

Respiration

Revision notes · Aerobic and anaerobic respiration, how the body responds to exercise, oxygen debt, and metabolism as the sum of all reactions in a cell or body.

For AQA GCSE Biology 8461 and Combined Science: Trilogy 8464. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

Respiration Spec 4.4.2

Aerobic and anaerobic respiration Spec 4.4.2.1

Cellular respiration is an **exothermic** reaction which is continuously occurring in living cells. In an exothermic reaction, energy is transferred to the surroundings. The energy transferred supplies all the energy needed for living processes.

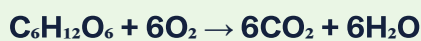
Organisms need energy for:

- chemical reactions to build larger molecules
- movement
- keeping warm.

Respiration in cells can take place **aerobically** (using oxygen) or **anaerobically** (without oxygen), to transfer energy.

Aerobic respiration

glucose + oxygen → carbon dioxide + water



Anaerobic respiration in muscles

glucose → lactic acid

As the oxidation of glucose is **incomplete** in anaerobic respiration, much less energy is transferred than in aerobic respiration.

Anaerobic respiration in plant and yeast cells

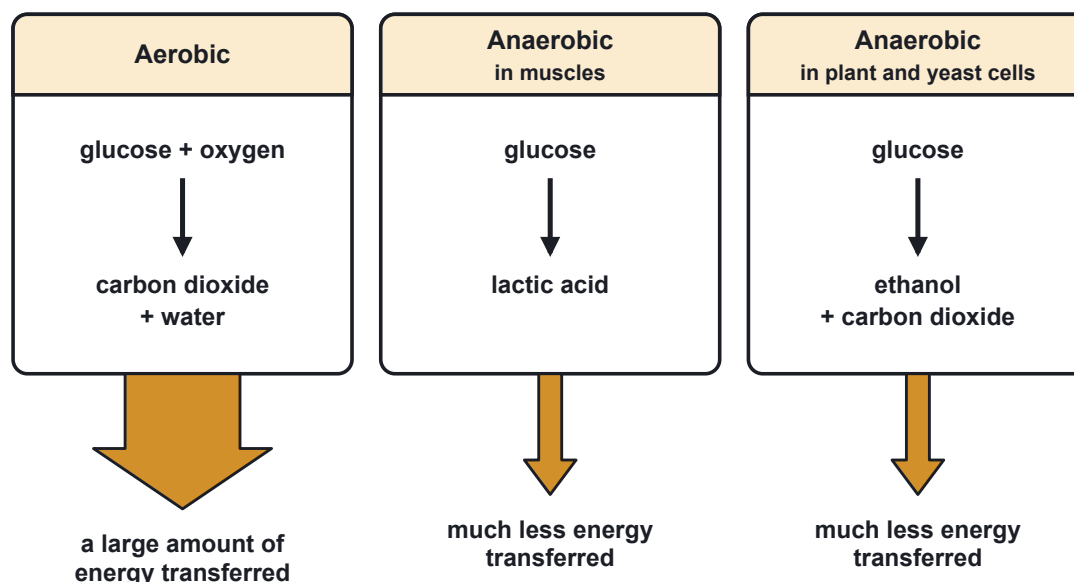
glucose → ethanol + carbon dioxide

Anaerobic respiration in yeast cells is called **fermentation**. It has economic importance in the manufacture of bread and alcoholic drinks.

Aerobic and anaerobic respiration compared			
	Aerobic	Anaerobic (muscles)	Anaerobic (plant and yeast cells)
Oxygen needed?	Yes	No	No
Products	Carbon dioxide and water	Lactic acid	Ethanol and carbon dioxide
Energy transferred	A large amount, as glucose is completely oxidised	Much less, as glucose is only partly oxidised	Much less, as glucose is only partly oxidised

Common mistake: Plants respire all the time, not only at night, and so do all other living cells. Respiration is not breathing; it happens inside cells.

Exam tip: In a comparison, give both sides: aerobic needs oxygen, and anaerobic does not. Say anaerobic respiration transfers much less energy (never 'makes energy') because the oxidation of glucose is incomplete.



Aerobic respiration transfers **much more energy** than either type of anaerobic respiration.

Response to exercise Spec 4.4.2.2

During exercise the human body reacts to the increased demand for energy. The **heart rate, breathing rate and breath volume** increase during exercise to supply the muscles with more oxygenated blood. This brings more oxygen and glucose to the muscles for respiration.

If insufficient oxygen is supplied, anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a build-up of **lactic acid** and creates an **oxygen debt**. During long periods of vigorous activity, muscles become **fatigued** and stop contracting efficiently.

1. Exercise increases the demand for energy in the muscles.
2. Heart rate, breathing rate and breath volume increase, so more oxygenated blood reaches the muscles.
3. If the oxygen supply is still not enough, muscles respire anaerobically.
4. Glucose is only partly oxidised, so lactic acid builds up and an oxygen debt is created.
5. After long vigorous activity, muscles become fatigued and stop contracting efficiently.

