

Question 1 (50 marks)

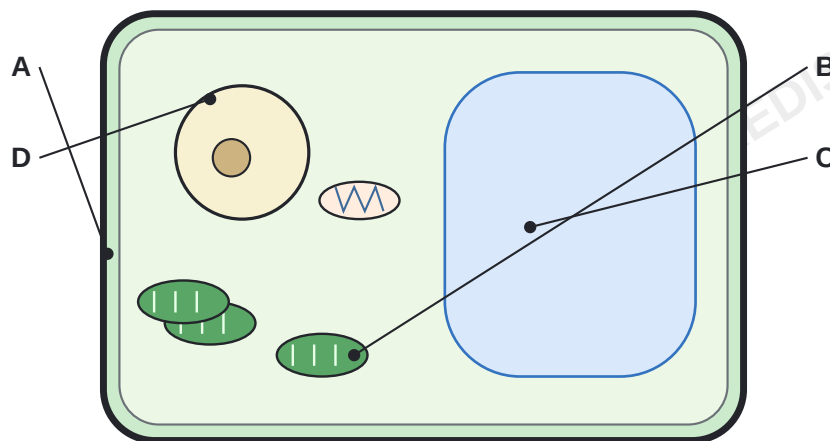
(a) The diagram shows a palisade mesophyll cell from a leaf, drawn from an electron micrograph.

(i) Name the structures labelled A, B, C and D.

(ii) State one function of structure B.

(iii) The cell also contains many small organelles that release energy from glucose, but these are not labelled. Name these organelles and name the process that takes place in them.

[8 marks]



Palisade mesophyll cell (not to scale).

(b) A student tested three food samples (P, Q and R) for the presence of nutrients. The results are shown in the table.

- State which nutrient or nutrients each sample contains. Give a reason for each answer.
- Name the reagent used in the test that gave a purple colour with sample Q.
- The Benedict's test was carried out in a hot water bath. Explain why the mixture was heated.
- The Benedict's test is only qualitative. Describe one way to use it to compare the amounts of reducing sugar in samples.

Sample	Benedict's test (heated)	Iodine solution	Biuret reagent	Ethanol and water
P	brick-red	blue-black	blue	stays clear
Q	blue	orange-brown	purple	stays clear
R	blue	orange-brown	blue	cloudy white emulsion

[8 marks]

(c) A student investigated osmosis using potato cylinders. Six cylinders, each with an initial mass of 3.00 g, were placed in sucrose solutions of different concentrations for 60 minutes. Each cylinder was blotted dry and reweighed. The results are shown in the table.

- Calculate the percentage change in mass of the cylinder in the 0.4 mol L⁻¹ solution.
- State the sucrose concentration that is isotonic to the potato cells. Explain your answer.
- Explain why the cylinder in distilled water (0.0 mol L⁻¹) increased in mass.
- Give one reason why each cylinder was blotted dry before it was reweighed.

Sucrose concentration (mol L ⁻¹)	0.0	0.1	0.2	0.3	0.4	0.5
Initial mass (g)	3.00	3.00	3.00	3.00	3.00	3.00
Final mass (g)	3.45	3.30	3.15	3.00	2.85	2.70

[8 marks]

(d) The template strand of part of a gene has the base sequence TAC CGA GTT AAA CTG. A portion of the genetic code is given in the table (Met = methionine, Ala = alanine, Gln = glutamine, Phe = phenylalanine, Asp = aspartic acid).

- Write the base sequence of the mRNA transcribed from this template strand.
- Use the table to give the sequence of amino acids in the polypeptide.
- State the anticodon on the tRNA that pairs with the second codon of the mRNA.
- Name the organelle where the polypeptide is assembled.
- A mutation changes the fourth triplet of the template strand from AAA to AAG. Explain why the polypeptide is unchanged.

mRNA codon	AUG	GCU	CAA	UUU	UUC	GAC
Amino acid	Met	Ala	Gln	Phe	Phe	Asp

[8 marks]

(e) A student used a 0.25 m² quadrat to estimate the number of daisy plants in a rectangular lawn of area 400 m². Five quadrats were placed in the lawn and the daisy plants in each were counted.

- Calculate the mean number of daisy plants per quadrat.
- Calculate the population density of daisy plants per m².
- Estimate the total number of daisy plants in the lawn.
- Describe how the student should have chosen where to place the quadrats.
- Suggest one way to make the estimate more reliable.

Quadrat	1	2	3	4	5
Daisy plants counted	6	9	4	8	3

[9 marks]

(f) The diagram shows a synapse between two neurones.

(i) Name the structures labelled A, B and C.

