PHOTOSYNTHESIS

8.1 - ANATOMY of LEAF FIG 8.3

- Mesophyll - interior of leaf
  - most chloroplasts located here
- STOMATA - pores - O_2, CO_2 enter/exit

CHLOROPLASTS

- double-membraned - (WHY?) → evolutionary history → endosymbionts
- thylakoids → contain chlorophyll (magnesium at center)

↓

porphyrin RING → hemoglobin is another → complexed with metal ions.

→ A grana is a STACK of thylakoids (plural GRANUM)

→ stroma is FLUID inside chloroplast

H_2O Splitting

★ electrons are transferred along with hydrogen ions to carbon dioxide, reducing the carbon dioxide to SUGAR

↳ the source of the O_2 given off by photosynthesis.

- FIG 8.5

- Inputs and Outputs of Photosynthesis

LIGHT REACTIONS → thylakoid membrane
CALVIN CYCLE → stroma

CARBON FIXATION → the incorporation of the CARBON from carbon dioxide INTO ORGANIC COMPOUNDS

8.2

PHOTONS - ?? particle? wave?
$\lambda\nu = c$; $\Delta E = h\nu$

- visible light → 380 nm - 750 nm

chorophyll a - blue-green
chlorophyll b - olive-green
carotenoids - yellow-orange

↳ photoprotection
↳ also in human eye
↳ ??? VITAMIN A - carrots - eyesight?

PHOTOSYSTEM

ANATOMY → Reaction Center Complex surrounded by light-harvesting complexes.

Key Terms & Concepts

(1) "Special pair of chlorophyll a molecules"

⇓ P680 in PS II

⇓ P700 in PS I

(named for wavelength they best absorb)

(2) Primary electron acceptor (varies)

(3) Cytochrome complex – cyt b_6f

– is a pump that used e^- to pump 4 H^+ into thylakoid space that results in proton-motive force that powers the ATP synthase

↳ the ATP synthase is oriented with the production side in the stroma and the ATP is then available for the CALVIN CYCLE

FIG 8.16

(4) An enzyme is required for the splitting of the H_2O molecule (complex contains a Mn ion!)

(5) Plastoquinone (Pq) carries e^- to the cytochrome b_6f complex

(6) Plastocyanin (Pc) carries e^- to PS I

(7) Ferredoxin (Fd) carries e^- to NAPH+ reductase → which takes up a H^+ from stroma to produce NADPH !!

8.3 Calvin Cycle

- G3P (glyceraldehyde 3-phosphate) is final product [one produced for use, **five** go back into cycle]

- Rubisco (enzyme) - ribulose biphosphate carboxylase ⇒ gets the process started by fixed a C from CO_2 to RuBP (ribulose 1,5 - biphosphate)

⇒ ATP and NADPH from the light reactions are used to phosphorylate and reduce to ① create G3P; and to ②: convert 5 G3P (15 carbon total) into 3 RuBP (15 carbon total)

See Diagrams on p. 172 text

Photo-respiration

→ Although Rubisco preferentially ADDS CO_2 to ribulose 1,5-biphosphate (RuBP) it CAN use O_2 as a substrate in place of CO_2

AND ....

> if the concentration of CO_2 is LOW ⇒ it will ADD O_2 to ribulose 1,5-biphosphate (RuBP) instead !!

→ This is the first step in a pathway called photorespiration

⇓

effect is to use up O_2 AND liberate CO_2 WITHOUT the production of useful energy stores.

→ About 1/3 of the CO_2 fixed is lost again as CO_2 because of photorespiration.

→

- when plants are forced to close their stomata because of heat and resulting H_2O loss, CO_2 levels drop and <u>photorespiration</u> kicks in

→ MOST PLANTS ARE <u>C-3 plants</u>

↳ carbon is captured into 3-carbon compound called 3-phosphoglycerate

→ C4 plants (corn, sugar cane) are special adaptations

→ rubisco is only contained in the chloroplasts of <u>bundle-sheath cells</u> (FIG 14-40 Albert)

↳ surrounded by mesophyll cells that <u>pump</u> carbon dioxide into the bundle-sheath cells <u>VIA</u> a 4-carbon "shuttle" molecule which breaks down into CO_2 and 3-carbon molecule which goes back to mesophyll to recharge into 4C again

BOTTOM <u>LINE</u> → CO_2 gets highly concentrated in Bundle Sheath cells & photorespiration avoided.

CAM PLANTS (pineapples, cacti, succulents)

- open stomata AT night and close during day

↳ CO_2 taken up AT NIGHT and fixed INTO CRASSULACEAN ACID

↳ mesophyll cells store the CO_2 in the organic ACID(s) overnight and in daytime the CO_2 is released and available to combine with ATP and NADPH from LIGHT reactions to synthesize SUGARS

C4	CAM
Spatial separation of steps corn, sugar cane	Temporal separation of steps cacti, succulents.

☆ MOST plants are C3 !!