PREVIOUS QUESTIONS XI 2012-2024 : *Chapter 7 - Photosynthesis in Higher Plants*

1Mark Questions

1. C_4 cycle is so called because of the presence of a C_4 acid.
   a) Name the C_4 acid.
   b) Name the leaf anatomy present in C_4 plants. *2014 Imp.*

2. The reaction centre of photosystems in green plants during light reaction is.....
   a) Xanthophyll b) Carotenoids
   c) Chlorophyll *b* d) Chlorophyll *a* *2016 March*

3. An enzyme present in plants, which shows carboxylation and oxygenation activity. Identify the enzyme. *2017 Imp.*

4. Choose the correct answer.
   Law of limiting factors is proposed by,
   a) CorneliusVanNiel b) Blackman
   c) Joseph Priestley d) Engelmann *2018 Model*

5. Choose the correct answer from the bracket.
   First stable product of carbondioxide fixation in C_4 palnt is...
   (PGA, OAA, PEP, RUBP) *2018 March*

6. Observe the relationship between first two terms and fill in the blank.
   C_4 plants : PEPcase
   C_3 plants : ..... *2018 Imp.*

7. Choose the correct answer.
   The primary acceptor of carbon dioxide(CO_2) in C_3 plants :
   (a) PEP (b) RuBP
   (c) PGA (d) OAA *2019 Model*

8. Name the special type of anatomy present in C_4 plants. *2022 Model*

9. Observe the first pair and fill the blank.
   Light reaction: Grana
   Dark reaction: _____ *2022 June*

10. Name the site of Dark Reaction in Chloroplast. *2022 Imp*

11. Name the enzyme present in plants which shows carboxylation and oxygenation activity. *2023 Model*

12. Fill in the blank:
    The site of dark reaction in photosynthesis is _____ part of chloroplast. *2023 March*

13. Write the name of the first stable compound formed during C 4 pathway. *2023 Imp*

14. Choose the correct answer from the following :
    Which of the following is the major pigment of Photosynthesis ?
    (a) Chlorophyll-a (b) Chlorophyll-b
    (c) Xanthophyll (d) Carotenoids *2023 Imp*

15. Which of the following is not related with light-reaction?
    a) Light absorption b) Water splitting
    c) Biosynthesis of glucose *2024 Model*

2 Marks Questions

1. An anatomist observed a peculiar type of large spherical bundle sheath cells in sugarcane leaf and a physiologist identified the presence of PEP carboxylase in that leaf mesophyll.
   a) Name the peculiar leaf anatomy
   b) Explain the physiological advantages of such type of plants. *2012 March*

2. 'Photorespiration is a curse to plants'
   a) Evaluate this statement.
   b) Find the reason for this event to takeplace. *2012 March*

3. 'There is a clear division of labour within the chloroplast.'
   Substantiate the given statement with an explanation stating two points. *2015 March*

4. Photosynthesis can be considered as the most significant physicochemical process on earth. Evaluate this statement citing any two significances. *2015 March*

5. C_4 plants have special features. List out any four specialities of C_4 plants compared to C_3 plants. *2015 March*

6. Write any four peculiarities of 'Z scheme' electron transport in light reaction. *2015 Imp.*

7. Name the following in C_4 pathway in C_4 plants:
   Leaf anatomy,
   Primary CO_2 acceptor,
   Enzyme responsible for primary CO_2 - fixation,
   First C_4 acid formed in mesophyll cells. *2015 Imp.*

8. Light reaction involve cyclic and non-cyclic electron transport. Classify the features given below under the above stages of light reaction.
   a) Only pigment system I is involved
   b) ATP and NADPH are formed
   c) Splitting of water occurs
   d) Only ATP is formed

Cyclic electron transport	Non-cyclic electron transport

2016 Imp.

9. Chemiosmosis theory of photosynthesis requires a proton gradient for ATP synthesis to occur. Explain any two events that causes proton gradient. *2016 Imp.*

10. An important difference between C_3 and C_4 plants is photorespiration. Explain how photorespiration occurs in C_3 plants. *2017 March*

11. Define Blackman's law of limiting factors and identify any two important factors which influence the rate of photosynthesis in plants. *2017 March*

12. Certain thylakoid pigments are called accessory pigments. Name them. Write their significance. *2019 March*

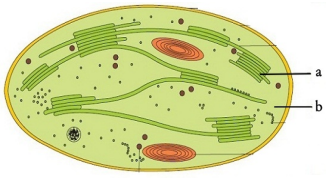
13. Match the items of column A with B.

