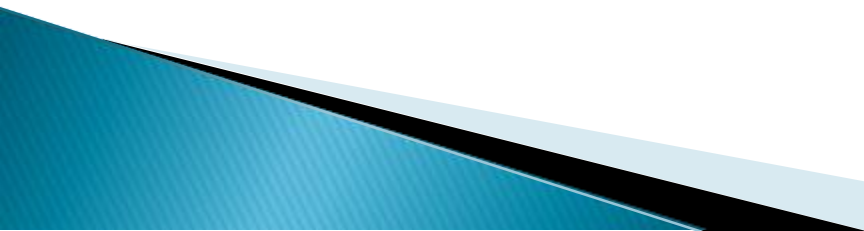


Metabolism: Anabolism and Catabolism

By

Dr. Sumbul Fatma

Objectives


- ▶ **Understand the concept of metabolic pathway**
 - ▶ **Identify types & characters of metabolic pathways– anabolic and catabolic**
 - ▶ **Identify ATP as the energy currency of cells**
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Metabolism

- ▶ All the chemical reactions taking place inside a cell are collectively known as **METABOLISM**
- ▶ Metabolism consists of:
 - energy consuming (**anabolic**) pathways
 - energy producing (**catabolic**) pathways

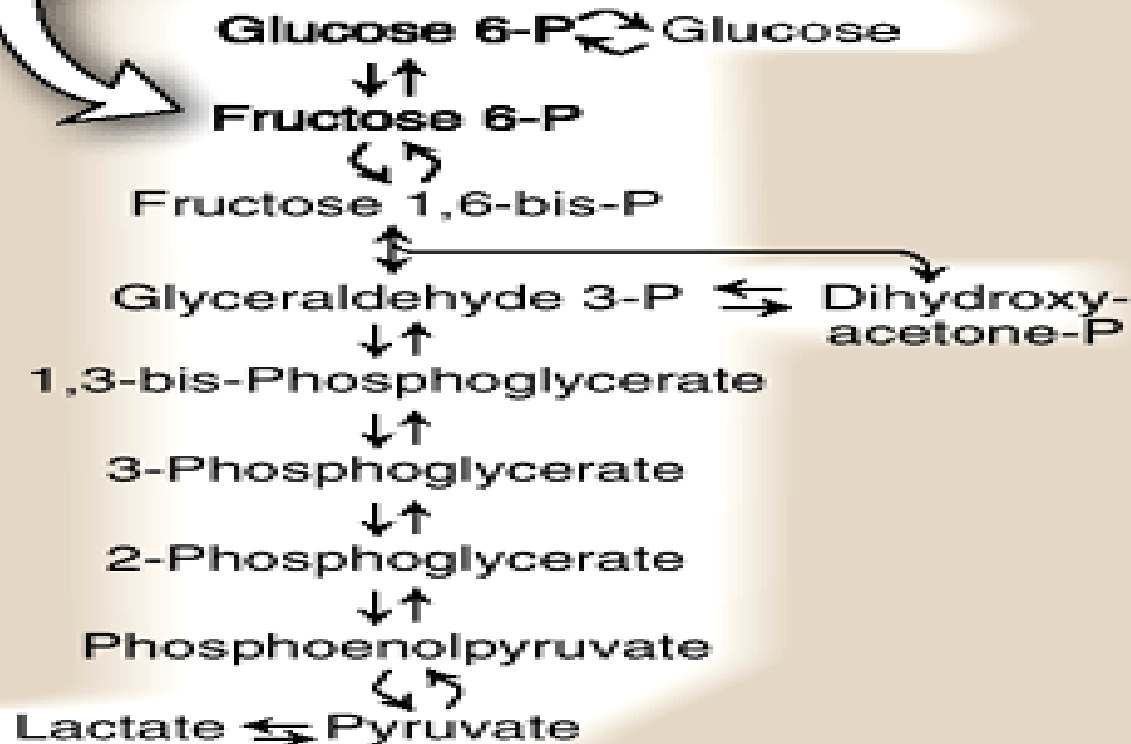
Pathway **Vs** Chemical Reaction

Metabolic Pathway:

- **A multi-step sequence of chemical reactions**
 - **A product of first reaction becomes a substrate for second reaction**
 - **Integrated pathways: Metabolism**
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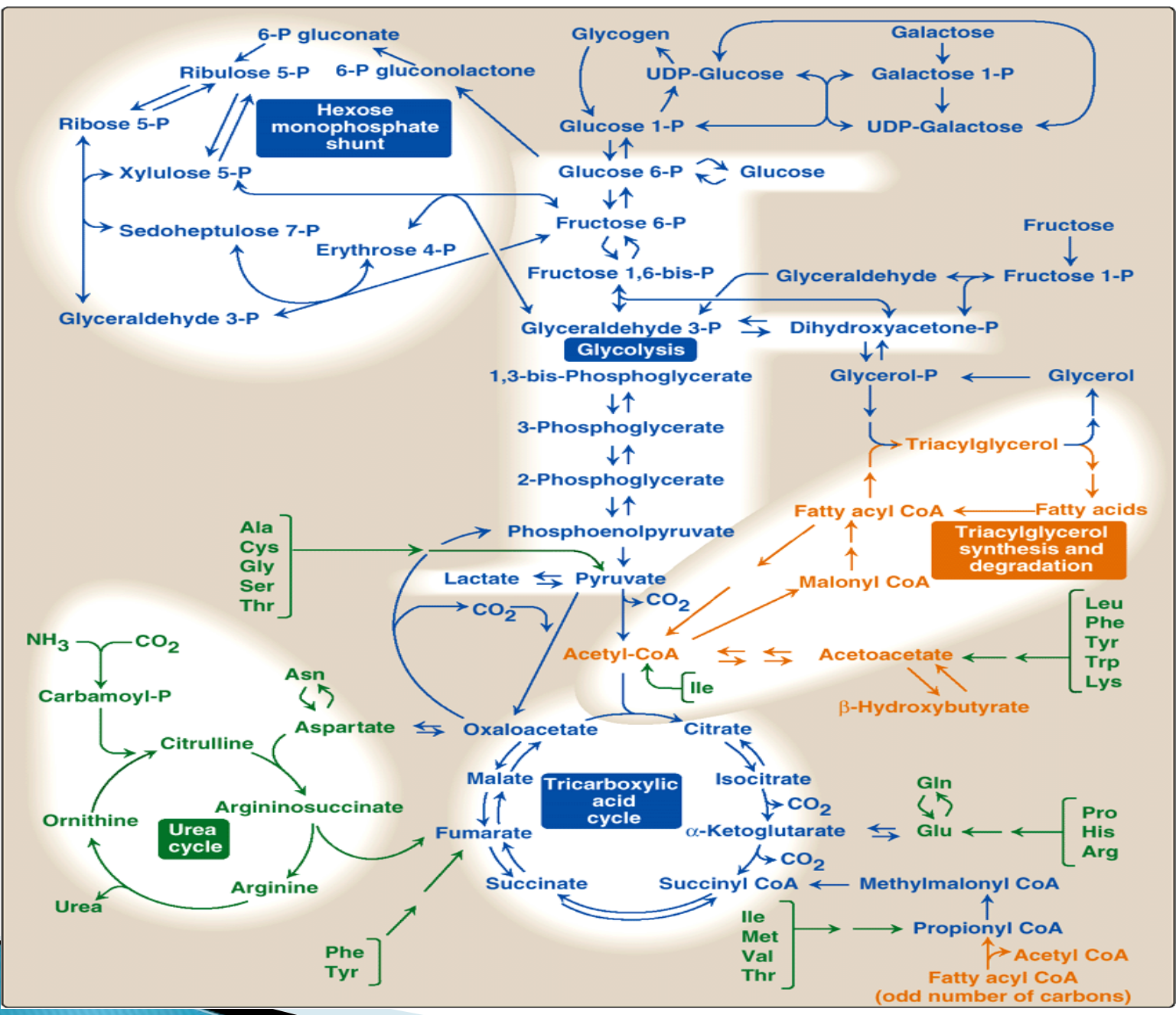
Glycolysis, an example of a metabolic pathway

The product of one reaction is the substrate of the subsequent reaction.

