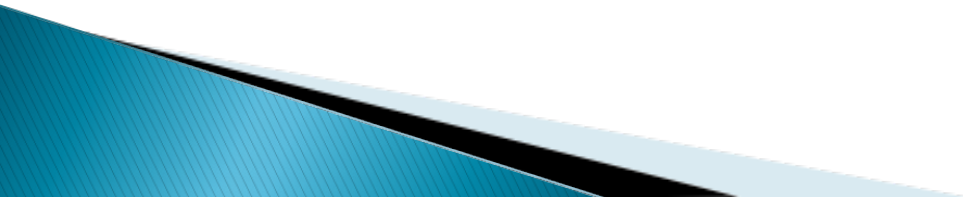


Metabolism: Anabolism and Catabolism

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

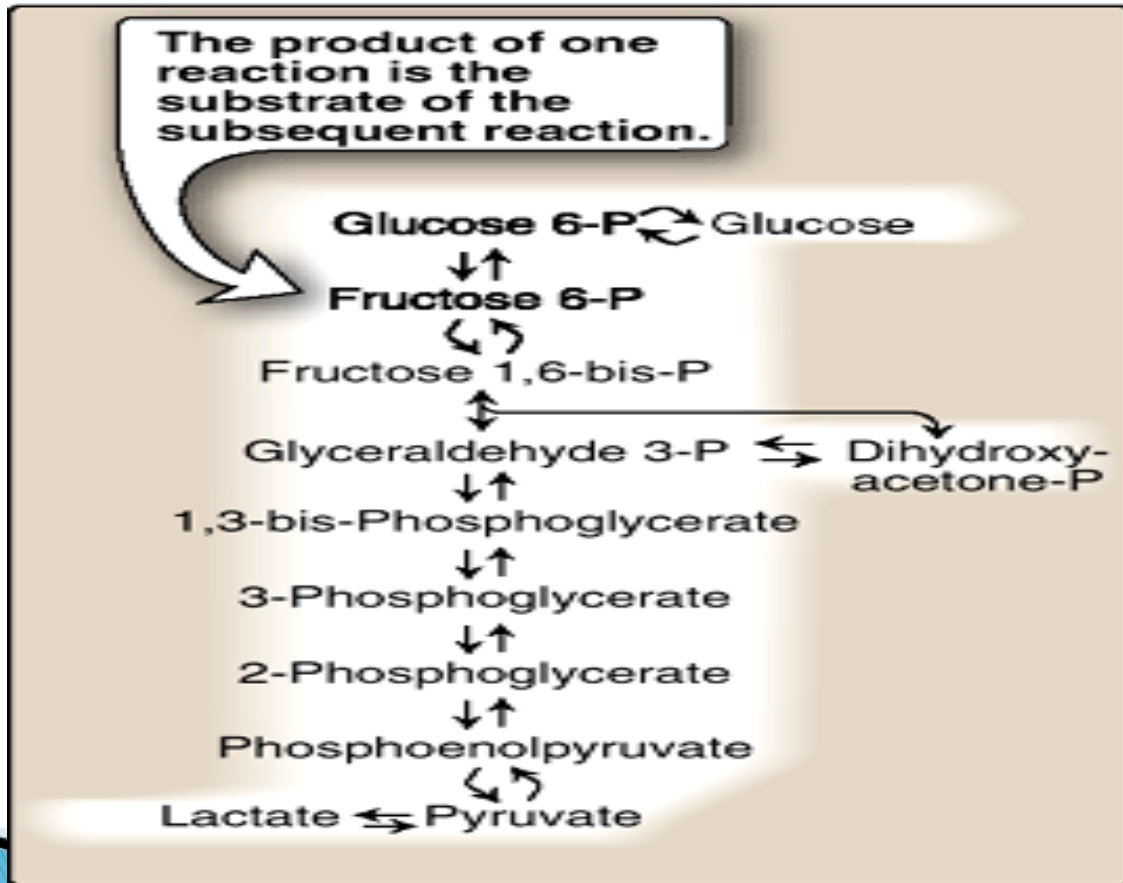
- All the chemical reactions taking place inside a cell are collectively known as **METABOLISM**
- Metabolism consists of:
 - energy consuming (**anabolic**) pathways
 - energy producing (**catabolic**) pathways

Pathway **Vs** Chemical Reaction

Metabolic Pathway:

