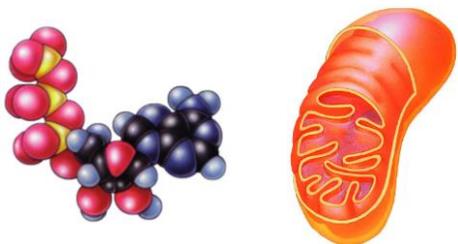


Chapter 9.2 & 9.4 Cellular Respiration STAGE 1: Glycolysis



Glycolysis

- Breaking down glucose
 - “glyco – lysis” (splitting sugar)



- most ancient form of energy capture
 - starting point for all cellular respiration
- inefficient
 - generate only **2 ATP** for every **1 glucose**
- in cytosol

Why does that make evolutionary sense?

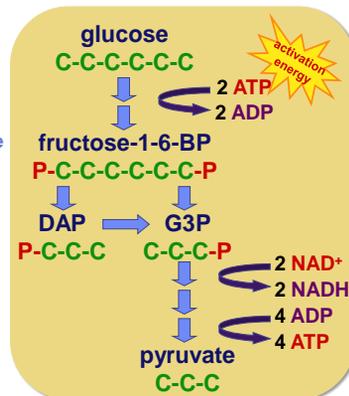
Evolutionary Perspective

- Life on Earth first evolved without free oxygen (O₂) in atmosphere
 - energy had to be captured from organic molecules in absence of O₂
- Organisms that evolved glycolysis are ancestors of all modern life
 - all organisms still utilize glycolysis

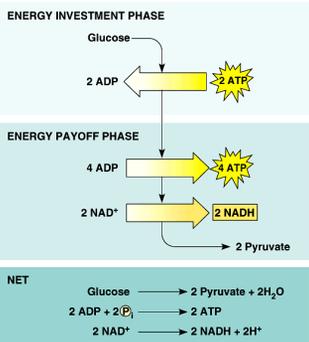


Overview

- 10 reactions
 - convert 6C glucose to two 3C pyruvate
 - produce 2 ATP & 2 NADH



Glycolysis Summary

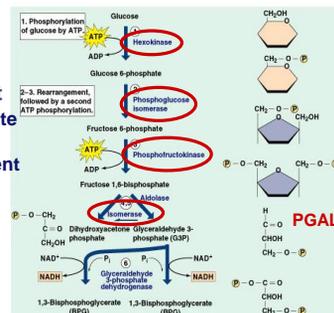


endergonic
invest some ATP

exergonic
harvest a little more ATP & a little NADH

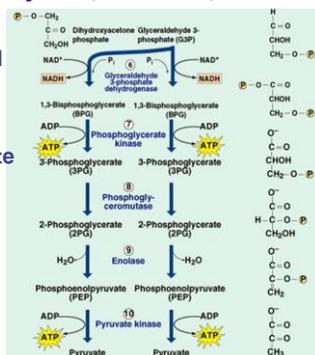
1st half of Glycolysis (5 reactions)

- Glucose “priming”
 - get glucose ready to split
 - phosphorylate glucose
 - rearrangement
 - now split ‘destabilized glucose’



2nd half of Glycolysis (5 reactions)

- **Oxidation**
 - ◆ G3P donates H
 - ◆ NAD → NADH
- **ATP generation**
 - ◆ G3P → pyruvate
 - ◆ donates P
 - ◆ ADP → ATP

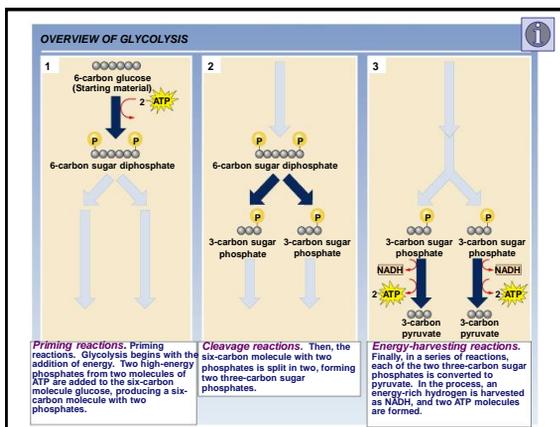
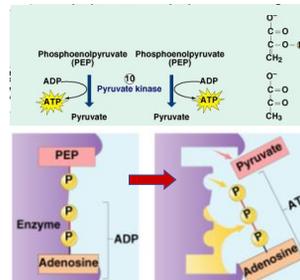


