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P530/1 BIOLOGY
MARKING GUIDE

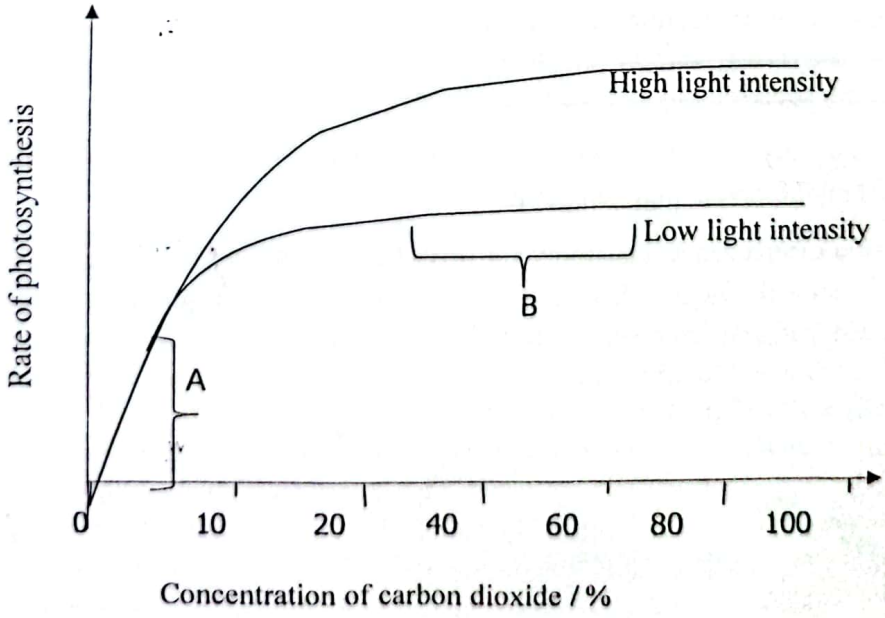
SECTION A (40 MARKS) 1 Mark each question.

GRID FOR SECTION A

1	A	11	A	21	B	31	B
2	A	12	B	22	C	32	B
3	B	13	C	23	D	33	C
4	C	14	B	24	C	34	D
5	A	15	B	25	B	35	C
6	B	16	C	26	D	36	C
7	C	17	B	27	B	37	C
8	B	18	C	28	D	38	B
9	C/B	19	D	29	C	39	A
10	D	20	~~D~~ No answer	30	C	40	C

SECTION B (60 MARKS)

41. The graph below shows the effect of carbon dioxide concentration on the rate of photosynthesis of an aquatic plant measured at two different light intensities. Study it carefully and then answer the following questions:



a) (i) Describe the effects of increasing light intensity on the rate of photosynthesis. (3 marks)

As light intensity increases, the rate of photosynthesis initially increases because more light energy is available to drive the light-dependent reactions of photosynthesis. This results in more ATP and NADPH being produced, which are essential for the Calvin cycle. However, after reaching a certain point, further increases in light intensity have no effect on the rate of photosynthesis. This plateau occurs because other factors, such as carbon dioxide concentration or temperature, become the limiting factors, preventing the rate from increasing further.

(ii) State precisely the rate limiting factor at: (1 mark)

B: Light intensity is the rate-limiting factor, as increasing light intensity leads to an increase in the rate of photosynthesis.

A: Carbon dioxide concentration is the rate-limiting factor because the rate of photosynthesis has plateaued, indicating that light is no longer limiting and that the availability of carbon dioxide is now controlling the rate.

b). Explain why increasing the concentration of carbon dioxide may increase the rate of production of carbohydrate at high light intensity. (3 marks)

At high light intensity, the light-dependent reactions are producing ample amounts of ATP and NADPH, which are used in the Calvin cycle to fix carbon dioxide into carbohydrates. If the concentration of carbon dioxide increases, more CO_2 molecules are available for fixation in the Calvin cycle. This accelerates the rate at which RuBP (ribulose bisphosphate) combines with CO_2 to form 3-phosphoglycerate, eventually leading to an increased production of carbohydrates. Thus, under conditions of high light intensity, increasing carbon dioxide concentration can boost the rate of photosynthesis and, consequently, carbohydrate production.

c). Explain how the anatomy and physiology of the leaves of C4 plants adapt the plant for high rates of carbon fixation at high temperatures. (3 marks)

C4 plants possess a specialized leaf anatomy known as Kranz anatomy, where the bundle sheath cells surrounding the vascular bundles are large and contain chloroplasts, unlike in C3 plants. The C4 pathway involves the initial fixation of CO_2 in mesophyll cells to form a 4-carbon compound (oxaloacetate) using the enzyme PEP carboxylase, which has a high affinity for CO_2 and is not inhibited by oxygen. This 4-carbon compound is then transported to the bundle sheath cells, where CO_2 is released for use in the Calvin cycle. This mechanism concentrates CO_2 around RuBisCO, minimizing photorespiration and enhancing carbon fixation efficiency even at high temperatures. This adaptation allows C4 plants to maintain high rates of photosynthesis and carbon fixation under conditions where C3 plants would suffer from increased photorespiration and reduced efficiency.

