wrinkled seed shapes are 'R' and 'r' respectively.

⁕ So, the genotypes of parents are RRYYand rryy. Thegamete^c produced by those parents i.e., (RY) and (ry) unite on fertilization to produce the F_1 hybrid, RrYy.



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

9 3 3 1

- Mendel, self pollinated the F_1 plants and observed the F_2 progeny. 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.
- Based on the results of dihybrid cross Mendel proposed 'Law of Independent Assortment'. This law states that 'When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters'.
- Independent assortment of the two pairs of genes an be well understood with the help of punnett square board.
- F_1 plant (RrYy) is a double heterozygote. This produces 50% of gametes with 'R' gene and other 50% of gametes with 'r' gene. Each of the gamete may contain either Y or y gene responsible for other character (color of seed).

- ⁕ The segregation of 50% ‘R’ and 50% ‘r’ is independent of the segregation of S0% Y and 50% y - Therefore, 50% of the ‘r’ bearing gametes have ‘Y’ and other 50% have ‘y’. Similarly 50% of ‘R’ bearing gametes have y and other 50% have ‘Y’. Thus F_1 produces four types gametes (pollen or eggs) with (RY), (Ry), (rY) (ry) genotypes in equal frequency i.e. 25% each (l/4th of the total gametes produced.
- ⁕ It is very easy to derive the composition of the zygotes that give rise to F_2 plants, by writing down 4 types of eggs and 4 types of pollen of the two sides of a Punnet square.

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 chranatin that is loosely packed and stains light is called as euchranatin.

Heterochromatin : The chranatin that is more densely packed and stains dark is called as heterochromation.

Euchromatin is transcriotionally active chromatin.

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

A. 1. Alfred Hershey and Martha Chase (1952)

2. They worked with viruses that infect bacteria, bacteriophages.

3. What is the function of DNA polymerase ?

A. 1. DNA polymerase uses a DNA template to catalyze polymerization of deoxynucleotides.

2. It is highly efficient and catalyzes polymerization in only one direction (5' → 3') .

4. What are the components of a nucleotide ?

A. 1. A pentose sugar (ribose or deoxyribose)

2. A nitrogenous base

3. 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. 5" A A T G C A G C T A T T A G G - 3"

write the sequence of

a) it s conplementary strand : 5" - T T A C G T C G A T A A T C C - 3"

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

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

A. TMV, GB bacteriophage, HIV.

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 exons are interrupted by introns. introns do not appear in mature processed RNA.

9. What is meant by capping and tailing ?

A. In capping an unusual nuoleotide (methy' guanosine triphosphote) is added to the 5" - end of hn RNA. In tailing, adenylate residues are added at 3"-end of hnRNA in a template indendent manner.

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

A. 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.**

11. What is meant by charging of tRNA ?

A. Amino acids are activated in the presence of ATP and linked to thier cognate tRNA - a process commonly called as 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 sunthesis and hence they are called stop or terminating 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 be cuase the sequence of nifiogenous 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 :** Transformation is uptake of naked DNA fragments from the surrounding environment and the expression of that genetic information in the recipient cell that is the reciepient cell has now acquired a charactetistic that it previously lacked.

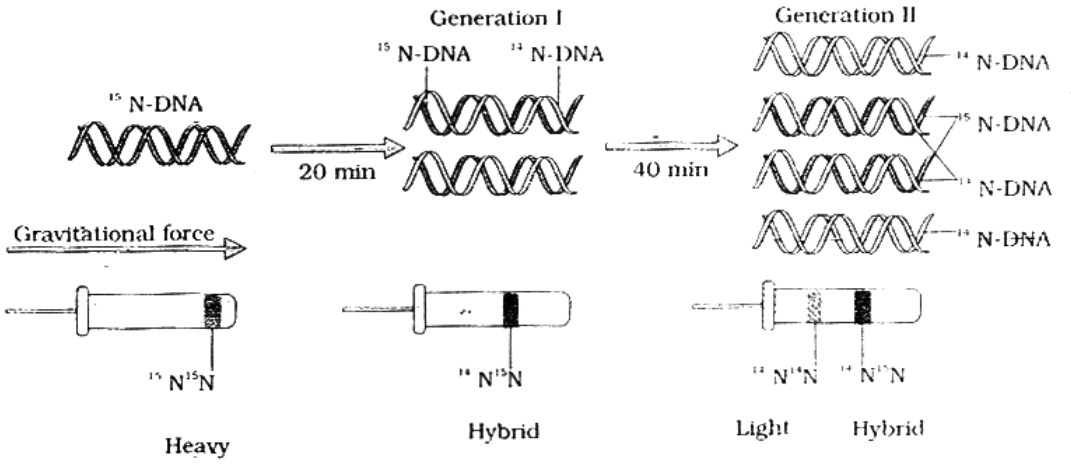
- **Griffiths** transformation experiment caducted on streptococcus preumoniace.
- He found that there are two strains of this bacteria.
- S-type (smoth walled) and R-type (rough)
- S-type is capsulated and virulent while R-type is non carsulated and non-virulent.
- He conducted his experiment in the following four stages.
  1) He injected S-type bacteria in mice, mice died.
  2) He injected R-type bacteria in mice, mice survived.
  3) He injected heat killed S-type bacteria, mice did not died.
  4) He injected the mixture of heat killed S-type and liver R-type and latter pro duced the disease.
- It shows that factor from this dead S-cells connected the live R-cells into live S cells and latter produced the disease.
- Thus DNA was shown to be genetic material that was responsible for induding smoth character of cells and thier virulence property in mice.