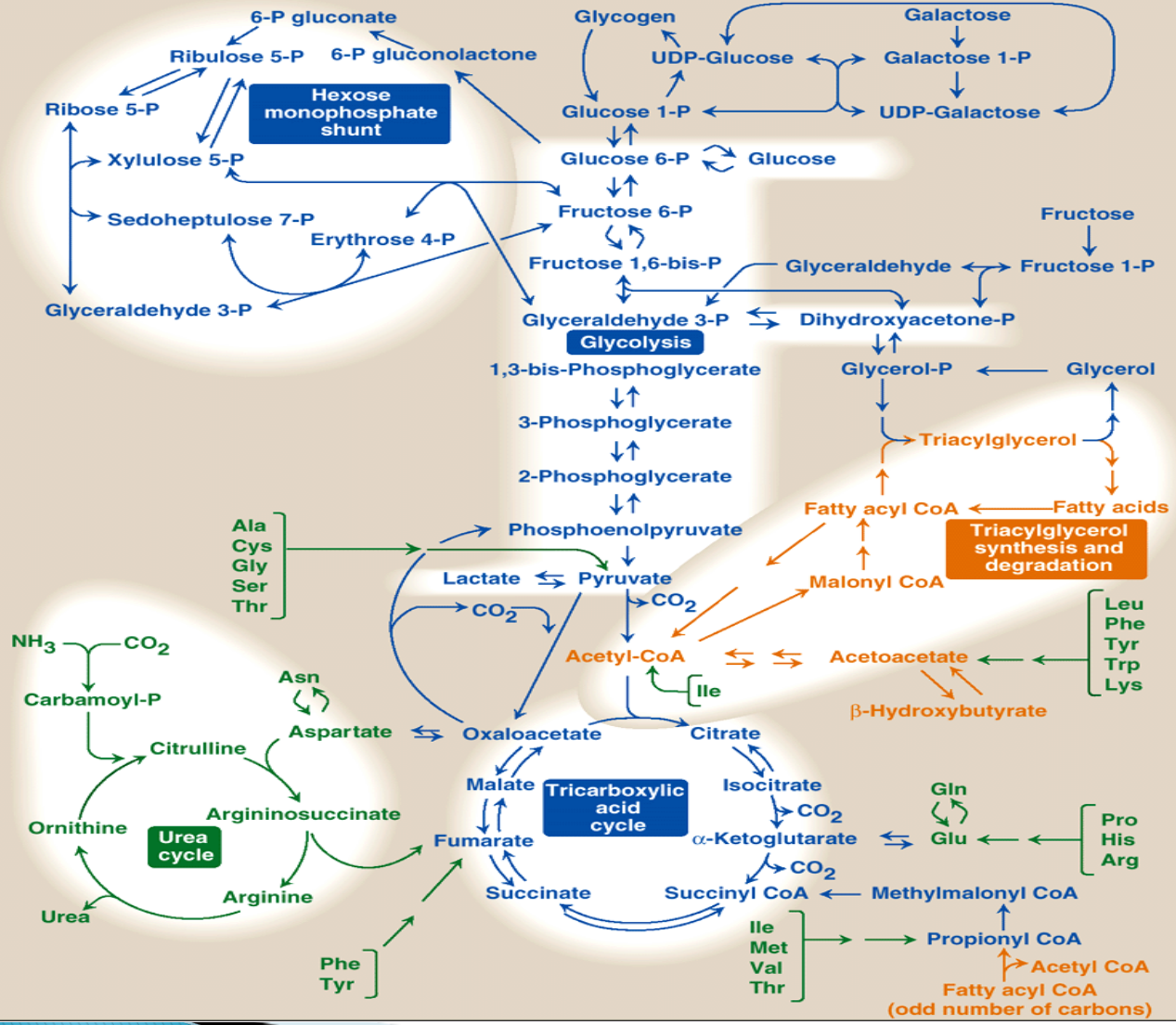
- A multi-step sequence of chemical reactions
 - A product of first reaction becomes a substrate for second reaction
 - Integrated pathways: Metabolism
- 