A		B	
a)	Reduction	i)	Formation of oxygen
b)	Photolysis	ii)	Formation of 3-PGA
c)	Photorespiration	iii)	Formation of PEP
d)	Carboxylation	iv)	Formation of glucose
		v)	Formation of phosphoglycolate

2019 March

14. Observe the figure given below.

Identify the parts a, b. Write their functions.



2019 March

15. C_4 plants have a special leaf anatomy. Name that anatomy. Write three peculiarities of this kind of anatomy. *2019 March*

16. Plants that are adapted to dry tropical regions have the C_4 pathway. Write any two advantages of C_4 plants over C_3 plants. *2019 Imp.*

17. RuBisCO is the most abundant enzyme in the plant world. How does RuBisCO involve in photorespiration ? *2019 Imp.*

18. Plants that are adapted to dry tropical regions have the C_4 pathway. Write any two advantages of C_4 plants. *2020 Model*

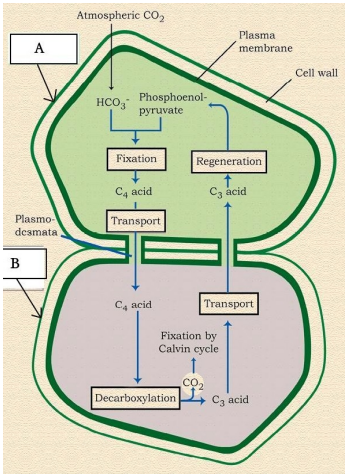
19. Define "The law of limiting factors". Write any two external factors which directly affect the rate of photosynthesis. *2020 Model*

20. Analyse the table given below and fill in the blanks a, b, c, d.

Process	Cyclic photophosphorylation	Non-cyclic photophosphorylation
Movement of electrons	Cyclic	_____(a)_____
Number of photosystems	_____(b)_____	_____(c)_____
Splitting of water	_____(d)_____	Present

2020 March

21. Observe the given figure showing C_4 pathway.



(a) Identify the cells A and B.
(b) Name the C_4 acid formed through this pathway.
(c) Name the enzyme involved in the formation of C_4 acid. *2020 March*

22. Notice the three stages of Calvin cycle given below.

Reduction, Regeneration, Carboxylation

(a) Arrange the above stages in correct order.
(b) Calvin cycle is also known as C_3 cycle (pathway). Give reason. *2020 March*

23.Analyse the table and fill in the blanks.

Charateristics	C_3 Plants	C_4 Plants
Primary CO2 acceptor	_____(a)_____	PEP
Primary CO2 fixation product	_____(b)_____	OAA
Leaf anatomy	Normal anatomy	_____(c)_____
Example	Hibiscus	_____(d)_____

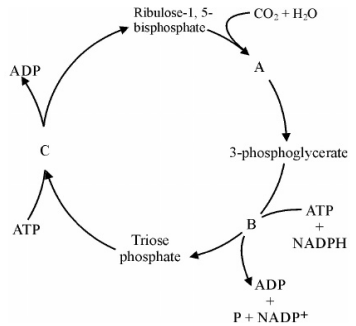
2020 Imp.

24.Light reaction and dark reaction are the two stages of photosynthesis. Write the differences between light reaction and dark reaction. *2020 Imp.*

25. Write any two differences between Cyclic and Non-cyclic photophosphorylation. *2021 Model*

26. (a) Write the name of two phases of Photosynthesis.
(b) Which are the sites of these phases in chloroplast ? *2021 Model*

27. Observe the figure of Calvin cycle given below:
(a) Write the name of three major events marked as A, B and C.
(b) Find out the name of first CO_2 acceptor given in the figure.