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

A. The hypothesis of semiconservative replication of DNA was tested by meselson and stahl in 1958.

- They cultured a species of bacteria (E.coli) 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 DNA was denser and heavier than the DNA present in bacteria grown in 14_N medium.
- When these bacteria with 15_N were transfereed 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 glutomate 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 at least three RNA polymerases in the nucleus.

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

2. RNA polymerase II transcribes the precursor of mRNA the hetrogenous neclear RNA (hnRNA)
3. RNA polymerase III 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 ?

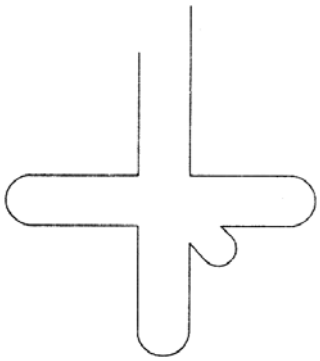
A. **George Gamow :** He pointed out the possibility of three letter code i.e. each codon consisting of three nitrogenous bases.

H.G. Khorana : The chernical method developed by H.G. Khorana was intsrumental in synthesizing RNA molecules with defined combinations of bases (homopolymers such as UUU and copolymers such as UUC, CCA)

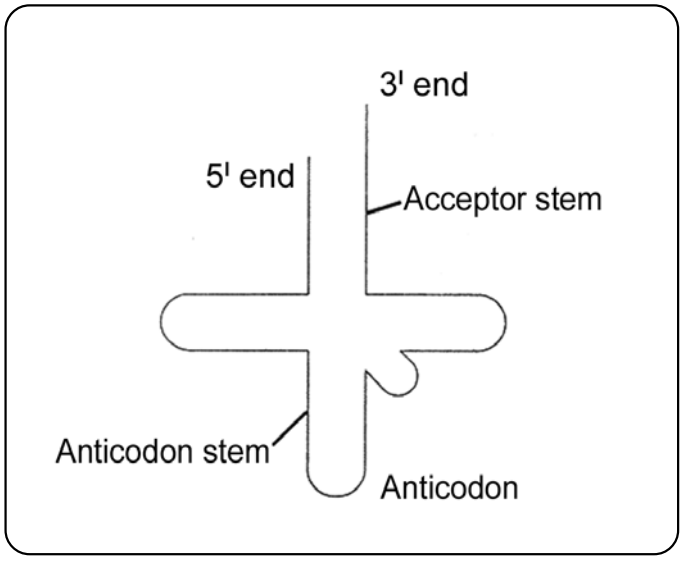
Marshall Nirengerg : Marshall Nirenberg's cell free system for profin synthesis finally helped the code to be deciphered.

