

Photosynthesis & Environment

how can we measure photosynthesis?

- measure amount of glucose produced
- measure amount of CO₂ consumed
- measure amount of O₂ given off

Rate of Photosynthesis

how fast does photosynthesis proceed?

amount CO₂ consumed in period of time

4 Factors affecting rate of photosynthesis

- 1-light intensity
- 2-temperature
- 3-concentration of CO₂
- 4-concentration of O₂

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, CO₂ all affect rate of photosyn at same time

factor in shortest supply is limiting factor

if you have optimum temp, optimum CO₂ levels, but low light, then light is limiting factor

Concentration of O₂ in atmosphere

what does this graph say?

at low levels of O₂, photosyn works great
the process of photosynthesis evolved in an atmosphere of methane gases, H₂, but not O₂

as more and more plants photosynthesized, amount of O₂ in atmosphere increased

today, O₂ concentration is 20%

above 20%, photosynthesis is inhibited

why? **enzyme rubisco** fixes CO₂ to RuBP
and the enzyme can get confused btw CO₂ & O₂ due to its structural formula

structural formula of CO₂: O=C=O

structural formula of O₂: 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 O₂ is 20%, how can it get higher?

CO₂ is brought into plant cells by pores in leaves called stomates

O₂, produced during photosyn leaves plant cells by stomates

H₂O is brought into plant cells by roots, but if it is hot, H₂O 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**

different 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
adaptations 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 CO₂
into acids
stomates close during day to conserve H₂O
acids release CO₂ & 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 O₂ & organic mat
uses 140 bill metric tons CO₂, 110 bill metric
tons H₂O

so why is CO₂ content of atmosphere increasing?
people burning fossil fuels for E
burning rainforests
less trees removes less CO₂ from
atmosphere

so what is the effect?
how does increasing CO₂ directly affect
plants & photosynthesis?

CO₂ is increasing temp of earth
how does this affect photosynthesis?