Glycolysis, an example of a metabolic pathway

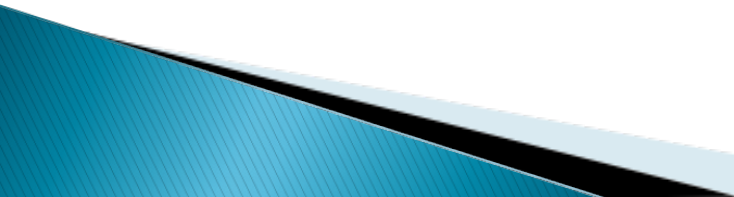


Metabolic Map

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



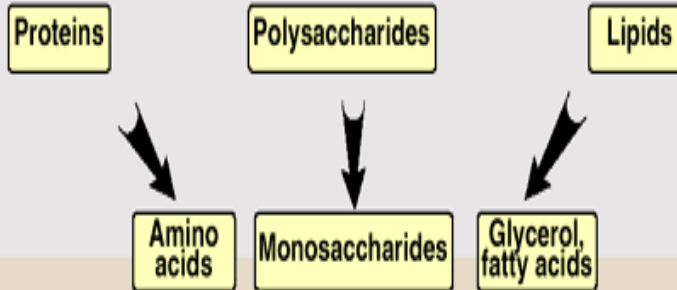
Classification

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

Catabolic Pathways

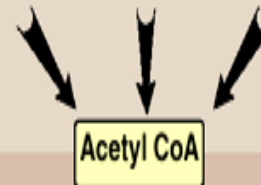
Stage I:

Hydrolysis of complex molecules to their component building blocks



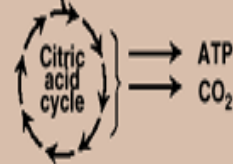
Stage II:

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

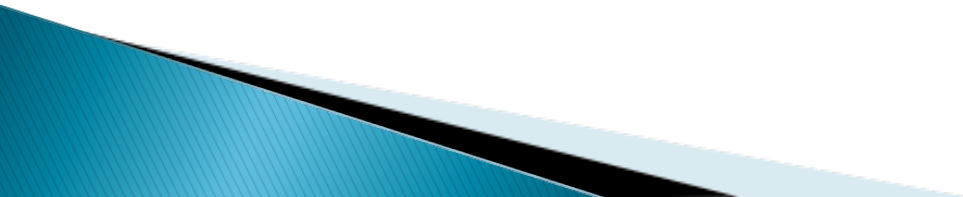


Stage III:

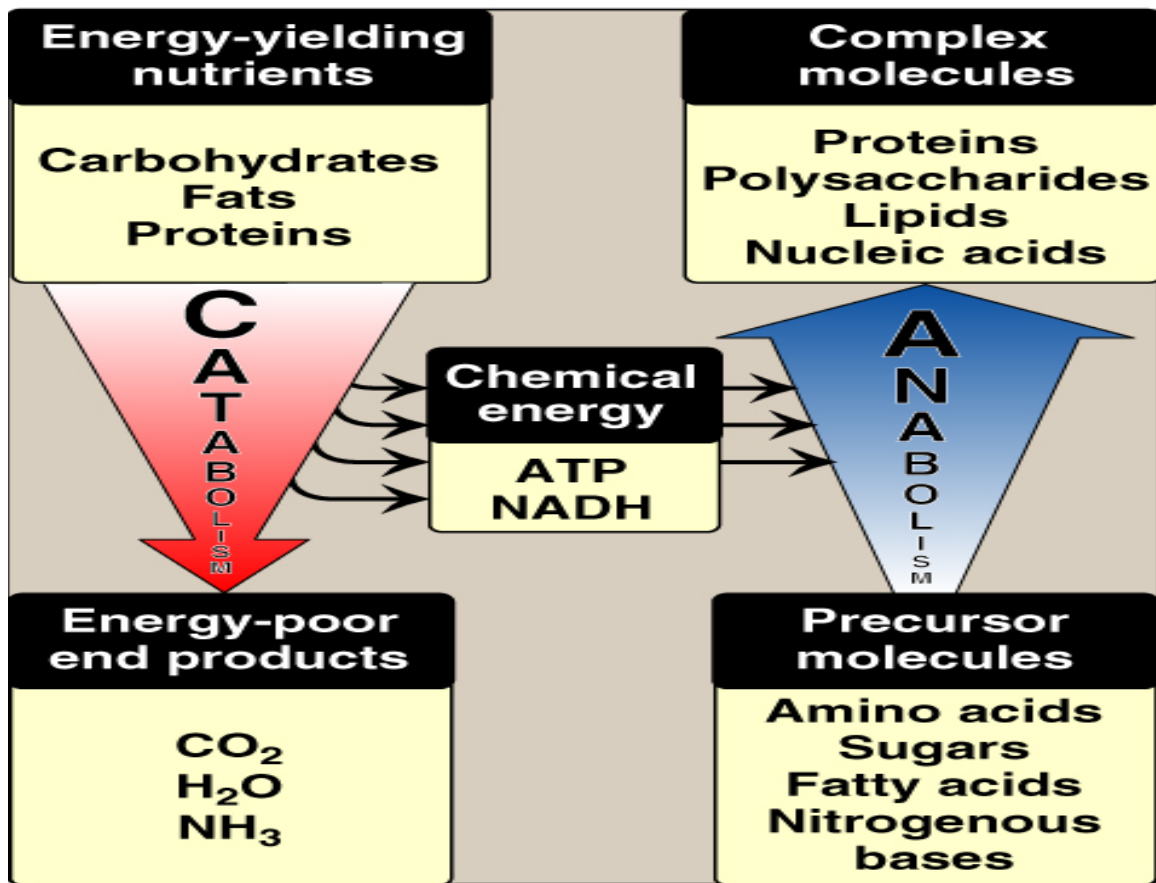
Oxidation of acetyl CoA; oxidative phosphorylation