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**

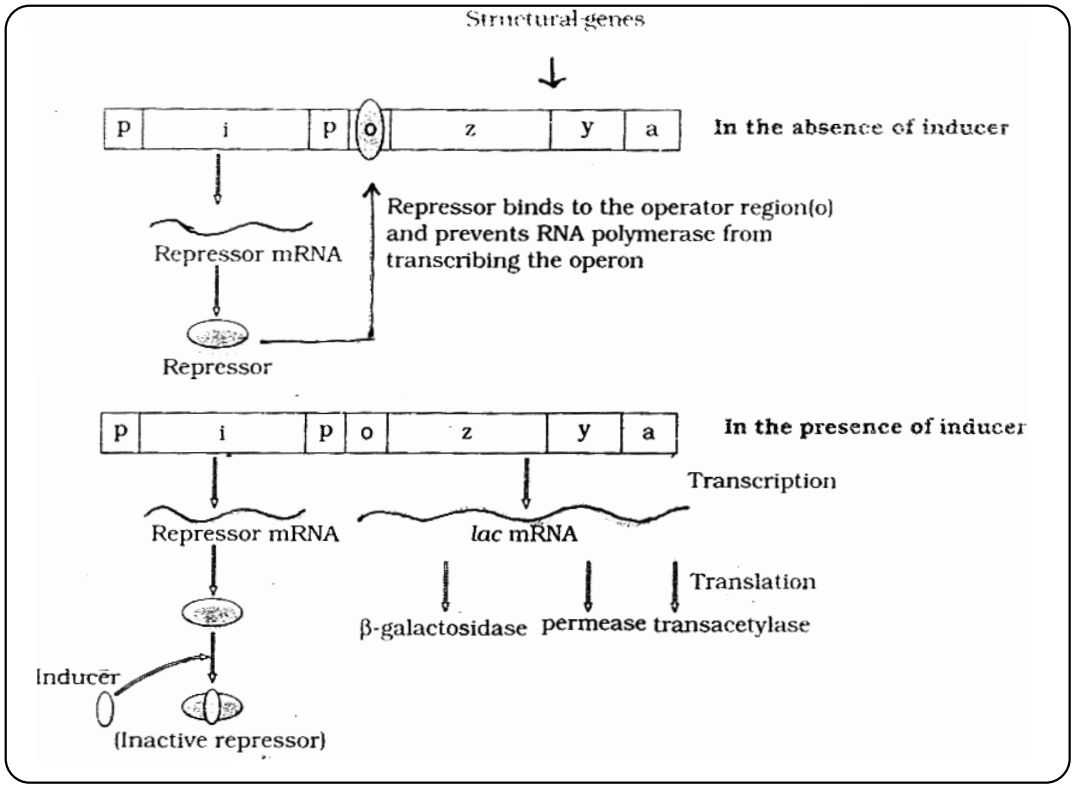


A.



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 organisons (except some viruses)	1.	RNA is not the genetic material (except a few viruses)
2.	Found in the nucleus nad some cell organelles.	2.	Only a small amount of RNA is found in nucleus majority of its present in cytoplasm.
3.	Double strandard	3.	Single strandard
4.	Sugar present is deoyribose	4.	Sugar is ribose
5.	Four nitrogenous bases present adenine, guanine, thymine, cytosine	5.	Four nitrogenous bases present adenine guanine, uracil, cytosine
6.	purine and pyramidine bases in equal number.	6.	No such proportion between purine and pyramidine.

9. Write the important features of Genetic code.

A. 1) The codon is triplet 61 codons code for amino acids and 3 codons do not code for any amino acids.

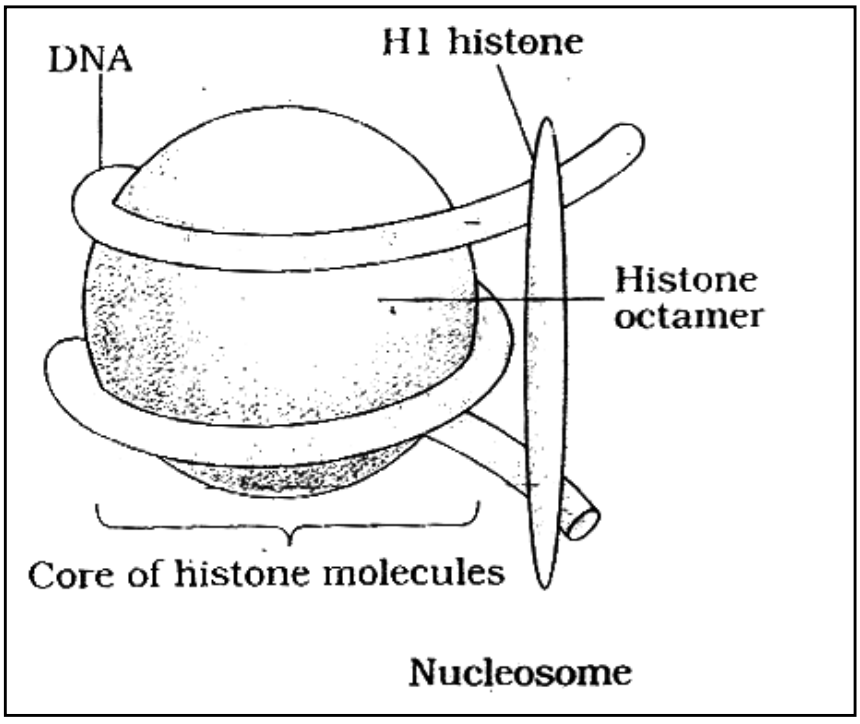
2) One codon codes for only one amino acid, hence it is **unambiguous** and **specific.**

