

Respiration

IGCSE Biology 0610 · Topic 12 revision notes

Everything from the 3 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Respiration in cells

2. Aerobic respiration

3. Anaerobic respiration

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1 Respiration in cells

Syllabus 12.1

Respiration is the chemical reactions in cells that break down nutrient molecules to **release energy**. Organisms use that energy for **muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature**. Respiration is controlled by enzymes, so in yeast its rate rises with temperature up to an optimum and then falls as the enzymes are denatured.

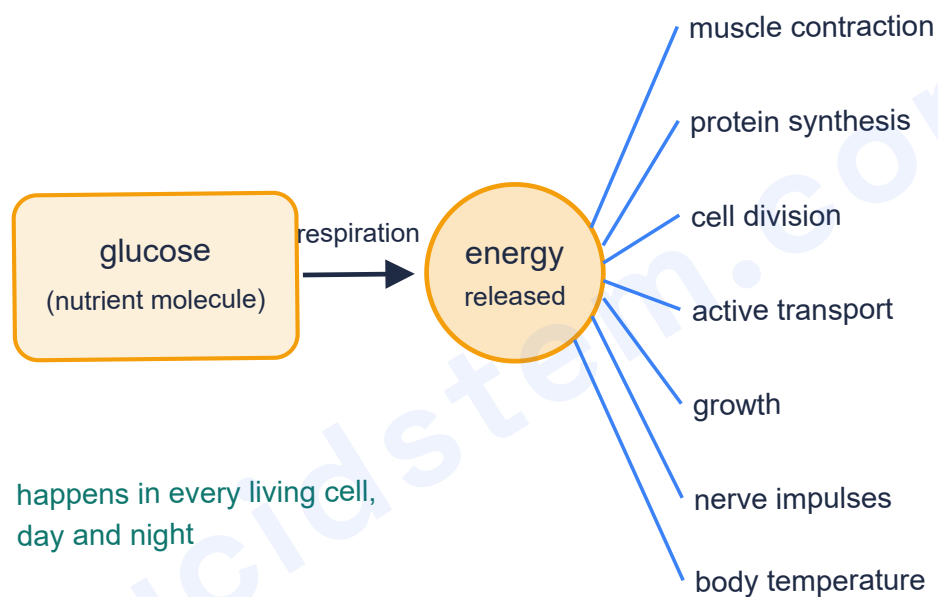


Fig. 1: respiration releases energy from glucose; the cell uses it for seven processes named in the syllabus

Respiration releases energy.

- ✓ **Respiration** happens in all living cells; breathing is only the movement of air.
- ✓ **Seven uses:** muscle contraction, protein synthesis, cell division, active transport, growth, nerve impulses, constant body temperature.
- ✓ **Yeast and temperature:** rate rises to an optimum (about 35 to 40 °C), then falls as enzymes denature.
- ✓ **Fair test:** same yeast mass, sugar volume and concentration, time; equilibrate in the bath first.

Watch out!

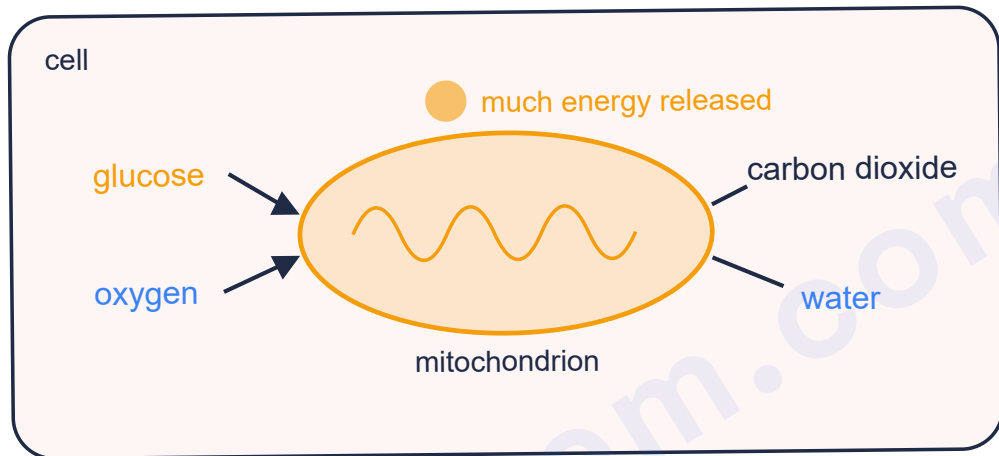
Respiration releases energy that is already stored in glucose. Never write that respiration "makes" or "produces" energy, and do not confuse respiration (a chemical process in cells) with breathing (ventilation, moving air in and out of the lungs).

The temperature axis is the independent variable and the carbon dioxide volume is the dependent variable. Do not say the yeast "dies at the optimum": the optimum is where respiration is fastest; it is above the optimum that the enzymes denature.

