Chem 306
Chapter 21 - Bioenergetics
Lecture Outline I

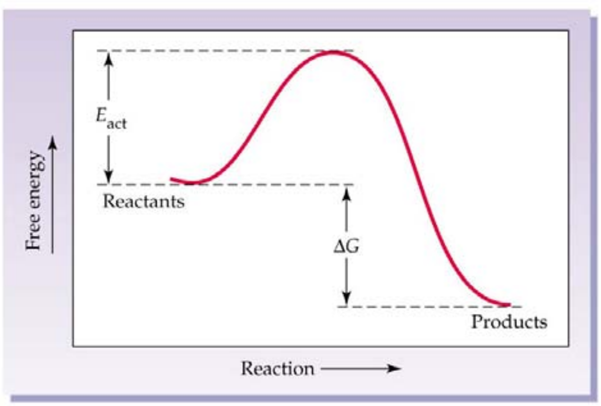
I. Energy Review

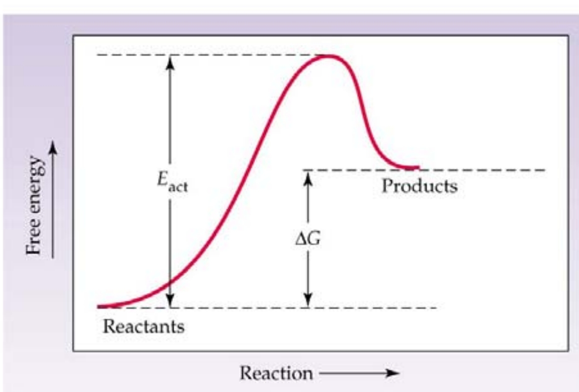
A. What makes reactions "go"?

1. A spontaneous process proceeds on its own without any external influence

2. Spontaneous processes proceed if a lower energy overall energy (G) state is attained.

Reaction Energy Diagrams





B. A closer look at the changes in Gibbs free energy ΔG

What factors affect ΔG?

Heat flow, the change in disorder, and temperature are factors that affect the overall free energy change for a process.

How are equilibrium and ΔG related?

The greater amount of free energy released, the further a reaxn proceeds toward product formation.

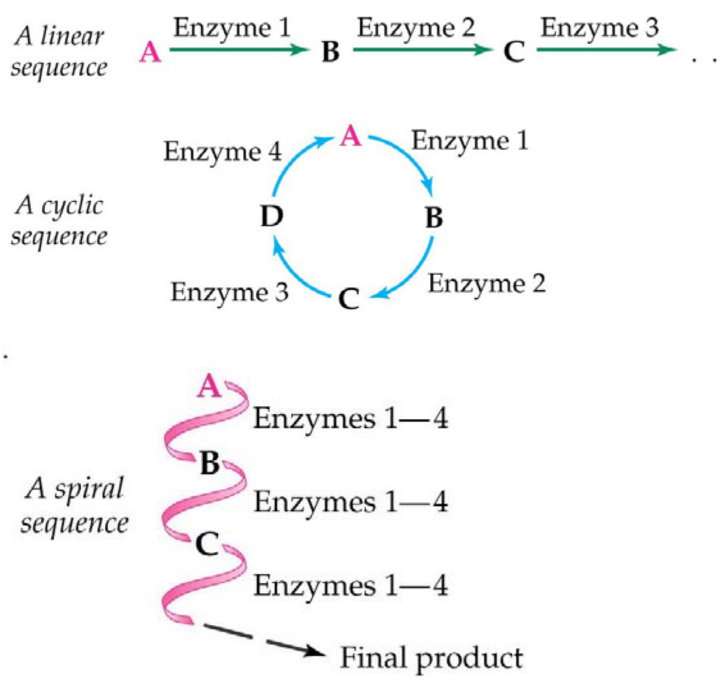
C. Examples

II. What is the source of our energy and what is it's fate in the body?

A. Energy from the sun is ultimately stored in chemical bonds. This stored energy in bonds found in food biomolecules is extracted by the body's biochemical machinery.

