

Chapter 11

Photosynthesis in Higher Plants

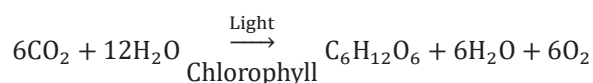
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INTRODUCTION

Photosynthesis is a pivotal biological process where in the green components of plants synthesize complex organic food substances, primarily carbohydrates. This intricate metabolic activity employs carbon dioxide and water in the presence of sunlight, generating carbohydrates while concurrently releasing oxygen as a by-product. The essence of photosynthesis lies in the conversion of solar energy into chemical energy, making it an anabolic, endergonic (energy-requiring), and oxido-reduction process.

The significance of photosynthesis extends beyond the mere sustenance of plants, as it profoundly influences our lives. All the food we consume, the fossil fuels we utilize, and even the air we breathe trace their origins back to photosynthesis. This process essentially transforms radiant solar energy into forms of energy accessible to biological systems.

Represented by a concise equation:



Central to photosynthesis is the green pigment chlorophyll, which plays a crucial role in capturing and utilizing light energy. This chapter delves into the intricate metabolic machinery underlying the photosynthetic process in plants, exploring the various phases and reactions responsible for converting light energy into chemical energy. Additionally, a thorough examination of the factors governing the rate of photosynthesis is conducted.

Importance of Photosynthesis

- The utilization of sunlight energy by plants in the process of photosynthesis serves as the fundamental bedrock of life on our planet. Food, constituting the stored energy derived from solar rays, is meticulously crafted by green plants through the intricate mechanism of photosynthesis, thus embodying the essence of sustenance on Earth. The importance of photosynthesis can be underscored through two pivotal aspects:
- **Primary Source of Food:** Photosynthesis stands as the primary source of sustenance for life on Earth. The manufacturing of food, orchestrated by green plants in collaboration with sunlight during

the photosynthetic process, represents the foundational energy reserve that fuels the diverse forms of life inhabiting our planet. This transformative process ensures the availability of essential nutrients and energy for the myriad organisms that rely on the organic compounds synthesized by plants.

- **Oxygen Production for Life Support:** Beyond its role in providing nourishment, photosynthesis plays a crucial role in maintaining the delicate balance of atmospheric gases. Green plants, as part of their photosynthetic endeavors, release oxygen into the atmosphere. This oxygen, a by-product of photosynthesis, becomes a life-sustaining element for a vast array of organisms across different ecosystems. The release of oxygen into the atmosphere is integral to the respiratory processes of numerous life forms, thereby contributing significantly to the overall vitality of Earth's biosphere.

WHAT DO WE KNOW?

The exploration into the intricacies of photosynthesis commenced approximately three centuries ago. Building upon the foundational knowledge acquired in preceding academic pursuits, our current understanding, substantiated by straightforward experiments, highlights the indispensable role of chlorophyll, light, and carbon dioxide (CO_2) in the process of photosynthesis.

- **Experiment Demonstrating the Necessity of Light and Chlorophyll:** A compelling experiment serves to underscore the vital requirements of light and chlorophyll for the occurrence of photosynthesis. A destarched potted plant, adorned with variegated leaves, becomes the subject of investigation. A select few leaves are diligently covered with black paper, effectively depriving them of direct sunlight. Following an exposure of the potted plant to sunlight for 1-2 hours, a comparative analysis is conducted. Subsequently, one leaf that was shielded from sunlight and another leaf that basked in the sun are subjected to starch testing. The outcome is revealing - the covered leaf exhibits a negative starch test, indicating the inability of photosynthesis to transpire in the absence of light. Conversely, the exposed leaf showcases distinct blue and yellow regions, signifying positive starch tests in the chlorophyll-rich areas.

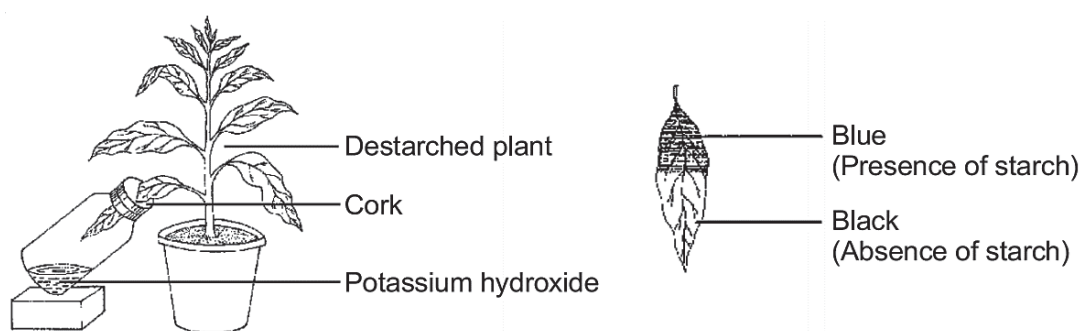


Fig. : Half leaf experiment

- **Experiment Demonstrating the Necessity of CO_2 (Moll's Half Leaf Experiment):** A pivotal experiment, known as Moll's Half Leaf Experiment, sheds light on the imperative role of carbon dioxide in the process of photosynthesis. In this experimental setup, a segment of a leaf is enclosed in a test tube containing cotton soaked in potassium hydroxide (KOH), known to absorb carbon dioxide. Simultaneously, the other half of the leaf remains exposed to the ambient air. Upon conducting starch tests on both halves of the leaf, a conclusive observation emerges - only the exposed portion of the leaf manifests a positive starch test. This unequivocally demonstrates the requirement of carbon dioxide for the photosynthetic process.