Total marks 10

42.(a) Describe how the following tissues bring about growth in higher plants.

(i) Vascular cambium (4 marks)

The vascular cambium is a layer of meristematic cells located between the xylem and phloem in the stems and roots of dicotyledonous plants. It is responsible for secondary growth, which increases the thickness or girth of the plant. The vascular cambium produces new xylem cells on the inside and new phloem cells on the outside. As the cambium continues to divide and produce new cells, the stem or root thickens, and the older, inner layers of xylem become wood, while the outer layers contribute to the formation of bark. This process is essential for the structural support and increased transport capacity as the plant matures.

(ii) Apical meristem (4 marks)

The apical meristem is a region of actively dividing cells located at the tips of roots and shoots in higher plants. It is responsible for primary growth, which leads to an increase in the length of the plant. In the shoots, the apical meristem gives rise to new leaves, stems, and flowers, contributing to the plant's vertical growth. In the roots, the apical meristem produces new root cells, allowing the roots to grow deeper into the soil. The cells in the apical meristem are undifferentiated and continuously divide, providing new cells that differentiate into various tissues needed for the elongation and development of the plant.

(b) How does growth in mammals differ from that in flowering plants? (2 marks)

Growth in mammals is generally determinate, meaning it occurs up to a certain point, usually ending after reaching adulthood. Mammals grow primarily through the process of cell division and enlargement throughout their bodies but stop growing once they reach maturity. - Cell division occurs throughout the body

In contrast, growth in flowering plants is often indeterminate, meaning it can continue throughout the plant's life. Flowering plants grow through the continuous activity of meristematic tissues (such as the apical meristem and vascular cambium) which allow for ongoing growth in height, girth and the formation of new leaves, flowers, and roots throughout the plant's life.

- Cell division is restricted on the meristems

10 MARKS

43. (a) Explain what is meant by:

(i) Osmo conformer? (2 marks)

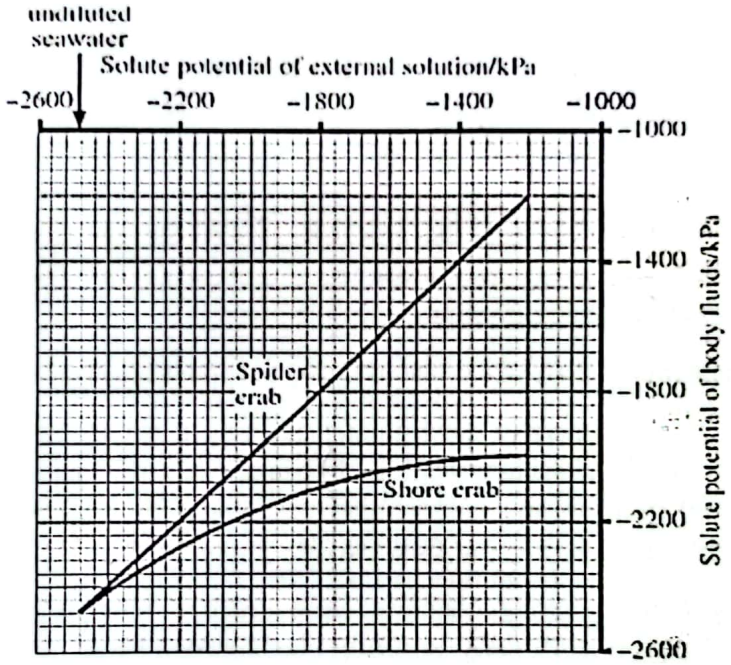
An Osmo conformer is an organism that maintains its internal body fluid osmolarity in equilibrium with the surrounding environment. The solute potential of their body fluids changes as the solute potential of the external environment changes, meaning they conform to the osmolarity of their surroundings. Many marine invertebrates, such as the spider crab, are Osmo conformers.

(ii) Osmo regulator? (2 marks)

An osmo regulator is an organism that actively regulates the osmolarity of its body

fluids, keeping it constant despite changes in the osmolarity of the external environment. This regulation allows them to live in environments where the external osmolarity is different from their internal body fluids. The shore crab is an example of an osmo regulator.