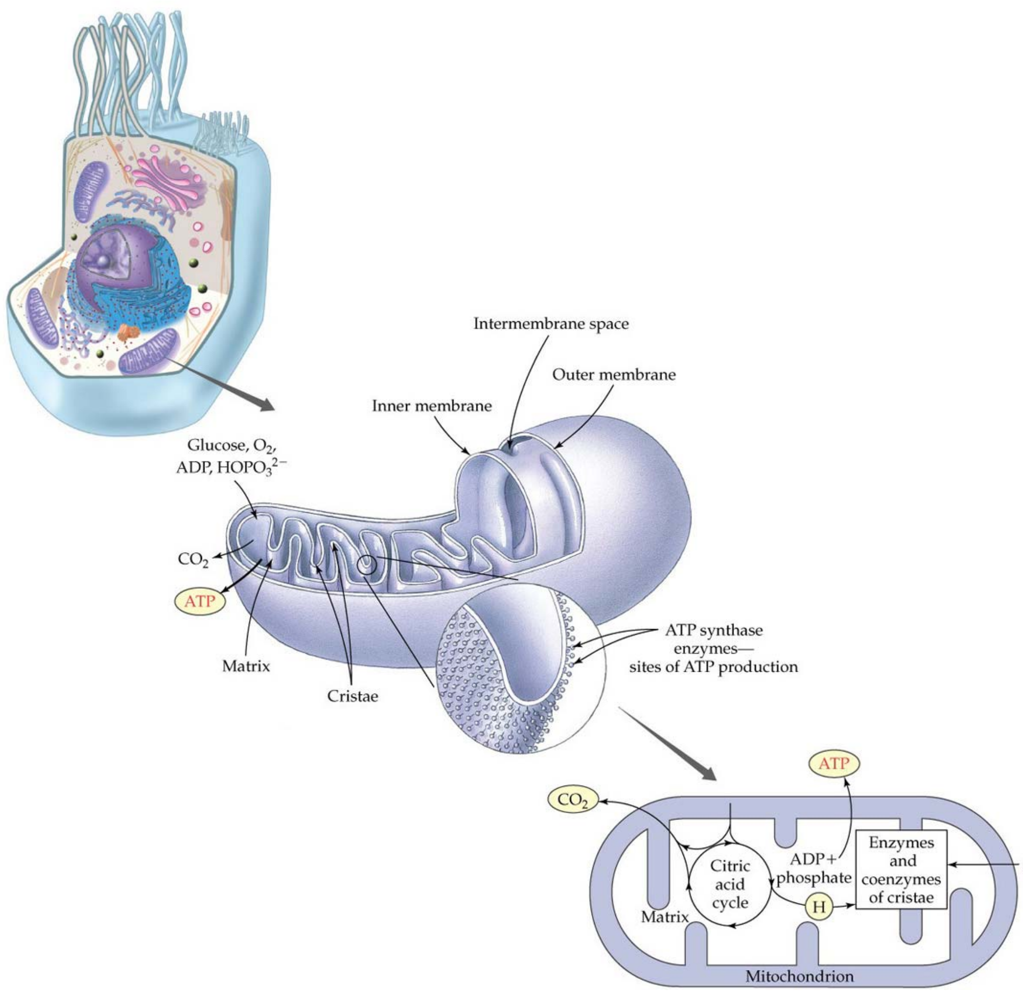
B. Chemical reactions in the body extract energy from food biomolecules. This energy is ultimately transferred (via sequences of chemical reactions) to adenosine triphosphate (ATP), the body's principal energy transporter.