Substrate-level Phosphorylation

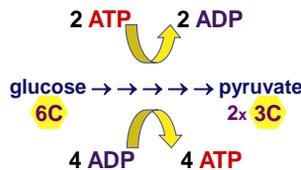
- In the steps of glycolysis, where did the P come from to make ATP from ADP?

P is transferred from PEP to ADP

- kinase enzyme
- ADP → ATP

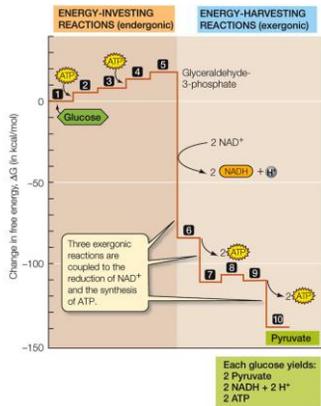


Energy accounting of Glycolysis



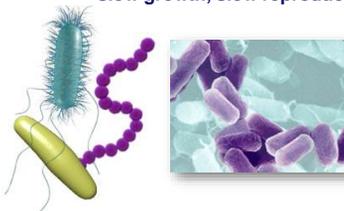
- **Net gain = 2 ATP**
 - ◆ some energy investment (2 ATP)
 - ◆ small energy return (4 ATP)
- 1 6C sugar → 2 3C sugars

Glycolysis Summary



Is that all there is?

- **Not a lot of energy...**
 - ◆ for 1 billion years+ this is how life on Earth survived
 - only harvest 3.5% of energy stored in glucose
 - slow growth, slow reproduction

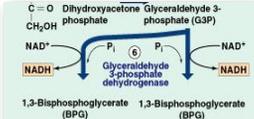


We can't stop there....

▪ Glycolysis

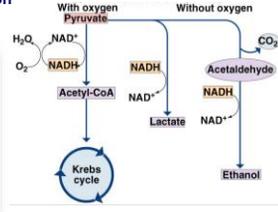


- Going to run out of NAD⁺
- How is NADH recycled to NAD⁺?
 - ♦ without regenerating NAD⁺, energy production would stop
 - ♦ another molecule must accept H from NADH



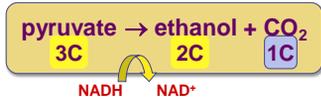
How is NADH recycled to NAD⁺?

- Another molecule must accept H from NADH
 - ♦ anaerobic respiration
 - ethanol fermentation
 - lactic acid fermentation
 - ♦ aerobic respiration



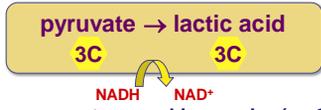
Anaerobic Fermentation

▪ Bacteria, yeast



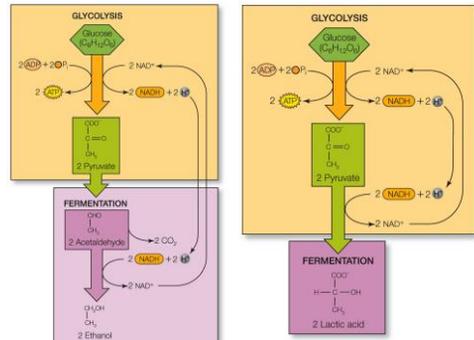
- beer, wine, bread
- at ~12% ethanol, kills yeast

▪ Animals, some fungi



- cheese, yogurt, anaerobic exercise (no O₂)

Anaerobic Fermentation



Pyruvate is a branching point

