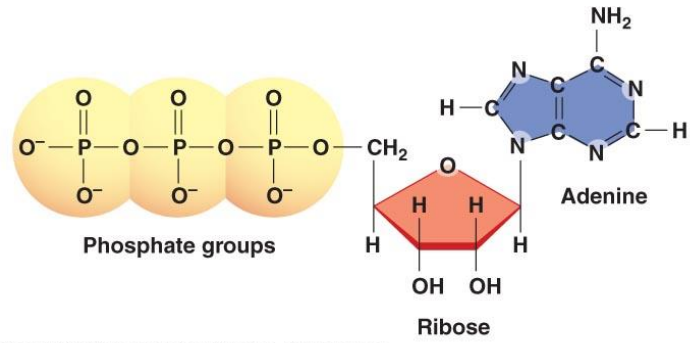
Zoology – How Animals Harvest Energy Stored in Nutrients

I. Animals must eat to provide the constant of energy needed to perform biological work.

ATP is the energy rich molecule that provides the energy animals need to do work. Animals generate ATP by breaking down organic nutrients (carbohydrates, fats, and proteins). Breaking down these nutrients provides the energy to change ADP + P to ATP.	 Copyright © 2008 Pearson Benjamin Cummings. All rights reserved.

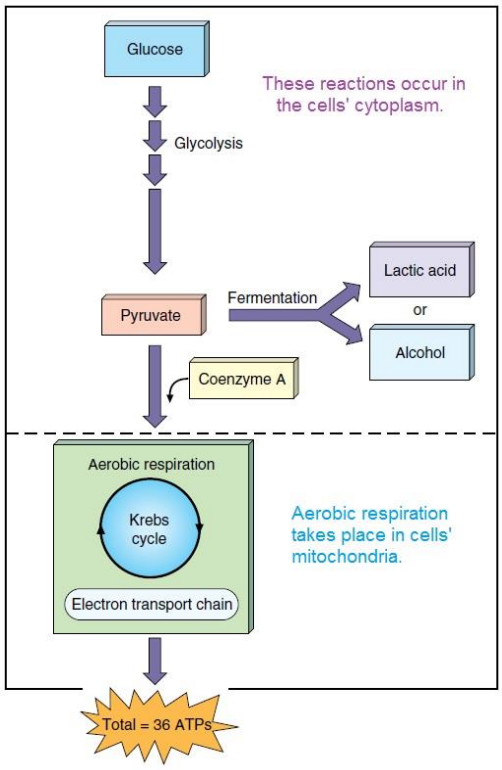
II. The **Central Metabolic Pathways** – how animals use food to produce ATP.

A. In cells, the breakdown of organic nutrients occurs in a step-by-step process.

B. **Glycolysis** – almost all cells initially breakdown the 6-carbon glucose molecules into two 3-carbon pyruvates (pyruvic acids).