Higher tier

Removing lactic acid and the oxygen debt

Higher tier

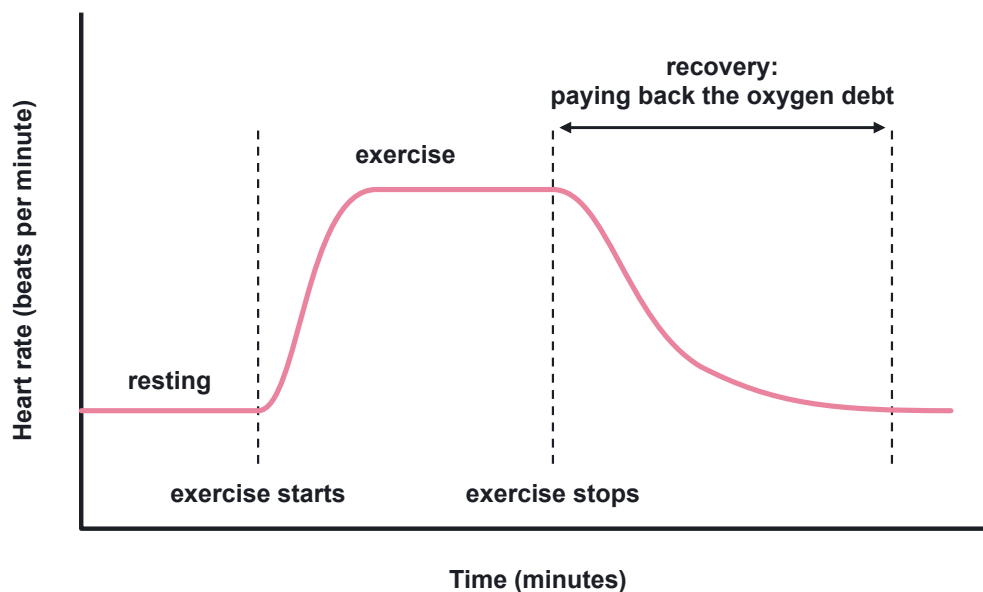
Blood flowing through the muscles transports the lactic acid to the liver, where it is converted back into glucose.

Higher tier

Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells. This is why you keep breathing hard, and your heart rate stays high, for a while after you stop.

Exam tip: To investigate exercise, measure pulse or breathing rate at rest, straight after exercise and at regular intervals during recovery. Keep the type and duration of exercise the same, and repeat to find a mean.

Exam tip: Say that anaerobic respiration happens because the oxygen supply is not enough, that lactic acid builds up, and that the muscles become fatigued. Do not say that muscles run out of energy completely.



Heart rate stays high after exercise while the **oxygen debt** is paid back.

Metabolism Spec 4.4.2.3

Metabolism is the sum of all the reactions in a cell or the body.

The energy transferred by respiration in cells is used by the organism for the continual **enzyme controlled** processes of metabolism that synthesise new molecules.

Metabolism includes:

- conversion of glucose to starch, glycogen and cellulose
- the formation of lipid molecules from a molecule of **glycerol** and **three molecules of fatty acids**
- the use of glucose and nitrate ions to form amino acids, which in turn are used to synthesise proteins
- respiration

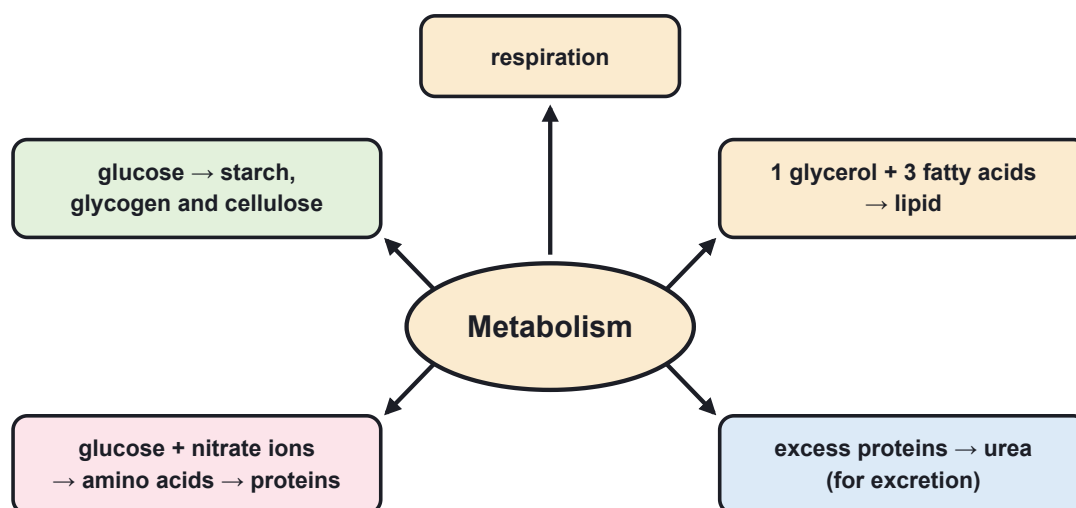
- breakdown of excess proteins to form **urea** for excretion.

Synthesis and breakdown of large molecules		
Large molecule	Made from (synthesis)	Broken down into (breakdown)
Carbohydrates (starch, glycogen, cellulose)	Sugars such as glucose	Sugars
Proteins	Amino acids	Amino acids
Lipids	One glycerol and three fatty acids	Fatty acids and glycerol

So sugars, amino acids, fatty acids and glycerol are the building blocks used to make carbohydrates, proteins and lipids, and the molecules that those large molecules are broken down into.

Exam tip: A lipid is made from one glycerol and three fatty acids. Learn the numbers 1 and 3.

All of these aspects are covered in more detail in the relevant specification sections but are linked together here.



Metabolism is the sum of all the reactions in a cell or the body.

Quick check

- Write the word equation for aerobic respiration.
- What are the products of anaerobic respiration in yeast?
- Why does anaerobic respiration transfer much less energy than aerobic respiration?
- Name the three things that increase during exercise to supply muscles with more oxygenated blood.
- What is metabolism?

Quick check answers

Respiration

1. glucose + oxygen $\rightarrow$ carbon dioxide + water
2. Ethanol and carbon dioxide.
3. Because the oxidation of glucose is incomplete.
4. Heart rate, breathing rate and breath volume.
5. The sum of all the reactions in a cell or the body.