3) Some amino acids are coded by more than one codon, hence the **code is degenerate.**
4) The codon is read in mRNA in a contiguous fashion there are **no punctuations.**
5) **The code is nearly univirsal** for example from bacteria to human UUU would code for phenyl alanine.
6) 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.**

- 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 chrmatin are seen as beads-on-string.



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 exploits cells and the cell constieuents 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 called as "molecular scissors". The cutting of DNA at specific locations became possible with molecular scissors. They are 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) are artificially restructured plasmids.

4. What is ECORI? How does it function ?

Ans:- ECORI is restriction enzyme obtained from a bacterium escherichia coli.
This enzyme specifically recognise the 5'-GAATTC-3' sites on the DNA and cut 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.** Plasmids, bacteriophages, Cosmids are the examples.

6. What is recombinant DNA ?

Ans:- Recombinant DNA formed by the integration of gene of interest within a suitable vector.

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' direection
5' GAATTC 3'
3' CTTAAG 5'

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

Ans:- PCR means **polymerase chain reaction**(PCR) it is the method used in **gene cloning** which is carried out by in computerised machine called thermocycler.

9. What is down stream processing ?

Ans:- After completion of the bio-synthatic stage, the product has to be subjected through a series of process before it is ready for marketing as a finished product. The proceses include separation and purification, which are collectively refered to as down stream processing.

10. How does one visualige DNA on an agargel ?

Ans:- The separated DNA fragments can be visualized only 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 where as 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 :-** The two enzymes responsible for restricting the growth of bacteriophage in Escherichia coli were isolated.

- One of these added methyl groups to DNA, while the other cut DNA. The latter was called restriction endonuclease.
- The first restriction endonuclease-Hind II, whose functioning depended on a specific DNA necleotide sequence was isolated and characterised later. It was found that Hind II always cut DNA molecules at a particular point by recognising a specific sequence of six base pairs. This specific base sequence is known as the recognition sequence for 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. This leaves single stranded portions at the ends.These overhanging stretches are called sticky ends or cohesive ends.
- ✻ The stickiness of the ends facilitates the action of the enzyme DNA ligase.
- ✻ 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.

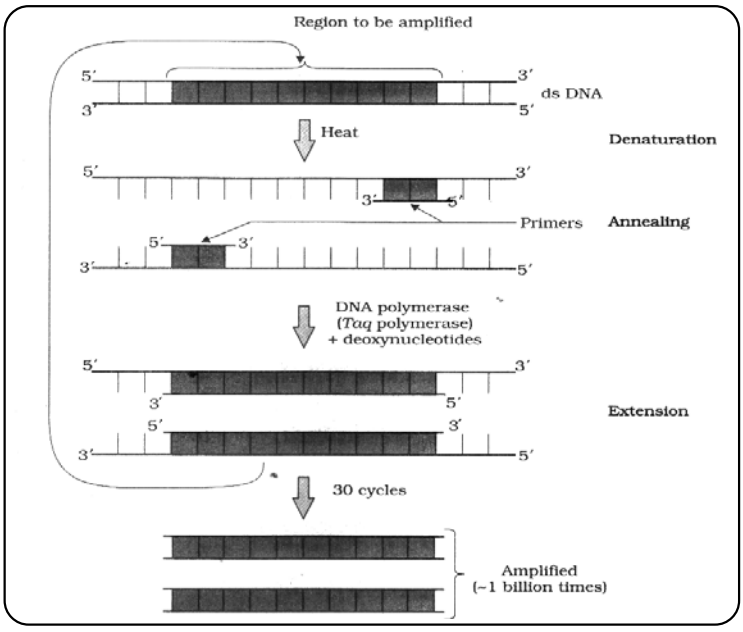
A. PCR stands for polymerase chain reaction. In this reaction, multiple copies of the GENE(DNA) of Interest are synthesised `invitro' using two sets of primers and the enzyme DNA polymerase.