1. The sequences of chemical reactions in the body make up the metabolic pathways.



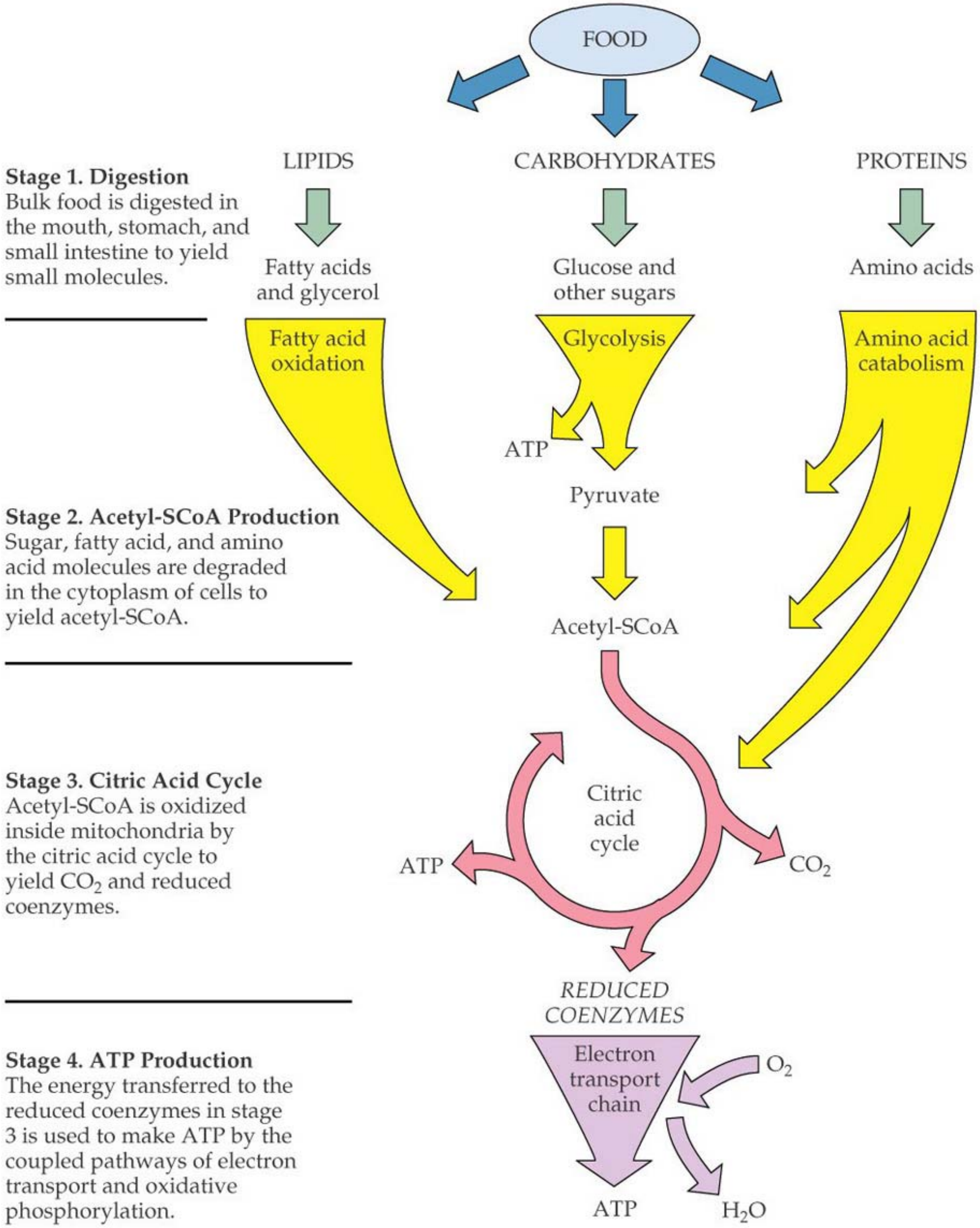
2. Catabolic processes vs Anabolic processes

C. Cell parts to know – *cytoplasm, mitochondrion, matrix, inner and outer mitochondrial membrane, cristae*



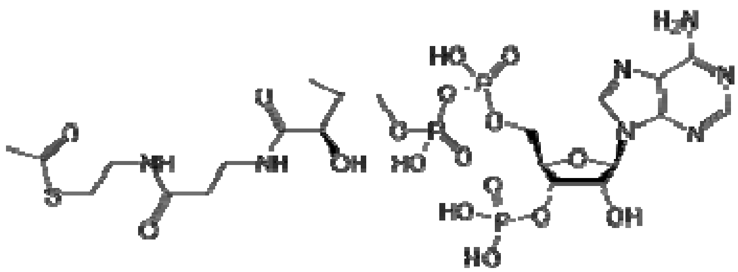
III. How are the reactions that break down food molecules organized?