2021 Model

28. (a) What is 'Kranz' anatomy ?
(b) Write two examples of plants that exhibit 'Kranz' anatomy. *2021 Model*

29. Light reaction is a process involved in photosynthesis.
(a) What is light reaction ?
(b) Where does it take place ? *2021 Sept.*

30. In some plants that are adapted to dry tropical region have the C_4 pathway.
(a) Name the special type of anatomy seen in C_4 plants.
(b) List out any two plants that shows C_4 pathway. *2021 Sept.*

31. Write any two events take place in z-scheme of light reaction. *2021 Sept.*

32. The Calvin cycle represents the main events in Dark reaction.
(a) Name the three main stages of Calvin cycle.
(b) What is the main product of Calvin cycle ? *2021 Sept.*

33. Calvin cycle or C_3 cycle in photosynthesis have 3 stages.
(a)Identify the three stages of Calvin cycle.
(b)Which is the primary CO_2 acceptor in Calvin cycle ? *2021 Imp.*

34. List out any two characteristic features of C_4 plants. *2021 Imp.*

35. Given below are some features of cyclic and non-cyclic photophosphorylation. List out the features of non-cyclic photophosphorylation from the hints provided.
(a) NADPH and ATP formed.
(b) Only one photo system involved.
(c) Splitting of water occurs.
(d) Both photosystems involved.
(e) Only ATP is formed.
(f) Oxygen is evolved. *2021 Imp.*

36. Accessory pigments are involved in the process of photosynthesis.
(a)Name any two accessory pigments.
(b)Write any one function of accessory pigment. *2021 Imp.*

37. List out any four external factors affecting photosynthesis. *2022 Model*

38. Plants adapted to dry tropical regions exhibit C_4 pathway.
(a) Name the first CO_2 acceptor in C_4 Pathway.
(b) Which is the first stable product formed in C_4 Pathway ? *2022 June*

39.Features of Cyclic and Non-Cyclic photo-phosphorylation is given below. Arrange them under two headings
(i) Splitting of water takes place.
(ii) Splitting of water absent.
(iii) Both ATP and NADPH are synthesized.
(iv) ATP alone is synthesized. *2022 Imp*

40. a) Which is the special leaf anatomy seen in C_4 plants?
    b) Productivity and yield are better in C_4 plants than C_3 plants. Why?
    2023 Model

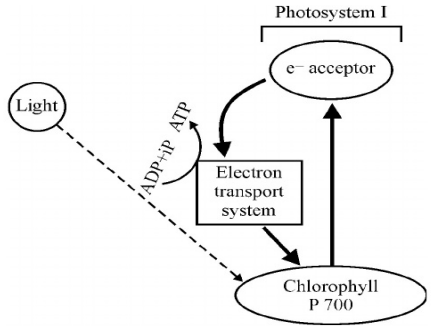
41. Some characteristic features of C_3 and C_4 plants are given below:
    - Kranz anatomy absent
    - Lack photorespiration
    - First product of CO_2 fixation is PGA
    - Primary CO_2 acceptor is PEP

    Arrange them as follows:

C_3 Plants	C_4 Plants
•	•
•	•

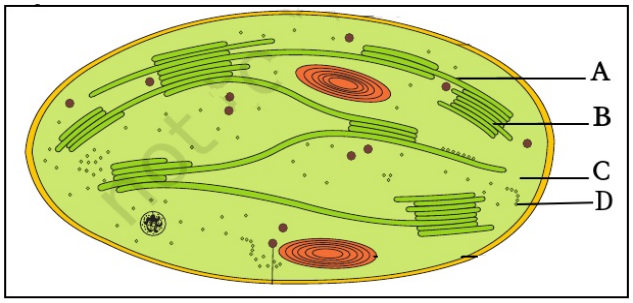
2023 March

42. (a) Identify and write the process given in the picture.
    (b) Where does it take place in chloroplast ?



2023 Imp

43. Label the parts A, B, C, D in the given diagram.



2023 2nd term

44. Define law of limiting factors.Write two external factors that directly affect the rate of photosynthesis.
    2023 2nd term

45. a) Define Blackman's law of limiting factors.
    b) Write the external factors which affect rate of photosynthesis.
    2024 Model

46. a) What is photorespiration?
    b) Photorespiration does not occur in C_4 plants. Why?
    2024 Model

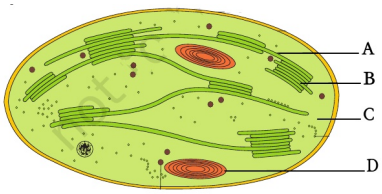
3 Marks Questions

1. Light reaction of photosynthesis is divided into two processes.In one process the electrons emitted will return to the place from where it is emitted.
    a) What are the names of these two processes?
    b) What happens to the electrons in the second phase?
    c)Explain it with schematic representation.
    2013 Imp.