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 polymerase (TAQ polymerase). Which remain active even during the high temperature included 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

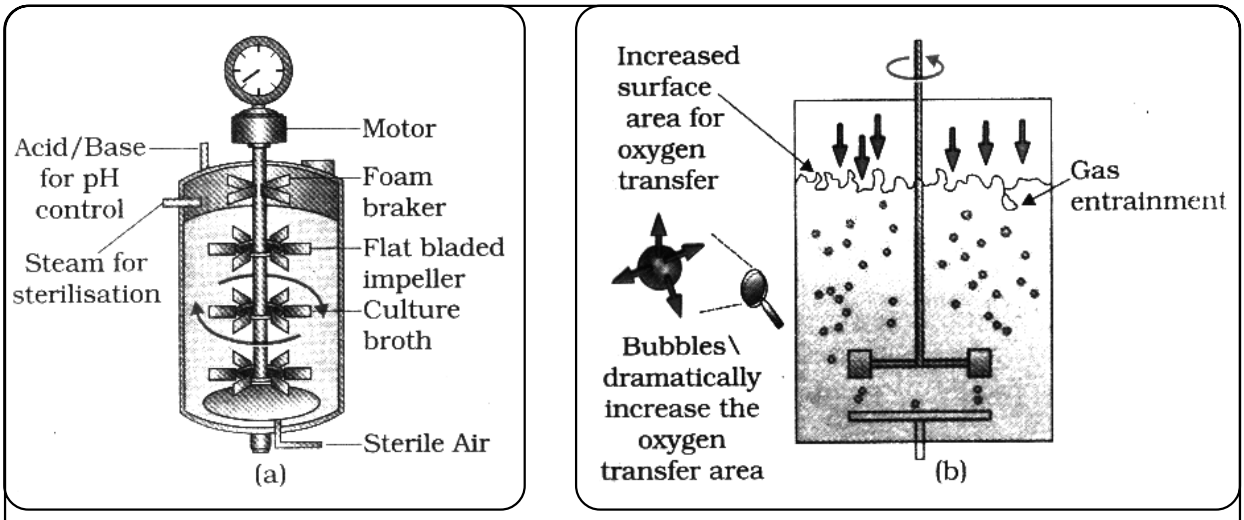
3. What is a bio-reactor? Describe briefly the stirring type of bioreactor?

A. **Bio-reactors** are large vessels which are used for biological conversion of raw material into specific products.

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 a agitator system, an oxygen delivery system, a foam control system, a temperature control system, 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 ligated DNA into recipient cells.

Recipient cells after making them competant to receive take up the DNA present in its surroundings.

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.

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

Gene Gun Method :- This method is suitable for plants. cells are bombarded with high velocity micro particles of gold or tungsten coated with DNA. This method also known as **`biolistic'** method.

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.

Isolation of Genetic Material (DNA) :-

The DNA is enclosed within the membrance, we have to break the cell open to release DNA along with other macromolecules such as RNA, proteins, polysaccharides and also lipids.

- 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. DNA that seperates out can be removed by spooling.

Cutting of DNA at specific Locations :-

- The purified DNA is cut into a number of fragments by restriction endonucleases. The process of cutting DNA with restriction enzymes is called **restriciton enzyme digestion.**
- It is performed by incubating purified DNA molecules with the restriction enzyme at the optimal conditions for that specific enzyme.

