2.3 Nutrition in plants and humans

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **nutrition in plants and humans** : photosynthesis and limiting factors, leaf structure, mineral ions, a balanced diet, digestion and absorption, and the energy in food.

You must be able to:

- write the equation for photosynthesis and explain limiting factors
- explain how leaves and the small intestine are adapted
- name digestive enzymes, their substrates and products
- analyse a photosynthesis investigation

1 Key knowledge and worked examples

Photosynthesis and digestion

idea	rule
photosynthesis	carbon dioxide + water → glucose + oxygen (light energy, chlorophyll)
limiting factors	light intensity, carbon dioxide concentration and temperature: the one in shortest supply limits the rate
amylase	starch → maltose (mouth, small intestine)
proteases	proteins → amino acids (stomach, small intestine)
lipase	lipids → fatty acids + glycerol (small intestine)
energy in food (J)	mass of water (g) ×4.2× temperature rise (°C)

Worked example 1: energy in food. 1.0 g of crisp heats 20 g of water by 30 °C. Find the energy per gram.

1. Known: 20 g; 30 °C; 1.0 g of food.
2. Rule: $m \times 4.2 \times \Delta T$, then ÷ mass of food.
3. Numbers: $20 \times 4.2 \times 30 = 2520$ J.
4. Result: 2520 **J/g** (2.52 kJ/g).

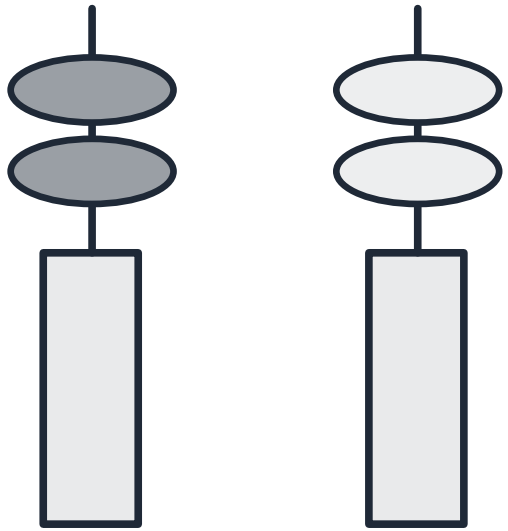
Worked example 2: rate of photosynthesis. A pondweed gives 36 bubbles in 3 minutes. Find the rate.

1. Known: 36 bubbles; 3 min.
2. Rule: bubbles ÷ time.
3. Numbers: 36 ÷ 3.
4. Result: 12 **bubbles per minute**.

Answer shapes: for a limiting factor, say which factor limits the rate and what happens if you increase it.