2. RuBisCo is an enzyme that catalyse two entirely different processes.

a) Which are the processes?

b) In which process, chloroplast alone is used as cell organelle?



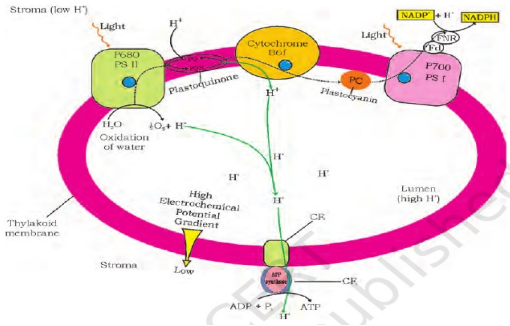
c) Label the parts A, B, C, D in the given diagram.

2013 Imp.

3. The light reaction of photosynthesis is divided into two reactions. They are cyclic and non-cyclic photophosphorylation. Mention any three difference between cyclic and non-cyclic reactions. *2014 Imp.*

4. a) Name the special type of leaf anatomy shown by C_4 plants.
   b) Illustrate the major advantages of C_4 plants over C_3 plants. *2016 March*

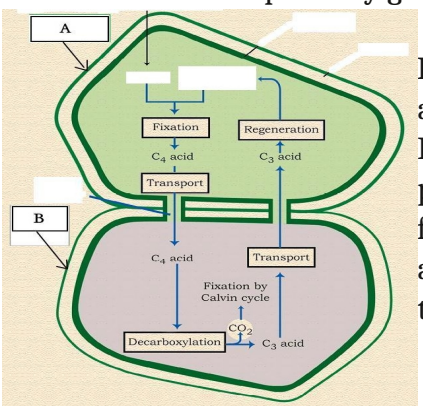
5. Observe the given figure and describe the process of ATP synthesis



2017 Imp.

6. Photophosphorylation takes place during photosynthesis.
   a)Name the types of photophosphorylation.
   b) Distinguish between them.
   (**Hint**: Any two differences) *2017 Imp.*

7. Observe the diagrammatic representation of Hatch and Slack pathway given below.



Identify the cells A and B.
Explain the process of formation of C_4 acid specifying the enzyme involved.

2018 Model

8. Photosynthesis is a process influenced by environmental factors as well as plant factors. Mention three factors under each category. *2018 March*

9. Arrange the following events in the appropriate boxes.
   a) Formation of *ATP* and $NADPH_2$.
   b) Only photosystem I is functional.
   c) Formation of *ATP* only.
   d) Both photosystem I and photosystem II are involved.
   e) Splitting of water.
   f) No oxygen release.

Cyclic photophosphorylation	Non-cyclic photophosphorylation

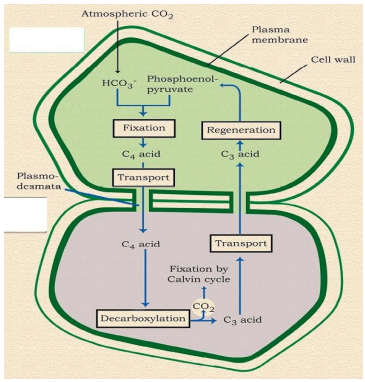
2018 Imp.

10. Salient features of light reaction and dark reaction of photosynthesis are given below. Arrange them in corresponding columns.
   Take place in Stroma.
   Photochemical phase.
   ATP and NADPH are utilised.
   Biosynthetic phase.
   ATP and NADPH are produced.
   Take place in Grana.

Light reaction	Dark reaction

2019 Model

11. Diagrammatic representation of Hatch and Slack pathway is shown below.
   Analyse the figure.



(a) Name the cells involved in this pathway.
(b) Identify the special type of anatomy present in the leaves of C_4 pants.
(c) Name two plants which show Hatch and Slack pathway.