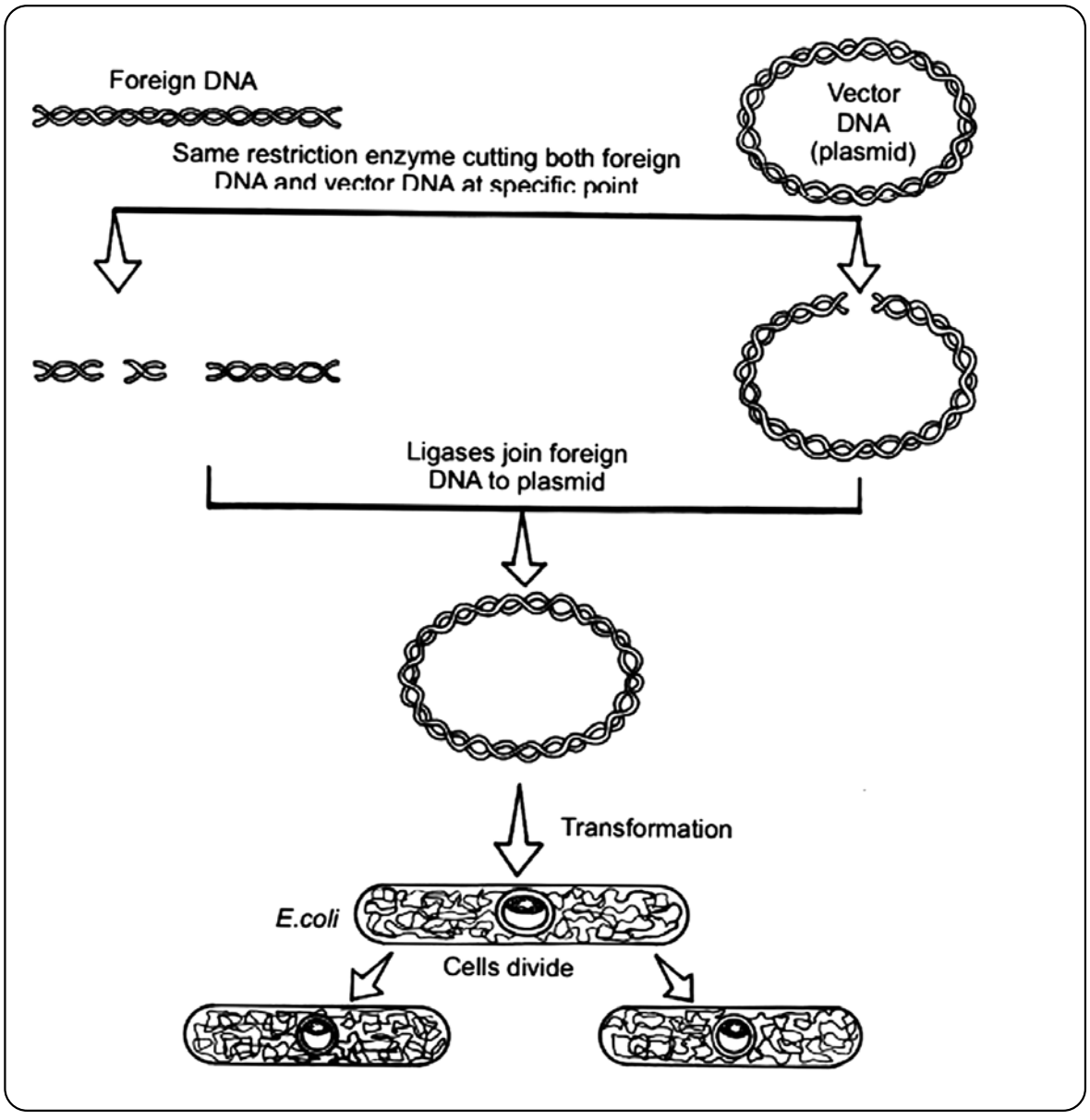
Separation and isolation of DNA fragments

- 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 DNA fragments separate (resolve) according to their size through the sieving effect providing by the agarose gel.
- The separated DNA fragments can be visualised only after staining the DNA with a compound known as ethidium bromide followed by exposure to UV radiation.

- We can see bright orange coloured bands of DNA in an ethidium bromide stained gel exposed to UV light. The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece. This step is known as **elution.**
- The DNA fragments purified in this way are used in constructing recombi nant DNA by joining them with cloning vectors.

Insertion of isolated gene 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.
- The joining of DNA involves several processes. After having cut the source DNA as well as the vector DNA with the same restriction enzyme (sticky end ligation technique), 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.**



Amplification of Gene of Interest using PCR

- PCR stands for Polymerase Chain Reaction. In this reaction, multiple copies of the gene (or DNA) of interest are synthesised in vitro 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.
- Such repeated amplification is achieved by the use of a thermostable DNA polymerase such a Taq polymerase.
- The amplified fragment, now can be used to ligate with a vector for further cloning.

Introduction of Recombinant DNA into the Host Cell/Organism

- There are several methods of introducing the ligated DNA into recipients cells. Recipient cells after making them `competent' to receive, take up the DNA present in its surroundings.
- 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.

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

Gene Gun Method :- This method is suitable for plants. cells are bombarded with high velocity micro particles of gold or tungsten coated with DNA. This method also known as **`biolistic'** method.

