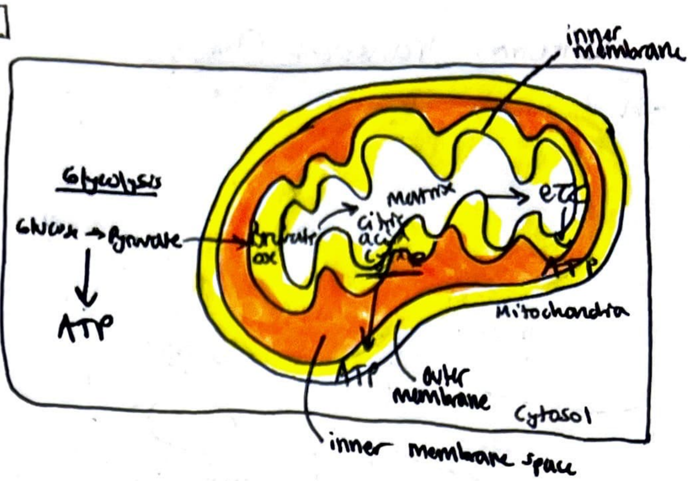
Cellular Respiration



1. Glycolysis

Big Picture: Glucose → Pyruvates → ATP

Zoom:

a) Energy Investment Phase
- Cell uses ATP to phosphorylate the intermediates of glycolysis

① Phosphofructokinase = enzyme that controls rate of glycolysis

b) Energy Payoff phase

→ Net

Glucose → 2 Pyruvate + $2H_2O$

4 ATP − 2 ATP used → 2 ATP

$2NAD^+ + 4e^- + 4H^+ \rightarrow 2NADH + 2H^+$

Exergonic = releasing energy

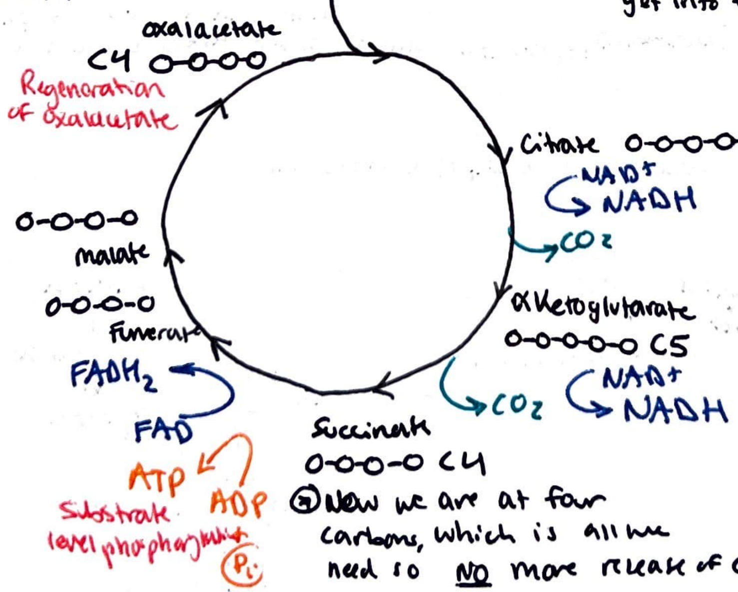
- the ATP produced in glycolysis is a result of substrate-level phosphorylation

O-O-O-O-O-O C6
Glucose
→ 2 ATP → 2 ADP + 2 Ⓟ
→ $2NAD^+$ → $2NADH + 2H^+$
→ 4 ADP + 4 Ⓟ → 4 ATP
→ 2 Pyruvate
O-O-O 3C
O-O-O 3C

2. Pyruvate Oxidation & the Citric Acid (Krebs) Cycle

- in the mitochondrial matrix
- needs O_2 to become oxidized
- How did the pyruvates travel from the cytosol to the matrix?
  - carrier proteins

NAD^+ → NADH
O-O-O Pyruvate (cytosol)
→ CO_2 Break down Pyruvate into Acetyl CoA into CO_2
O-O Acetyl CoA — need a C2 to get into the matrix