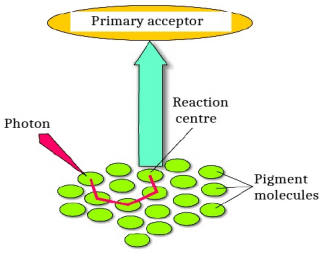
2019 Model

12. Transport of electrons through ETS of the chloroplast results photophosphorylation. Write any three differences between cyclic and non-cyclic photophosphorylations. *2019 Imp.*

13. C_4 plants have large cells around the vascular bundles of leaves called bundle sheath cells.
   (a) What is this anatomy called?
   (b) Write any two features of bundle-sheath cells. *2020 Model*

14. Melvin Calvin discovered CO_2 fixation in green plants.
    (a) Which are the three main stages of Calvin cycle?
    (b) Name the enzyme catalysing first stage of this cycle.
    (c) What is the peculiarity of this enzyme?
    2020 Imp.

15. Observe the given diagram of LHC.
a) Name the pigment that forms the reaction centre.
b) Name any one accessory pigment involved in photosynthesis.
c) Mention the function of accessory pigment.



2022 Model

16. Write any three differences between cyclic and non-cyclic photophosphorylation. *2022 June*

17. The leaf anatomy of C_4 plants is different from other plants.
    (a) Name this anatomy
    (b) Write any two advantages of C_4 plants
    2022 Imp

18. Photophosphorylation takes place during photosynthesis.
a) Name the two types of photophosphorylations.
b) Mention the differences between them.
2023 Model

19. Write any 3 external and internal features that affect photosynthesis. *2023 March*

20. (a) What is the name of special kind of leaf anatomy seen in C_4 plants ?
    (b) Which are the two types of cells seen in this anatomy ?
    (c) Why do C_4 plants have better productivity and yield than C_3 plants ? *2023 Imp*

21. Write any three differences between cyclic and non-cyclic photophosphorylation. *2023 2nd term*

22. Some features of light reaction and dark reaction of photosynthesis are given below. Arrange them in corresponding columns.
    * Biosynthetic phase
    * Photochemical phase
    * ATP and NADPH are utilised
    * Take place in stroma
    * ATP and NADPH are produced
    * Take place in grana

Light reaction	Dark reaction

2024 Model

4 Marks Questions

1. Light reaction and dark reaction are the two stages of photosynthesis.
   a) Where does light reaction occurs?
   b) What are its end products?
   c) Comment on their roles in dark reaction.
   2012 Imp.

2. C_4 plants are adapted to overcome a wasteful process found in C_3 plants and hence productivity and yields are better in these plants.
   a) Name the wasteful process found in C_3 plants.
   b) Identify the cells involved in C_4 pathway.
   c) Write any two differences between C_3 plants and C_4 plants. *2013 March*

3. Light reaction is otherwise called photophosphorylation.
   a) Justify the statement.
   b) Locate the site of this reaction.
   c) Write any two differences between cyclic photophosphorylation and non-cyclic photophosphorylation. *2013 March*

4. Plants that are adapted to dry tropical regions have a special type of CO_2 fixation in addition to C_3 cycle.
   a) Name this pathway.
   b) Can you identify any speciality in the leaf anatomy of such plants? If so, what is this anatomy called?
   c) Which is the primary CO_2 acceptor in this pathway?
   d) Write any one advantage of such plants over C_3 plants. *2014 March*

5. The use of radioactive C^{14} by Melvin Calvin in algal photosynthesis studies led to the discovery of CO_2 fixation in green plants.
   a) Identify the first stable product in this CO_2 fixation cycle.
   b) Which are the three main stages of this cycle?
   c) Workout how many ATP and NADPH molecules will be required to make one molecule of glucose. *2014 March*

Answer key

1Mark Questions

1. a) Oxaloacetic acid/OAA
   b) Kranz anatomy
2. d) Chlorophyll *a*
3. RuBisCO/RuBP carboxylase-oxygenase.
4. b) Blackman
5. OAA
6. RuBisCO/RuBP carboxylase-oxygenase.
7. (b) RuBP
8. Kranz anatomy
9. Stroma
10. Stroma
11. RuBisCO/RuBP carboxylase-oxygenase.
12. Stroma
13. Oxaloacetic acid/OAA
14. (a) Chlorophyll-a
15. c) Biosynthesis of glucose