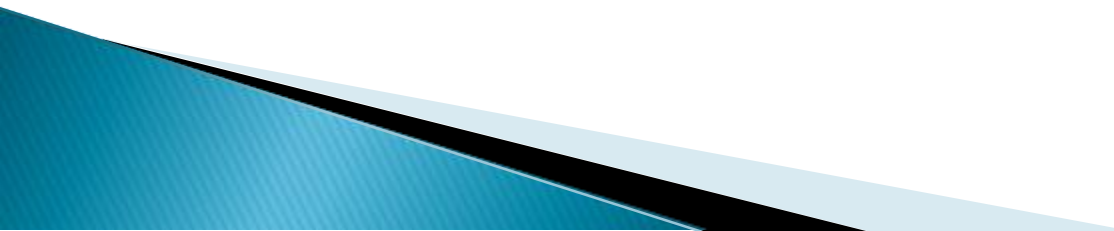


Metabolic Map

- ▶ Different pathways can intersect, forming an integrated and purposeful network of chemical reactions **“The Metabolic Map”**



Classification

- ▶ **Most pathways can be classified**
catabolic
anabolic
 - ▶ **Note: Pathways that regenerate a component are called cycles**
- 

Catabolic Pathways

Stage I:

Hydrolysis of complex molecules to their component building blocks

Proteins

Polysaccharides

Lipids

Amino acids

Monosaccharides

Glycerol, fatty acids

Stage II:

Conversion of building blocks to acetyl CoA (or other simple intermediates)

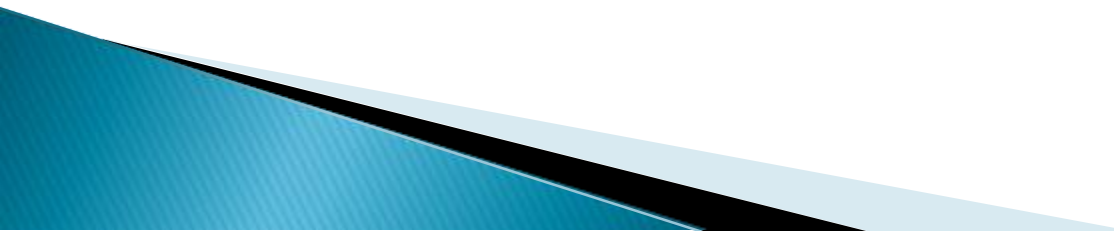
Acetyl CoA

Stage III:

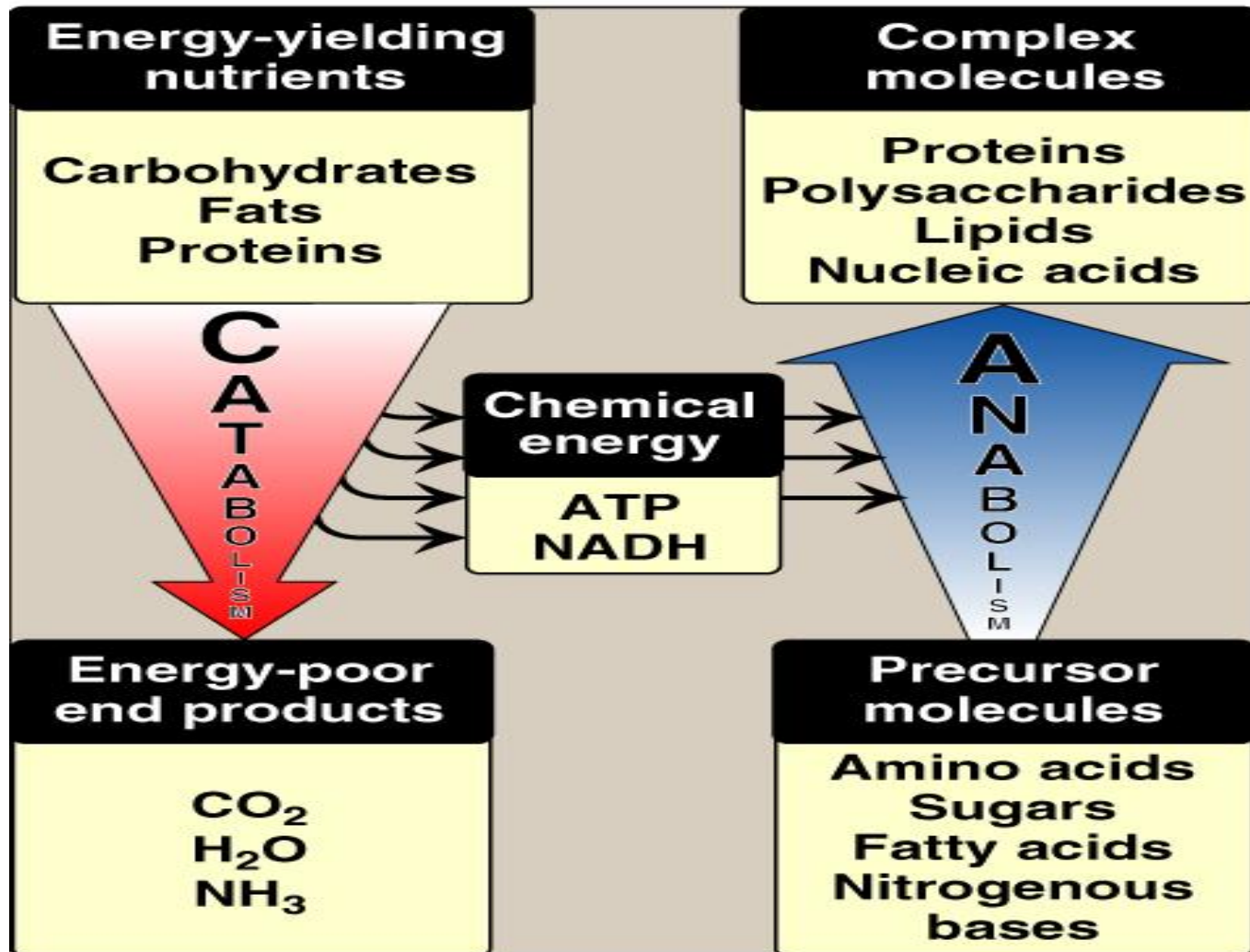
Oxidation of acetyl CoA; oxidative phosphorylation