2 Aerobic respiration

Syllabus 12.2

Aerobic respiration is the chemical reactions in cells that **use oxygen** to break down nutrient molecules to **release energy**. Word equation: **glucose + oxygen → carbon dioxide + water**. Extended: the balanced chemical equation is **$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$** .



glucose + oxygen → carbon dioxide + water

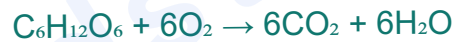


Fig. 1: glucose and oxygen are used in the mitochondrion; carbon dioxide and water are released, with a large amount of energy

Reactants left, products right.

- ✓ **Definition:** chemical reactions in cells that use oxygen to break down nutrient molecules to release energy.
- ✓ **Word equation:** glucose + oxygen → carbon dioxide + water.
- ✓ **Extended:** $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$; count atoms to check.
- ✓ **Energy** is released, not made, and is not written in the balanced equation.

Watch out!

Oxygen is a reactant, not a product, and water is a product. Students often swap them when writing the word equation in a hurry. Plants respire aerobically all the time too, in light and in darkness.

Write the formulae exactly: $C_6H_{12}O_6$, O_2 , CO_2 , H_2O . "60" or " H_2O_6 " loses the mark, and energy is not a substance, so it is not written as a product in the balanced equation.

3 Anaerobic respiration

Syllabus 12.3

Anaerobic respiration is the chemical reactions in cells that break down nutrient molecules to release energy **without using oxygen**. It releases **much less energy per glucose molecule** than aerobic respiration. In yeast: **glucose** → **alcohol + carbon dioxide**. In muscles during vigorous exercise: **glucose** → **lactic acid**. Extended: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$; lactic acid builds up in muscles and blood, causing an **oxygen debt** that is repaid after exercise.

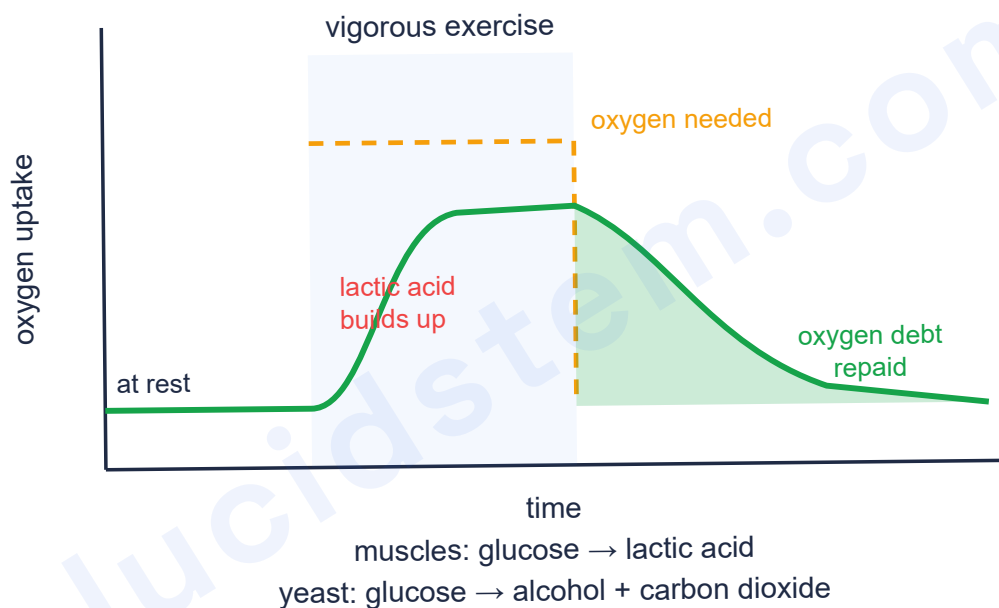


Fig. 1: during a sprint the oxygen taken in falls short of the oxygen needed, so muscles also respire anaerobically; after exercise extra oxygen is taken in to repay the oxygen debt

Two equations, one debt.

- ✓ **Anaerobic:** breaks down nutrients to release energy without oxygen; much less energy per glucose.
- ✓ **Yeast:** glucose $\rightarrow$ alcohol + carbon dioxide (Extended: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$).
- ✓ **Muscles:** glucose $\rightarrow$ lactic acid. No carbon dioxide.
- ✓ **Oxygen debt (Extended):** fast heart rate carries lactic acid to the liver; deep fast breathing supplies oxygen; the liver respire lactic acid aerobically.

Watch out!

Anaerobic respiration in muscles makes only lactic acid: no carbon dioxide and no alcohol. Only the yeast equation has carbon dioxide. Never write "glucose $\rightarrow$ lactic acid + carbon dioxide".

The balanced yeast equation has two ethanol and two carbon dioxide, and no oxygen on either side. Ethanol is C_2H_5OH , not CH_3OH .

The oxygen debt is the extra oxygen needed after exercise to remove lactic acid, not a shortage of oxygen in the air. Lactic acid is broken down in the liver, and it is carried there by the blood.