

CARBON FIXATION PATHWAYS IN PHOTOSYNTHESIS

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Abstract: With the help of this article, you can learn about the process of photosynthesis, which is one of the main characteristics of plants, and the ways in which carbon can be absorbed in this process.

Keywords: photosynthesis, carbon, ATP, H₂O, Oxygenic photosynthesis, Carbon absorption

The process of photosynthesis is vital for plants because it is their main way of producing food and storing energy. It is also the main source of energy for all life on Earth, as plants are a key component of the food chain. To better understand the process of photosynthesis, let us take a closer look at its main stages:

1. Light stage:

In this stage, light energy, mainly from the sun, is absorbed by chlorophyll molecules inside the chloroplasts. Chlorophyll absorbs this energy in the form of photons and converts it into chemical energy. In this process, water molecules (H₂O) are broken down, releasing oxygen (O₂). At the end of this process, the following energy sources are produced:

- ATP (adenosine triphosphate): A chemical energy storage molecule.
- NADPH: An electron transport molecule.

2. Dark stage (Calvin cycle):

In this stage, carbon dioxide (CO₂) is absorbed from the environment through the stomata of the plants. The transformation of CO₂ and its conversion

into organic substances (e.g., glucose) is carried out using the energy of ATP and NADPH. In this step:

- CO₂ (carbon dioxide from the atmosphere) is converted into an organic compound, namely glucose, through several chemical reactions.

- This glucose is used by the plant for growth, development, and energy storage.

Ecological importance of photosynthesis:

Photosynthesis also plays an important role in maintaining the stability of ecosystems on Earth. Plants, through photosynthesis, reduce the amount of carbon dioxide in the atmosphere and increase the amount of oxygen, which provides a source of oxygen necessary for other life forms. In addition, the organic substances produced by plants serve as the basis of the food chain. Photosynthesis is also important in combating climate change, as plants absorb carbon dioxide and reduce its release into the atmosphere. Various studies are being conducted to make this process more efficient, for example, increasing the efficiency of photosynthesis through genetically modified plants. This process of photosynthesis supports the functioning of the entire biosphere and ensures the continuation of life on Earth. The process of carbon fixation in photosynthesis is one of the important biological processes by which plants, algae, and some bacteria convert solar energy into chemical energy. During photosynthesis, carbon dioxide (CO₂) is absorbed from the air and organic substances (mainly glucose) are formed. This process is not only a source of energy for plants, but is also vital for the entire biosphere.

Two main pathways of photosynthesis

The process of photosynthesis occurs in two main pathways:

1. Oxygenic photosynthesis (photosynthesis that produces O₂)

This type of photosynthesis occurs mainly in plants, green algae, and some bacteria. In oxygenic photosynthesis, the energy of sunlight splits water, forming oxygen (O₂) and hydrogen ions. This process occurs in two stages:

- Photon reaction or light reactions: Absorbing the energy of sunlight, water splits into oxygen and protons. In this process, oxygen (O_2) is produced and the energy is converted into ATP and NADPH molecules.

- Black reactions (Calvin cycle): In this stage, carbon dioxide (CO_2) is absorbed from the air and organic substances (such as glucose) are formed through a series of chemical reactions. The Calvin cycle ensures the absorption of carbon. In oxygenic photosynthesis, CO_2 molecules are mainly combined by the plant and converted into sugars through the Calvin cycle.

2. Oxygenic photosynthesis (photosynthesis that does not produce O_2)

Anoxygenic photosynthesis occurs in some bacteria, such as sulfide bacteria or some blue-green bacteria. This type of photosynthesis does not split water and does not produce oxygen. In oxygenic photosynthesis, carbon fixation also occurs from CO_2 , but there is no oxygen exchange.

Carbon fixation

The process of carbon fixation is related to the Calvin cycle of photosynthesis. Through this cycle, plants and other photosynthetic organisms convert solar energy into chemical energy and synthesize organic substances. This process consists of the following steps:

1. Carbon dioxide fixation: CO_2 molecules from the air are introduced into the chloroplasts. There, the carbon atoms react with ribulose diphosphate (RuBP).

2. Carbon fixation: CO_2 combines with RuBP to form 3-phosphoglycerate (3-PGA).

3. Reductive stage: 3-PGA is converted to organic compounds such as glucose using ATP and NADPH.

4. Regeneration: RuBP is regenerated and the cycle continues.

Carbon fixation during photosynthesis is extremely important for ecological systems. Carbon fixed by plants and photosynthetic organisms is the main source of organic matter necessary for plant growth and development. In

addition, photosynthesis reduces the amount of CO₂ in the atmosphere, helping to regulate the climate.

The process of carbon fixation in photosynthesis serves as an energy source for all life forms in the biosphere. The efficiency and importance of this process are of great importance not only for plants, but also for ecosystems on Earth as a whole. A better understanding of the ecological significance of photosynthesis and carbon fixation can be an important factor in the fight against climate change. Scientific research is ongoing to better understand and improve the process of carbon fixation during photosynthesis. By accelerating or increasing the efficiency of this process, it can significantly improve global food supply, reduce carbon in ecosystems, and help combat climate change.

1. Genetic engineering and increasing the efficiency of photosynthesis

Science is seeking to use genetic engineering methods to improve the process of photosynthesis. For example, it is possible to accelerate the Calvin cycle of photosynthesis and create plants that absorb more carbon. This will allow to increase plant growth and yield. These processes can be carried out in the following areas:

- Research related to the enzyme RuBP carboxylase/oxygenase (Rubisco): Rubisco is the main enzyme in carbon absorption in photosynthesis, but the efficiency of this enzyme can be low. Today, scientists are looking for ways to enhance the activity of this enzyme or create new variants.

- Conversion to the C₄ pathway of photosynthesis: C₄ photosynthesis is a more efficient form of photosynthesis. C₄ plants (e.g., corn) absorb more CO₂ and are more efficient at photosynthesis. Research is underway to convert C₃ plants to C₄ photosynthesis through genetic engineering.

- Increased carbon use efficiency: The chemical structure of plants can be optimized to fix carbon more quickly and convert it into organic matter. Such changes can lead to faster plant growth and yield.

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