Anabolic Pathways

- **Precursor molecules into complex molecules**
 - **Endergonic reactions require ATP**
 - **Divergent process**
- 

Catabolism Vs Anabolism



Comparison of catabolic and anabolic pathways

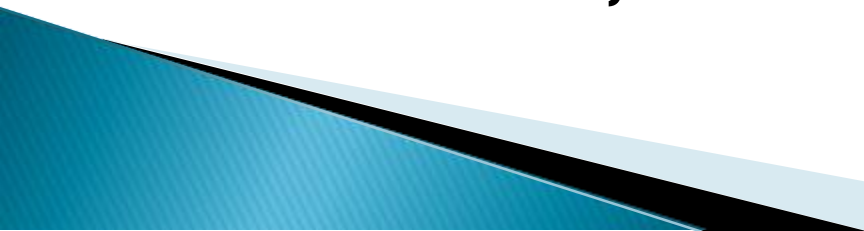
Anabolic

- ▶ Simple to complex molecules
- ▶ Endergonic
- ▶ Involves reductions
- ▶ Requires NADPH
- ▶ Divergent process

Catabolic

- ▶ Complex to simple molecules
- ▶ Exergonic
- ▶ Involves oxidations
- ▶ Requires NAD⁺
- ▶ Convergent process

Amphibolic Pathways

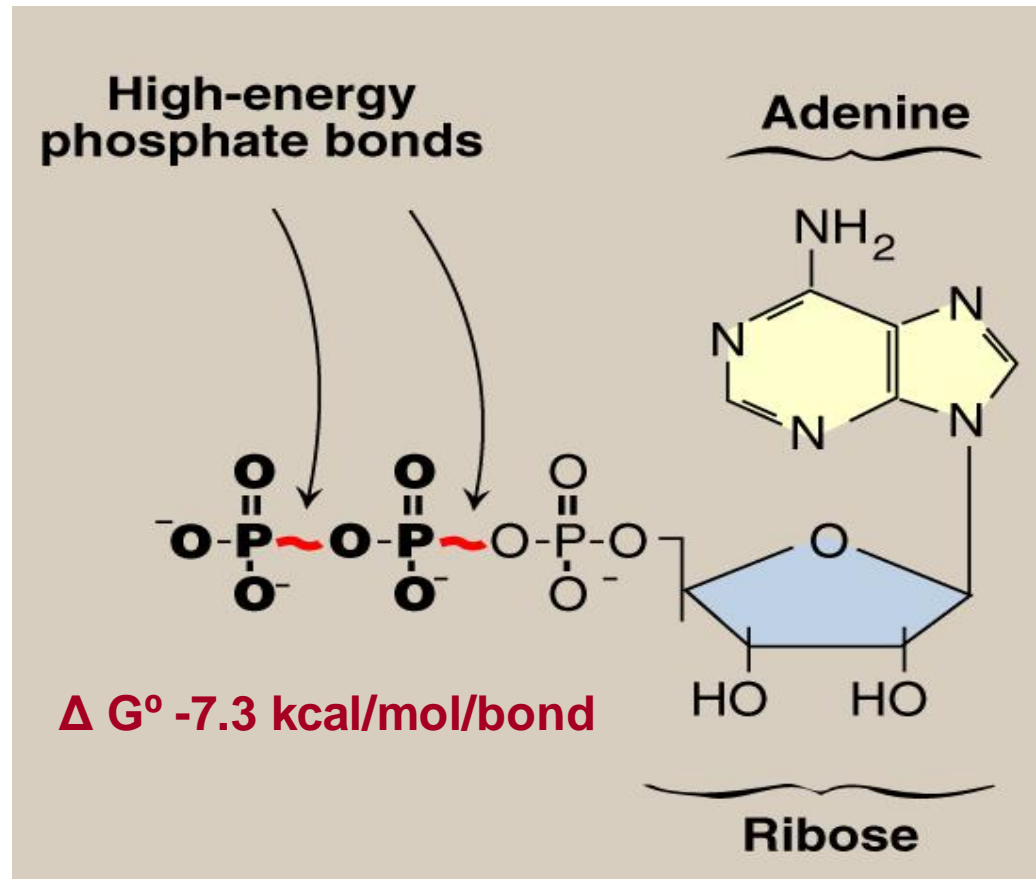
- ▶ **Amphi = Dual, amphibolic: dual pathway**
 - ▶ **For example,**
Krebs cycle is mainly a **catabolic cycle,**
but with some **anabolic features,**
e.g., part of Krebs cycle is used for the
synthesis of glucose from amino acids
- Therefore, **Krebs cycle is amphibolic****
- 

Energy Currency: ATP



- ▶ The free energy liberated in the hydrolysis of ATP is used to drive the endergonic reactions
- ▶ ATP is formed from ADP and P_i when fuel molecules are oxidized
- ▶ This **ATP-ADP cycle** is the fundamental mode of energy exchange in biological systems

Adenosine Triphosphate (ATP)

