# Anaerobic Respiration In Yeast

Name _____ Date _____

In biology, **anaerobic respiration** is a way for an organism to produce usable energy without the involvement of oxygen; it is respiration without oxygen. Respiration is a redox reaction that processes energy in a form usable by an organism, chiefly the process of producing ATP, the "universal energy currency of life". It employs an electron transport chain, with inorganic molecules other than oxygen used as a final electron acceptor.

In humans, it is generally muscle tissue that respires anaerobically usually during exercise, when the body cannot take enough oxygen to the cells for respiration. This means not enough energy is made, and the muscles need more. Thus they do it without the presence of oxygen. However, when they have stopped exercising, often an oxygen debt has been created, due to the large amounts of lactic acid in the muscles. Therefore, humans often need to breathe heavily after exercising in order to remove the oxygen debt.

Yeasts are single-celled fungi. They are used in commercial processes such as making wine and beer and baking bread. When yeast cells are prevented from getting enough oxygen, they stop respiring aerobically, and start to respire anaerobically instead. The first step of fermentation in brewing is where complex sugars or polysaccharides are broken down into monosaccharides, for example glucose by yeast. The glucose is then broken down into **ethanol** (alcohol) and carbon dioxide in a decomposition reaction, where energy is also produced – although there is less energy produced than in aerobic respiration.

| | | | | |
|---|---|---|---|---|
| $C_6H_{12}O_6$ | $2CH_3CH_2O$ | + | $2CO_2$ | |
| glucose | ethanol | + | carbon dioxide | (+some energy) |

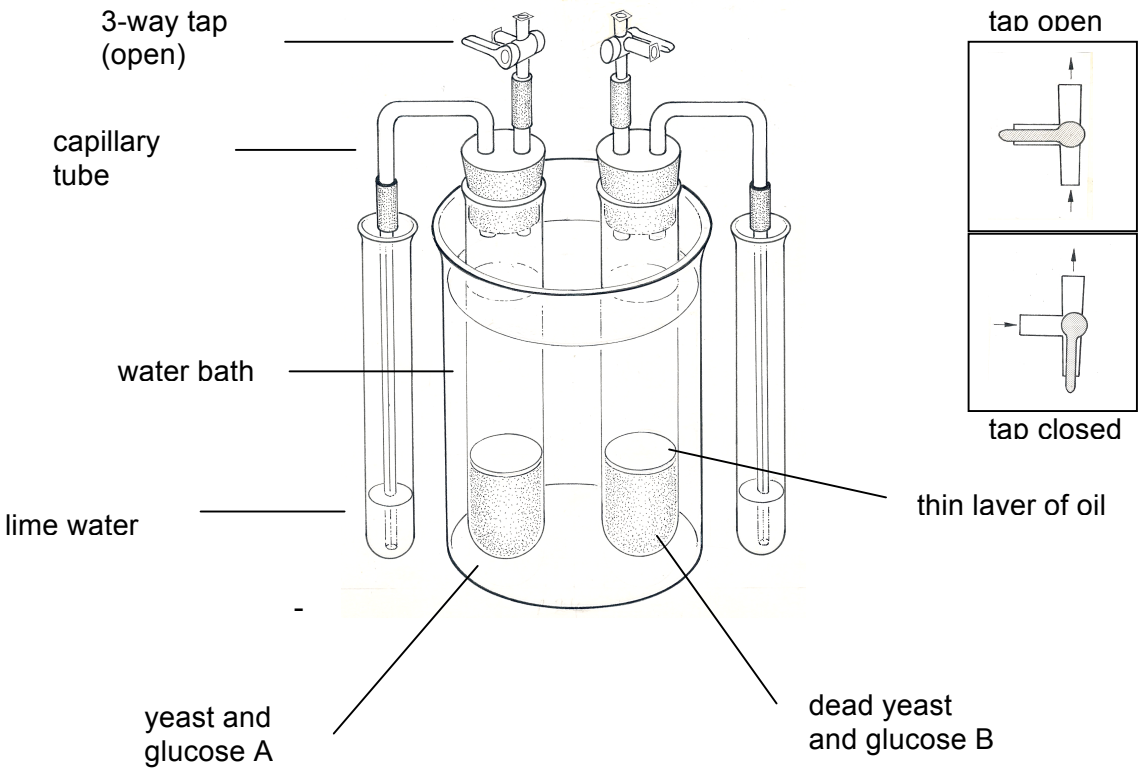
Muscle cells can also respire anaerobically when they are short of oxygen. If muscles are overworked, the blood can't reach them fast enough to deliver enough oxygen for aerobic respiration. This happens\ns when a person does a 'burst' activity, such as a spring, or quickly lifting a heavy weight. This time the glucose is broken down into a substance called **lactic acid.**

| | | | | |
|---|---|---|---|---|
| $C_6H_{12}O_6$ | $2C_3H_6O_3$ + | $2CO_2$ | | |
| glucose | lactic acid | + | carbon dioxide | (+some energy) |

Anaerobic respiration provides enough energy to keep the overworked muscles going for a short period, but continuing the 'burst' activity makes lactic acid build up in the bloodstream, producing muscle cramps. The person then has to rest, to oxidise the lactic acid fully. This uses oxygen. The volume of oxygen needed to completely oxidise the lactic acid that builds up in the body during anaerobic respiration is called the **oxygen debt.**

**Materials**

- 1 set of apparatus (see below)
- 10 $cm^3$ glucose/active yeast solution
- eye dropper
- spirit marker
- graduated cylinder (10 $cm^3$)
- 10 $cm^3$ glucose/inactive yeast solution
- thermometer
- ruler




**Procedure**

NOTE. The lime water should go milky within 15 minutes. After 30 minutes the fermenting mixture will froth up and fill the test-tube.

READ ALL OF INSTRUCTION BEFORE PROCEEDING.

1. Label two boiling tubes A and B (see figure). Place 1 g of active dried yeast in A. In B place 1 g of deactivated yeast.
2. Pour about 30 mm (depth) lime water into each of two clean test-tubes. Half fill a beaker or jar with warm water at about 40 °C.

3. Pour 10 $cm^3$ glucose solution in each of the tubes. The glucose solution has been made with boiled water. As you pour this solution into the tubes, tilt the tube so that the liquid runs down the side of the tube without splashing and introducing air. Swirl the tubes gently to mix the yeast and glucose solution. Do not shake.

Use an eye dropper to cover the surface of the solution in each tube with a thin layer of oil.

4. Check that the taps are open (pointing upwards) and then fit the rubber bungs securely into each tube. Place both tubes in the water bath so that their delivery tubes are dipping into the lime water in the two test-tubes. (*See Figure)*

5. Leave the boiling tubes to acquire the temperature of the water bath for a minute, then close the taps (pointing downwards).

6. Observe any changes in the lime water and in the tubes with the yeast and glucose solution.

**Discussion**

1. What changes did you observe in the lime water and in the tubes containing the yeast and glucose?

2. How do these observations support the idea that respiration is taking place in the yeast?

**3.** Suppose it is argued that the results are due not to respiration but to a simple chemical reaction between the yeast and glucose, in much the same way as hydrochloric acid and calcium carbonate react, what evidence do you have from the experiment to refute this argument?

**4.** It is further argued that by bubbling air through lime water, the same results could be achieved. What control experiment could you carry out to show that this was not the case in your experiment?

**5.** Assuming that the results are due to respiration in the yeast, how was the experiment designed to show that it was anaerobic respiration (i.e. respiration in the absence of oxygen)?

**6.** What was the role of the glucose solution in this experiment?