

Respiration

What is Respiration?

When you hear the word 'respire,' you probably think of breathing. When you breathe, you are taking in oxygen with each inhale and releasing carbon dioxide with each exhale. This gas exchange is important for respiration, but while breathing is a physical process, respiration can be thought of as more of a chemical process. All organisms, from a single bacterial cell to a coral reef colony to a blue whale, undergo respiration.

Food molecules absorbed after digestion are taken in, broken down, and the energy freed in the process is used to power the organism's movements and physiological functioning. **Respiration** is the biochemical process in which the cells of an organism obtain energy by combining oxygen and glucose, resulting in the release of carbon dioxide, water, and **ATP** (the currency of energy in cells).

When we examine the equation for cellular respiration, we see that the reactants are glucose and oxygen (for aerobic respiration), and the products are carbon dioxide, water, and ATP. Note the number of oxygen, carbon dioxide, and water molecules involved in each 'turn' of the process.

Importance of Respiration

By the end of this lesson you should be able to:

Explain the importance of respiration.

Identify two types of respiration in living organisms.

Compare aerobic and anaerobic respiration.

Explain the importance of anaerobic respiration in industry and at home.

Describe experiments to show respiration in plants and animals.

Respiration is the process whereby food materials are broken down within the cell to release energy necessary for body activities. In this topic you will learn more on how glucose is broken down to release energy for the cell.

In Form One respiration was identified as one characteristic of living organisms. In the topic of cell structures and function you learnt that the mitochondrion is the site for respiration. In the topic gaseous exchange we learn that oxygen and carbon IV oxide are the respiratory gases. In the topic nutrition we learnt that glucose is assimilated and broken down to release energy for the cell, we also learnt important factors that determine energy requirements in man.

In this topic on respiration we will learn more on how glucose is broken down to release energy for the cell.

Importance of Respiration

Respiration produces energy that is used to carry out various activities in the body. The activities include;

Reproduction

Growth and development

Repair of worn out tissues

Muscle contractions to bring about various movements.

Types of respiration

There are two types of respiration: **Aerobic respiration** and **Anaerobic respiration**.

Aerobic Respiration

Aerobic respiration refers to the chemical breakdown of glucose in presence of oxygen to release energy for the cell. It takes place in two phases within the cell. The first phase is called glycolysis. It occurs in the cell cytoplasm and produces only 2 ATP molecules for every glucose molecule. The second phase is called Krebs cycle. It occurs in the mitochondrion and produces 36 ATP molecules.

Glycolysis

During glycolysis, glucose molecules are broken down by enzymes into pyruvic acid with release of two ATP molecules for every glucose molecule. This occurs in the cell cytoplasm.

KREBS CYCLE

The pyruvic acid in the cytoplasm enters the mitochondrion. In presence of oxygen it becomes oxidized into carbon IV oxide and water. **36 ATP molecules** are produced. The overall reaction for aerobic respiration is shown.

Oxygen + glucose

Anaerobic Respiration

Anaerobic respiration refers to the chemical breakdown of glucose in the absence of oxygen to liberate energy. Various organisms produce different products during the process.
Anaerobic Respiration in Animals

In animals glucose is broken down anaerobically when oxygen supply is less than oxygen demand. Lactic acid is a toxic substance and must be quickly cleared from the respiring tissues. When oxygen is available the lactic acid is broken down into carbon IV oxide, ATP, and water. This is called paying of oxygen debt. The liver may also convert the lactic acid into glycogen for storage.

In the sportsmen the lactic acids will be broken down after the activity when the sportsman continues to breathe deeply. Deep and rapid breathing (panting) enables the sportsman to take in enough oxygen to break down the pyruvic acid. This is called paying the oxygen debt.

The Mitochondrion

Anaerobic Respiration

Anaerobic respiration refers to the chemical breakdown of glucose in the absence of oxygen to liberate energy. Various organisms produce different products during the process.

In animal cells glucose is usually broken down anaerobically during strenuous activities (when oxygen supply is less than oxygen demand). Two ATP molecules and lactic acid are produced. Lactic acid is a toxic substance and must be quickly cleared from the respiring tissues. When oxygen is available (paying of oxygen debt) the lactic acid is broken down in the respiring tissues into carbon IV oxide, ATP, and water. The liver may also convert the lactic acid into glycogen for storage.