Now we are at four carbons, which is all we need so NO more release of CO_2

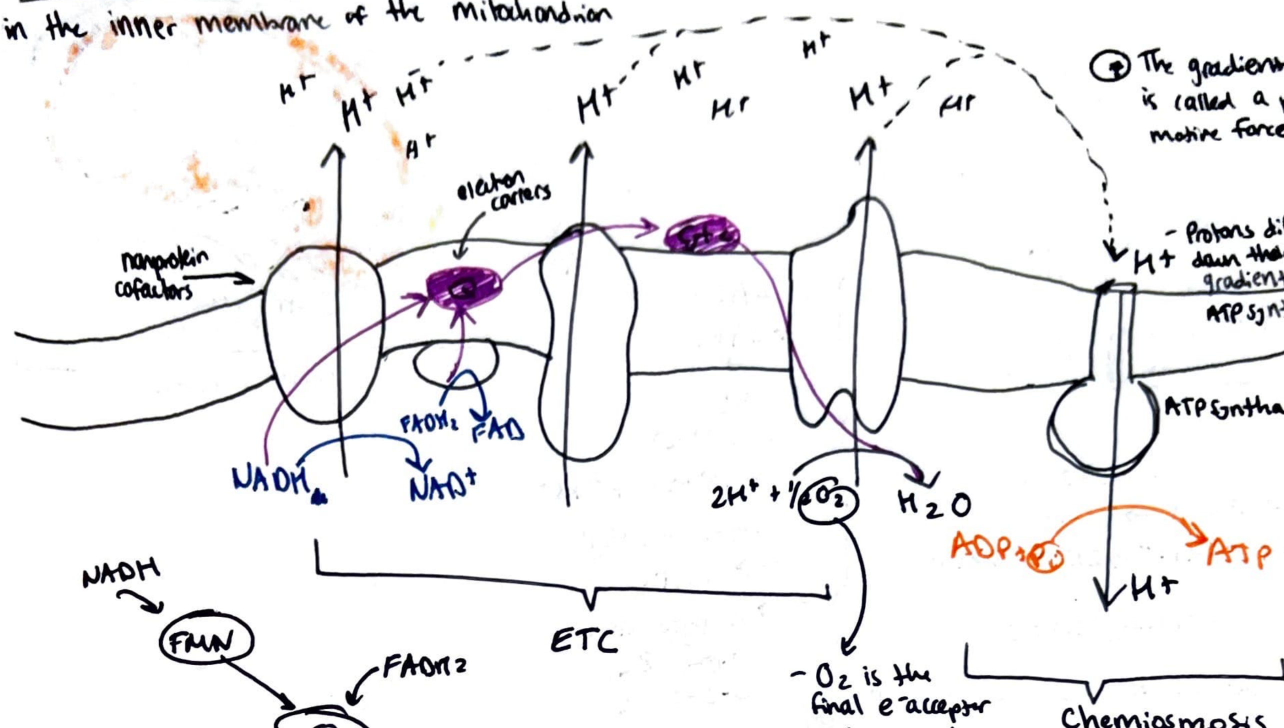
(X2)
- 2 pyruvates being oxidized so... it takes 2 turns of the Kreb's cycle to ox. 1 glucose molecule

NET (2 turns)
- 6 NADH
- 2 ATP
- 2 $FADH_2$
- 4 CO_2

NADH & $FADH_2$ now become our carriers of energy (energy from glucose)
→ Will be used in ETC for oxidative phosphorylation of ADP + Ⓟi → ATP

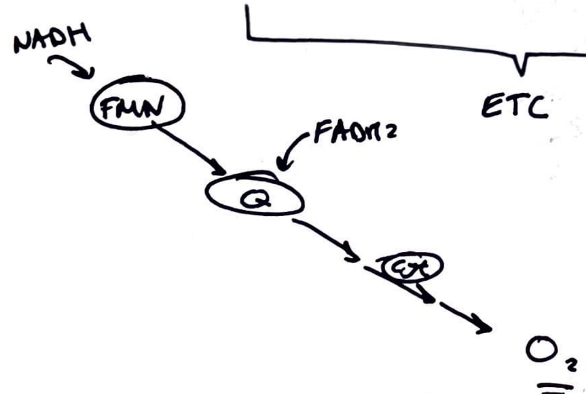
3. Electron Transport Chain

- in the inner membrane of the mitochondrion



* The gradient created is called a proton motive force

- Protons diffuse back down their concentration gradient through ATP synthase



- O_2 is the final e⁻ acceptor and pulls the e⁻ down the ETC to a lower energy state
- O_2 is reduced & picks up 2 H^+ to form H_2O

