


Topic 06

**BotanY**



@Millersville University

Photosynthesis

Hoefnagles (2018) Chap. 5

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**I. Introduction**

**A. Summary Eqn**

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

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



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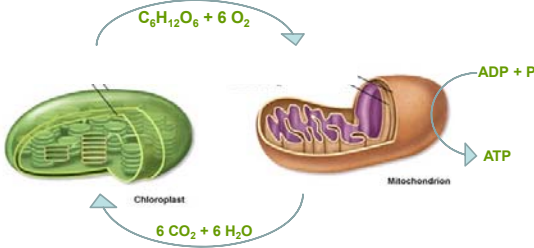
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**I. Introduction**

**B. Destiny of carbohydrates**

1. ATP needs



Chloroplast

Mitochondrion



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**I. Introduction**

**B. Destiny of carbohydrates**  
**2. Various Organics**

6 O<sub>2</sub>

C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>

Starch  
 Cellulose  
 Amino Acids  
 Lipids  
 Pigments  
 Floral Fragrances  
 Hormones  
 Alkaloids  
 THC  
 Etc.

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**I. Introduction**

**C. Light & Pigments**

Light

Chloroplast

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**I. Introduction**

**C. Light & Pigments**

**1. Electromagnetic Spectrum**  
**a. EM radiation speed is constant**  
**186 K mi/sec (300 K km/sec)**

Increasing wavelength

Increasing energy

Gamma rays X rays Ultra-violet Infrared Microwaves Radio

Wavelength (m)

Frequency (s<sup>-1</sup>)

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**I. Introduction**

C. Light & Pigments

1. EM Spectrum

a. EM radiation speed is constant

b. Wavelength ( $\lambda$ ) varies / E varies

Wavelength (m)

Frequency (s<sup>-1</sup>)

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**I. Introduction**

C. Light & Pigments

1. EM Spectrum

a. EM radiation speed is constant

b. Wavelength ( $\lambda$ ) varies / E varies

Wavelength (m)

Frequency (s<sup>-1</sup>)

c. Sun releases UV, visible, IR

400 500 600 700 750 nm

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**I. Introduction**

d. Photosynthesis Action Spectrum falls within visible light.

Rate of photosynthesis (measured by O<sub>2</sub> release)

$\lambda$

Action Spectrum for Photosynthesis

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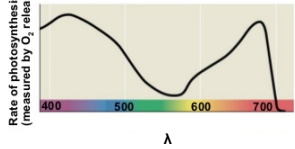
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**I. Introduction**

d. Photosynthesis Action Spectrum falls within visible light.



Rate of photosynthesis (measured by O<sub>2</sub> release)

λ

Action Spectrum for Photosynthesis

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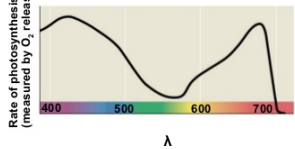
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**I. Introduction**

d. Photosynthesis Action Spectrum falls within visible light.



Rate of photosynthesis (measured by O<sub>2</sub> release)

λ

Action Spectrum for Photosynthesis

- 1) Shorter λ's too energetic
- 2) Longer λ's E too low.
- 3) Green & Yellow Green λ's not absorbed

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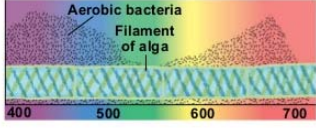
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**I. Introduction**

d. Photosynthesis Action Spectrum falls within visible light.



Aerobic bacteria  
Filament of alga

400 500 600 700

λ

- 1) Shorter λ's too energetic
- 2) Longer λ's E too low.
- 3) Green & Yellow Green λ's not absorbed
- 4) Theodor Engelmann's (Germany) 1883 experiments.

