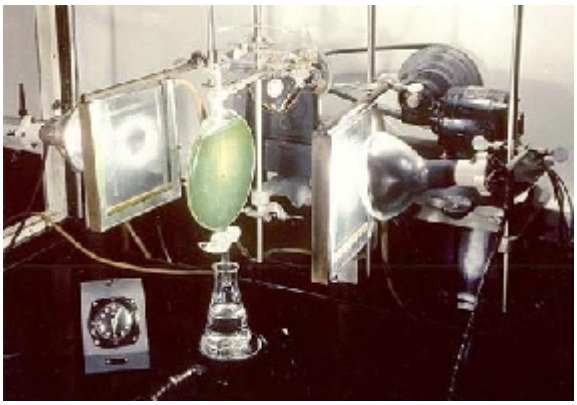


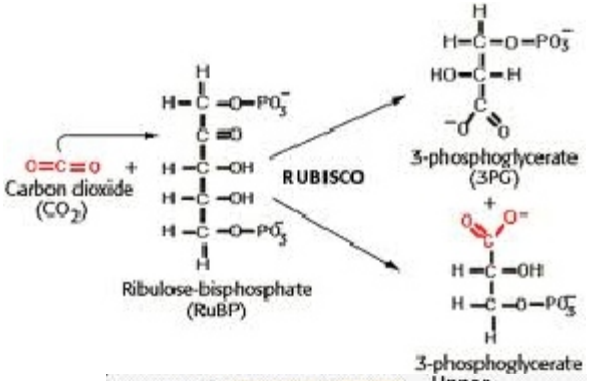
PHOTOSYNTHETIC CARBON CYCLE (DARK REACTIONS)

22 Nov91, rvsd 19Nov93, 15Nov 95, 25 Nov 96, 22 Nov 99, 19 Nov 01, 22 Nov 02, 19 Nov 03, 17 Nov 04, 21Nov05, 5Nov07, 12Nov08, 9Nov09, 10Nov10, 9Nov11
BRP: 389-403, BKH 5th: 462-474, BKH: 303-315, 7th: 309-320

Melvin Calvin elucidated dark reactions (Nobel Prize):

1) radiotracer with $H^{14}CO_3^-$, Chlorella in "lollipop", quenched in EtOH
2) two dimensional chromatography
3) autoradiography

"REDUCTIVE CARBOXYLATION"



I. CARBON FIXATION in C-3 plants (p 310)

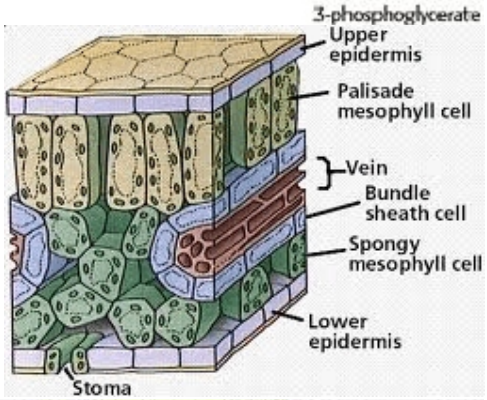
Carboxylation of ribulose 1,5 PO_4 at carbonyl (number 2 carbon), breaks into two molecules of 3-phosphoglycerate

enzyme: **ribulose 1,5 bis PO_4 carboxylase/oxygenase** (Rubisco)

II. REDUCTION OF 3 PHOSPHOGLYCERATE: (p 311)

1) first **phosphorylate with ATP** to make 1,3 bis phosphoglycerate (phosphoglycerokinase)
2) **reduce with NADPH** to 3-PO_4-glyceraldehyde.