A. The Really BIG picture



1. Stage 1 – Digestion

2. Stage 2 – Acetyl –S – CoA Production

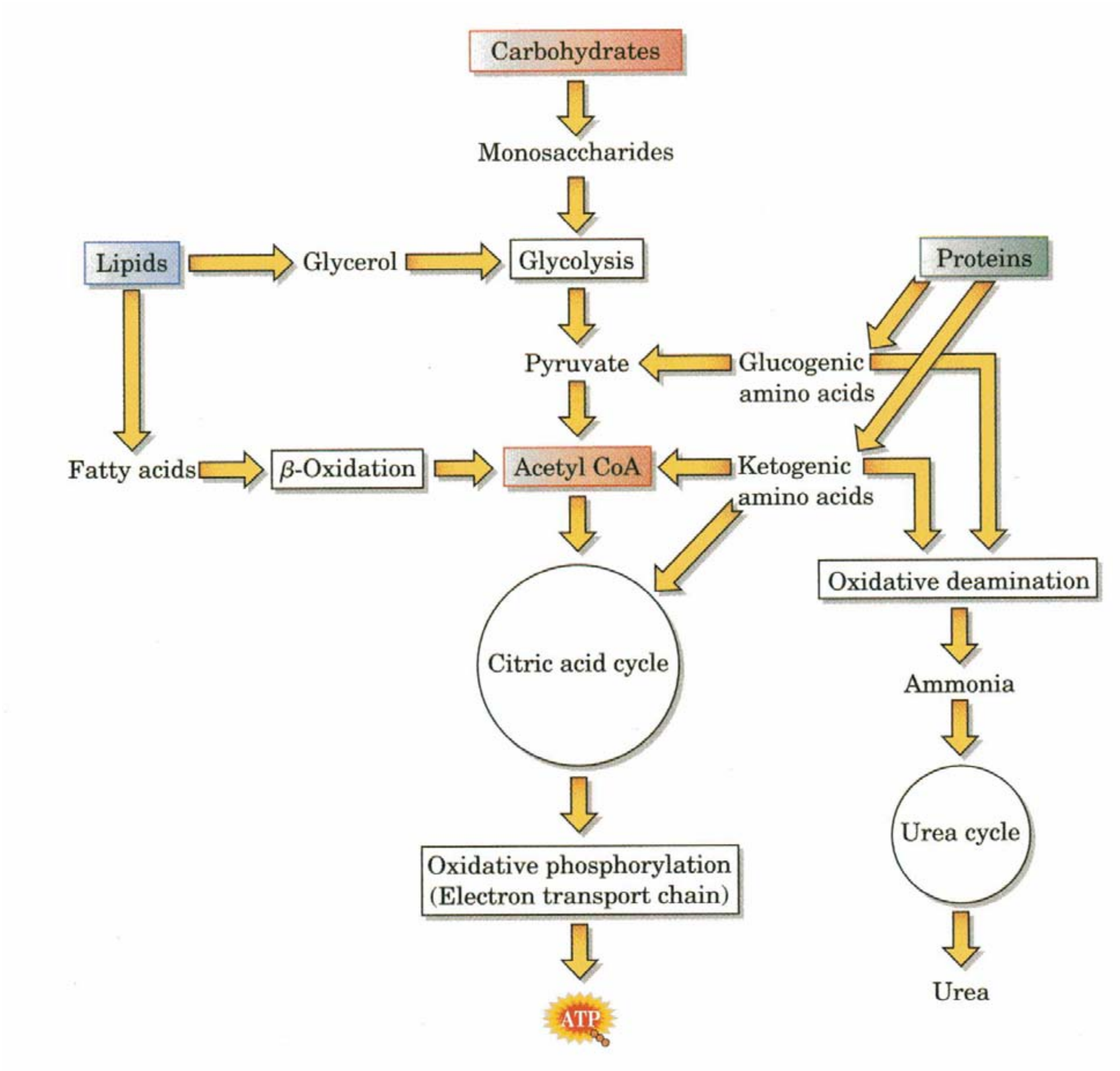


Acetyl – S - CoA

3. Stage 3 – Citric Acid Cycle

4. Stage 4 – ATP Production

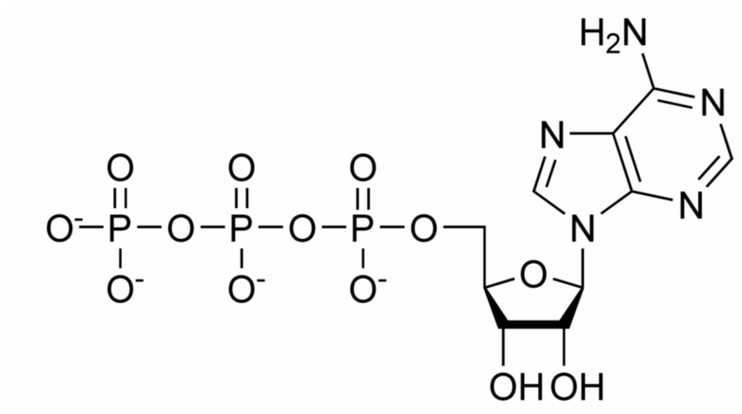
Another big picture diagram..