* ETC does NOT make energy directly
  ∴ ATP is produced in chemiosmosis
  → instead it generates a proton gradient across the inner membrane, which stores PE that can be used to phosphorylate ADP

Fermentation = If NO O_2 is avaliable (anerobic), pyruvates cannot enter krebs cycle but instead undergo fermentation

- catabolic
- Why? → to regenerate NAD+ so that it doesn't become depleted in the cell

a) Alcohol fermentation

2 pyruvate $\xrightarrow{2\,CO_2}$ 2 Acetaldehyde $\xrightarrow{2NADH + 2H^+ \to 2NAD^+}$ 2 Ethanol

b) Lactic Acid fermentation

2 pyruvate $\xrightarrow{2NADH + 2H^+ \to 2NAD^+}$ 2 Lactate

Glucose
↓ Glycolysis
Pyruvate

× No O_2 → Reduced to lactate or ethanol & NAD+ recycled after NADH is oxidized

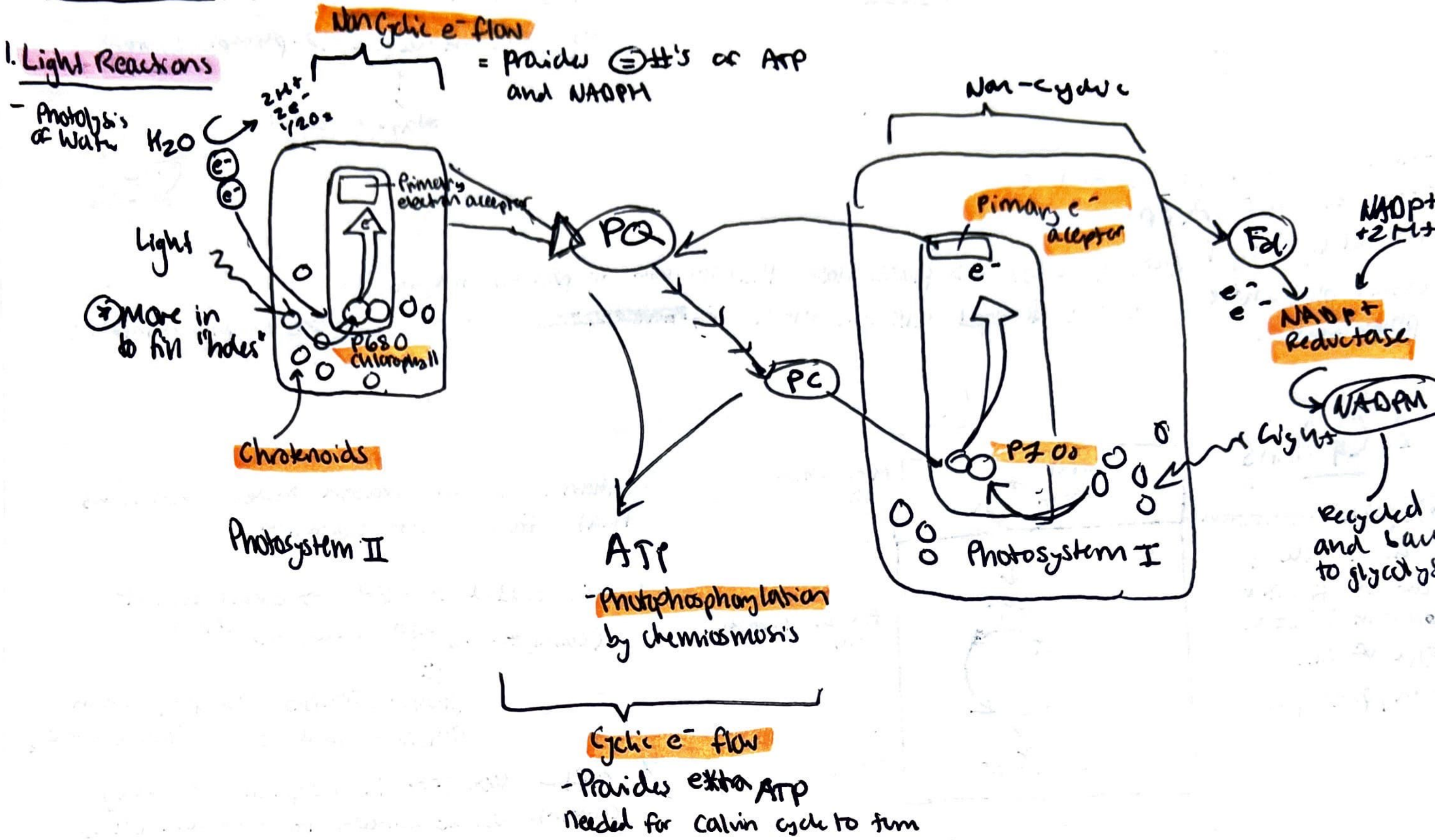
O_2 ✓ → oxidized to acetyl CoA & oxidation continued in krebs