(b) The spider crab (Maia) lives in the sea at a depth of over 30 metres while the shore crab (Carcinus) lives in estuaries as well as along the shoreline. When the two species of crab are placed in dilute solutions of seawater, the solute potential of their body fluids is altered. The results are shown in the graph below.



(i) Explain the effect of diluting seawater on the solute potential of the body fluids of the spider crab. (3 marks)

When the spider crab is placed in a dilute solution of seawater, its body fluids' solute potential decreases (becomes more negative). This occurs because the spider crab is an Osmo conformer, meaning its body fluids' solute potential adjusts to match the solute potential of the surrounding environment. As the external seawater becomes more dilute (less negative solute potential), the body fluids of the spider crab also become less negative, but not as rapidly as the external solution.

(ii) When the shore crab is placed in dilute solutions of seawater, it absorbs salt through its gills from the surrounding solution. What is the effect of absorbing salt on the solute potential of the body fluids? (1 mark)

Absorbing salt increases the solute concentration in the shore crab's body fluids, which decreases the solute potential (makes it more negative).

(iii) What is the evidence from the graph that shows the shore crab absorbs salt when placed in dilute solutions of seawater? (2 marks)

The graph shows that as the external solute potential becomes less negative (due to

dilution), the solute potential of the shore crab's body fluids remains relatively constant and more negative than the external solution. This indicates that the shore crab actively absorbs salt to maintain its internal solute potential, ~~demonstrating osmoregulation.~~

10

44. (a) Define the term gene pool. (2 marks)

A gene pool is the complete set of different genes and alleles present in all the individuals within a population of a particular species. It represents the total genetic diversity available within a population.

02

(b) State the factors that may cause the gene pool of a population to be static. (2 marks)

~~Factors that may cause the gene pool of a population to be static include:~~

- Lack of mutations: No new alleles are introduced into the population.
- Random mating: Individuals mate randomly, ensuring that allele frequencies remain constant.
- No ~~natural~~ selection: All alleles confer equal fitness, so no allele is favoured over another.
- ~~No mig~~ /migration.
- No gene flow: There is no immigration or emigration, so the gene pool remains closed.

any 2
- Large population.

(c) (i) State any three factors that may contribute to the change in frequency of dominant and recessive alleles in a population. (3 marks)

- Natural selection
- Genetic drift /Bottleneck
- Gene flow (migration)
- Selective mating
- Artificial selection
- Small population

any 3.

(ii) Explain how each factor stated above in (c) (i) may cause changes in the frequency of the dominant and recessive alleles in a population. (3 marks)

Natural selection: Alleles that confer a survival or reproductive advantage become more common in the population over time. ~~For example~~, if a ~~dominant~~ allele ~~provides a selective advantage, its frequency will increase, while the frequency~~ of the ~~recessive allele may decrease.~~

01

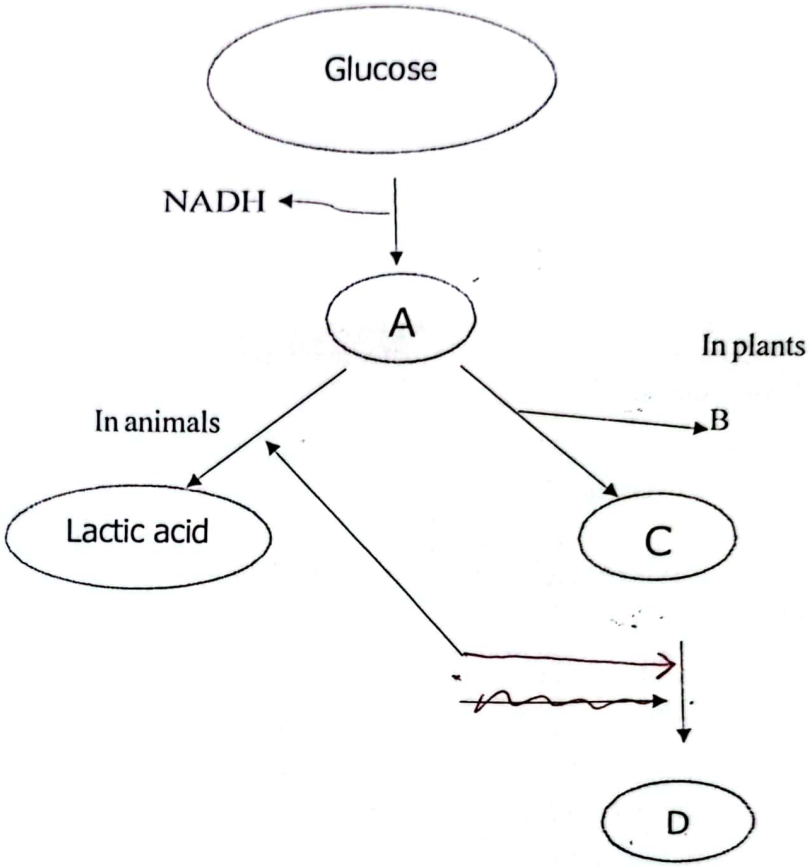
Genetic drift: ~~Random fluctuations in allele frequencies occur in small populations due to chance events. For instance,~~ A dominant allele might become more or less common purely by chance, leading to changes in allele frequencies independent of selection pressures.