IV. What are the major strategies of metabolism?

A. ATP and Energy Transfer - ATP is the body's energy transporting molecule

1. Structure of ATP



ATP – adenosine triphosphate

2. How does ATP release energy?

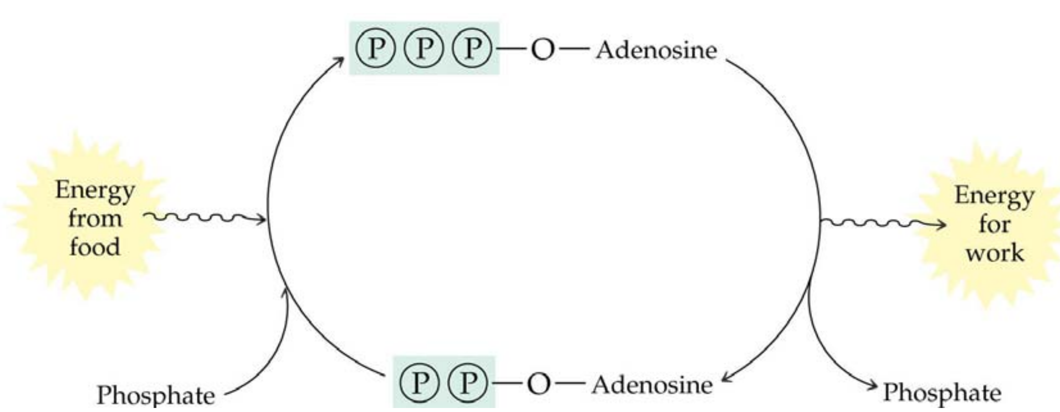
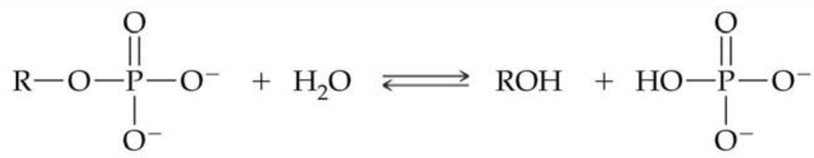