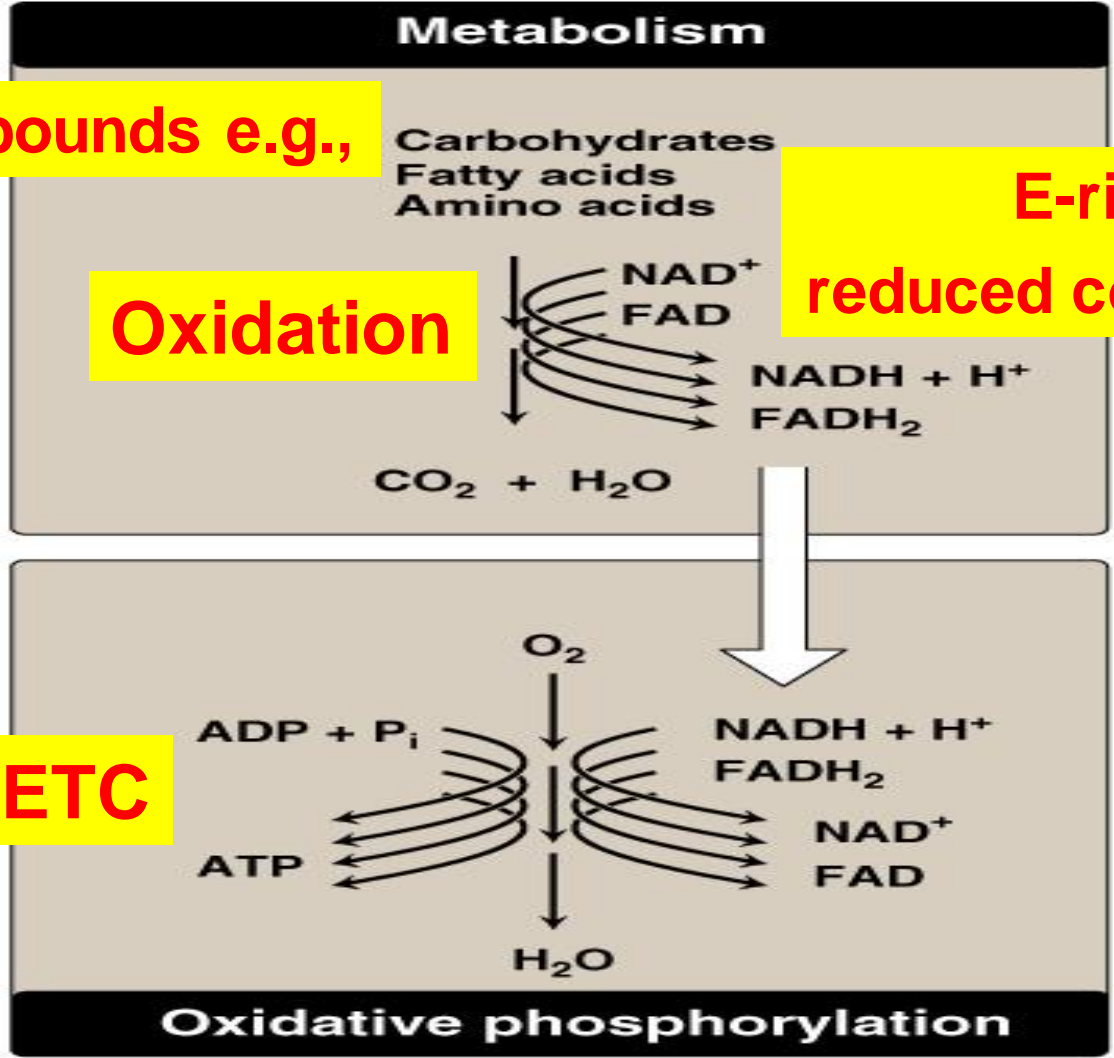


Oxidation-Reduction in Metabolism

E-rich compounds e.g.,

Oxidation

E-rich reduced coenzymes



Oxidation/Reduction

Oxidation:

