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Photosynthesis and cellular respiration comparison answer key

The relationship between photosynthesis and cellular respiration is such that the products of one system are the reactants of the other. Photosynthesis involves the use of energy from sunlight, water and carbon dioxide to produce glucose and oxygen. Cellular respiration uses glucose and oxygen to produce carbon dioxide and water. To emphasize this point even more, the equation for photosynthesis is the opposite of cellular respiration. Humans, animals and plants depend on the cycle of cellular respiration and photosynthesis for survival. The oxygen produced by plants during photosynthesis is what humans and animals inhale for the blood to transport to the cells for respiration. The carbon dioxide produced during respiration is released from the body and absorbed by plants to help provide the energy they need for growth and development. This is the never ending cycle that sustains life on earth. The process of photosynthesis is used by plants and other photosynthetic organisms to produce energy, whereas the process of cellular respiration breaks down the energy for use. Despite the differences between these two processes, there are some similarities. For example, both processes synthesize and use ATP, the energy currency. Below are some of the similarities and differences between these two systems. Similarities between Photosynthesis and Cellular Respiration

Comparative Features

Photosynthesis

Cellular Respiration

Reduction-Oxidation Reaction

Electron Transport Chain (ETC)

Synthesize ATP

Utilize ATP

Phosphorylation

Electron Carriers

Differences between Photosynthesis and Cellular Respiration

Comparative Features

Photosynthesis

Cellular Respiration

Occurs in...Plants, Algae and Photosynthetic Bacteria

All living organisms

Function/Purpose

Capture, convert and store energy - light energy from the sun is converted into chemical energy and stored in the bonds of glucose

Release energy - chemical energy stored in glucose is released to produce ATP for the cell

Reactants/Inputs

Carbon dioxide, Water and Light energy

Glucose and Oxygen

Metabolic Process

Anabolic - CO₂ and energy from ATP and NADPH are used to build glucose molecules

Catabolic - glucose is broken down to produce CO₂ and energy in the form of ATP, NADH and FADH₂

Location

Chloroplast of the plant cell

Glycolysis occurs in the Cytoplasm while the Mitochondria is the site of the Krebs' Cycle and Electron Transport Chain (ETC)

Source of Energy

Sunlight

Glucose (sunlight is not required)

Electron Carriers

NADPH

NADH and FADH₂

Stages

Light dependent Reactions - Light energy and water are used to produce ATP and NADPH

Calvin Cycle - Carbon dioxide and the energy from ATP and NADPH are used to produce glucose

Glycolysis - Glucose is combined with ATP to produce pyruvate molecules, NADH and more ATP

Pyruvate Oxidation - Pyruvate molecules are broken down into Acetyl-CoA (2-carbon compound) and CO₂ is produced

Krebs' Cycle - Acetyl-CoA is combined with 4-carbon molecules to form the 6-carbon citrate molecules used to generate NADH, CO₂, FADH₂ and ATP

Electron Transport Chain - Energy stored in NADH and FADH₂ during the Krebs cycle is used to generate ATP, Water, NAD⁺ and FAD

Products/Outputs

Glucose and Oxygen

Carbon dioxide and Water

Equation

$$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$
$$6\text{O}_2 + 6\text{H}_2\text{O} \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$$

The cycle of photosynthesis and respiration maintains the balance of oxygen and carbon dioxide. Photosynthesis produces the oxygen to replenish oxygen that is used up by living organisms during respiration. Carbon dioxide produced during respiration is one of the reactants plants need to perform photosynthesis. Photosynthesis and cellular respiration are both part of a mutually beneficial relationship. Cellular respiration cannot occur without photosynthesis, and photosynthesis certainly cannot occur without the help of its partner. Photosynthesis and respiration are reactions that complement each other in the environment. They are in reality the same reactions but occurring in reverse. While in photosynthesis carbon dioxide and water yield glucose and oxygen, through the respiration process glucose and oxygen yield carbon dioxide and water. They work well since living organisms supply plants with carbon dioxide which undergoes photosynthesis and produces glucose and these plants and bacteria give out oxygen which all living organisms need for respiration. Cellular Respiration versus Photosynthesis comparison chart