Production of Heat during Respiration

Demonstration to show that heat is produced during germination. In this experiment some seeds are soaked in water for a day so that they begin to germinate. A second set of beans is boiled to kill them. This is to be used in the control set up. Both sets of peas are then washed in dilute disinfectant, so that the bacteria and fungus are killed. Each set of beans is then put into a vacuum flask. The temperature of each flask is noted and recorded every day for four days.

Note that in the demonstration with unboiled peas the thermometer shows increase in temperature while the boiled seeds does not show increase in temperature. Seeds store food which is broken down during germination to produce energy in form of heat causing a rise in temperature. In the control set up, boiling denatured the enzymes in the seeds. The boiled seeds did not respire and therefore there was no rise in temperature.

This experiment shows that during respiration energy is released.

Comparison between Aerobic and Anaerobic Respiration

As observed during the previous lessons in respiration there are clear differences and similarities between aerobic and anaerobic respiration.

Aerobic respiration is oxygen dependent. It only occurs in the presence of oxygen. It takes place in the cytoplasm and mitochondria. During this process glucose is completely broken down into carbon IV oxide and water. Aerobic respiration releases more energy. 38 ATP molecules are released from every molecule of glucose used.

Anaerobic respiration occurs in cell cytoplasm only. During this process glucose is partially broken down. The products are lactic acid and energy in animals. Plants release ethanol. Carbon IV oxide and energy. Less energy is released; only 2 ATP molecules for every sugar molecule used.

Respiration Process

- The muscles of respiration contract thereby expanding the chest cavity.
- This causes a negative pressure within the pleural cavity (where the lungs are housed) which forces the lungs to expand.
- The expansion of the lungs reduces the air pressure in the lungs.
- This draws air from the environment which is at a higher pressure. *Air will flow from an area of high pressure to low pressure.*
- Air is taken in through the nose and the air is 'filtered' and heated in the nasal cavity.
- It then passes down the throat and enters the trachea where it rushes into the bronchi.
- The bronchi divides the air flow between the two lungs.
- The air then passes into smaller air tubes known as bronchioles and empty into the lungs.
- The air enters the tiny air sacs within the lungs, called alveoli, where oxygen crosses into the blood and carbon dioxide empties into the lung.
- The respiratory muscles relax and the chest cavity contracts.
- The elastic lungs recoil and pushes air out through the air passages where it is emptied into the environment.

Advantages of Aerobic Respiration

1. It is good for the heart.

Exercises for aerobic respiration are regarded as one of the best forms of workout to strengthen the cardiovascular system, which means they keep the heart, lungs and arteries clean and healthy. But to enjoy their optimum benefits, you need to calculate your individual training heart rate zone with the use of recommended formulas to make sure that you are performing them at the right intensity.

2. It improves cognition.

Aerobic exercises require you to memorize a number of steps as they progress, which creates a mental training that can improve your cognitive skills. And if you are using a fast pace, you will be coerced to quickly adapt to the changes in sequence, which will keep you on your toes not only physically, but also mentally.

3. It boosts endurance.

Basically a high-energy workout, aerobic respiration can improve your endurance by optimizing the amount of calories you burn, while keeping your heart rate high throughout a session. Thus, it is ideal if you are trying to tone your muscles and lose weight.

Disadvantages of Aerobic Respiration

1. It can include high-impact exercises that could be bad for the body.

The repetitive and high-impact steps in aerobics could not be good if you have ligament or bone problems. As you can see, this type of workout would use steps that can be difficult for you to keep up, if you have joint problems. Basically, most movements performed in aerobics are high-impact, which are not suitable for someone with weak bones.

2. It can result to a body shape you did not desire.

Too much of aerobic respiration can result to a body shape that you did not want, where you can begin to look straight without curves or any undesirable body shape. You could end up having an emaciated, hungry look, though you should have the powerful look of a sprinter.

3. It comes with issues on social environment.

Aerobics are usually held in a class setting, which makes the experience enjoyable if you love working out with other people. But if you are not the social type, then this regimen would not work for you, especially if you are intimidated easily.

For aerobic respiration to work for you, you should make sure its advantages weigh out the disadvantages on your end. It is also important to combine it with other forms of workout to get the best results.

Reference

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