2 Practice

2.1 Name **two** mineral ions that plants need, and give a use of each. [2]



2.2 Name the deficiency disease caused by too little vitamin C, and the one caused by too little iron. [2]

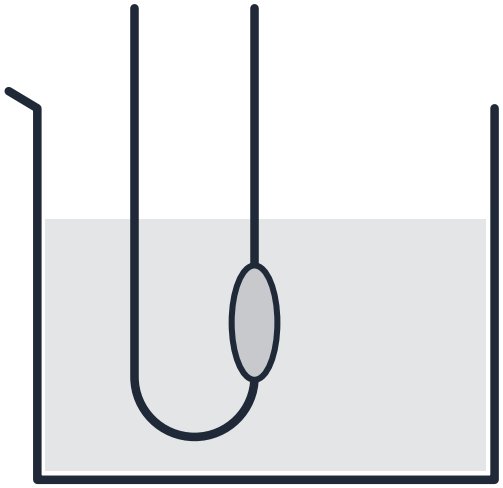


orange

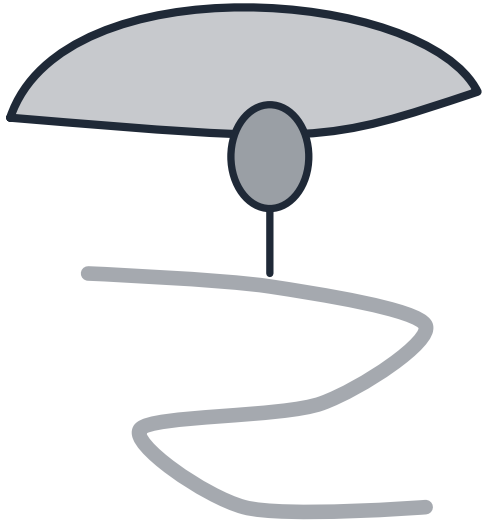


spinach

2.3 Describe how to test a leaf for starch, and give the positive result. [2]

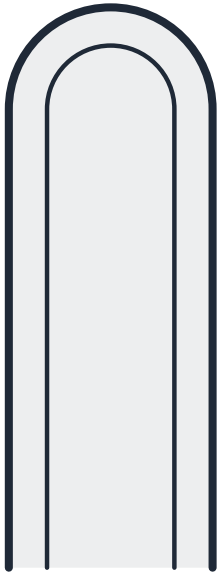


2.4 Give **two** roles of bile in digestion. [2]

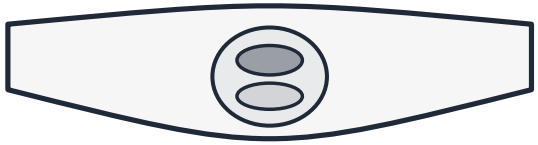


3 Exam-style questions

3.1 Explain how the villi of the small intestine are adapted for absorbing digested food. [3]



3.2 Explain **three** ways a leaf is adapted for photosynthesis. [3]



3.3 A student puts a piece of pondweed in water at different distances from a lamp and counts the bubbles of oxygen in one minute. A beaker of water is placed between the lamp and the plant. The results are shown.



distance / cm	10	20	30	40	50
bubbles per min	60	40	22	12	8

(a) At 20 cm the student counted 38, 41 and 41 bubbles in three repeats. Calculate the mean, and give **one** reason why repeats are taken. [3]

(b) Describe and explain the trend in the results. [4]

(c) Suggest why the beaker of water was used, and name **two** other variables the student should control. [3]

(d) Explain why counting bubbles is not an accurate way to measure the rate of photosynthesis, and describe how the method could be improved. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- nitrate: to make amino acids and proteins
- magnesium: to make chlorophyll

2.2

- vitamin C: scurvy
- iron: anaemia

2.3

- boil the leaf in water, then in ethanol to remove the chlorophyll; rinse in water
- add iodine solution: the starch areas turn blue-black

2.4

- it neutralises stomach acid, giving the alkaline pH that intestine enzymes need
- it emulsifies fats into small droplets, giving a larger surface area for lipase

3.1

- many villi (and microvilli) give a large surface area
- the wall is only one cell thick, so the diffusion distance is short
- a good blood supply (capillaries) keeps the concentration gradient steep; a lacteal absorbs fatty acids and glycerol

3.2

- broad and thin: a large surface area to absorb light and a short distance for gases
- palisade cells packed with chloroplasts near the upper surface, to absorb most light
- stomata and air spaces let carbon dioxide diffuse to the cells

3.3

(a) $(38 + 41 + 41) \div 3 = \mathbf{40}$; to spot anomalies, or to make the mean more reliable

(b) as the distance increases, the number of bubbles falls; the light intensity falls further from the lamp; light is the limiting factor; so less light energy for photosynthesis and less oxygen is made

(c) to absorb heat from the lamp, so the temperature stays the same; any two (1 mark each): carbon dioxide concentration (sodium hydrogencarbonate), the same piece of pondweed, the temperature of the water, the time allowed at each distance

(d) points to include:

- bubbles may be different sizes, so the number does not show the volume of oxygen (K)
- small bubbles may be missed, or bubbles counted when the student loses count (K)
- the gas may not be pure oxygen; some oxygen dissolves in the water (An)
- improvement: collect the gas in an inverted measuring cylinder or a gas syringe (photosynthometer) (App)
- measure the volume collected in a fixed time, e.g. 5 minutes (App)
- let the plant adjust for a few minutes at each new distance before measuring (App)

Levels: **5–6** a full, logical answer with correct biology and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.