Chpt 10: Photosynthesis

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

-Photoautrotrophs: 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

-Chemoautrotrophs: 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  , less E; shorter  , more E

Electromagnetic spectrum: usuable E waves
gamma, X, UV, vis lt, infrared, radiowaves
shorter  ----------> longer 
more E ----------> less E

visible lt are  anims can detect w/photo-sensitive cells (rods & cones) eyes
we sense those  as colors, ROY G BIV
violet, indigo, blue, green, yell, orange, red
shorter  ----------> longer 
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 lt λ ----------> white
obj that absorbs all lt λ ----------> black
black: absence of color
white: combination of all colors
pigments: molecules that absorb certain λ of light and reflects others
color reflected is color we see
green shirt: green λ is reflected, blues and reds are absorbed
white shirt: all λ 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 pigmt
  - chlorophyll b: secondary photosyn. pigmt

there are also other accessory pigmts
- 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

$6\ CO_2 + 6\ H_2O \text{----------} > C_6H_{12}O_6 + 6\ O_2$

inorg materials glucose

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
- -H2O is split
- -ATP is made, NADPH+ is produced
  (nicotinamide adenine dinucleotide phosphate)

Light Rx

light strikes chlorophyll molecule

chlorophyll pigment absorbs light E

e- within pigmt become "excited" or "energiz"

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/reduct rx) finally releasing E to make ATP

-some E is used to split H2O or oxidize H2O called photolysis H2O----> H+ +e- + O2

O2 is released to atmosphere

-the e- replace chlorophyll e- lost by PSI

-H+ 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 sunlt E

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_2 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. $NADPH_2$, 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 $C_{12}H_{22}O_{11}$