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

Selection of Transformed host Cells :

1. Selectable marker gene
2. Colony hybridization

1. 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 amplicillin resistance gene, one is able to select a transformed cell in the presence of amplicillin. The amplicillin resistance gene in this case is called a **selectable marker.**
- Sometimes the ligation of alien DNA is carried out at a restriction site present in one of the two antibiotic resistance genes. Some host cells will receive the recombinant vector.

- ✻ Some others will contain normal unaltered vector. Some others wil contain no vector i.e. will not be transformed.
- ✻ The-recombinant plasmids will lose tetracycline resistance due to insertion of foreign DNA but can still be selected out from non-recombinant ones by plating the transformants on ampicillin containing medium.
- ✻ The transformants growing on ampicillin containing medium are then transferred on to a medium containing tetracycline. The recombinants will grow in ampicillin containing medium but not on that containing tetracycline. But, non-recombinants will grow on the medium containing both the antibiotics.

Colony hybridization :

- ✻ In order to select the cells with the desired gene, the method of colony hybridization is also used. In this method gene specific probes are used. A probe is a small fragment of single stranded DNA or RNA which is tagged with radioactive. molecule and is complimentary to atleast one part of the desired DNA.

Obtaining the Foreign Gene Product :-

When we insert a piece of alien DNA into a coloning vector and transfer it into a bacterial, plant or animal cell, the alien DNA gets multiplied.

- ✻ 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.
- ✻ If any protein encoding gene is expressed in a heterologous (new) host it is called a **recombinant protein.**
- ✻ The cultures may be used for extracting the desired protein and then purifying it by using different separation techniques.
- ✻ Production of large quantities of proteins and enzymes requires the use of bioreactors. Large volumes (100-1000 litres) of culture can be processed in bioreactors.

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

A. **Tools of Recombinant DNA technology.**

Restriction enzymes, polymerase enzymes. ligases, vectors and the host organism are the tools of recombinant DNA technology.

Restriction Enzymes :- The two enzymes responsible for restricting the growth of bacteriophage in Escherichia coli were isolated.

- One of these added methyl groups to DNA, while the other cut DNA. The latter was called restriction endonuclease.
- The first restriction endonuclease-Hind II, whose functioning depended on a specific DNA necleotide sequence was isolated and characterised later. It was found that Hind II always cut DNA molecules at a particular point by recognising a specific sequence of six base pairs. This specific base sequence is known as the recognition sequence for Hind II.
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- 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. This leaves single stranded portions at the ends.These overhanging stretches are called sticky ends or cohesive ends.
- The stickiness of the ends facilitates the action of the enzyme DNA ligase.
- Restriction endonucleases are used in genetic engineering to forms `recombinant' molecules of DNA, which are composed of DNA from different sources/ genomes.

Cloning Vectors :-

- The DNA used as a carrier for transferring a fragment of foreign DNA into a suitable host is called **vector.**
- Vectors used for multiplying the foreign DNA sequences are called **cloning vectors.**

- Commonly used cloning vectors are plasmids, bacteriophages, cosmids and artificial chromosomes.
- Plasmids are extra chromosomal circular DNA molecules found in almost all bacterial species.
- The advantage of a plasmid is that it is very easy to isolate and reintroduce into the bacterium. artificially restructured plasmids like $P^{BR\ 322}$, $P^{UC\ 19,\ 101}$ are popularly used.
- Plasmids and bacteriophages have the ability to replicate within bacterial cells, independent of the control of chromosomal DNA.
- Bacteriophages, because of their high number per cell, have very high copy numbers of their genome within the bacterial cells.

Ligases :

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

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. Cry protein :- It is a protein toxin produced by bacillus thuringiensis that kills certain insects.

The proteins encoded by the genes cry I Ac and Cry II Ab control the cotton boll-worms, while that of 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 at a time when the symptoms of the disease or not yet visible. 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 safely 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. 1. Green Revolution :- Around 1960s, several countries including India experienced substantial and dramatic increase in agricultural production which was termed as green revolution

2. Norman Borlaug

SHORT ANSWER QUESTIONS (4 MARKS)

1. List out the beneficial aspects of transgenic plants.

A. 1. Transgenic crops having resistance to pathogen and pest.
Ex:- Bt. cotton is resistant to insect.

2. Transgenic plants suitable for food processing technology
Ex:- Transgenic tomato `Flavr savr'

3. Transgenic plants with improved nutritional value.
Ex:- Transgenic golden rice obtained from `Taipei'.

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 stress caused by chemicals, cold, drought, salt, heat.
Ex:- Basmati variety of rice
Transgenic plants have been shown to express the genes of insulin interferan human growth hormon antibiotics antibodies etc.,

