

## Chpt 10: Photosynthesis

Autotrophs: organisms capable of capturing E from inorganic materials and turning it into organic compounds

- Photoautotrophs: do this by capturing E from the sun

organisms must have chlorophyll

some bacteria: blue-green bacteria

some Protistans: plant-like protists

K. Plantae: all plants

no fungi, no anims

- Chemoautotrophs: capture E by oxidizing inorganic substances, Fe, S & using these to make organic compds

done by bacteria deep in soil, deep in ocean, other extreme environmts

What do you know about light?

made of particles called photons

travels in waves

wavelength: distance btw peaks of waves

longer  $\lambda$ , less E; shorter  $\lambda$ , more E

Electromagnetic spectrum: usable E waves

gamma, X, UV, vis It, infrared, radiowaves

shorter  $\lambda$  -----> longer  $\lambda$

more E -----> less E

visible It are  $\lambda$  anims can detect w/photo-sensitive cells (rods & cones) eyes

we sense those  $\lambda$  as colors, ROY G BIV  
violet, indigo, blue, green, yell, orange, red

shorter  $\lambda$  -----> longer  $\lambda$

more E -----> less E

sunlight contains a blending of all colors

how do we really know they are all there?

what makes a rainbow?

when light strikes object, 3 things can happen:

1-reflected: bounces off, gives us color we see

2-transmitted: goes through object

3-absorbed: goes into object

object that reflects all  $\lambda$  -----> white

obj that absorbs all  $\lambda$  -----> black

black: absence of color

white: combination of all colors

pigments: molecules that absorb certain  $\lambda$  of  
light and reflects others

color reflected is color we see

green shirt: green  $\lambda$  is reflected, blues and  
reds are absorbed

white shirt: all  $\lambda$  reflected

what about black?

why are you told to wear white outside on a  
hot summer's day and not black?

chlorophyll is green pigment

green is reflected, blue, violet, & red absorbed

look at absorption spectrum of light p. 191

(also on website link)

2 types chlorophyll: a & b

chlorophyll a: primary photosynthetic pigment

chlorophyll b: secondary photosyn. pigment

there are also other accessory pigments

carotenes: reds & oranges

xanthophylls: yellows

phycocyanins: blues & purples

sometimes pigments mask chlorophyll, but it is

always there

chloroplasts: cellular organelle containing chlorophyll

plants cells contain from 1----->several 1000 chloroplasts

protistans usually have several chloroplasts

blue-green bacteria: no chloroplasts,  
chlorophyll a floats freely in cell

chloroplasts have particular structure

surrounded by double membrane

inside are thylakoids: disks containing chlorophyll

disks are stacked into grana (granum)

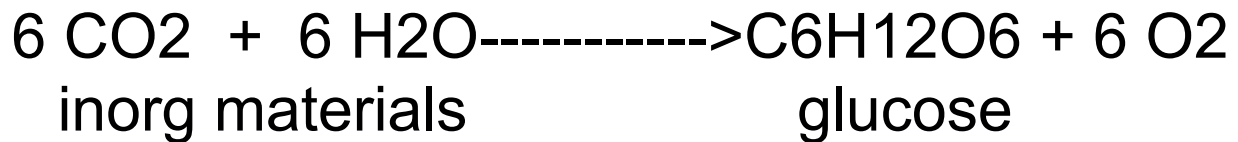
stacks are called photosystems or light-collecting units

thylakoids & grana are surrounded by stroma

stroma: gel-like substance

enzymes are present in stroma

## Photosynthesis



rx does not happen in one step

3 main E conversions

1-absorption of light E

2-conversion of light E----->chemical E

3-storage of chemical E into glucose

2 main sets of reactions

1-light rx or light-dependent rx (It required)

2-dark rx or light-independent rx

can take place in light or dark

## Light Rx

take place in grana (stacks of thylakoids)  
called photosystems I & II  
grana contains enzymes

3 major events happen

- light E is captured
- H<sub>2</sub>O is split
- ATP is made, NADPH<sup>+</sup> is produced  
(nicotinamide adenine dinucleotide  
phosphate)

## Light Rx

light strikes chlorophyll molecule

chlorophyll pigment absorbs light E

e- within pigment become "excited" or "energized"

e- jumps to higher E level

then e- moves by series of steps called e-transport system (ETS), transferring e- from one molecule to another (oxidation/reduction rx) finally releasing E to make ATP

-some E is used to split H<sub>2</sub>O or oxidize H<sub>2</sub>O  
called photolysis  $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{e}^- + \text{O}_2$   
O<sub>2</sub> is released to atmosphere

-the e- replace chlorophyll e- lost by PSI

-H<sup>+</sup> is attached to NADP-----> NADPH  
this goes to dark rx

-ATP also goes to dark rx

Dark Rx cannot run without light rx  
need  $H^+$  from NADPH  
need ATP  
can't get either of these without sunlight

Dark Rx or light-independent rx  
can occur in light or dark  
also called Carbon fixation rx  
also called Calvin cycle  
named after Melvin Calvin who worked  
out biochemistry in 1950's

- glucose is made in dark rx
- occurs in stroma of chloroplasts
- each turn of the Calvin cycle fixes one molecule of  $CO_2$

steps of dark rx

CO<sub>2</sub> is fixed by RuBP

makes unstable 6 C sugar

6 C sugar splits into 2 molecules PGA

PGA phosphoglyceric acid 2- 3 C comp  
using E fr. ATP, H fr. NADPH<sub>2</sub>, convert 2 PGA  
to 2 molecules PGAL

phosphoglyceraldehyde

take off C ----->will be used to make glucose

5 C are left, convert these by series of steps  
back to RuBP

cycle runs 6 times----->makes one glucose

the sugars that are produced by this process go  
to leaf cells of plants

the plants use it for their own food & E for  
growth

-some sugar-phosphates are converted to lipids  
& proteins to make plant structures

-some sugars are converted to starch & stored

-some converted to sucrose C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>