جامعة الملك سعود
King Saud University

بِسْمِ اللهِ الرَّحْمَنِ الرَّحِيمِ

MED437 KING SAUD UNIVERSITY

BIO TEAM

Biochemistry Team 437

Metabolism: anabolism and catabolism

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Highlights

Objectives:

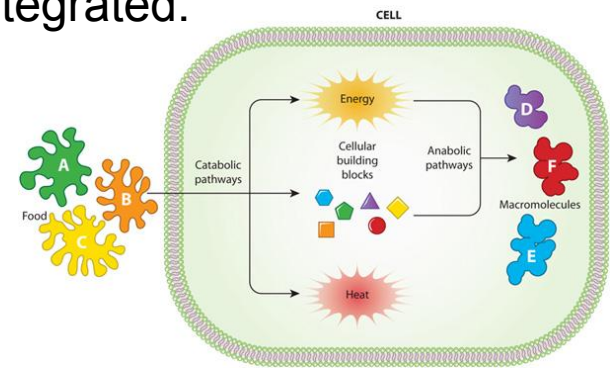
- Understand the concept of metabolic pathway
- Identify types and characters of metabolic pathways- anabolic and catabolic
- Identify ATP as the energy currency of cells

Metabolism:

METABOLISM is all the chemical reactions taking place inside a cell.

A metabolic pathway is a multistep sequences of enzyme-catalyzed reactions.

> Metabolic pathways are tightly regulated and highly integrated.



Consists of (classified as):

1- Anabolism (anabolic pathway) بناءة
بنى

2- Catabolism (catabolic pathway) هدامة

Pathways that regenerate a component are called **cycles**.

