Slide 1

Light and Photosynthesis

Lecture 10

Learning Outcomes

- Definition of Photosynthesis
- Equation for Photosynthesis
- Chloroplasts and Chlorophyll
- Different plants metabolisms

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Increasing energy 10 ⁻⁵ mm 10 ⁻³ nm 1 nm 10 ³ nm 10 ⁸ nm 1 m 10 ³ m Samma X-rays UV Infrared Wicers Radio varies Visible light Visible light Wavelength (nm)	 Light travels as waves Wavelengths in nanometers (nm) Visible light between 380 and 750nm Energy 'packages' in light = PHOTONS
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Photosynthesis

- Process by which plants use light energy to make food molecules from carbon dioxide (CO₂) and water (H₂O)
- Most important chemical process on earth
- Provides food supply for virtually all organisms on earth



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Raw Materials for Photosynthesis



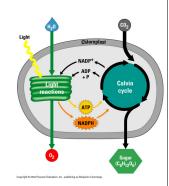
- · Carbon Dioxide CO2
 - Obtained from air via stomata
- Water H₂O
 - Obtained from soil via
- Sunlight
- Inorganic minerals
 Nitrate NO-3
 Magnesium Mg2+

Overall Equation for Photosynthesis $6 \text{ CO}_2 + 6 \text{ H}_2\text{O} \xrightarrow{\text{Light energy}} \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2$ Carbon Water dioxide Glucose Oxygen

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Photosynthesis Overview

- Light Dependent Reaction
- in thylakoid membranes
- Light energy converted into ATP
- Water split
 - electrons from water → NADPH
- Light Independent Reactions
- Calvin Cycle synthesize carbohydrate

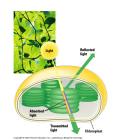


Chlorophyll

- · Chlorophyll a
 - Absorbs blue-violet and red light
 - Green is reflected
- · Chlorophyll b
 - Blue and orange
 - Green is reflected



- Absorb blue-green
- Reflect yellow- orange





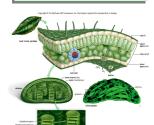
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Accessory Pigments



- Xanthophylls
- Carotenes
- Beta carotene
- Converted to Vitamin A in body
- Absorb shortwave blue and violet light
- Reflects orange and yellow light

Chloroplasts



- Double membrane bound organelle
- Site of photosynthesis

· Thylakoid membranes

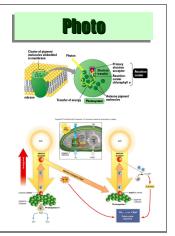
- Chlorophyll embedded in membranes
- Light reactions
- Organized in stacks or 'grana'

· Liquid stroma

- Calvin cycle

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- Light energy captured by pigments
- Energy used to synthesize ATP molecules
- Hydrogen + electrons used to synthesize sugars
- H₂O Water molecule split
- Oxygen gas byproduct



Rubisco



- · RuBP Carboxylase
- Enzyme catalyzes joining of CO_2 to RuBP (Ribulose BiPhosphate) a 5carbon sugar
- First step in Calvin-Benson Cycle

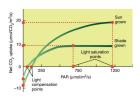
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Calvin Cycle - Synthesis Synthesis requires energy ATP produced in light reaction Hydrogen + electrons CO₂ fixation Rubisco enzyme catalyzes Phosphogycerate (3C) in C3 plants End product G3P (Glyceraldehyde 3 Phosphate) → Sugars → Starch → Cellulose → Hitrogen Proteins

Plant Response to Light As level of light increases Plant increases Plant increases the rate of photosynthesis Light Saturation Point - Maximum rate of photosynthesis Light Saturation Point - Maximum rate of photosynthesis Compensation point - Light intensity where photosynthesis = respiration no net gain of energy - Varies by species

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Adaptations to Shade



- Light (therefore ATP energy) limiting factor
- Plants produce more chlorophyll
- Lower compensation point allows some carbon gain at low light intensity
- · Lower energy demands
- Synthesize less rubisco
- At high light intensity light saturationpoint low due to lack of Rubisco

Redwood Sorrel

- Habitat floor of Redwood Forests CA and OR
- Adaptations to grow in shade
- 1/200th intensity of full sunlight
- Leaves fold down when exposed to full sun
- · Visible to eye

