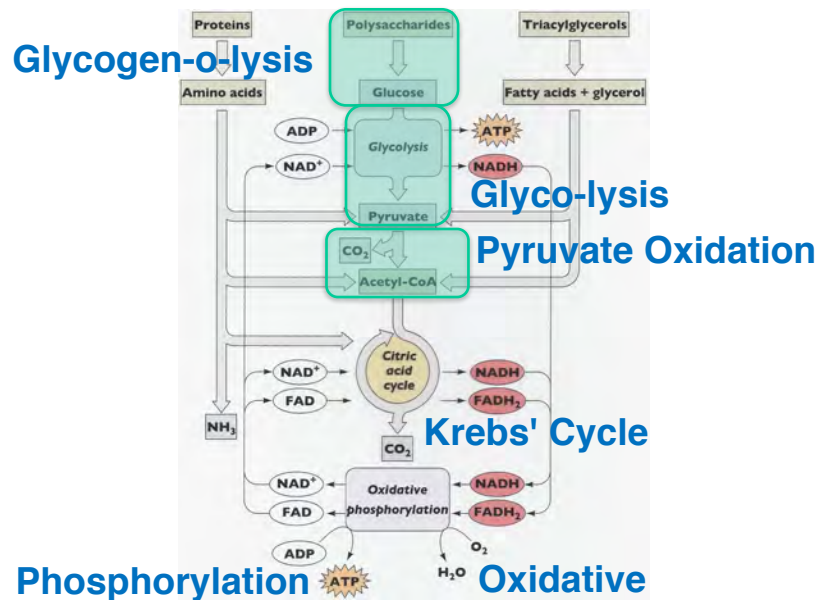


# Pyruvate Oxidation

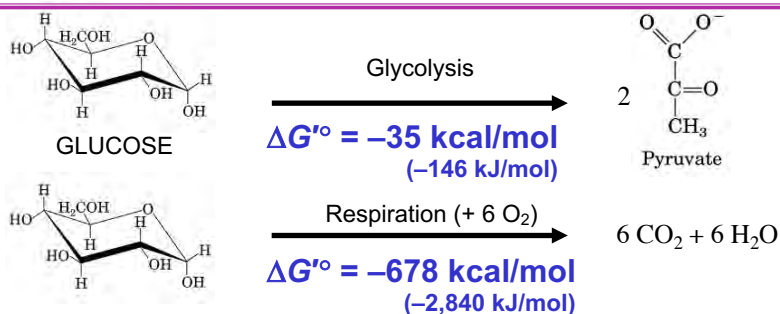
**ONLY when O<sub>2</sub> is present**

- This is why its called cellular respiration.
- The end result will be the COMPLETE oxidation of carbon to CO<sub>2</sub>

## Pyruvate Oxidation



# Pyruvate Oxidation



Occurs in three major stages:

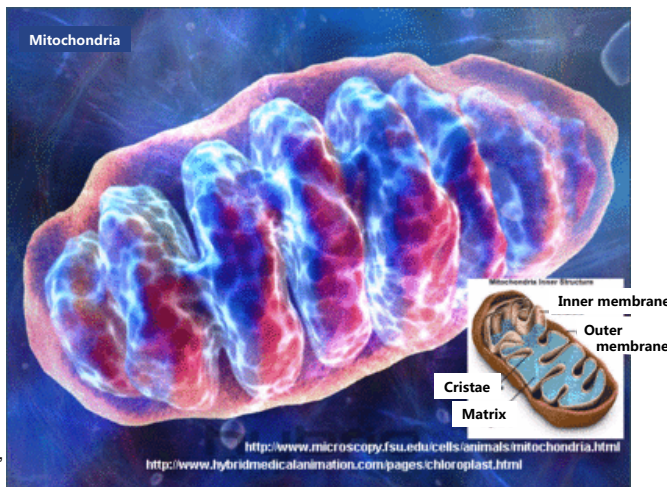
- Process in which cells consume O<sub>2</sub> and produce CO<sub>2</sub>
- Provides more energy (ATP) per glucose than glycolysis
- Process is slower than glycolysis
- Evolutionary origin: developed about 2,500 mya
- Used by animals, plants, and many microorganisms
- Other fuel sources (lipids and AA) converge on respiration.