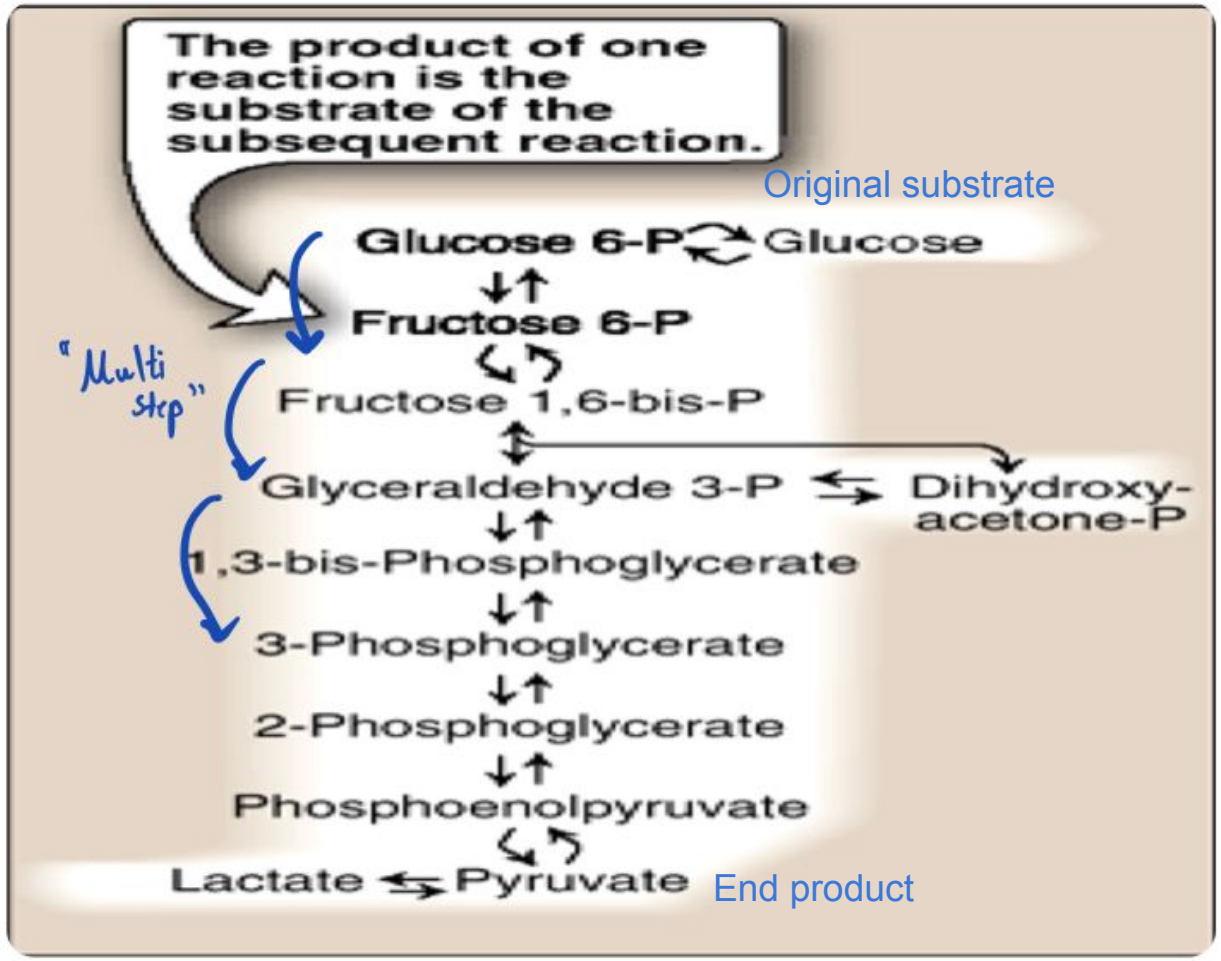
Pathway Vs Chemical reaction

Metabolic pathways:

- A multi-step sequence of chemical reactions.
- A product of first reaction becomes a substrate for second reaction.
- Integrated (not separated) pathways.

Metabolic pathways are bidirectional.

An example of a metabolic pathway (Glycolysis):



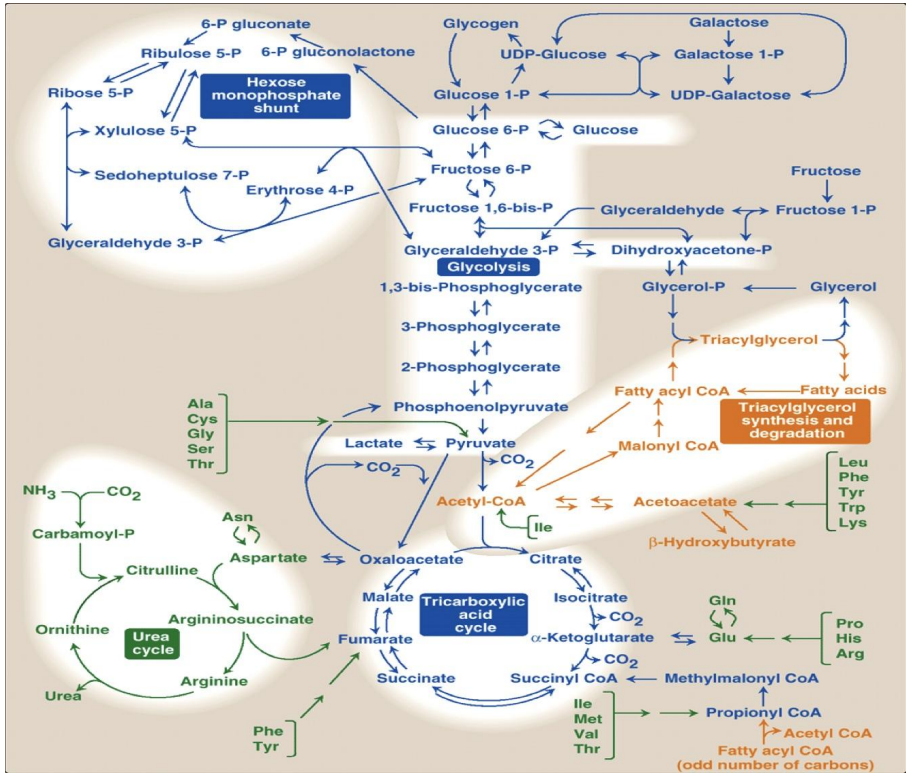
Whereas chemical reactions happen with one step and one direction

Metabolic Map

Different pathways can intersect, forming an integrated and purposeful network of chemical reactions The Metabolic Map.

