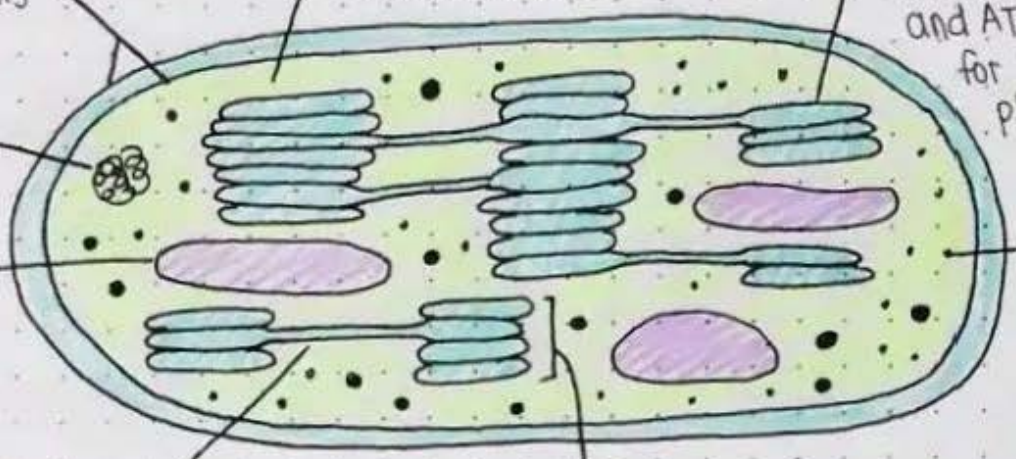
PHOTOSYNTHESIS

STRUCTURE OF CHLOROPLAST



double membrane
evidence for endo-symbiosis

Stroma
has appropriate enzymes and suitable pH

thykaloid
has electron transport chain and ATP synthase for photophos-phorylation

circular DNA

Starch granule

ribosome

lamella
Connects and separates thykaloid stacks maximizing photosynthetic efficiency

granum
Stacks that increase SA : V ratio. Small volumes quickly accumulate ions

STAGES OF PHOTOSYNTHESIS

light energy

light dependent reaction

water → oxygen → diffuses out of chloroplast

water → hydrogen

chlorophyll → chemical energy

e⁻ → NADPH

ATP

diffuses into chloroplast → carbon dioxide

NADPH + ATP → carbon fixation

light independent reaction

carbon fixation → organic compounds

Photosynthesis

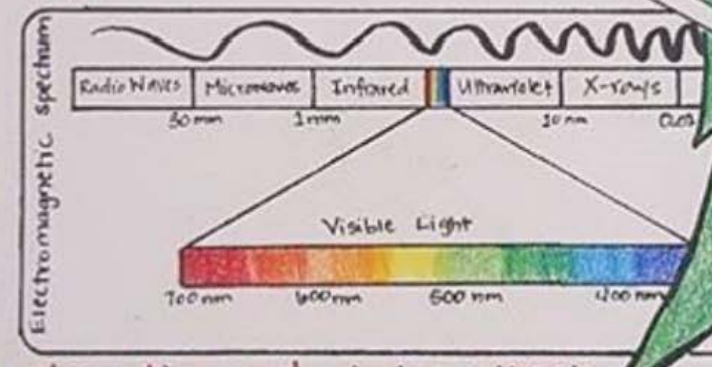
Sun

Definition: A process that captures and transforms light energy from the sun and store it in high-energy sugar molecules.

Different types of chlorophyll absorb different wavelengths of light. Unabsorbed wavelengths get reflected.

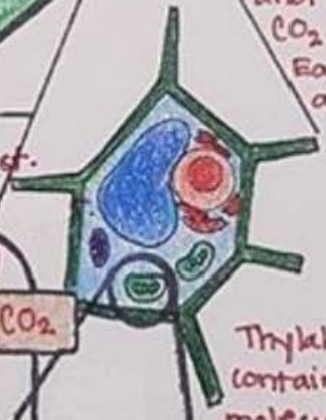
Light is a form of energy called electromagnetic radiation. Electromagnetic radiation travels in waves of various wavelengths.

