Chpt 4: 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 animals

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

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 λ, less E; shorter λ, more E

Electromagnetic spectrum: usuable E waves

gamma, X, UV, vis lt, infrared, radiowaves

shorter λ ----------> longer λ

more E ----------> less E

visible lt are λ animals can detect w/photo-sensitive cells (rods & cones) eyes

we sense those λ as colors, ROY G BIV

violet, indigo, blue, green, yell, orange, red

shorter λ ----------> longer λ

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: when light bounces off, this gives us the color we see

2-transmitted: when light goes through object

3-absorbed: when light goes into object

object that reflects all lt  ----------> white

obj that absorbs all lt  ----------> black

black: absence of color

white: combination of all colors

pigments: molecules that absorb certain  of light and reflects others

color reflected is color we see

green shirt: green  is reflected, blues and reds are absorbed

white shirt: all  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 chlorophyll on website link
- 2 types chlorophyll: a & b
  - chlorophyll a: primary photosynthetic pigmt
  - chlorophyll b: secondary photosyn. pigmt

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

6 CO_2 + 6 H_2O----------> $C_6H_{12}O_6$ + 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-------><u>chemical E</u>

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 from ATP, H from $NADPH_2$, 2 PGA molecules are converted 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 $C_{12}H_{22}O_{11}$