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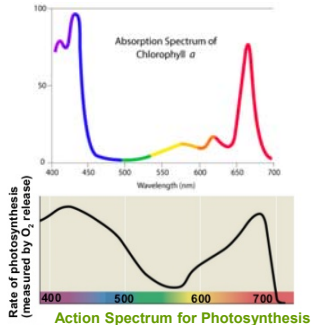
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**I. Introduction**

2. Which pigments are important?

a) Absorption spectrum for chlorophylls



The graph shows the absorption spectrum of Chlorophyll a (top) and the action spectrum for photosynthesis (bottom). The x-axis is Wavelength (nm) from 400 to 700. The y-axis for the top graph is relative absorption (0-100). The y-axis for the bottom graph is Rate of photosynthesis (measured by O<sub>2</sub> release). The absorption spectrum has peaks at ~430 nm and ~660 nm. The action spectrum shows a broad range of activity with peaks at ~400 nm and ~680 nm.

Rate of photosynthesis (measured by O<sub>2</sub> release)

Action Spectrum for Photosynthesis

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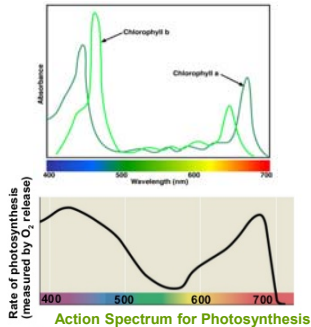
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**I. Introduction**

2. Which pigments are important?

a) Absorption spectrum for chlorophylls



The graph shows the absorption spectra of Chlorophyll a and Chlorophyll b (top) and the action spectrum for photosynthesis (bottom). The x-axis is Wavelength (nm) from 400 to 700. The y-axis for the top graph is Absorbance. The y-axis for the bottom graph is Rate of photosynthesis (measured by O<sub>2</sub> release). Chlorophyll a peaks at ~660 nm, and Chlorophyll b peaks at ~450 nm. The action spectrum shows peaks at ~400 nm and ~680 nm.

Rate of photosynthesis (measured by O<sub>2</sub> release)

Action Spectrum for Photosynthesis

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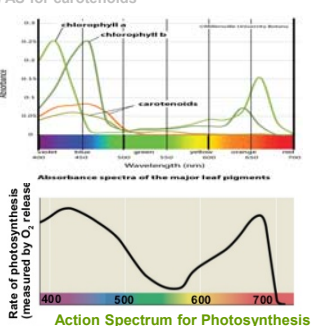
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**I. Introduction**

2. Which pigments are important?

a) Absorption spectrum for chlorophylls

b) AS for carotenoids



The graph shows the absorbance spectra of Chlorophyll a, Chlorophyll b, and Carotenoids (top) and the action spectrum for photosynthesis (bottom). The x-axis is Wavelength (nm) from 400 to 700. The y-axis for the top graph is Absorbance. The y-axis for the bottom graph is Rate of photosynthesis (measured by O<sub>2</sub> release). Chlorophyll a peaks at ~660 nm, Chlorophyll b at ~450 nm, and Carotenoids at ~400 nm. The action spectrum shows peaks at ~400 nm and ~680 nm.

Rate of photosynthesis (measured by O<sub>2</sub> release)

Action Spectrum for Photosynthesis

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### I. Introduction

2. Which pigments are important?

- a) Absorption spectrum for chlorophylls
- b) AS for carotenoids
- c) Necessary: Chl. a
- d) Accessory Pigments:
  - Chl. b
  - Carotenoids

chlorophyll b  
chlorophyll a  
xanthophyll  
β-carotene  
lutein  
lycopene

Absorption

Wavelength (nm)

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### II. Process Review

A. Where?

- Chloroplasts of mesophyll.
- Specifically in thylakoids (light rxns) & stroma (light-inde rxns)