- 1) Pyruvate oxidation (acetyl CoA production)
- 2) acetyl CoA oxidation (CO<sub>2</sub> production)
- 3) electron transfer and oxidative phosphorylation (H<sub>2</sub>O production)

# Pyruvate Oxidation

Localization: In Eukaryotes, Respiration is Localized to the Mitochondria (Compartmentation)

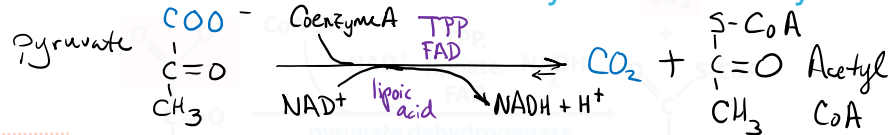
- Glycolysis occurs in the cytoplasm.
- Pyruvate Oxidation and Citric Acid Cycle occurs in the mitochondrial matrix.<sup>†</sup>
- Fantastic example of *Compartmentation*.
- Oxidative phosphorylation occurs in the inner membrane.



<sup>†</sup>Except succinate dehydrogenase, which is located in the inner membrane

# Pyruvate Oxidation

## Conversion of Pyruvate to Acetyl-CoA

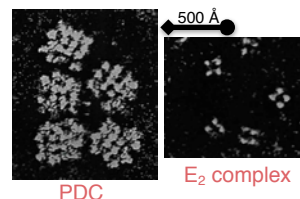


- Net reaction:
  - oxidative decarboxylation of pyruvate
    - Means pyruvate will get oxidized as the carboxylate leaves (as  $\text{CO}_2$ )
  - first carbons of glucose to be fully oxidized (C3 & C4)
- Fairly simple reaction done by a complicated process.
- Highly thermodynamically favorable/irreversible ( $\Delta G^\circ = -8$  kcal/mol); mostly due to the loss of  $\text{CO}_2$
- Catalyzed by the **Pyruvate Dehydrogenase Complex (PDC)**
  - Three main enzyme, each with multiple subunits: **E1**, **E2**, **E3**
  - Regulatory subunits: PD kinase & PD phosphatase
  - Overall structure of **E1<sub>96</sub>**, **E2<sub>24</sub>**, **E3<sub>24</sub>**
  - requires 5 coenzymes
  - **TPP**, **lipoic acid**, and **FAD** are prosthetic groups.
  - **$\text{NAD}^+$**  and **CoA-SH** are co-substrates.

# Pyruvate Oxidation

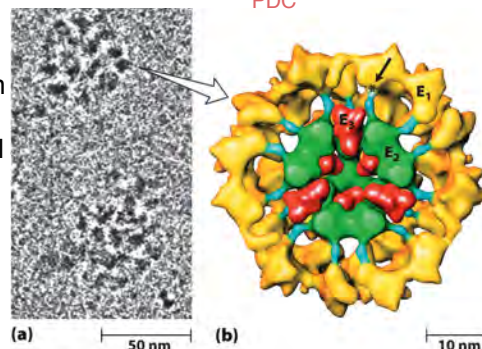
PDC is a large (up to **10 MDa**) multienzyme complex.

- **pyruvate dehydrogenase (E<sub>1</sub>)**
- **dihydrolipoyl transacetylase (E<sub>2</sub>)**
- **dihydrolipoyl dehydrogenase (E<sub>3</sub>)**



## Cryoelectronmicroscopy

- Samples are in a near-native frozen hydrated state.
- Low **temperature** protects biological specimens against **radiation** damage.
- Electrons have a smaller wavelength and produce much **higher-resolution** images than light.
- No need for a crystal.



# Pyruvate Oxidation