Requires two ATP and 2 NADPH for every carbon atom fixed, thus 12 ATP, 12 NADPH for one glucose molecule)



III. DI- AND POLYSACCHARIDE SYNTHESIS: (p 314)

reverse glycolysis:

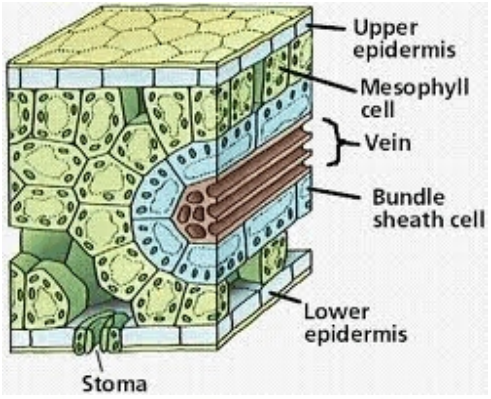
glyceraldehyde is phosphorylated (PO_4 bonds *hydrolyzed* to make it **exergonic**)

Glucose used to make either sucrose, starch, or cellulose

Sucrose: glucose-6-P to G-1-P, tied to Uridine TP, **UDP-glucose** (activated) + PP_i
then F-6-P replaces UDP, sucrose-6-P, dephosphorylated

Starch: **an ADP activated glucose** added onto growing chain

(Note that **glucose is usually *not* end product**, rather leads to sucrose or starch)



IV. REGENERATION OF RIBULOSE 1,5-BISPHOSPHATE

(BRP 3rd, p 304, not in subsequent editions)

complex set of steps, involving

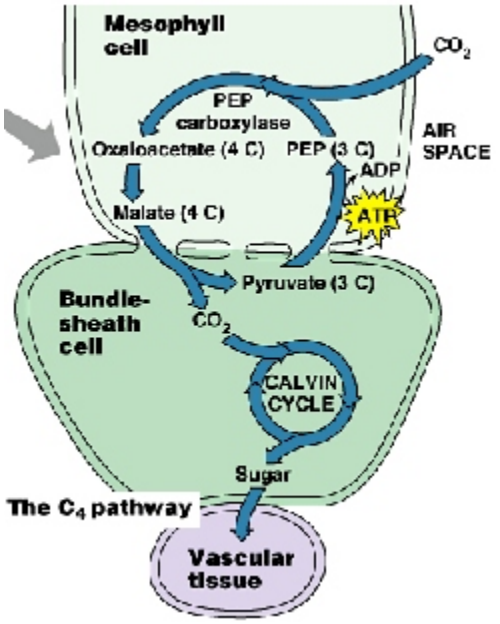
condensation	(erythrose -4-P + DHAP to make seduheptulose-1,7-bis P)
dephosphorylation	(Remove a PO_4 from sedoheptulose-1,7-bisP to S-7-P)
transketolation	(transfer of 2 carbon fragment fr S-&-P to G-3-P, makes xylose-5-P & ribose-5-P)
isomerization	(ribose-5-P, an aldose isomerized to ribulose-5-P, a ketose)

C-4 PLANTS, HATCH-SLACK PATHWAY:

(illustration on p. 318, pathway on p 319)

CO_2 from surrounding **spongy mesophyll** is assimilated in **mesophyll cells**, pumped to **bundle sheath cells**:

1) fixation occurs in mesophyll cells to **PEP** at #3 carbon to make **oxaloacetic H^+**
2) **oxaloacetic H^+** is reduced using NADPH to **malate** which diffuses through plasmodesmata into bundle sheath cells to transfer C fragment to RuDP
3) **malate is decarboxylated and oxidized** yielding pyruvate, **CO_2** and NADPH
4) **the CO_2 enters the Calvin Cycle, completed in the bundle sheath cells.**



ADVANTAGES OF C-4:

Hatch Slack occurs in mesophyllic cells, ready access to CO_2,
RuDP carboxylase is also oxygenase, low CO_2 and hi O_2, conducts photorespiration
Serves to pump CO_2 into the cell.

CYCLIC PHOTOPHOSPHORYLLATION

PHOTORESPIRATION: ribulose 1,5, bis PO4 is catabolized when no other source of energy is available, catalyzed by Rubisco