Light & Photosynthesis



Helps regulate Earth's environment. Produces the O_2 we breathe, and it removes CO_2 from Earth's atmosphere.

Light absorption and photosynthesis take place inside an organelle called a chloroplast.



Thylakoids contain pigment molecules called chlorophyll.

Light-dependent

Light-independent

light energy

H_2O

O_2

Takes place in the thylakoids. Main function is to capture and transfer light energy. "photo" part

NADP+

ADP

Calvin Cycle
The "synthesis" part. Take place in stroma.

CO_2

sugar

P

ATP

energy stored in bonds

e^- e^-

H^+

NADPH

energy-carrying molecules

light

Stroma

thylakoid

chloroplast

Stages of Photosynthesis

$$6CO_2 + 6H_2O \rightarrow\rightarrow\rightarrow 6O_2 + C_6H_{12}O_6$$

(glucose)

INTRO TO photosynthesis

primary producers on earth →

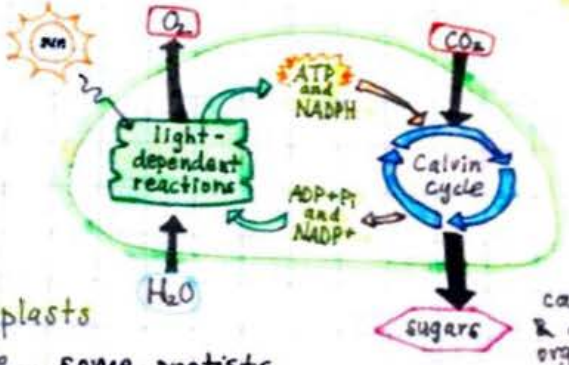
PHOTOAUTOTROPHS
- → makes food through light energy from sun
- → converts light energy into chemical energy, which uses it to assemble complex organic molecules from simple inorganic raw materials

- → producers use the organic molecules they create as energy sources & own building blocks
- → serve directly/indirectly as consumers' food
  - ↳ use organic molecules obtained as building blocks for own cells
- → both eventually become energy for decomposers
  - ↳ material ultimately returns to simple inorganic molecules, completing the energy cycle

* cycling of matter through producers, consumers, and decomposers is NOT infinite.

- second law of thermodynamics states entropy's energy loss

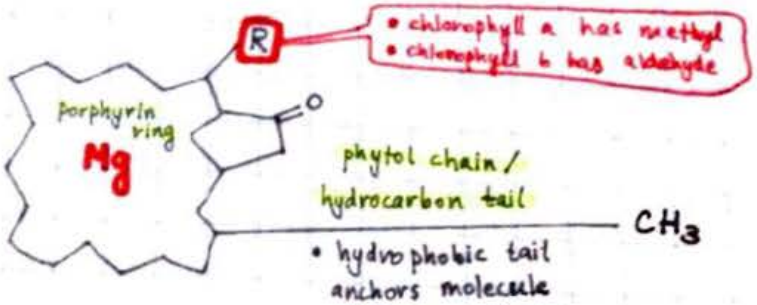
→ some useful free energy is lost at each stage of the cycle; therefore a continual input of free energy from the sun is required for life to continue



* photosynthesis occurs in the chloroplasts
  - ↳ carried out by plants, algae, some protists and cyanobacteria

- CHLOROPHYLL -

- begins process of photosynthesis
- absorbs light energy
- multiple types: **chlorophyll a** (blue-green) **chlorophyll b** (yellow-green)