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

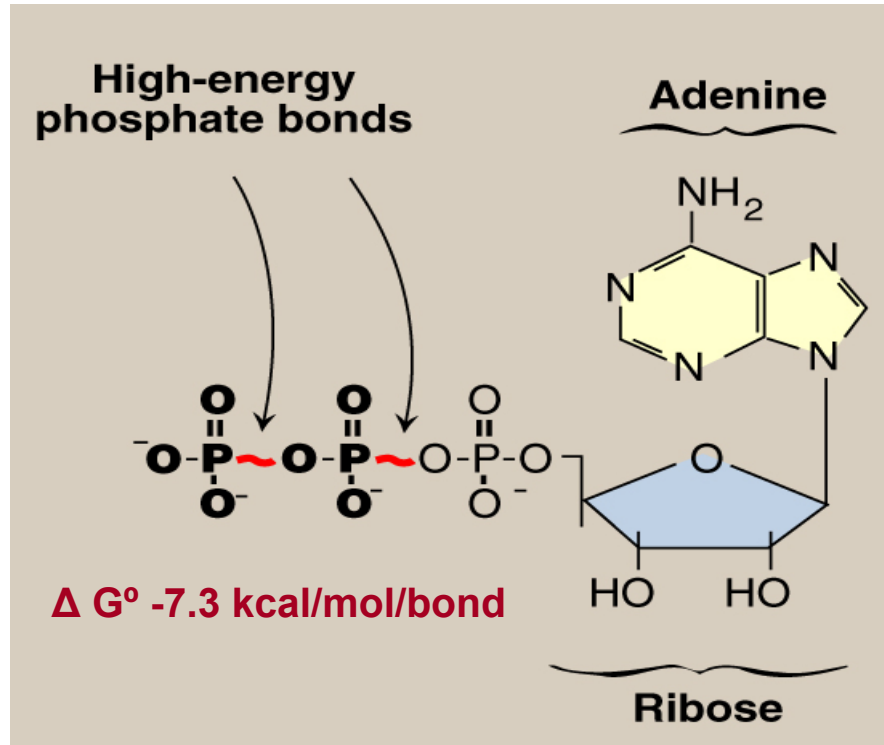
- **Amphi = Dual, amphibolic: dual pathway**
- **For example,**
Krebs cycle is mainly a **catabolic cycle, but with some **anabolic** features,**
e.g., part of Krebs cycle is used for the synthesis of glucose from amino acids
Therefore, **Krebs cycle is amphibolic**

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 Pi 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