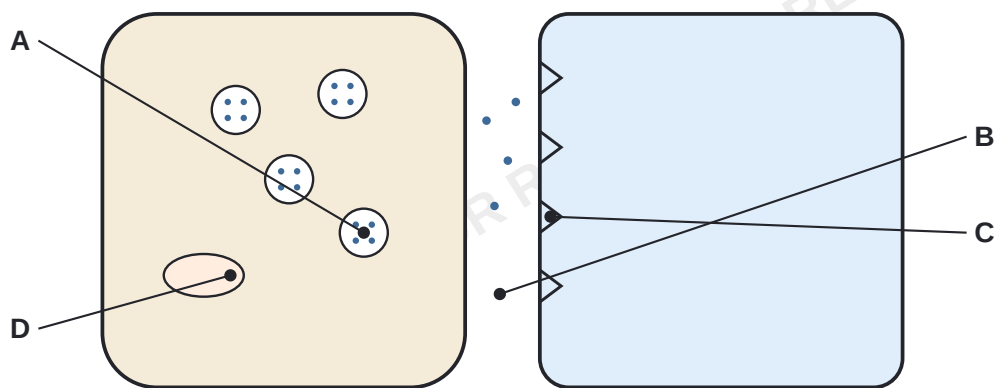
(ii) Name the chemicals that are stored in structure A.

(iii) Explain why an impulse can only cross the synapse in one direction.

(iv) Structure D is present in large numbers in the first neurone. Name structure D and explain why it is needed there.

(v) Name one neurotransmitter.

[9 marks]



A synapse between two neurones (not to scale).

QUESTIONS 2 TO 7

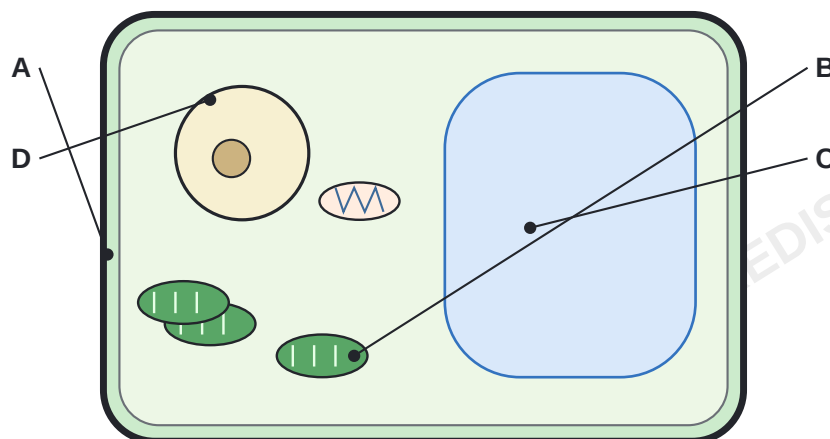
50 marks each · in the real paper you answer any FIVE

This practice paper prints all six so you can choose your best five, or attempt more than the real paper allows.

THE WORKED ANSWER TO THAT QUESTION

Question 1 (50 marks) [Compulsory question: Organisation of life, structures and processes, interactions]

(a) The diagram shows a palisade mesophyll cell from a leaf, drawn from an electron micrograph. (i) Name the structures labelled A, B, C and D. (ii) State one function of structure B. (iii) The cell also contains many small organelles that release energy from glucose, but these are not labelled. Name these organelles and name the process that takes place in them.



Palisade mesophyll cell (not to scale).

(a) Answer: (i) A cell wall; B chloroplast; C (large) vacuole; D nucleus. (ii) B carries out photosynthesis (traps light and makes glucose). (iii) mitochondria; aerobic respiration.

- Approach: identify each structure from its position and shape, then link structure to function.
- (i) A is the thick outer layer made of cellulose (cell wall). B is the green oval organelle containing stacked membranes (chloroplast). C is the large clear sac occupying much of the cell (vacuole, filled with cell sap). D is the round structure with a nucleolus inside it (nucleus). 1 mark each = 4.
- (ii) Chloroplasts contain chlorophyll, which absorbs light energy; in them light energy is used to make glucose from carbon dioxide and water (photosynthesis). Any one correct function = 2.
- (iii) The organelles that release energy from glucose are mitochondria (1) and the process is aerobic respiration (1).

KEY TAKEAWAY

Plant cell: cell wall, large vacuole and chloroplasts distinguish it from an animal cell; mitochondria in every cell carry out aerobic respiration.

(b) A student tested three food samples (P, Q and R) for the presence of nutrients. The results are shown in the table. (i) State which nutrient or nutrients each sample contains. Give a reason for each answer. (ii) Name the reagent used in the test that gave a purple colour with sample Q. (iii) The Benedict's test was carried out in a hot water bath. Explain why the mixture was heated. (iv) The Benedict's test is only qualitative. Describe one way to use it to compare the amounts of reducing sugar in samples.