2 Marks Questions

1. a) Kranz anatomy
   b) Photorespiration doesnot takeplace, Can tolerate high temperature and high light intensity, Increased productivity
2. a) During photorespiration CO_2 is released and no ATP or NADPH is synthesised. ATP is utilized
   b) In C_3 plants, under certain conditions O_2 bind to RuBisCO and thus CO_2 fixation is blocked.
3. Grana of chloroplast - Light reaction
   Stroma of chloroplast - Dark reaction
4. Photosynthesis is the process through which solar energy is trapped and converted into chemical energy. This energy is the basis for running life on earth.
5. Photorespiration absent, Can tolerate high light intensity and high temperature, Kranz anatomy present, High productivity
6. Movement of electron is not cyclic/PS I and PS II are involved/ATP and NADPH are produced/ Photolysis or splitting of water occur/Release of oxygen ***(any 4)***
7. Leaf anatomy - Kranz anatomy
   Primary CO_2 acceptor - PEP(Phpsphoenol pyruvic acid)
   Enzyme responsible for primary CO_2 fixation - PEPcase(PEP carboxylase)
   First C_4 acid formed in mesophyll cells - OAA(Oxaloacetic acid)
8.

Cyclic electron transport	Non-cyclic electron transport
a) Only pigment system I is involved d) Only ATP is formed	b) ATP and NADPH are formed c) Splitting of water occurs

9. Protons released by splitting of water accumulate within the lumen of the thylakoids/ As electrons move through the photosystems, protons are transported across the membrane/ To reduce NADP + to NADPH+ H+, protons are taken from the stroma. ***(any 2)***
10. In C_3 plants some O_2 bind to RuBisCO, and form one molecule each of phosphoglycerate and phosphoglycolate. In the photorespiration there is neither synthesis of sugars, nor of ATP. Rather it results in the release of CO_2 with the utilisation of ATP.
11. If a chemical process is affected by more than one factor, then its rate will be determined by the factor which is available to its minimal value.
    Light/temperature/CO_2 concentration/water/ number, size, age and orientation of leaves/ mesophyll cells and chloroplasts/ internal CO_2 concentration /the amount of chlorophyll.
    (any 2)
12. Chlorophyll *b*, xanthophylls and carotenoids Absorb light and transfer the energy to chlorophyll *a* and protect chlorophyll a from photo-oxidation.
13.

A		B	
a)	Reduction	iv)	Formation of glucose
b)	Photolysis	i)	Formation of oxygen
c)	Photorespiration	v)	Formation of phosphoglycolate
d)	Carboxylation	ii)	Formation of 3-PGA

14. a. Grana - trapping the light energy and synthesis of ATP and NADPH(Light-reaction/ Photochemical reaction)
    b. Stroma - enzymatic reactions synthesise sugar (Dark reaction/Biosynthetic phase)
15. Kranz anatomy
    The bundle sheath cells form several layers around the vascular bundles/ the cells have a large number of chloroplasts/ thick walls impervious to gases/no intercellular spaces
    (any 3)
16. Photorespiration absent/Can tolerate high light intensity and high temperature/ Kranz anatomy present/High productivity ***(any 2)***
17. In C_3 plants some O_2 bind to RuBisCO, and form one molecule each of phosphoglycerate and phosphoglycolate. It results in the release of CO_2 with the utilisation of ATP.
18. Photorespiration absent/Can tolerate high light intensity and high temperature/ Kranz anatomy present/High productivity ***(any 2)***
19. If a chemical process is affected by more than one factor, then its rate will be determined by the factor which is available to its minimal value.
    Light/temperature/CO_2 concentration/water/ number, size, age and orientation of leaves/ mesophyll cells and chloroplasts/ internal CO_2 concentration /the amount of chlorophyll.
    (any 2)
20. (a) Non-cyclic (b) One (c) Two (d) Absent
21. (a) A. Mesophyll cells B. Bundle sheath cells
    (b) Oxaloacetic acid/OAA
    (c) PEPcase(PEP carboxylase)
22. (a) Carboxylation, Reduction, Regeneration
    (b) The first product of CO_2 fixation is a C_3 acid
23. (a) RuBP (b) 3-phosphoglyceric acid(3-PGA)
    (c) Kranz anatomy (d) Maize/Sorghum

24.