1. This produces a **net gain of 2 ATP.**

C. **Anaerobic respiration** (a.k.a. **Fermentation**)



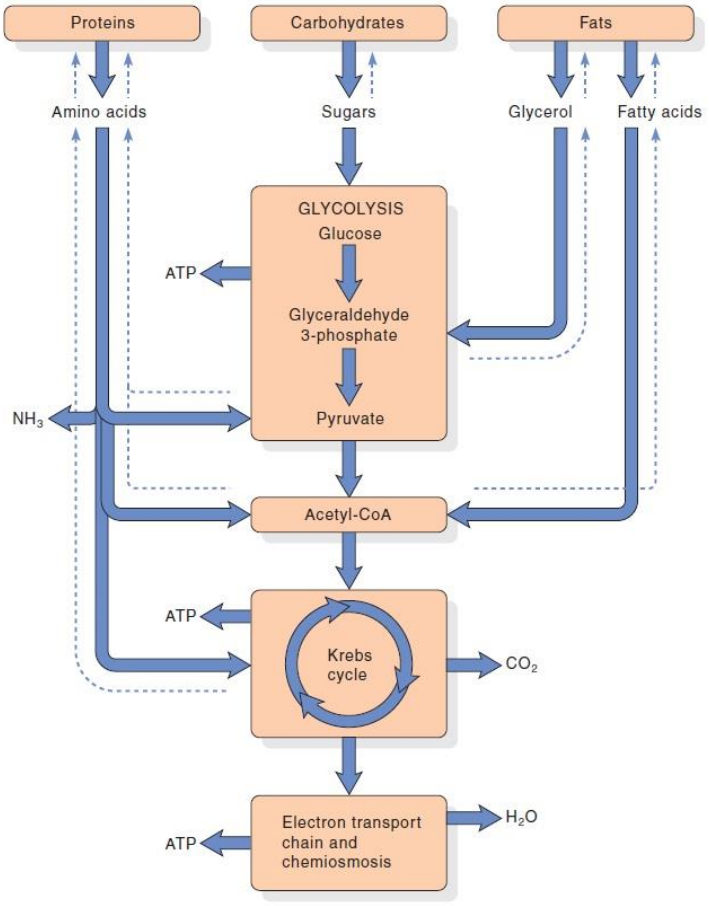
1. Occurs in the absence of oxygen
2. Animal cells do this to regeneration molecules needed to produce ATP in glycolysis. Without ATP, the cells will die.
3. The pyruvate (formed from glycolysis) accepts H atoms and generates organic molecules such as…
   i. **Lactic acid** –produced by muscles deprived of oxygen during a vigorous workout. This is why you're sore the next day.
   ii. **Alcohol** –produced by yeast fermenting fruits, etc.
4. The glucose molecule is not completely oxidized (degraded), so a lot of energy remains in the products.
   i. This produces no further ATP for the cell.

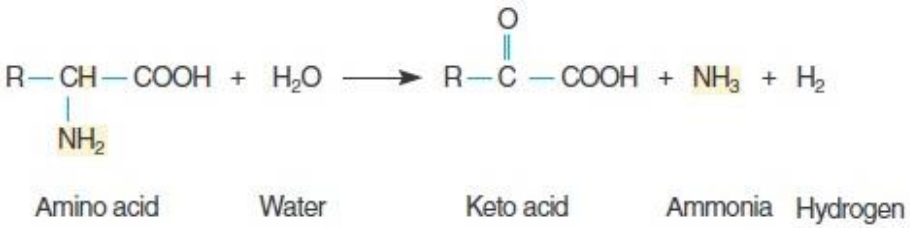
D. **Aerobic Respiration** – the Major Source of ATP. Requires free oxygen and occurs in the mitochondria of eukaryotic cells.

1. **Transition Step** – one carbon is removed (as CO_2) from the pyruvate generated by glycolysis to produce an **acetyl group**.
2. A carrier molecule, **Co Enzyme A**, joins the acetyl group to produce **Acetyl-CoA**.
3. Acetyl-CoA enters the **Krebs Cycle** (a.k.a. the citric acid cycle or TCA cycle) to complete the breakdown of glucose.
   i. Energy from this breakdown process is stored by electron carriers and transferred to the **Electron Transport Chain**.
   ii. **34 ATP molecules** are assembled by the electron transport chain.

III. What happens if cells don't have any glucose available?

A. Catabolism of glucose is the most common metabolic pathway for cells to make ATP, but cells can also harvest from fats and proteins.



B. Using fats to make ATP.
   1. Fats are complex molecules made of smaller subunits, glycerol and fatty acids.
   2. Fats are broken down, and the subunits enter various parts of the metabolic pathway.
   3. 1 gram of fat provides 2.5 times more ATP energy than 1 gram of protein or carbohydrates.
      i. That is why many animals store energy as fat in adipose tissue.

C. Using proteins to make ATP.
   1. Proteins are broken into their building blocks, amino acids.
   2. The deamination reaction removes an amine group and produces ammonia. An oxygen atom replaces this group to make a keto acid.
   3. The keto acid enters the Krebs cycle.
   4. The ammonia is highly toxic and must be excreted.