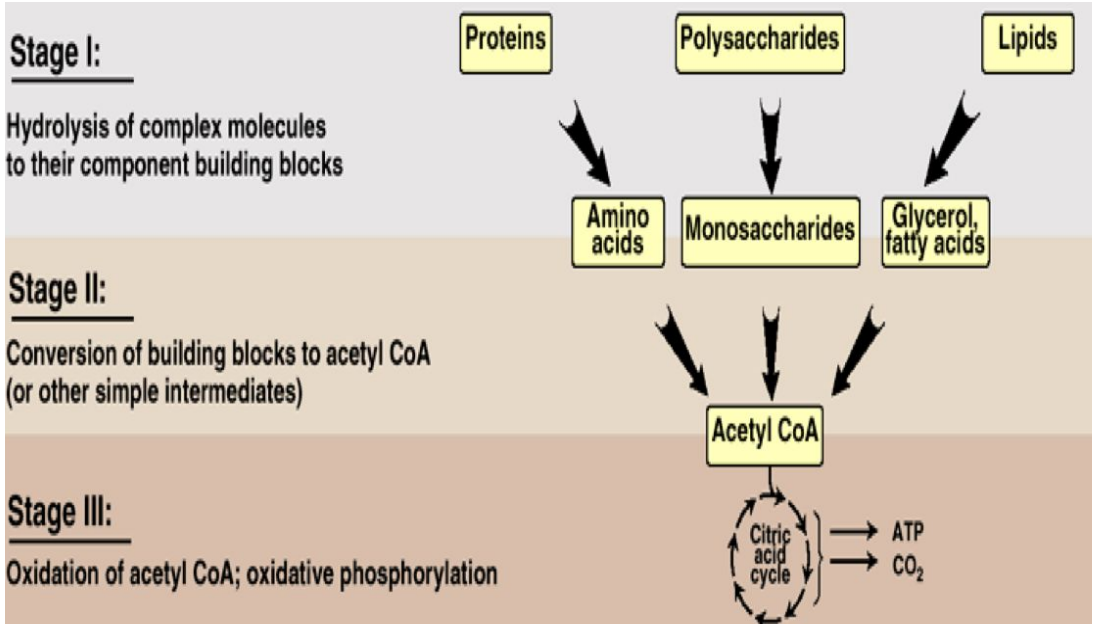
> The metabolic map shows how all pathways come together, it helps us understand the effect of each path on the entire metabolism.

Example:
(الصورة للفهم فقط)



Catabolic Pathways

Breaking down complex molecules to produce energy



Anabolic Pathways

-Use ATP produced by catabolic pathways
-Monomers + Energy (ATP) = Polymers

- Precursor molecules into complex molecules
- Endergonic reactions require ATP
- Divergent process
  Starts with a small number of molecules and keeps on increasing

Amphibolic Pathways

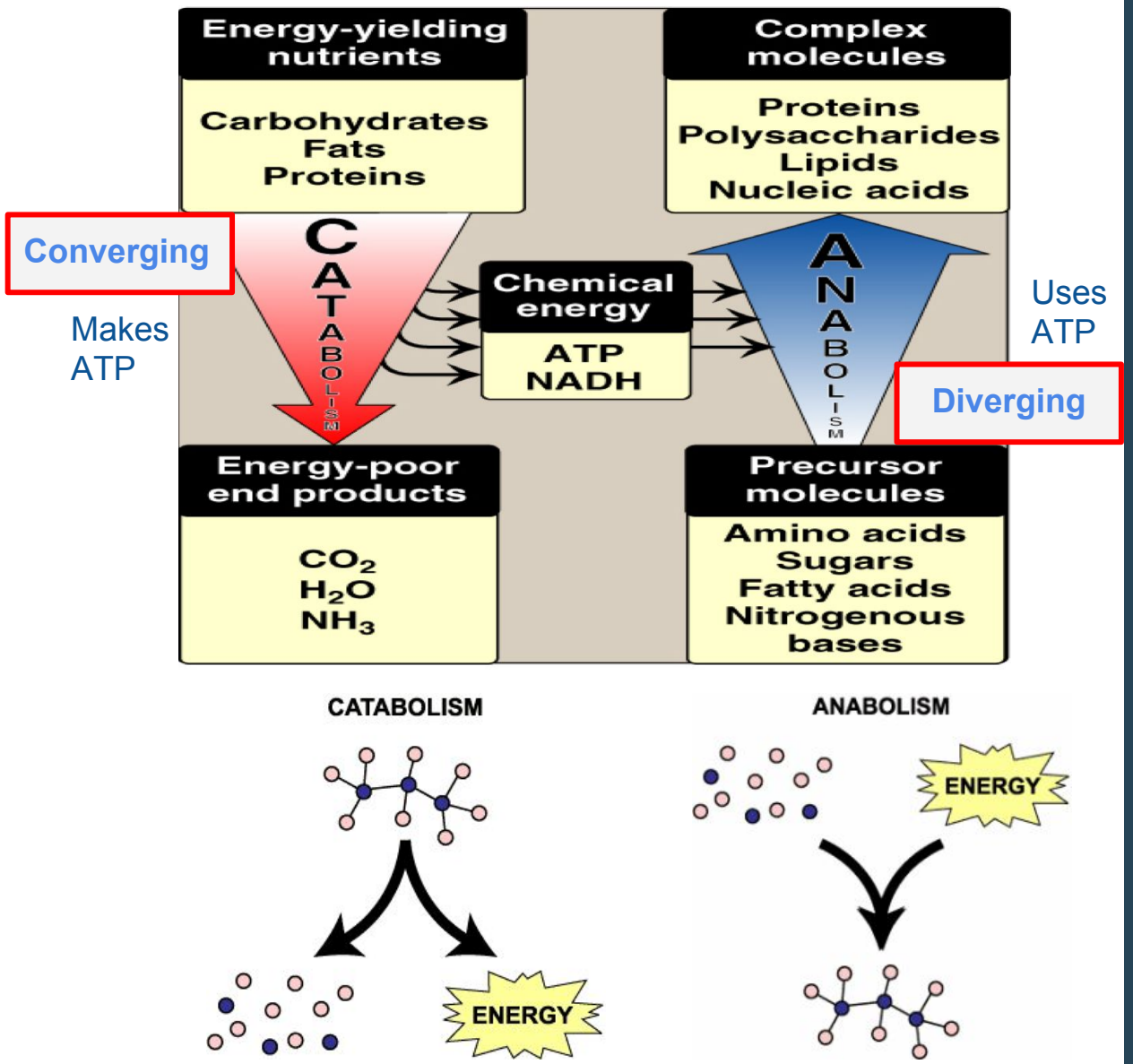
- Amphi = Dual, amphibolic: dual pathway (both catabolic and anabolic)
- For example: Krebs cycle is mainly a catabolic cycle, but with some anabolic features, e.g., part of Krebs cycle is used for the synthesis of glucose from amino acids

