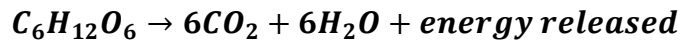


# Respiration

## Aerobic respiration

- All cells need energy
- Provided by burning glucose
- The energy is released very gradually in a series of small, enzyme controlled reactions
- Respiration is a number of chemical reactions that break down nutrient molecules in living cells to release energy
- **In aerobic respiration oxygen is used in the breakdown of glucose**
- Respiration takes place in all living cells at all times
- Most energy is released in the mitochondria
- Cells that require a lot of energy have many mitochondria
- Liver cells have high metabolism and have many mitochondria
- The epithelial cells of the small intestine absorb glucose and other molecules by active transport, so have large numbers of mitochondria

***glucose + oxygen → carbon dioxide + water + energy released***



## Using energy

Energy is required for;

- Muscle contraction
- Cell division
- Absorption of nutrients in the gut by active transport
- Sending impulses along nerves
- Protein synthesis for making enzymes, some hormones and antibodies
- Making new cell membranes and cell structures like the nucleus during growth
- Keeping the body temperature constant, some energy is released in the form of heat

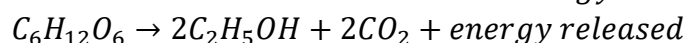
## Anaerobic respiration

- **Anaerobic respiration is the chemical reaction in cells that break down glucose to release energy without using oxygen**
- During strenuous exercise, too little oxygen may reach the body muscles for aerobic respiration to supply all the energy the muscles need
- Muscle tissue respire anaerobically to release energy
- Most of the enzyme catalysed reactions of aerobic respiration do not happen without oxygen
- As a result glucose is not broken down to carbon dioxide and water but to lactic acid instead

***glucose → lactic acid + energy released***

- Cardiac muscle does not respire anaerobically as it would not release enough energy for the heart to beat properly
- Some bacteria also respire anaerobically to make lactic acid (often used to make yogurt)
- Yeast respire anaerobically when oxygen is absent or short in supply in their surroundings to make alcohol and carbon dioxide

***glucose → alcohol + carbon dioxide + energy released***



- Plant roots respire anaerobically when land is flooded and soils become saturated with water so little or no oxygen is available
- Far less energy is released from each molecule in anaerobic respiration compared to aerobic respiration
- This is because glucose is not completely broken down and a lot of energy remains stored in lactic acid and in alcohol in the form of chemical bond energy

### Lactic acid

- Lactic acid can slowly poison muscles and cause cramps so it must be removed from the body
- The build-up of lactic acid in the muscles and blood, during vigorous exercise, causing an oxygen debt
- The oxygen debt is repaid after strenuous exercise by breathing faster and deeper in order to supply more oxygen for aerobic respiration to break down lactic acid
- Oxygen debt is removed during recovery by aerobic respiration of lactic acid in the liver
- After exercise the heart continues to beat at a fast rate in order to transport lactic acid in blood from the muscles to the liver
- The enzyme catalysed reactions that release most of the energy in aerobic respiration occur in mitochondria
- These cell structures do not function without a supply of oxygen
- During anaerobic respiration, glucose is partly broken down in the cytoplasm and alcohol or lactic acid is produced from the end product of this partial breakdown