Loss of hydrogen

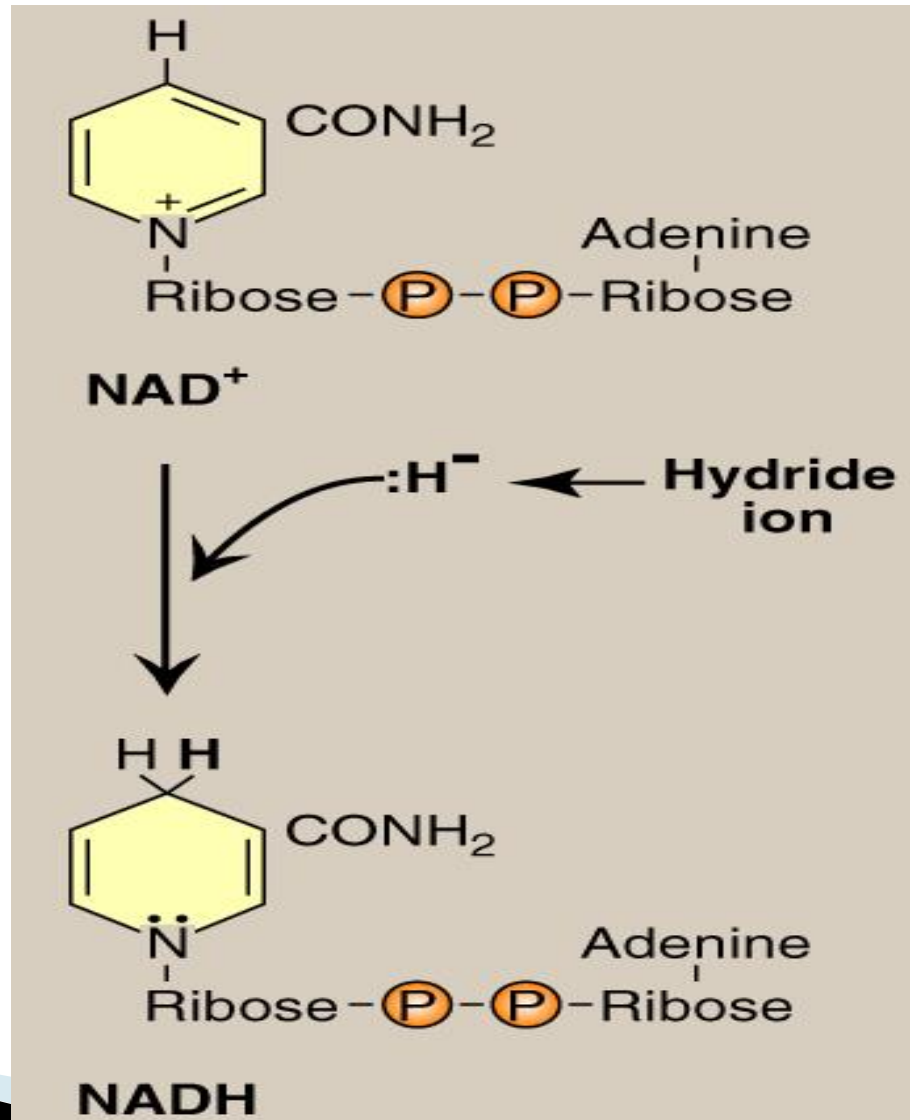
Loss of electrons

Reduction:

Gain of hydrogen

Gain of electrons

NAD⁺/ NADH



Regulation of Metabolism

Intracellular signals:

Substrate availability

Product inhibition

Allosteric activators

Intercellular communications:

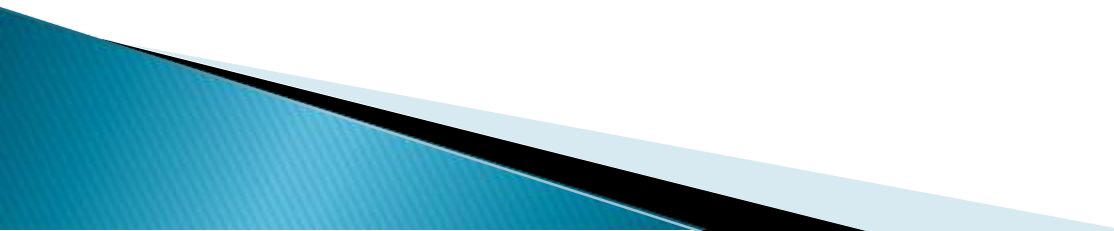
Chemical signaling (hormones):

Second messenger

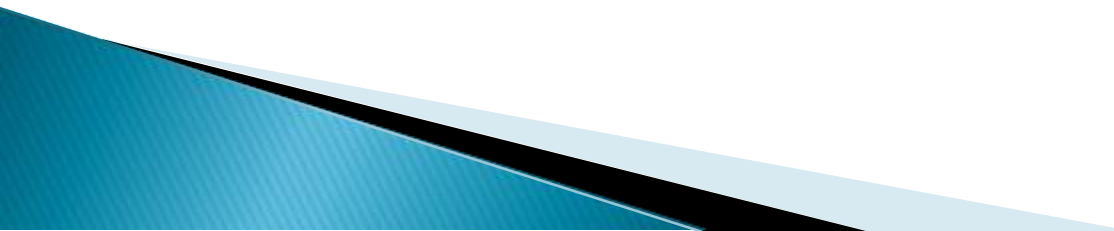
cAMP, cGMP

Ca/phosphatidylinositol


Metabolic Fuel

- ▶ Carbohydrates & lipids (**mainly**) and proteins (**little extent**) are used for energy production
 - ▶ These are– glucose, fatty acids and amino acids
 - ▶ Glucose is the major metabolic fuel of most tissues
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Take Home Message-1

- ▶ **Metabolism is the sum of all biochemical pathways that occur inside the cells.**
 - ▶ **A metabolic pathway is a multistep sequences of enzyme-catalyzed reactions.**
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Take Home Message-2