- hydrophobic tail anchors molecule into a membrane

composed of porphyrin ring attached to a hydrocarbon tail

orphyrin → light absorbing portion; has magnesium in the centre

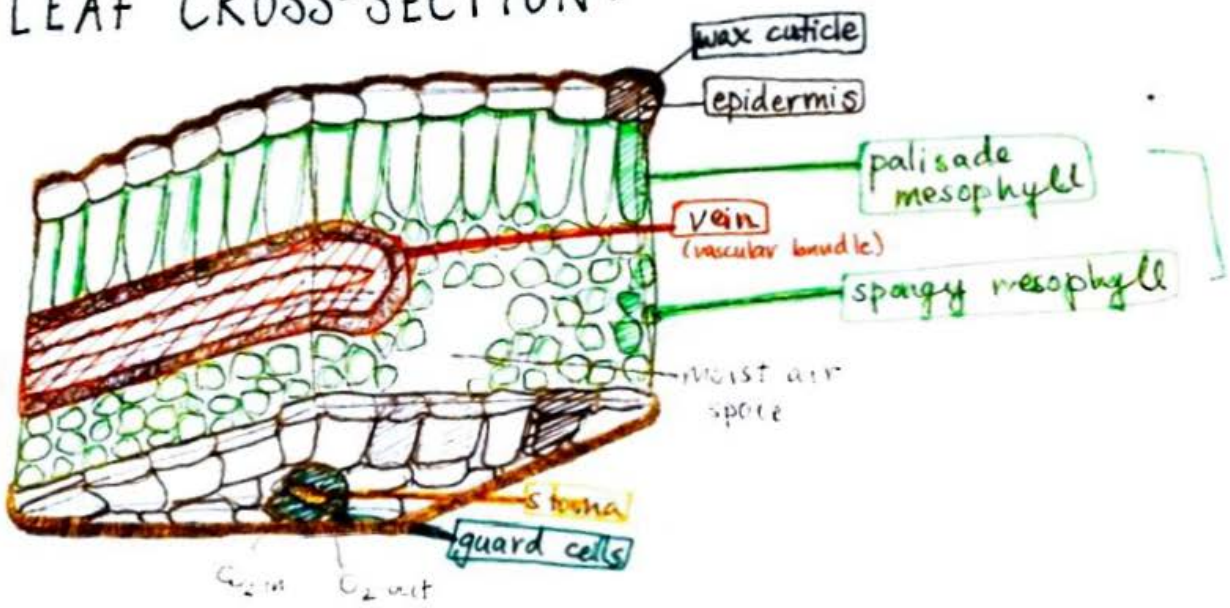
erent functional groups in chlorophyll a/b result in different types of light absorbed

phyll a → primary light-absorbing pigment

PHOTOSYNTHETIC STRUCTURES

→ In leaves, the structure and arrangement maximizes the surface area exposed to sunlight & limits distances gases need to travel to reach chloroplasts

< LEAF CROSS-SECTION >



waxy cuticle : covers surface of leaf, water resistant ; protects leaf from excessive absorption of light and evaporation of water

epidermis : transparent, colourless layer that allows light to pass through to get to the mesophyll layer

palisade & spongy mesophyll : chloroplasts are most abundant here and majority of photosynthesis takes place here

guard cells : epidermal cells that create openings and regulate them

stomata : openings on leaf that allow for exchange of gases, also allows escape of water vapour via transpiration

veins : aka vascular bundles transport water & minerals from roots to leaves and carry carbohydrates from leaves to roots

PROKARYOTIC AUTOTROPHS: cyanobacteria

(cyano bacteria) → largest group of photosynthesizing prokaryotes (aka blue-green algae)
- blooms can be caused by fertilizers/detergents
- live in many different environments w/ nutrient-rich water; can be toxic/pose environmental hazard

↑ closely related to chloroplasts; likely the first organisms to use sunlight to produce oxygen
↳ lack membrane-bound organelles and use infoldings as sites of photosynthesis & respiration

cyanobacteria paved the way for heterotrophic life on earth

EUKARYOTIC AUTOTROPHS: algae & plants

- algae, some protists, and plant cells have chlorophyll located in the chloroplasts → creates green colour
↳ leaves are primary photosynthetic organs

→ chloroplasts only in leaves & stems (only those areas can photosynthesize)

PHOTOSYNTHESIS EQUATION

→ overall process of photosynthesis:

$$6CO_2 + 6H_2O + \text{light energy} \xrightarrow{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

carbon dioxide; water; glucose; oxygen

→ produces glucose or other simple sugars
→ essentially the reverse of cellular respiration
→ plant must contain to photosynthesize:
- chlorophyll
- CO_2
- water
- light energy