

## Brief Note on Significance of Absorption Spectra in Plant Biology

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### DESCRIPTION

An absorption spectrum is a fundamental concept in physics and chemistry that reveals the interaction between light and matter. It illustrates how atoms, molecules, or ions absorb specific wavelengths of electromagnetic radiation when subjected to it. When light passes through a substance, certain wavelengths are absorbed, causing distinct dark lines or bands to appear in the spectrum. These absorption patterns are unique to each substance and provide valuable information about its composition and properties. Absorption spectra play a critical role in fields such as spectroscopy, astronomy, and chemical analysis, enabling scientists to identify substances, study their energy levels, and gain insights into their behavior on a molecular level.

Light, as the primary energy source for photosynthesis, is pivotal to the process. Plants have evolved an array of pigments, most notably chlorophylls, carotenoids, and phycobilins, which are specialized molecules capable of absorbing specific wavelengths of light. The process begins when light strikes these pigments, exciting their electrons to higher energy states. This energy is then transferred through a series of pigment molecules until it reaches a specific chlorophyll molecule known as the reaction center. Here, the energy is used to initiate the chemical reactions that convert carbon dioxide and water into glucose and oxygen.

### Absorption spectrum

The absorption spectrum is a graphical representation that illustrates the wavelengths of light absorbed by a particular substance, in this case, plant pigments. It reveals which colors of light are most efficiently captured and used for photosynthesis. The absorption spectrum for plants typically shows peaks of absorption in the blue and red regions of the visible light spectrum. Chlorophyll, the primary pigment responsible for capturing light in photosynthesis, is a diverse family of pigments found in the chloroplasts of plant cells. There are two main types of chlorophyll in plants: Chlorophyll-a and chlorophyll-b. Each of these pigments absorbs light at slightly different wavelengths, contributing to the overall absorption spectrum of plants.

**Chlorophyll-a:** This pigment has two absorption peaks, one in the red region (around 665 nm-680 nm) and the other in the blue region (around 430 nm-450 nm). These peaks correspond to the wavelengths of light that chlorophyll-a is most efficient at absorbing. The absorbed energy is used to stimulate the initial steps of photosynthesis.

**Chlorophyll-b:** Chlorophyll-b, on the other hand, primarily absorbs light in the blue region (around 640 nm-660 nm) and the red-orange region (around 620 nm-640 nm). This pigment complements chlorophyll-a by capturing light at wavelengths that chlorophyll-a does not absorb as effectively.

**Green Gap:** The absorption spectrum also reveals a conspicuous gap in the green region of the spectrum, roughly between 500 nm-600 nm. This "green gap" occurs because chlorophyll pigments are relatively inefficient at absorbing green light. Instead, they reflect it, giving leaves their characteristic green color. As a result of this, plants appear green to our eyes, as the green wavelengths are not absorbed but rather bounce off the leaves and reach our retinas.

### Significance of absorption spectrum

**Efficient energy capture:** By targeting specific wavelengths of light for absorption, plants optimize their energy capture during photosynthesis. This selective absorption ensures that the energy absorbed is maximally effective in driving the chemical reactions that produce glucose and oxygen.

**Light adaptation:** Plants have evolved to thrive in various environments with different light conditions. Their ability to adjust the composition of pigments and their absorption spectra allows them to adapt to available light sources. For example, shade-adapted plants may have more chlorophyll-b, which absorbs blue light more efficiently than chlorophyll-a, to make the most of limited light.

**Environmental sensing:** The absorption spectrum also serves as a form of environmental sensing for plants. Changes in the quality and quantity of light can trigger responses in plants, such as altering growth patterns or activating protective mechanisms.

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**Received:** 25-Jul-2023, Manuscript No. JPBP-23-27184; **Editor assigned:** 27-Jul-2023, PreQC No. JPBP-23-27184 (PQ); **Reviewed:** 10-Aug-2023, QC No. JPBP-23-27184; **Revised:** 17-Aug-2023, Manuscript No. JPBP-23-27184 (R); **Published:** 24-Aug-2023, DOI: 10.35248/2329-9029.23.11.272.

**Citation:** Smerj I (2023) Brief Note on Significance of Absorption Spectra in Plant Biology. J Plant Biochem Physiol. 11:272.

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This information helps plants optimize their use of available resources.

**Photo protection:** The absorption spectrum also informs our understanding of photo protection mechanisms in plants. When light energy absorbed by pigments exceeds the plant's capacity for photosynthesis, harmful reactive oxygen species can be generated. Understanding the spectrum helps us comprehend how plants mitigate such risks through processes like non-photochemical quenching.

**Photochemistry and agriculture:** In agriculture and horticulture, knowledge of the absorption spectrum is essential for optimizing light conditions in controlled environments. Artificial lighting can be adjusted to provide the most beneficial wavelengths for plant growth and development, thereby increasing crop yields and quality.

**Plant breeding:** Plant breeders and genetic engineers use information about pigments and the absorption spectrum to

develop crop varieties with specific characteristics, such as drought resistance, pest resistance, or enhanced nutritional value.

## CONCLUSION

The absorption spectrum is a phenomenal aspect of plant biology that shows the complex interaction between plants and light. It showcases nature's precision in capturing specific wavelengths of light for the vital process of photosynthesis. This colorful spectrum not only helps plants to grow in diverse environments but also holds practical implications for agriculture, horticulture, and scientific research. As we continue to explore the complexities of plant biology, our understanding of the absorption spectrum and its applications will become more complex. This information shows the complex network of responses and adaptations that enable plants to flourish and contribute to the significant life on Earth.