01

Gene flow (migration): The movement of individuals between populations can introduce new alleles or change allele frequencies. If individuals carrying a ~~recessive allele migrate into a population, the frequency of that allele may increase, or if they emigrate, it may decrease.~~

01

45. The figure below shows a scheme for anaerobic respiration. Study it carefully and then give responses to the following questions;



a) (i) Name the substances labelled B and C (1 mark)

B: Ethanol Carbondioxide.

C: Carbon dioxide (CO_2) ~~Ethanal~~ 01

(ii) Give the role of NAD^+ in the process of respiration. (1 mark)

NAD^+ acts as an electron carrier. It accepts electrons during glycolysis, becoming reduced to NADH, which then carries the electrons to the electron transport chain to generate ATP; (in aerobic respiration) or is recycled back to NAD^+ in anaerobic respiration, allowing glycolysis to continue. 01

b) Describe the fate of:

(i) Compound A in the roots of plants living in waterlogged soils. (3 marks)

Compound A, which is pyruvate, undergoes anaerobic respiration in waterlogged soils where oxygen is scarce; In the absence of oxygen, pyruvate is converted into ethanol and carbon dioxide through alcoholic fermentation. This process regenerates NAD^+, which allows glycolysis to continue, providing a small amount of ATP necessary for the plant's survival under anaerobic conditions; 03

(ii) Lactic acid from anaerobic respiration. (3 marks)

Lactic acid, produced in muscle cells during anaerobic respiration, accumulates when oxygen is insufficient. Once oxygen becomes available, lactic acid is transported to the liver, where it is converted back into pyruvate. Pyruvate can then enter the mitochondria and be used in the Krebs cycle for further energy production. Alternatively, lactic acid can be converted back into glucose via gluconeogenesis in the liver.

c) Explain why many plants or parts of plants indulge in anaerobiosis for a short period of time. (2 marks)

Many plants or plant parts switch to anaerobic respiration temporarily when oxygen is unavailable, such as in waterlogged conditions or compacted soils. Anaerobic respiration provides a quick but limited supply of ATP, allowing the plant to survive under hypoxic conditions. However, because anaerobic respiration is less efficient and can lead to the accumulation of toxic byproducts (like ethanol), plants only rely on it for short periods until oxygen levels are restored.

46. a) (i) Distinguish between solute potential and water potential. (2 marks)

Solute potential (also called osmotic potential) is the component of water potential that is due to the presence of solute molecules. It is always negative, and the more solute present, the lower (more negative) the solute potential.

Water potential is the overall potential energy of water in a system, and it is a measure of the tendency of water to move from one area to another. Water potential is affected by both solute potential and pressure potential, and it determines the direction of water movement.

(ii) Explain why the water potential in plant roots is higher than the water potential in the leaves in plants. (2 marks)

Water potential in plant roots is higher than in the leaves because roots absorb water from the soil, which generally has a higher water potential. As water moves up the plant towards the leaves, it is lost through transpiration. This loss of water increases the concentration of solutes in the leaves, thus lowering the water potential in the leaves compared to the roots.

b) (i) Describe how root pressure contributes to the transport of water in plants. (3 marks)

Root pressure is generated when ions are actively transported into the xylem of the roots, lowering the water potential within the xylem. This causes water to move into the xylem from the surrounding root cells by osmosis, generating a positive pressure that pushes water upwards through the xylem vessels towards the stem and leaves. Root pressure is most significant in small plants and during conditions when transpiration is low, such as at night.

(ii) Describe how the structure of the cells of the endodermis is adapted for their role in the transport of water in a plant. (3 marks)

The cells of the endodermis have a structure known as the Casparian strip, which is a band of suberin (a waxy substance) that encircles the cell walls, making them impermeable to water and solutes. This strip forces water and solutes to pass through the cell membrane of the endodermal cells, allowing selective uptake of nutrients and preventing the passive loss of water and solutes from the xylem back into the cortex. The endodermis thus acts as a gatekeeper, regulating the flow of water and minerals into the vascular tissue.

$NAD^+ + 2H^+ + 2e$

↓

$NADH_2$