Light reaction	Dark reaction
Solar energy is trapped and ATP & NADPH are formed	ATP & NADPH are utilised
Sunlight is directly involved	Sunlight not directly involved
Takesplace in thylakoid membrane of chloroplast	Takesplace in stroma of chloroplast
Pigments are involved	Pigments are not involved

25.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella	Takesplace in grana lamella
(any 2)	***(any 2)***

26. (a) Light reaction/Photochemical phase
Dark reaction/Biosynthetic phase
(b) Light reaction - Grana
Dark reaction - Stroma

27. (a) A. Carboxylation B. Reduction
C. Regeneration
(b) Ribulose-1,5-bisphosphate/RuBP

28. (a) The bundle sheath cells form several layers around the vascular bundles, the cells have a large number of chloroplasts, thick walls impervious to gases and without intercellular spaces.
(b) Maize, Sorghum

29. (a) In light reaction solar energy is trapped with the help of pigments and ATP & NADPH are synthesised
(b) Grana of chloroplast

30. (a) Kranz anatomy
(b) Maize, Sorghum

31. ATP & NADPH synthesised/Splitting of water(photolysis)/release of oxygen ***(any 2)***

32. (a) Carboxylation, Reduction, Regeneration
(b) Glucose

33. (a) Carboxylation, Reduction, Regeneration
(b) Ribulose-1,5-bisphosphate/RuBP

34. Photorespiration absent, Can tolerate high light intensity and high temperature, Kranz anatomy present, High productivity***(any 2)***

35. (a) NADPH and ATP formed. (c) Splitting of water occurs. (d) Both photosystems involved. (f) Oxygen is evolved.

36. (a) Chlorophyll b, xanthophylls, carotenoids ***(any 2)***
(b) Absorb light and transfer the energy to chlorophyll *a*, help to utilize a wider range of wavelength of incoming light, protect chlorophyll a from photo-oxidation. ***(any 2)***

37. Light, temperature, CO_2 concentration, water

38. (a) PEP(Phpsphoenol pyruvic acid)
(b) Oxaloacetic acid/OAA

39.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
(ii) Splitting of water absent.	(i) Splitting of water takes place.
(iv) ATP alone is synthesized.	(iii) Both ATP and NADPH are synthesized.

40. (a) Kranz anatomy
(b) Photorespiration absent, Can tolerate high light intensity and high temperature

41.

C_3 Plants	C_4 Plants
Kranz anatomy absent	Lack photorespiration
First product of CO_2 fixation is PGA	Primary CO_2 acceptor is PEP

42. (a) Cyclic photophosphorylation
(b) Thylakoid (Stroma lamella)

43. A. Stroma lamella B. Granum(Grana lamella)
C. Stroma D. Ribosomes

44. If a chemical process is affected by more than one factor, then its rate will be determined by the factor which is available to its minimal value.
Light/temperature/CO_2 concentration/water/ ***(any 2)***

45. a) If a chemical process is affected by more than one factor, then its rate will be determined by the factor which is available to its minimal value.
b) Light, temperature, CO_2 concentration, water

46. a) In C_3 plants some O_2 bind to RuBisCO, and form one molecule each of phosphoglycerate and phosphoglycolate. This process is called photorespiration
b) C_4 plants have a special leaf anatomy called Kranz anatomy which prevents O_2 binding with RuBisCO and increase intracellular CO_2 concentration .

3 Marks Questions

1. a) Cyclic photophosphorylation and Non-cyclic photophosphorylation
   b) Electrons moves to PS I
   c) *Diagram - refer text*
2. a) Carboxylation(C_3 cycle) and Oxygenation (Photorespiration)
   b) Carboxylation(C_3 cycle)
   c) A. Stroma lamella B. Granum
   C. Stroma D. Starch granule
3.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella	Takesplace in grana lamella
(any 3)	***(any 3)***

4. a) Kranz anatomy
   b) Photorespiration absent, Can tolerate high light intensity and high temperature, Kranz anatomy present, High productivity
5. Chemiosmotic Hypothesis explains accumulation of protons in the lumen of thylakoid forming a proton gradient. Protons released by splitting of water accumulate within the lumen of the thylakoids. As electrons move through the photosystems, protons are transported across the membrane. To reduce NADP + to NADPH+ H+, protons are taken from the stroma. When the protons move from the lumen to the stroma through ATP synthase enzyme ATP is synthesised.
6. a) Cyclic photophosphorylation and Non-cyclic photophosphorylation
   b)

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella	Takesplace in grana lamella
(any 2)	***(any 2)***

7. A. Mesophyll cells B. Bundle sheath cells
   Phosphoenol pyruvate (PEP), a 3-carbon molecule present in the mesophyll cells combines with CO_2 to form Oxaloacetic acid/ OAA, a C_4 acid. The enzyme responsible for this fixation is PEP carboxylase or PEPcase.
8. External factors : Light, temperature, CO_2 concentration, water ***(any 3)***
   Plant factors : number, size, age and orientation of leaves, mesophyll cells and chloroplasts, internal CO_2 concentration, the amount of chlorophyll.***(any 3)***
9.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
b) Only photosystem I is functional.	a) Formation of *ATP* and *NADPH*$_2$.
c) Formation of *ATP* only.	d)Both photosystem I and photosystem II are involved.
f) No oxygen release.	e) Splitting of water.