TABLE 21.1 Free Energies of Hydrolysis of Some Phosphates



Compound Name	Function	ΔG (kcal/mol)
Phosphoenol pyruvate	Final intermediate in conversion of glucose to pyruvate (glycolysis)—stage 2, Figure 21.5	−14.8
1, 3-Bisphosphoglycerate	Another intermediate in glycolysis	−11.8
Creatine phosphate	Energy storage in muscle cells	−10.3
ATP (⟶ADP)	Principal energy carrier	−7.3
Glucose 1-phosphate	First intermediate in breakdown of carbohydrates stored as starch or glycogen	−5.0
Glucose 6-phosphate	First intermediate in glycolysis	−3.3
Fructose 6-phosphate	Second intermediate in glycolysis	−3.3

The hydrolysis of other phosphates yields more energy than ATP.so why aren't these phosphates the energy currency of the cell?

B. Coupled Reactions

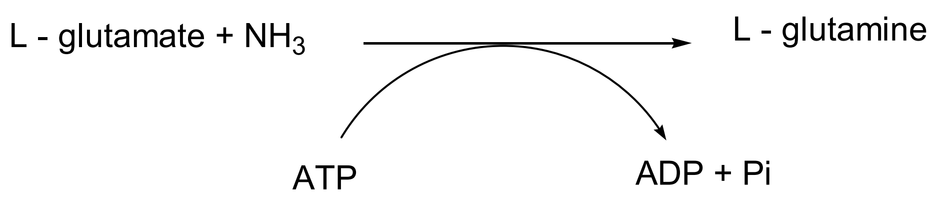
Reactions that require energy can be coupled with a reaction that supplies energy.

$$\text{Glucose} + HOPO_3^{\,2-} \rightleftharpoons \text{Glucose} - 6 - \text{phosphate} + H_20 \quad \Delta G = +\ 3.3\ \text{kcal}$$

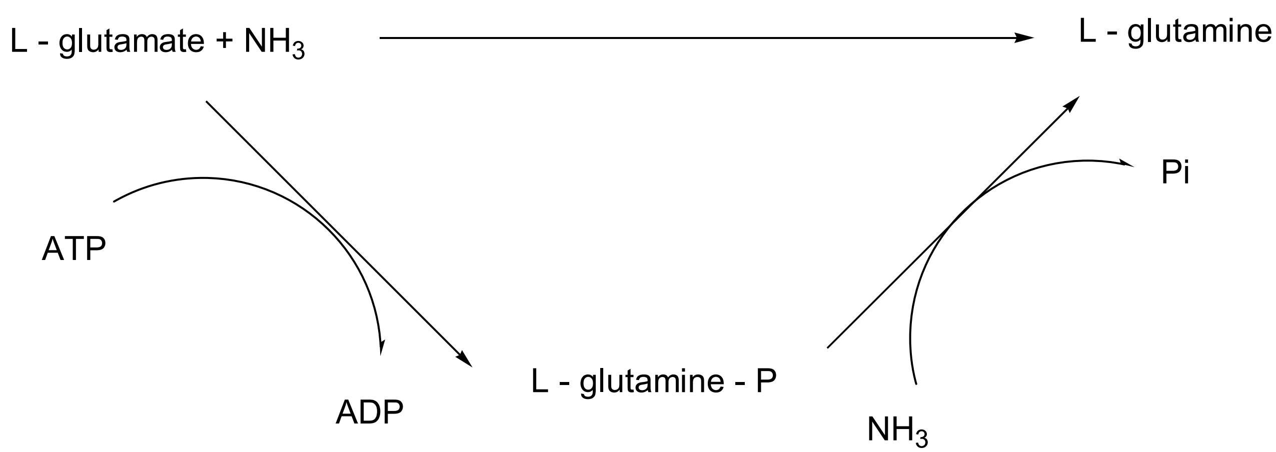
$$\text{ATP} + H_2O \rightleftharpoons \text{ADP} + HOPO_3^{\,2-} + H+ \quad \Delta G = -\ 7.3\ \text{kcal}$$

How is coupling a reaction different than a reaction occurring simultaneously?