Outer membrane  
Intermembrane space  
Inner membrane  
Thylakoids  
Stroma

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### II. Process Review

B. Light Rxns

1. Photosystems

light

stroma  
thylakoid  
lumen of thylakoids

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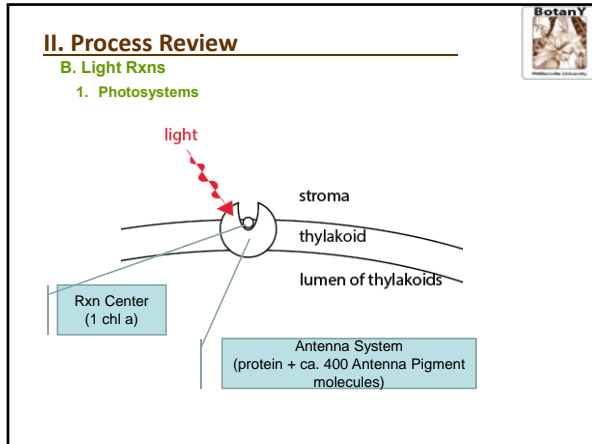
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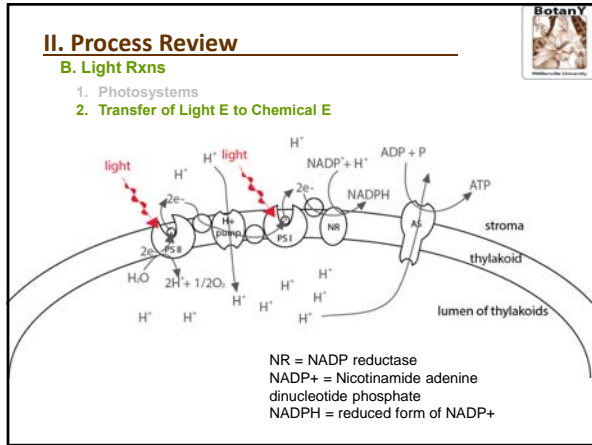
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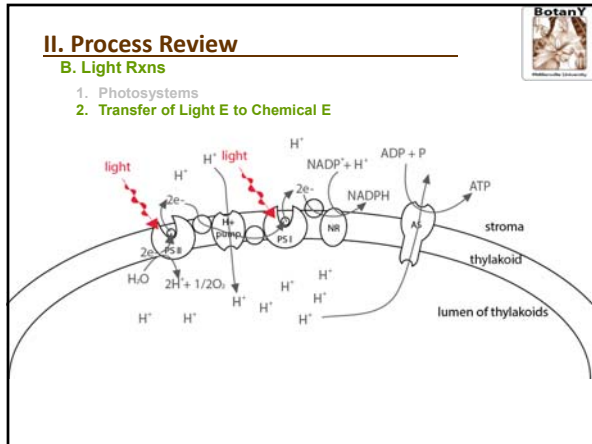
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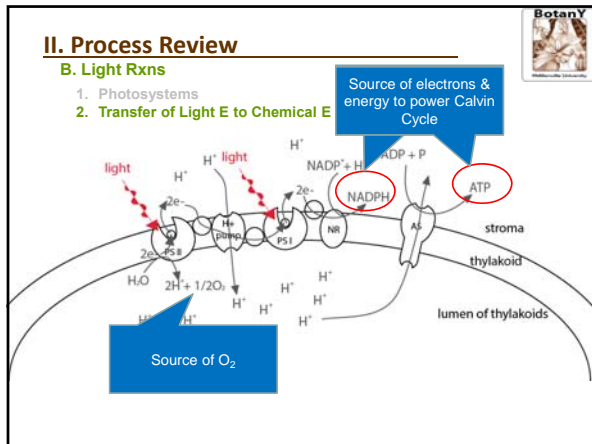