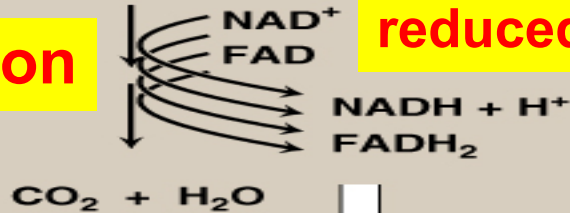
E-rich compounds e.g.,

Metabolism

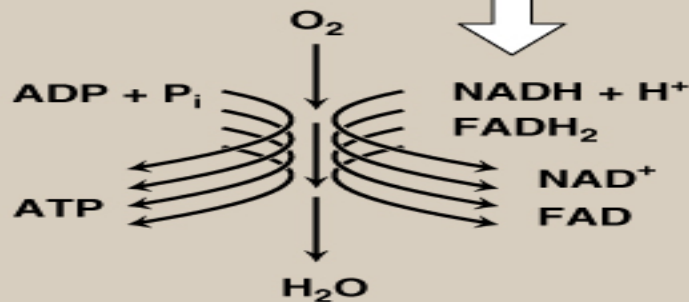
Carbohydrates
Fatty acids
Amino acids

Oxidation

E-rich
reduced coenzymes



ETC



Oxidative phosphorylation

Oxidation/Reduction

Oxidation:

Loss of hydrogen

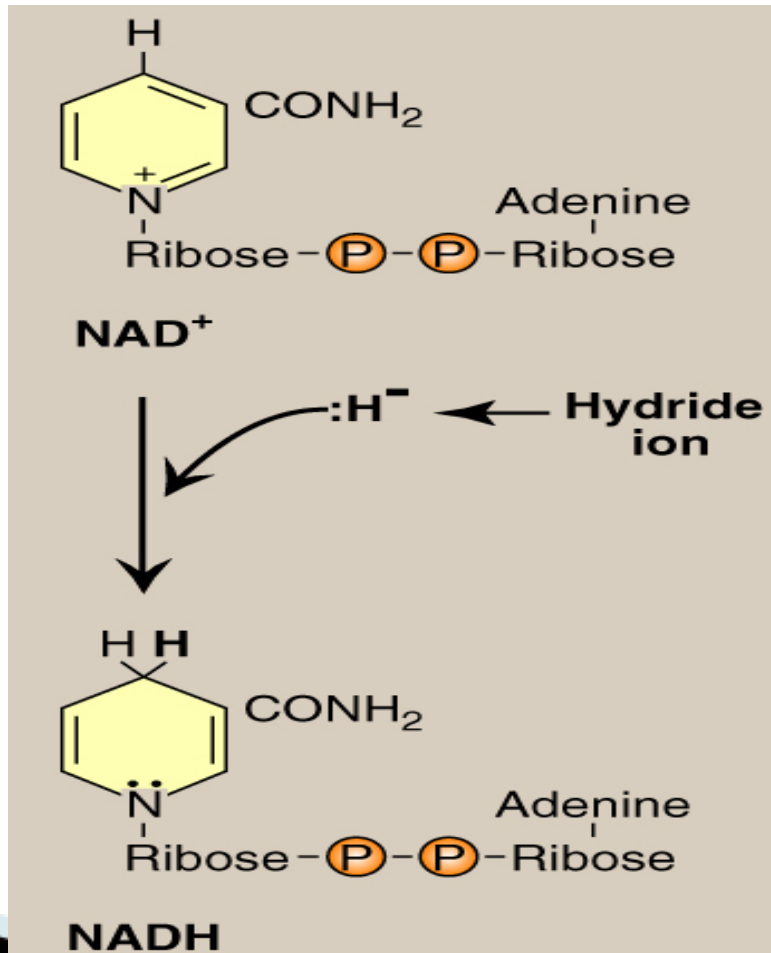
Loss of electrons

Reduction:

Gain of hydrogen

Gain of electrons

NAD⁺/ NADH



Regulation of Metabolism

Intracellular signals:

Substrate availability

Product inhibition

Allosteric activators

Intercellular communications:

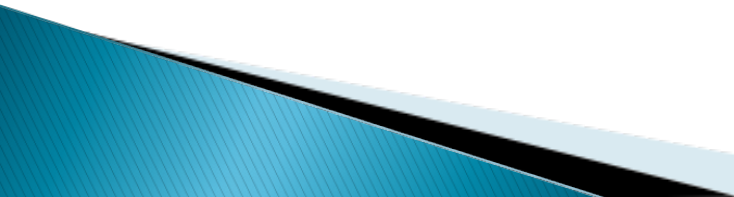
Chemical signaling (hormones):

