Photosynthesis & Environment

how can we measure photosynthesis?

-measure amount of glucose produced

-measure amount of CO_2 consumed

-measure amount of O_2 given off

Rate of Photosynthesis

how fast does photosynthesis proceed?

amount CO_2 consumed in period of time

4 Factors affecting rate of photosynthesis

1-light intensity

2-temperature

3-concentration of CO_2

4-concentration of O_2

Light intensity

what does graph say about light intensity?

as light intensity increases, photosynthesis increases up to a point, then it begins to decrease

before we reach intensity of full sunlight, photosynthesis has reached saturation point & the rate levels off

light rx become saturated w/sunlight E & they proceed as fast as they can

in still brighter light, chlorophyll accumulates E faster than it can be used in ETS, so some E goes to O2 molecule & makes H2O2 (H peroxide) this damages chloroplasts, decreasing the rate of photosynthesis

this is called photoinhibition

Effect of temperature on rate of photosynthesis

- what does this graph say?

graph shows there is an optimum temp range 15 C - 30 C

above & below these temp, photosyn is inhibited -----Why?

what is limiting condition?

H2O

too cold, H2O moves too slow, frozen

too hot, H2O evaporates

Effect of CO2 concentration

what does graph say?

as the CO2 concentration increases, the rate of photosynthesis increases up to a point, but then levels off

above CO2 saturation point, an increase in CO2 has no more effect

light, temp, CO_2 all affect rate of photosyn at same time
factor in shortest supply is limiting factor
if you have optimum temp, optimum CO_2 levels, but low light, then light is limiting factor

Concentration of O_2 in atmosphere
what does this graph say?
at low levels of O_2, photosyn works great
the process of photosynthesis evolved in an atmosphere of methane gases, H, but not O_2
as more and more plants photosynthesized, amount of O_2 in atmosphere increased
today, O_2 concentration is 20%
above 20%, photosynthesis is inhibited
why? enzyme rubisco fixes CO_2 to RuBP and the enzyme can get confused btw CO_2 & O_2 due to its structural formula

structural formula of CO_2: O=C=O

structural formula of O_2: O=O

both molecules are held together by double bonds that are similar distance apart
so they both fit into the active site of rubisco

But if atmospheric O_2 is 20%, how can it get higher?
CO_2 is brought into plant cells by pores in leaves called stomates
O_2, produced during photosyn leaves plant cells by stomates
H_2O is brought into plant cells by roots, but if it is hot, H_2O can also leave plant cells by stomates, called transpiration
these pores can be opened & closed by plant cells as needed

if stomates close to prevent H2O loss,
CO2 can't get in and O2 can't get out
thus, CO2 levels drop and O2 levels rise

when CO2 is fixed by RuBP--->forms 2 PGA
when O2 is fixed instead---->forms 1 PGA &
1 molecule glycolate (2C)
glycolate is taken out of chloroplast---->
broken down to CO2, thus we lose some C
called photorespiration

thus, relatively high levels CO2---->increases
photosynthesis
but relatively high levels O2----->decreases
photosynthesis and increases
photorespiration

diff groupings of plants based on photosyn
majority of plants are C3 plants
these do photosyn as we have learned
called C3 b/c when CO_2 is fixed by RuBP, it makes PGA, a 3 C compd

C4 plants & CAM plants have evolved adaptat to hot, environments
C4 plants: sugarcane, corn, crabgrass
where they grow H_2O is available, but high temps make plants lose H_2O
so they fix CO_2 by combining with 3C acid, thus making a 4 C compd (C4 plant)

this combining of CO_2 w/3 C acid makes another step in pathway (this is also in diff cell) and this step uses a diff enzyme, so it does not get confused btw O_2 & CO_2

then 4C compd is transported to Calvin cycle where it releases CO_2 & cycle proceeds

so C4 plants can close stomates to prevent H_2O loss, but store CO_2 by combining w/ 3C acid, then there is lots of CO_2 available for rubisco, so it fixes CO_2 instead of extra O_2 that is also present
these plants are very efficient & grow well even better than other crop plants (soy, rice, wheat)

CAM plants: crassulacean acid metabolism
- also adapted to hot, dry environmts, deserts
- these plants open stomates at night, fix CO_2 into acids
- stomates close during day to conserve H_2O
- acids release CO_2 & it enters Calvin cycle
- this is not efficient process
- slow growth

Photosynthesis & Atmosphere
- photosynthesis is the largest single biochemical process on earth
- produces 90 bill metric tons O_2 & organic mat
- uses 140 bill metric tons CO_2,110 bill metric tons H_2O

so why is CO_2 content of atmosphere increasing?
- people burning fossil fuels for E
- burning rainforests
  - less trees removes less CO_2 from atmosphere

so what is the effect?
- how does increasing CO_2 directly affect plants & photosynthesis?
- CO_2 is increasing temp of earth
- how does this affect photosynthesis?