* Strict/obligate anaerobes = Only NO O_2
  Strict/obligate aerobes = Only O_2
  Facultative anaerobes = Either ex. yeasts, ~~[illegible]~~ many bacteria, muscle cells

Photosynthesis

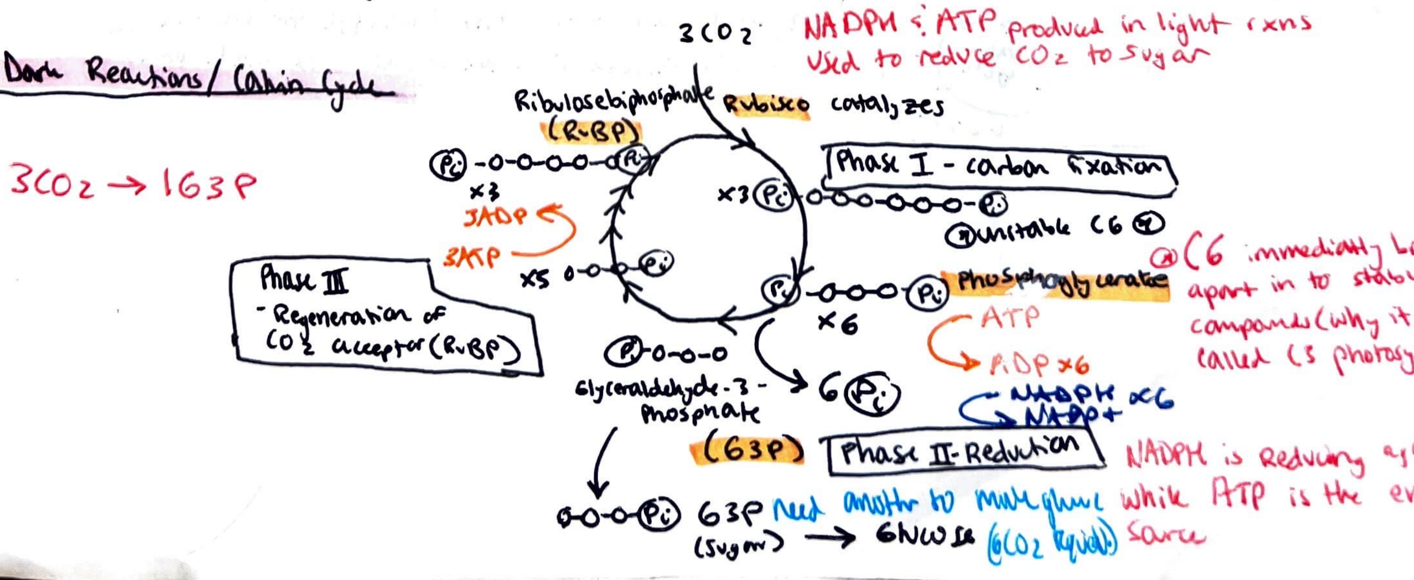
- Purpose: to transform solar energy into chemical bond energy stored in sugar & other organic molecules via chloroplasts
- Autotrophs = producers, use light to make food
- Heterotrophs = consumers; aquire energy from consuming other organisms
- Chemoautotrophs = use sulfur @ deep ocean ⓔ

