

PHOTOSYNTHETIC DARK REACTIONS

revised 13 July 2016

BRP: 389-403, Campbell 7th: 193-198, Sadava: Campbell 10th: 199-203

If not already covered: (p 187)

Chloroplasts: double membrane, grana, thylakoid discs, stroma

Two word overall dark reactions:

LEARN: "Reductive Carboxylation": requires NADPH and ATP

To identify the products of **carbon fixation** (carboxylation)

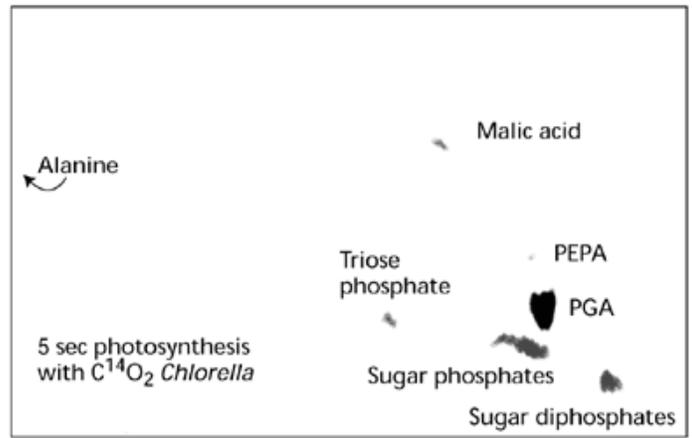
Melvin Calvin, 1946:

A) radiotracer with $H^{14}CO_3$ in lollipop filled with *Chlorella*.

B) two dimensional chromatography to separate products

C) autoradiography to identify recently made products (^{14}C labeled)

Got Nobel Prize in 1961 for work, identified 3 PGA as first stable product



CARBON FIXATION ("Calvin Cycle": p 200)

Carboxylation of ribulose 1,5 PO_4 at ketone carbonyl breaks into two molecules of **3 phosphoglycerate**

RuBP carboxylase (RuBisco): enzyme which perform the fixation reaction.

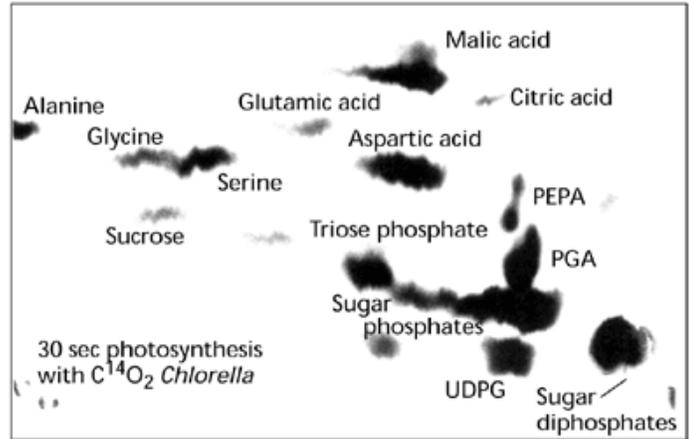
3 phosphoglycerate (PGA: first stable product of fixation): **C-3 plant**

CARBOHYDRATE SYNTHESIS: (see p 168 for glycolysis)

Run **glycolysis in reverse** to make glucose fr PGA (pp 169-168):

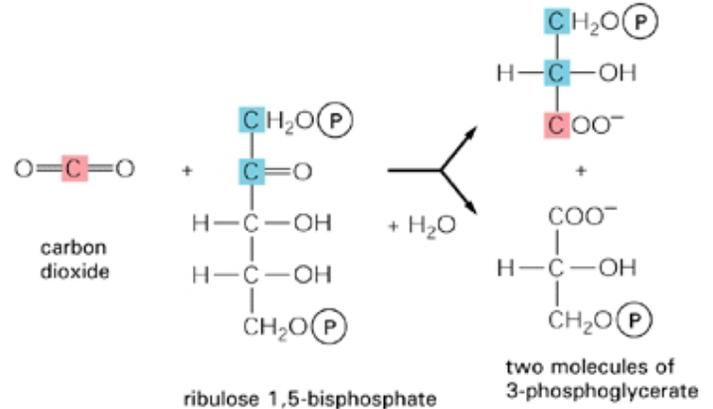
MAJOR FEATURES: 3 phosphoglycerate to glucose: (p 200)

- 1) **ATP PHOSPHORYLATES** PGA, makes 1,3 bis phosphoglycerate
- 2) **NADPH REDUCES** 1,3 bis phosphoglycerate forms $3PO_4$ glyceraldehyde.
- 3) PO_4 glyceraldehyde is then run through the rest of reverse glycolysis to make glucose. (P 168)
- 4) Glucose is used to make either sucrose or starch (or cellulose) to form a single glucose molecule: requires two ATP and 2 NADPH for every carbon atom fixed, thus 12 ATP, 12 NADPH per glucose



Photorespiration: In hot and dry, stomata close **low CO_2** , O_2 high.

Oxidation occurs: RuBisco can oxidize PGA in these conditions



C-4 PLANTS, HATCH-SLACK PATHWAY: (illustration on p. 202)

occurs in mesophyll cells, pumps CO_2 into bundle sheath cells:

fixation occurs to **PEP** at #3 carbon to make **oxaloacetic H^+**

oxaloacetic H^+ is reduced using NADPH to **malate** which diffuses through **plasmodesmata** into bundle sheath cells to transfer C frag to RuDP

Entire Calvin Cycle occurs in bundle sheath cells.

ADVANTAGES OF C-4: Why does crabgrass grow better than KY bluegrass in the Summer?

Purpose: " **CO_2 pump**": Hatch Slack occurs in **mesophyll cells**, these cell have ready access to CO_2 , pass it to bundle sheath cells.

C-4 plants overall reactions: p 202. C-4 plants grow well in hot, dry (crab grass), C-3 Not so much (KY bludgrass).