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

A. 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 due to transfer of the new genes into related wild species through natural out-crossing. This may result in the development of 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 during a particular phase of growth. These crystals contain a toxic insecticidal protein.
2. The Bt toxin proteins exists as inactive protoxins but once as 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 and eventually cause the death of the insect.
4. Specific Bt toxin genes were isolated from Bacillus thuringiensis and incorporated into several crop plants such as cotton.
5. The choice of genes depends upon the crop and the targeted pest, as most Bt toxins are insect group specific.
6. The toxin is coded by a gene named `cry'. There are a number of them, for example, the proteins encoded by the genes cryIAc and CryIIAb control the cotton bollworms, while that of cryIAb controls corn borer.

4. Give a brief account of Pest resistant plants.

1. A nematode Meloidegyne incognitia infects the roots of tobacco plants and causes a great reduction in yield.
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. The **fermentors** are big vessels needed to grow microbes in industries for production of beverages and antibiotics etc.

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

A. **Monascuspurpureus.** The statins lower blood cholesterol level by competitively inhibiting enzyme which is responsible for synthesis of cholesterol.

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

A. Since in it floes grow and the microbes consume main part of organic matter in effluent to reduce BOD of effluent.

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

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

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

A. Aspergillus niger produces Citric acid, Clostridium butylicum produces Butyric acid while Lactobacillus produces Lactic acid; all the 3 are acid producers bacteria.

7. Name any two genetically modified crops.

A. Bt cotton, Bt brinjal.

8. Name any two industrially important enzymes.

A. (i) Lypase, and (ii) Amylase.

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

A. Cyclosporin, trichoderma polysporum.

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. Fungi are also known to form symbiotic associations with plants (mycorrhiza). Many members of the genus G/omus form mycorrhiza. The fungal symbiont in these associations facilitates absorption of phosphorus by the plant from the soil. Plants having such associations show other benefits also, 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. **Biofertilisers** are organisms that enrich the nutrient quality of the soil. The main sources of biofertilisers are bacteria, fungi and cyanobacteria. You have studied about the nodules on the roots of leguminous plants formed by the symbiotic association with *Rhizobium.* These bacteria fix atmospheric nitrogen into organic forms, which is used by the plant as a nutrient. Other bacteria can fix atmospheric nitrogen while free-living in the soil (examples *Azospirillwn* and *Azotobacter),* thus enriching the nitrogen content of the soil.

Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environments. Many of them can fix atmospheric nitrogen, e.g. *Anabaena, Nostoc, Oscillatoria*, etc. In paddy fields cyanobacteria serve as an important biofertiliser. Blue green algae also add organic matter to the soil and Increase its fertility.

Fungi are also known to form symbiotic associations with plants (mycorrhiza). Many members of the genus G/omus form mycorrhiza. The fungal symbiont in these associations facilitates absorption of phosphorus by the plant from the soil. Plants having such associations show other benefits also, 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. ✤ Treatment of waste water is done by heterotrophic microbes naturally present in the sewage.

✤ Before disposal, hence, sewage is treated in sewage treatment plants to make it less polluting.

Treatment of sewage involves two steps. 1) Primary treatment 2) Secondary treatment

Primary treatment: It is a physical process of removal of small and large particles through filtration and sedimentation.

✤ The sewage is allowed to go into the primary setting tank, where the suspended material settle down to form primary sludge.

✤ The effluent is taken for secondary treatment. The anaerobic sludge digestion is important in secondary sewage treatment.

Secondary sewage treatment:

✤ It is a biological process that employs the heterotrophic bacteria naturally present in the sewage.

The effluent from the primary treatment is passed into large aeration tanks, where it is constantly agitated and air is pumped in it.

✤ This allows the rapid growth of aerobic bacteria into floes, which consume the organic matter of sewage and reduce the BOD,

✤ The effluent is passed into a settling tank, where the floes are allowed to sediment forming the activated sludge.

- A small part of the activated sludge is pumped back into aeration tank as inoculum.
- The remaining major part of the sludge is pumped into sludge digesters, where the anaerobic bacteria digest the organic matter and produce a mixture of gases such as methane, hydrogen sulphide and CO2. These gases form biogas which can be used as a source of energy as it is inflammable.