10.

Light reaction	Dark reaction
Photochemical phase.	Take place in Stroma.
ATP and NADPH are produced.	ATP and NADPH are utilised.
Take place in Grana.	Biosynthetic phase.

11. (a) Mesophyll cells and Bundle sheath cells
    (b) Kranz anatomy
    (c) Maize, Sorghum
12.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella	Takesplace in grana lamella
(any 3)	***(any 3)***

13. (a) Kranz anatomy
    (b) The bundle sheath cells form several layers around the vascular bundles, the cells have a large number of chloroplasts, thick walls impervious to gases and without intercellular spaces. ***(any 2)***

14. (a) Carboxylation, Reduction, Regeneration
(b) RuBP carboxylase-oxygenase or RuBisCO.
(c) It catalyses carboxylation and oxygenation

15. a) Chlorophyll *a*
b) Chlorophyll *b*, xanthophylls and carotenoids ***(any 1)***
c) Absorb light and transfer the energy to chlorophyll *a* and protect chlorophyll a from photo-oxidation.

16.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella ***(any 3)***	Takesplace in grana lamella ***(any 3)***

17. (a) Kranz anatomy
(b) Photorespiration absent, Can tolerate high light intensity and high temperature, Kranz anatomy present, High productivity***(any 2)***

18. a) Cyclic photophosphorylation and Non-cyclic photophosphorylation
b)

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella	Takesplace in grana lamella

19. External factors : Light, temperature, CO_2 concentration, water ***(any 3)***
Plant factors : number, size, age and orientation of leaves, mesophyll cells and chloroplasts, internal CO_2 concentration, the amount of chlorophyll.***(any 3)***

20. (a) Kranz anatomy
(b) Mesophyll cells and Bundle sheath cells
(c) Photorespiration absent, Can tolerate high light intensity and high temperature, Kranz anatomy present

21.

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella ***(any 3)***	Takesplace in grana lamella ***(any 3)***

22.

Light reaction	Dark reaction
Photochemical phase	Biosynthetic phase
ATP and NADPH are produced	ATP and NADPH are utilised
Take place in grana	Take place in stroma

4 Marks Questions

1. a) Grana of chloroplast
b) ATP & NADPH
c) ATP & NADPH are used along with CO_2 and water to synthesise sugar in biosynthetic phase

2. a) Photorespiration
b) Mesophyll cells and Bundle sheath cells
c)

C_3 plants	C_4 plants
Photorespiration present.	Photorespiration absent.
Cannot tolerate high light intensity and high temperature.	Tolerate high light intensity and high temperature.
Kranz anatomy absent.	Kranz anatomy present.
CO_2 acceptor is RuBP RuBisCO is the enzyme.	CO_2 acceptor is PEP PEPcase is the enzyme.
CO_2 fixation product PGA.	CO_2 fixation product OAA.
Low productivity. ***(any 2)***	High productivity. ***(any 2)***

3. a) ATP synthesis is done with the help of light energy
   b) Grana of chloroplast
   c)

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Electrons move cyclically	Movement of electrons is non-cyclic
Only PS I involved	Both PS I and PS II involved
ATP synthesised	ATP & NADPH synthesised
No splitting of water and release of oxygen	Splitting of water and release of oxygen
Takesplace in stroma lamella ***(any 2)***	Takesplace in grana lamella ***(any 2)***

4. a) C_4 cycle/Hatch and Slack pathway
   b) Yes. Kranz anatomy
   c) PEP/Phosphoenol Pyruvic acid
   d) Photorespiration absent, Can tolerate high light intensity and high temperature, Kranz anatomy present, High productivity***(any 1)***
5. a) 3-PGA
   b) Carboxylation, Reduction. Regeneration
   c) 18 ATP and 12 NADPH