An example of a coupled reaction:

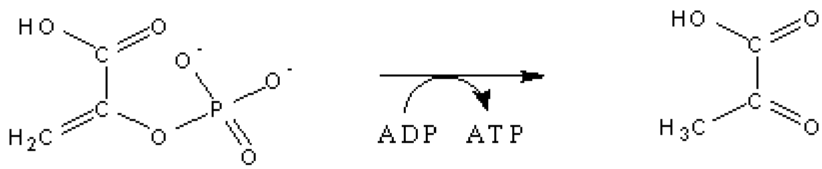


What is really happening is:



2. How is ATP regenerated?

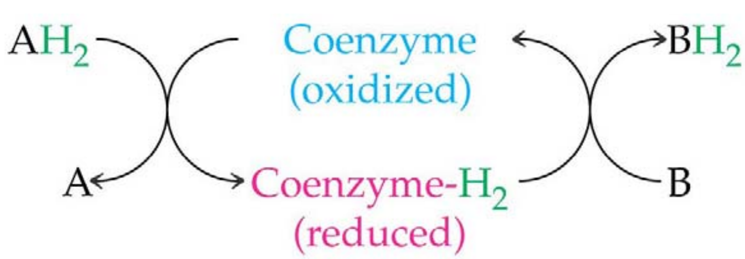
ADP + Pi ⟶ ATP $\Delta G = +7.3$ kcal



phosphoenol pyruvate pyruvate

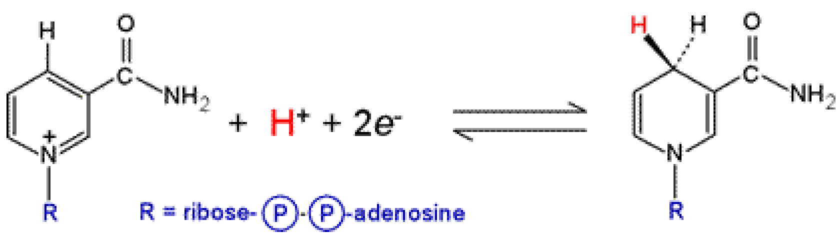
C. Oxidized and Reduced Coenzymes – Why are they so important in catabolism?

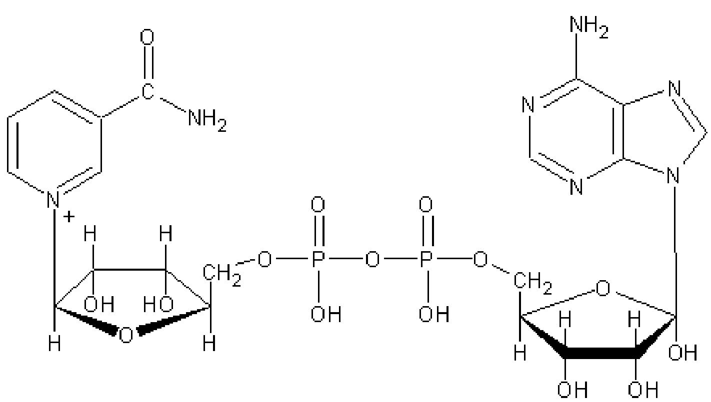
To deal with the demand for oxidizing/reducing agents, coenzymes cycle between their oxidized and reduced forms.



Coenzyme	As Oxidizing Agent	As Reducing Agent
Nicotinamide adenine dinucleotide	NAD^+	$NADH/H^+$
Nicotinamide adenine dinucleotide phosphate	$NADP^+$	$NADPH/H^+$
Flavin adenine dinucleotide	FAD	$FADH_2$
Flavin mononucleotide	FMN	$FMNH_2$

How does NAD+ act as an oxidizing agent? What really happens when a coenzyme gets reduced?





Why are reduced coenzymes called electron carriers?