Year 12 Science: Photosynthesis and respiration in the cell

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. Where in the chloroplast are water molecules split?

2. A cell breaks down 5 glucose molecules. How many ATP can it make at most aerobically (38 per glucose), and how many anaerobically?

3. Besides ATP, what does anaerobic respiration make in yeast?

4. Doubling the light makes no difference to a plant's rate of photosynthesis, but adding carbon dioxide raises it. What was limiting?

5. A pondweed shoot gives off 72 bubbles in 4 minutes. What is the rate?

Exam-style question: tomatoes in a glasshouse

A grower in Pukekohe raises tomatoes in a glasshouse. On sunny days she pumps in extra carbon dioxide, raising it to 1000 parts per million; outside air has about 424 parts per million.

6. Write the word equation for photosynthesis and name the organelle where it happens.

7. Calculate how many times higher the carbon dioxide concentration is inside the glasshouse than outside.

8. Explain why the tomato plants photosynthesise faster at midday than at sunrise.

9. Discuss why the extra carbon dioxide raises the rate of photosynthesis on a bright summer day but makes little difference on a dull winter morning, and why letting the glasshouse overheat would lower the rate.

Fix the mistake

10. Correct this statement: "Plants photosynthesise, and animals respire."

11. Correct this statement: "Respiration makes energy."

12. Correct this statement: "The light-independent stage happens in the dark."

13. Correct this statement: "Anaerobic respiration happens in the mitochondria without oxygen."

Answer key (for parents and tutors)

1. Where in the chloroplast are water molecules split?
   On the thylakoid membranes (the grana), in the light-dependent stage.
2. A cell breaks down 5 glucose molecules. How many ATP can it make at most aerobically (38 per glucose), and how many anaerobically?
   Aerobically 5 × 38 = 190 ATP; anaerobically 5 × 2 = 10 ATP.
3. Besides ATP, what does anaerobic respiration make in yeast?
   Ethanol and carbon dioxide.
4. Doubling the light makes no difference to a plant's rate of photosynthesis, but adding carbon dioxide raises it. What was limiting?
   Carbon dioxide concentration.
5. A pondweed shoot gives off 72 bubbles in 4 minutes. What is the rate?
   72 bubbles ÷ 4 min = 18 bubbles/min.
6. Write the word equation for photosynthesis and name the organelle where it happens.
   Carbon dioxide + water → glucose + oxygen, using light energy, in the chloroplasts (Achieved).
7. Calculate how many times higher the carbon dioxide concentration is inside the glasshouse than outside.
   1000 ppm ÷ 424 ppm = 2.36, about 2.4 times higher.
8. Explain why the tomato plants photosynthesise faster at midday than at sunrise.
   At sunrise the light is dim, so the light-dependent stage makes little ATP and hydrogen, and the cool air slows the enzymes; by midday the light is far stronger and it is warmer, so chlorophyll absorbs more energy and the enzymes work faster (Merit).
9. Discuss why the extra carbon dioxide raises the rate of photosynthesis on a bright summer day but makes little difference on a dull winter morning, and why letting the glasshouse overheat would lower the rate.
   Excellence links the factors: on a bright, warm day light is not limiting, so carbon dioxide is in shortest supply; adding more lets the stroma's enzymes fix more carbon dioxide into glucose, so the rate rises. On a dull winter morning light is the limiting factor, so the light-dependent stage cannot supply enough ATP and hydrogen to use the extra carbon dioxide, and the cold also slows the enzymes, so adding carbon dioxide is wasted. If the glasshouse overheats, the enzymes pass their optimum and begin to denature, so the active sites no longer fit their substrates, and the plants may close their stomata to save water, so less carbon dioxide gets in and the rate falls even with plenty of light and carbon dioxide.
10. Correct this statement: "Plants photosynthesise, and animals respire."
    Plant cells respire all the time too; they also photosynthesise when there is light.
11. Correct this statement: "Respiration makes energy."
    Energy cannot be made; respiration releases the chemical energy stored in glucose and transfers it to ATP.
12. Correct this statement: "The light-independent stage happens in the dark."
    It does not need light directly, but it runs in the light, because it uses the ATP and hydrogen the light-dependent stage makes.
13. Correct this statement: "Anaerobic respiration happens in the mitochondria without oxygen."
    Anaerobic respiration happens only in the cytoplasm; the mitochondria need oxygen to do their part.