Second messenger

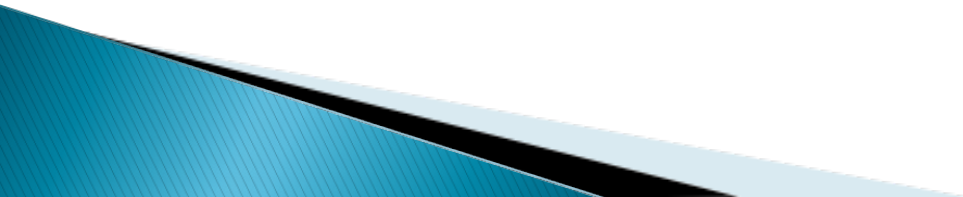
cAMP, cGMP

Ca/phosphatidylinositol

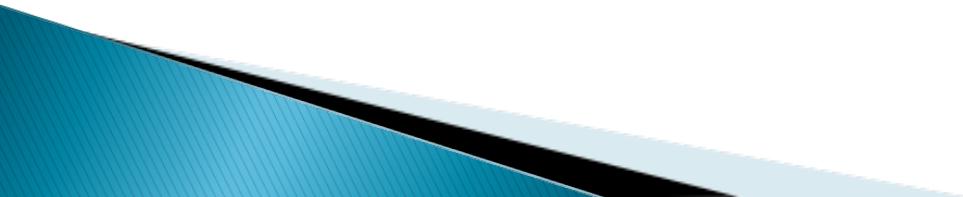
Metabolic Fuel

- **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**
- 

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

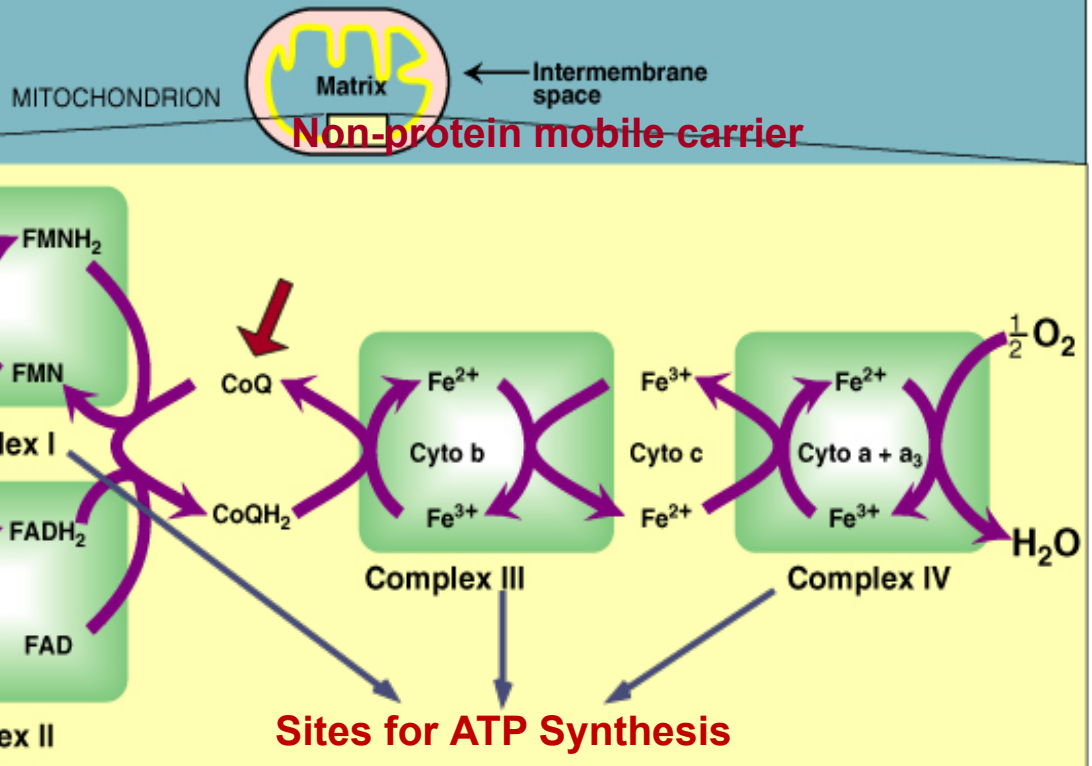
- **Catabolism is a convergent process that provides energy to cells in the form of ATP.**
 - **Anabolism is a divergent process that consumes energy for the synthesis of complex molecules.**
 - **Metabolic pathways are tightly regulated and highly integrated.**
- 

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