Cellular Respiration

Photosynthesis

Production of ATP

Yes; theoretical yield is 38 ATP molecules per glucose but actual yield is only about 30-32. Yes

Reactants

C₆H₁₂O₆ and 6O₂

6CO₂ and 12H₂O and light energy

Requirement of sunlight

Sunlight not required; cellular respiration occurs at all times. Can occur only in presence of sunlight

Chemical Equation (formula)

$$6\text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{ATP (energy)}$$
$$6\text{CO}_2 + 12\text{H}_2\text{O} + \text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O}$$

Process

Production of ATP via oxidation of organic sugar compounds. [1] glycolysis: breaking down of sugars; occurs in cytoplasm [2] Krebs Cycle: occurs in mitochondria; requires energy [3] Electron Transport Chain-- in mitochondria; converts O₂ to water. The production of organic carbon (glucose and starch) from inorganic carbon (carbon dioxide) with the use of ATP and NADPH produced in the light dependent reaction

Fate of oxygen and carbon dioxide

Oxygen is absorbed and carbon dioxide is released. Carbon dioxide is absorbed and oxygen is released. Energy required or released? Releases energy in a step wise manner as ATP molecules

Requires energy

Main function

Breakdown of food. Energy release. Production of food. Energy Capture. Chemical reaction

Glucose is broken down into water and carbon dioxide (and energy). Carbon dioxide and water combine in presence of sunlight to produce glucose and oxygen. Stages

4 stages: Glycolysis, Linking Reaction (pyruvate oxidation), Krebs cycle, Electron Transport Chain (oxidative phosphorylation). 2 stages: The light dependent reaction, light independent reaction. (AKA light cycle & calvin cycle)

What powers ATP synthase

H⁺ proton gradient across the inner mitochondria membrane into matrix. High H⁺ concentration in the intermembrane space. H⁺ gradient across thylakoid membrane into stroma. High H⁺ concentration in the thylakoid lumen

Products

6CO₂ and 6H₂O and energy(ATP)

C₆H₁₂O₆ (or G3P) and 6O₂ and 6H₂O

What pumps protons across the membrane

Electron transport chain. Electrochemical gradient creates energy that the protons use to flow passively synthesizing ATP. Electron transport chain

Occurs in which organelle? Mitochondria

Glycolysis (cytoplasm)

Chloroplasts

Final electron receptor

O₂ (Oxygen gas)

NADP⁺ (forms NADPH)

Occurs in which organisms? Occurs in all living organisms (plants and animals). Occurs in plants, protista (algae), and some bacteria. Electron source

Glucose, NADH + , FADH₂

Oxidation

H₂O at PSII

Catalyst - A substance that increases the rate of a chemical reaction

No catalyst is required for respiration reaction. Reaction takes places in presence of chlorophyll. High electron potential energy

From breaking bonds

From light photons. Photosynthesis is a process in photoautotrophs that converts carbon dioxide into organic compounds in the presence of sunlight. Respiration is the set of metabolic reactions that take in cells of living organisms that convert nutrients like sugar into ATP (adenosine tri phosphate) and waste products. Processes involved

Processes in photosynthesis are divided on basis of requirement of sunlight while respiration processes are divided on basis of requirement of oxygen. Hence in photosynthesis you have the light dependent reactions and the dark reactions while in respiration there is aerobic respiration and anaerobic respiration. In photosynthesis light dependent reactions, ultra violet light strikes chlorophyll pigments which excites electrons leading to separation of oxygen molecules from carbon dioxide. In the dark reactions, carbon molecules now independent of oxygen are converted into carbohydrates and stored in plant cells as energy and food source. In aerobic cellular respiration oxygen is utilized to convert organic compounds into energy and in anaerobic respiration converts organic compounds into energy without using oxygen. Site of Reactions

Photosynthesis takes place in the chloroplasts and organelles of a plant cell. Respiration takes place in the cytoplasm and mitochondria in the cell of a living organism. Reaction kinetics

The electron acceptor in photosynthesis is NAD⁺ while in respiration the electron acceptor is NADH. In cellular respiration reaction 36 molecules of ATP are produced in complete oxidation of one molecule of glucose. Video comparing Photosynthesis and Respiration

References

Wikipedia: Photosynthesis

Wikipedia: Cellular respiration

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