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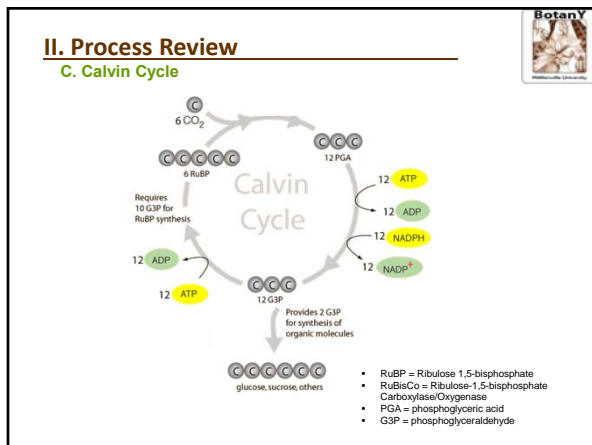
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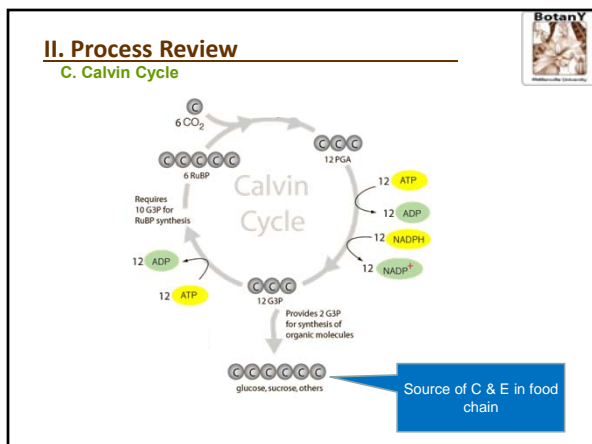
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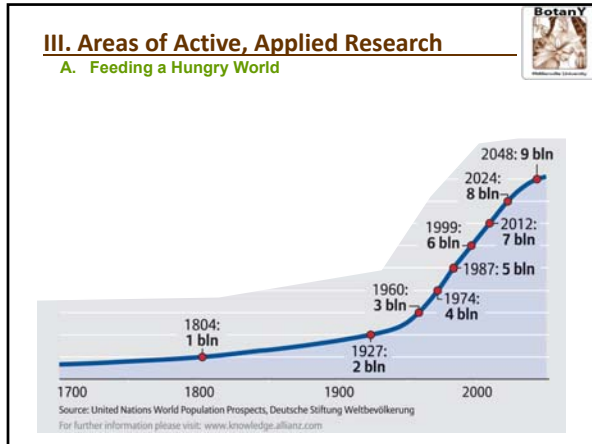
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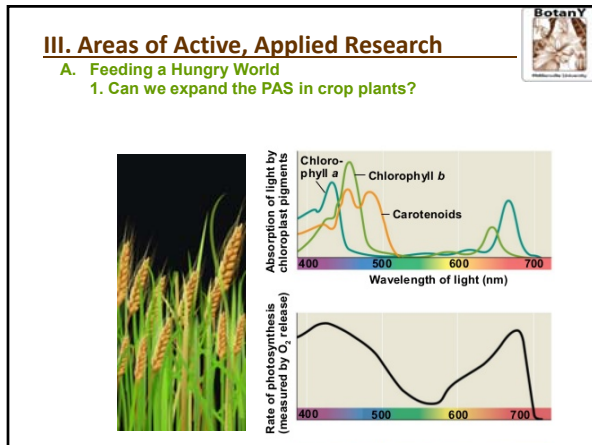
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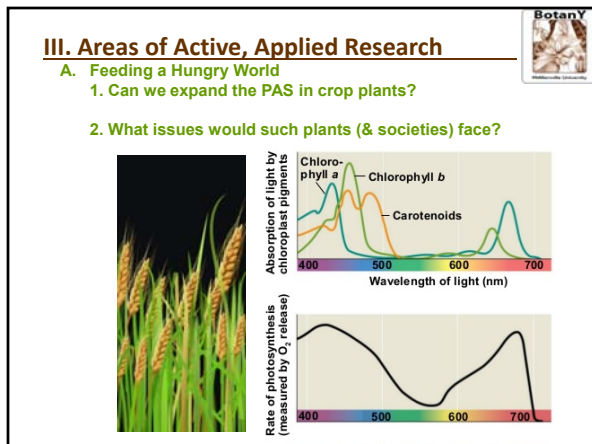
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**III. Areas of Active, Applied Research**  
B. Mitigating Climate Change