(b) Answer: (i) P: reducing sugar and starch; Q: protein; R: lipid (fat). (ii) biuret reagent. (iii) the reaction between a reducing sugar and Benedict's reagent needs heat. (iv) use a

colorimeter, or compare the colour or time taken against known concentrations.

- Approach: match each positive colour change to the test that produces it.
- (i) P gave a brick-red colour with Benedict's (reducing sugar present) and blue-black with iodine (starch present). Q gave purple with biuret (protein). R gave a cloudy white emulsion with ethanol and water (lipid). 3 marks.
- (ii) Biuret reagent (sodium hydroxide and copper sulfate) turns purple when protein is present. 1 mark.
- (iii) The reaction between the reducing sugar and the copper(II) ions in Benedict's reagent is slow at room temperature; heating (about 80 °C) provides the energy needed for the colour change to brick red. 2 marks.
- (iv) Heat each sample for the same time with the same volume of reagent and compare the final colour with standards made from known concentrations of glucose (a colorimeter makes this measurement objective), or time how long the colour change takes. Any one method described = 2 marks.

KEY TAKEAWAY

Food tests: iodine for starch, Benedict's (heat) for reducing sugar, biuret for protein, ethanol emulsion for lipid; colour or time against standards makes a test quantitative.

(c) A student investigated osmosis using potato cylinders. Six cylinders, each with an initial mass of 3.00 g, were placed in sucrose solutions of different concentrations for 60 minutes. Each cylinder was blotted dry and reweighed. The results are shown in the table. (i) Calculate the percentage change in mass of the cylinder in the 0.4 mol L⁻¹ solution. (ii) State the sucrose concentration that is isotonic to the potato cells. Explain your answer. (iii) Explain why the cylinder in distilled water (0.0 mol L⁻¹) increased in mass. (iv) Give one reason why each cylinder was blotted dry before it was reweighed.

(c) Answer: (i) -5.0%. (ii) 0.3 mol L⁻¹ because there is no change in mass, so no net movement of water. (iii) water entered by osmosis from higher to lower water potential. (iv) removes surface liquid that would add to the mass.

- Approach: percentage change = (final – initial) ÷ initial × 100; zero change means water moves in and out at the same rate.
- (i) $(2.85 - 3.00) \div 3.00 \times 100 = -5.0\%$. The negative sign shows a loss of mass. 2 marks.
- (ii) The 0.3 mol L⁻¹ cylinder stayed at 3.00 g (0% change), so the sucrose solution has the same water potential as the potato cells and there is no net movement of water. 2 marks (concentration and reason).
- (iii) Distilled water has a higher water potential than the cytoplasm of the potato cells, so water moves through the partially permeable membrane into the cells by osmosis, increasing the mass. The cell walls stop the cells bursting. 3 marks.
- (iv) Surface liquid would be weighed as well, giving a mass that is too high. 1 mark.

KEY TAKEAWAY

Osmosis is the net movement of water across a partially permeable membrane from high to low water potential; no mass change marks the isotonic concentration.

(d) The template strand of part of a gene has the base sequence TAC CGA GTT AAA CTG. A portion of the genetic code is given in the table (Met = methionine, Ala = alanine, Gln = glutamine, Phe = phenylalanine, Asp = aspartic acid). (i) Write the base sequence of the mRNA transcribed from this template strand. (ii) Use the table to give the sequence of amino acids in the polypeptide. (iii) State the anticodon on the tRNA that pairs with the second codon of the mRNA. (iv) Name the organelle where the

polypeptide is assembled. (v) A mutation changes the fourth triplet of the template strand from AAA to AAG. Explain why the polypeptide is unchanged.

(d) Answer: (i) AUG GCU CAA UUU GAC. (ii) Met–Ala–Gln–Phe–Asp. (iii) CGA. (iv) ribosome. (v) the new codon UUC also codes for phenylalanine; the genetic code is degenerate.

- Approach: transcribe by base pairing (A–U, T–A, C–G, G–C), then read the mRNA in codons.
- (i) TAC→AUG, CGA→GCU, GTT→CAA, AAA→UUU, CTG→GAC, so the mRNA is AUG GCU CAA UUU GAC. 2 marks.
- (ii) AUG = Met, GCU = Ala, CAA = Gln, UUU = Phe, GAC = Asp: Met–Ala–Gln–Phe–Asp. 2 marks.
- (iii) The anticodon is complementary to the codon GCU, so it is CGA. 1 mark.
- (iv) Translation occurs at a ribosome. 1 mark.
- (v) AAG on the template gives the mRNA codon UUC. The table shows that UUC codes for phenylalanine, the same as UUU, so the amino acid sequence is unchanged. This is possible because more than one codon can code for the same amino acid (the genetic code is degenerate). 2 marks.