1. Light Reactions



- Chemiosmosis in chloroplasts & mitochondria
  - Similarities: ETC assembled in the membrane translocates protons across the membrane, building up a proton motive force; series of carriers that get ↑ electronegative in ETC, ATP synthase works the same
  - Differences: ETC in mitochondrian transfer chemical energy from food molecules → ATP while chloroplast ETC transform light energy into chemical energy & the photosystems capture light energy to drive the chain
    - Spatial organization = Mitochondrial mem. pumps H+ from matrix out into intermembrane space while the Chloroplast's thylakoid membrane pumps H+ from the stroma to the thylakoid compartement

2. Dark Reactions / Calvin Cycle



· Alternative Mechanisms of Carbon Fixation have evolved in hot, arid climates

1. <u>Photorespiration</u> NO CO_2

Rubisco transfers O_2 to RuBP → 5-C molecule splits into → 2-C molecule (glycolate) → goes to peroxisome & broken down into CO_2

→ 3-C molecule (3-phosphoglycerate) → stays in calvin

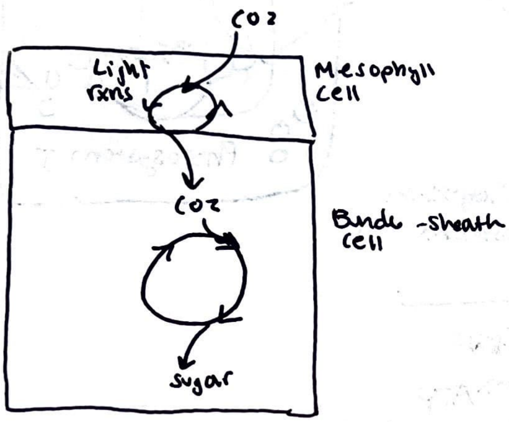
O_2 → no CO_2

- Rubisco can accept O_2 and CO_2
- Produces NO ATP
- fostered by hot, bright, dry days => plants close their stomata to prevent dehydration
- certain plants have adapted & developed alternate modes of [redacted] carbon fixation that minimize photorespiration

2. <u>C_4 Plants</u>

① spatial separation
- calvin cycle & carbon fixation occur in different types of cells

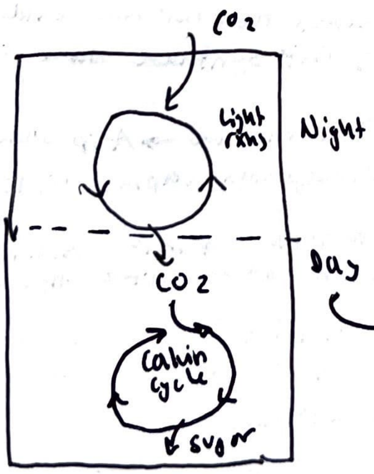
- corn, pineapple



- enhances carbon fixation under conditions that favor photorespiration
- 1. CO_2 added to PEP → oxaloacetate (4C) (catalyzed by PEP carboxylase) ⇒ greater affinity for CO_2 than RUBISCO and NO affinity f
  2. after fixation in mesophyll cells, they convert oxaloacetate to malate (4C
  3. Mesophyll cells export the malate thro plasmodesmata to bundle sheath cells where the 4C compounds release C which is then fixed by rubisco in calvin cycle

3. <u>CAM Plants</u>

- Succulents
- Cacti



- open their stomata at night which conserv water during the day and prevents CO_2 from en the cell

→ light rxns supply ATP & NADPH for calvin cycle
- CO_2 released from the organic acids made previously