

RESPIRATION

Definition

Is the production of energy by living cells. The most common respiratory substrate (nutrient respired) is glucose, but fat and protein can be used.

The chemical energy in glucose cannot directly be used by body processes so it is converted in the mitochondria to the chemical energy of ATP which can be used directly by the cells e.g. muscle contraction, nerve impulse conduction.

About 40% of the chemical energy in the substrate becomes ATP and the rest is lost as heat so the process is about 40% efficient.

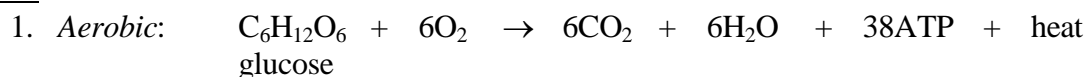
Aerobic Respiration uses oxygen and completely breaks down glucose to carbon dioxide and water creating 38 molecules of ATP for each molecule of glucose. It occurs in the mitochondria.

Man normally respire aerobically

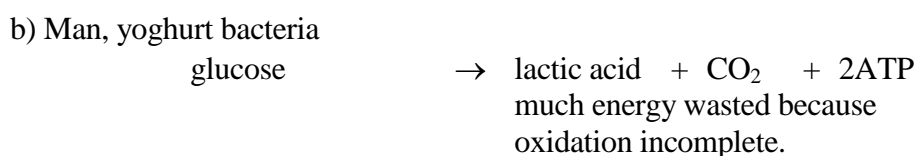
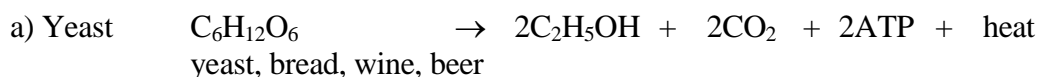
Anaerobic respiration does not use oxygen and only partly breaks down glucose releasing only 2 molecules of ATP. This process occurs in the cytoplasm.

In man, anaerobic occurs during vigorous exercise because muscles cannot obtain sufficient O_2 to produce all required energy, i.e. used to supplement aerobic respiration. Lactic acid is poisonous and if concentration rises too much the muscle cramps. Massaging the muscle increases circulation and provides O_2 to break down the lactic acid. When exercise stops lactic acid is broken down – this requires oxygen (the “oxygen debt” after exercise) and is why extra O_2 must be obtained by the lungs after exercise has finished.

Equations



2. *Anaerobic:*



Anaerobic respiration is also known as fermentation.

Comparison of Aerobic and Anaerobic respiration

	AEROBIC	ANAEROBIC
O ₂	used	not used
Energy	38 ATP per molecule of glucose	2 ATP only
waste product	CO ₂ + H ₂ O	or lactic acid + CO ₂ man or other acids + CO ₂ yoghurt bacteria
occurs in	mitochondria of cells	cytoplasm
organisms	all advanced organisms and many others	yeast bacteria, fungi and higher organisms when O ₂ in short supply/ exercise
industrial use	bread making vinegar manufacture antibiotic manufacture single cell protein manufacture	wine beer yoghurt

Industrial uses of Respiration

1. Yoghurt – bacterial fermentation at 42⁰C - the lactic acid produced curdles the milk and gives the acidic taste.
2. Wine – Yeast fermentation at room temperature – the yeast present on the surface of the grapes, produces alcohol.
3. Beer - Yeast fermentation at room temperature – the malt seeds germinate and convert stored starch to sugar, are then boiled and yeast produces alcohol and carbon dioxide.
4. Bread - Yeast fermentation at room temperature – the carbon dioxide causes the dough to rise and then expands on baking.
5. Penicillin – Fungal aerobic fermentation – the Penicillium fungus makes penicillin which is then purified.