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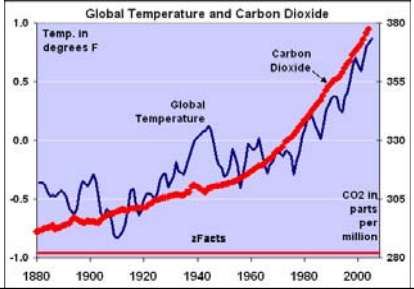

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**III. Areas of Active, Applied Research**  
B. Mitigating Climate Change  
1. Facts  
a. The Earth is warming. CO<sub>2</sub> is a greenhouse gas.



The graph shows two data series from 1880 to 2000. The left y-axis represents 'Temp. in degrees F' ranging from -1.0 to 1.0. The right y-axis represents 'CO2 in parts per million' ranging from 280 to 380. The x-axis shows years from 1880 to 2000 in 20-year increments. A blue line represents 'Global Temperature', which shows seasonal fluctuations but a clear upward trend starting around 1950. A red line represents 'Carbon Dioxide', which shows a steady, accelerating increase from approximately 280 ppm in 1880 to over 380 ppm in 2000. The text 'zFacts' is visible at the bottom of the graph area.

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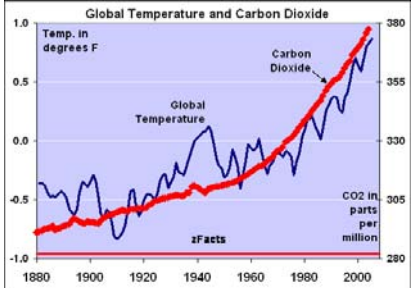

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**III. Areas of Active, Applied Research**  
B. Mitigating Climate Change  
1. Facts  
a. The Earth is warming. CO<sub>2</sub> is a greenhouse gas.  
b. Photosynthesis removes CO<sub>2</sub> from atmosphere.  
 $6 \text{ CO}_2 + 6 \text{ H}_2\text{O} \gggggg \text{ C}_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2$



The graph is identical to the one in the middle section, showing the correlation between rising global temperatures and increasing atmospheric CO<sub>2</sub> levels from 1880 to 2000. The text 'zFacts' is visible at the bottom of the graph area.

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**III. Areas of Active, Applied Research**

**B. Mitigating Climate Change**

**2. Storing Carbon**

a. Plants remove CO<sub>2</sub> from atmosphere. Store it in their bodies.

**b. Landscapes with greater biomass store more carbon**



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**III. Areas of Active, Applied Research**

**B. Mitigating Climate Change**


**2. Storing Carbon**

a. Plants remove CO<sub>2</sub> from atmosphere. Store it in their bodies.

b. Landscapes with greater biomass store more carbon

**c. Could algae be used to remove CO<sub>2</sub> from atmosphere?**

1) Algal Farms positioned near river deltas to exploit nutrient-rich waters that could otherwise cause Dead Zones.



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**III. Areas of Active, Applied Research**

**B. Mitigating Climate Change**

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**c. Could algae be used to remove CO<sub>2</sub> from atmosphere?**

1) Algal Farms positioned near river deltas to exploit nutrient-rich waters that could otherwise cause Dead Zones.

2) Collect algae before they die and are decomposed and could cause Dead Zones



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**III. Areas of Active, Applied Research**

B. Mitigating Climate Change

2. Storing Carbon

a. Plants remove CO<sub>2</sub> from atmosphere. Store it in their bodies.


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**c. Could algae be used to remove CO<sub>2</sub> from atmosphere?**

1) Algal Farms positioned near river deltas to exploit nutrient-rich waters that could otherwise cause Dead Zones.

2) Collect algae before they die and are decomposed and could cause Dead Zones

3) Sequester algae in CO<sub>2</sub>-free "land fills" or use to make biodiesel



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**III. Areas of Active, Applied Research**

B. Mitigating Climate Change

2. Storing Carbon

3. C-neutral biofuels

a. Keep fossil fuels in the ground

b. Grow plants/algae and convert to ethanol or biodiesel



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**III. Areas of Active, Applied Research**


B. Mitigating Climate Change

2. Storing Carbon

3. C-neutral biofuels

a. Keep fossil fuels in the ground

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Topic Done.



A rectangular box containing the text "Topic Done." in the top left corner. In the top right corner of the box is a small square logo with the word "Botany" above an illustration of a plant. The rest of the box is empty.

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