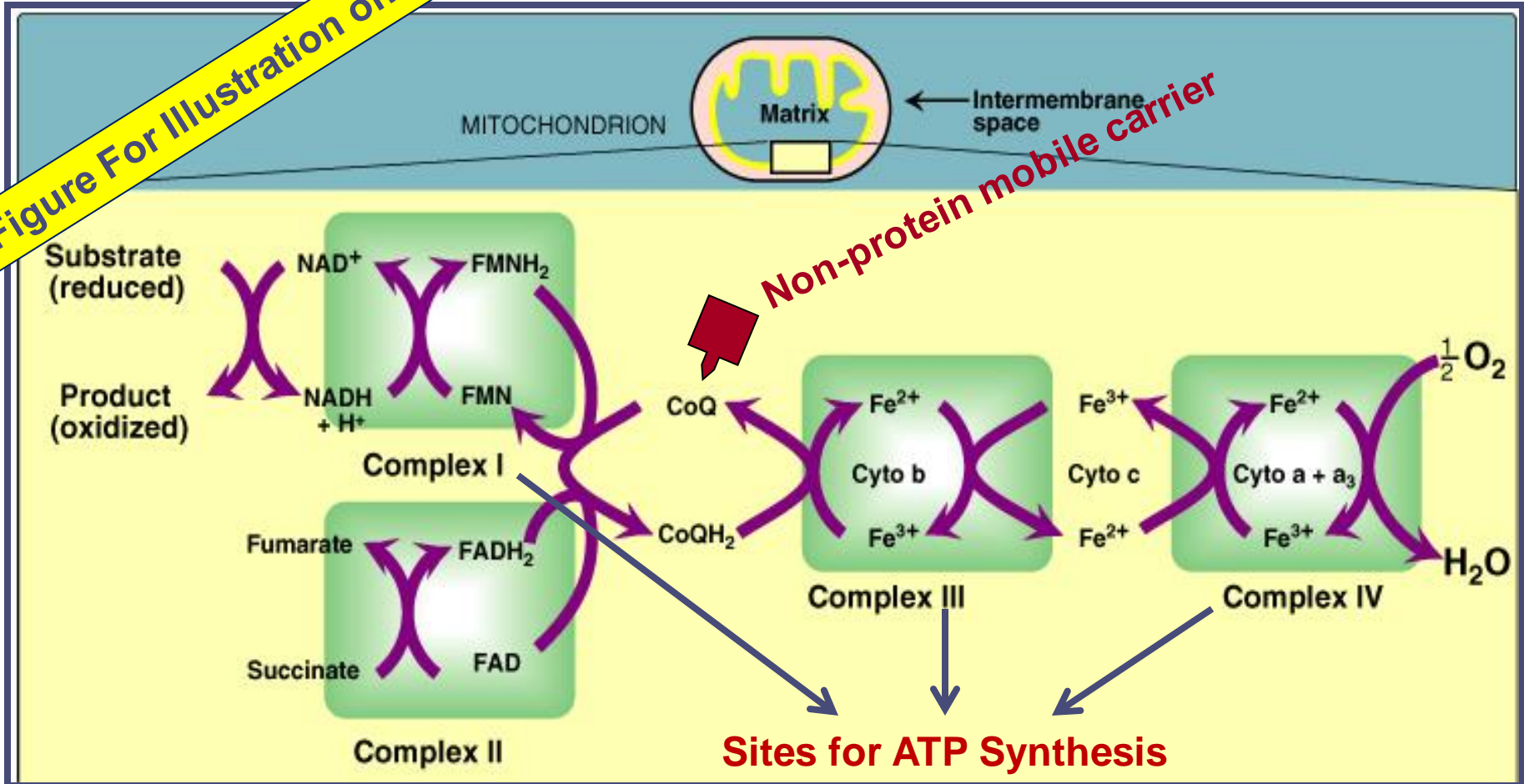
- ▶ **Catabolism is a convergent process that provides energy to cells in the form of ATP.**
 - ▶ **Anabolism is a divergent process that consumes energy for the synthesis of complex molecules.**
 - ▶ **Metabolic pathways are tightly regulated and highly integrated.**
- 

Take Home Message-3

- ▶ ATP is the energy currency of the cells

Electron Transport Chain (ETC)

Figure For Illustration only



Electron transport and ATP synthesis are tightly coupled processes