KEY TAKEAWAY

mRNA is complementary to the template strand and read in codons; the genetic code is degenerate, so some mutations are silent.

(e) A student used a 0.25 m² quadrat to estimate the number of daisy plants in a rectangular lawn of area 400 m². Five quadrats were placed in the lawn and the daisy plants in each were counted. (i) Calculate the mean number of daisy plants per quadrat. (ii) Calculate the population density of daisy plants per m². (iii) Estimate the total number of daisy plants in the lawn. (iv) Describe how the student should have chosen where to place the quadrats. (v) Suggest one way to make the estimate more reliable.

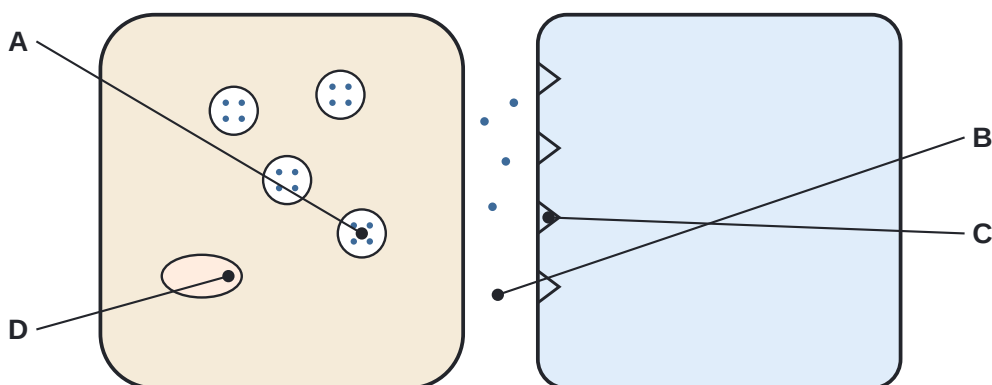
(e) Answer: (i) 6. (ii) 24 per m². (iii) 9600. (iv) at random, using random coordinates. (v) use more quadrats.

- Approach: mean count → density per m² → scale up by the area.
- (i) $(6 + 9 + 4 + 8 + 3) \div 5 = 30 \div 5 = 6$ plants per quadrat. 2 marks.
- (ii) 6 plants per 0.25 m², so $6 \div 0.25 = 24$ plants per m². 2 marks.
- (iii) $24 \times 400 = 9,600$ daisy plants. 2 marks.
- (iv) Choose positions at random, for example by using random numbers as grid coordinates or throwing the quadrat over the shoulder, to avoid bias. 2 marks.
- (v) Use a larger number of quadrats and calculate the mean (reduces the effect of an unusually crowded or empty quadrat). 1 mark.

KEY TAKEAWAY

Population estimate = mean count per quadrat $\div$ quadrat area $\times$ total area; random placement removes bias.

(f) The diagram shows a synapse between two neurones. (i) Name the structures labelled A, B and C. (ii) Name the chemicals that are stored in structure A. (iii) Explain why an impulse can only cross the synapse in one direction. (iv) Structure D is present in large numbers in the first neurone. Name structure D and explain why it is needed there. (v) Name one neurotransmitter.



A synapse between two neurones (not to scale).

(f) Answer: (i) A vesicle; B synaptic gap (cleft); C receptor. (ii) neurotransmitter. (iii) neurotransmitter is released only from the first neurone and receptors are only on the second neurone. (iv) mitochondria, which provide ATP for making and releasing neurotransmitter. (v) acetylcholine.

- Approach: follow the impulse from the first neurone, across the gap, to the second neurone.
- (i) A is the small sac of molecules in the first neurone (vesicle); B is the narrow space between the neurones (synaptic gap or cleft); C is the protein on the surface of the second neurone that binds the chemical (receptor). 3 marks.
- (ii) Vesicles store neurotransmitter molecules. 1 mark.
- (iii) Neurotransmitter is released only from the vesicles of the first neurone and receptors are found only on the membrane of the second neurone, so the signal can only pass from first to second. 2 marks.
- (iv) D is a mitochondrion. Making neurotransmitter, moving the vesicles to the membrane and releasing the contents need ATP (energy), which mitochondria supply by aerobic respiration. 2 marks.
- (v) Acetylcholine (or noradrenaline, dopamine, serotonin). 1 mark.

KEY TAKEAWAY

At a synapse a neurotransmitter diffuses across the gap from vesicles to receptors, so the impulse passes in one direction only.

LOS: Compulsory question: Organisation of life, structures and processes, interactions (Leaving Certificate Biology, Higher Level written paper, All strands)

QUESTIONS 2 TO 7