Therefore, Krebs cycle is **amphibolic**

Classification of metabolic pathway

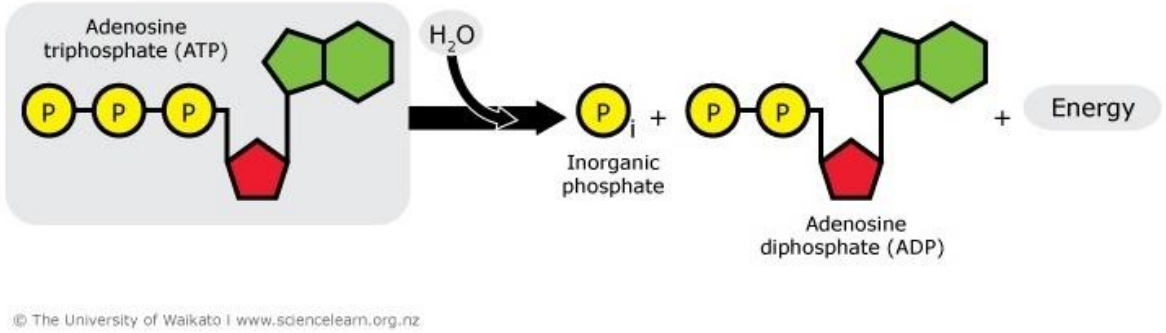
Catabolism Vs Anabolism

Catabolic	Anabolic
Complex to simple molecules	Simple to complex molecules
Exergonic (energy producing) (provides energy in form of ATP)	Endergonic (energy consuming)
Involves oxidations	Involves reductions
Requires NAD^+	Requires NADPH
Convergent process	Divergent process

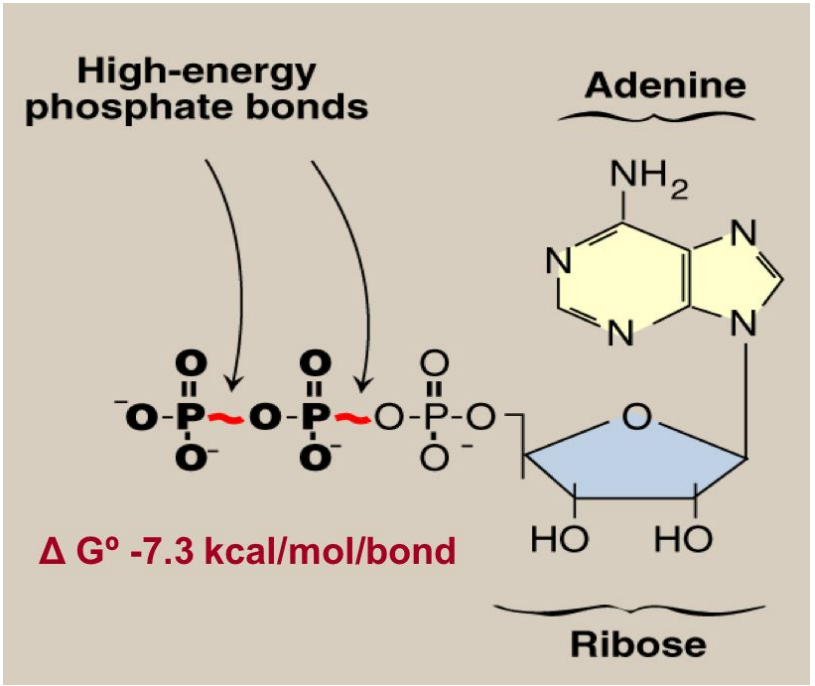


Energy Currency: ATP

$ATP + H_2O \rightarrow ADP + P_i$



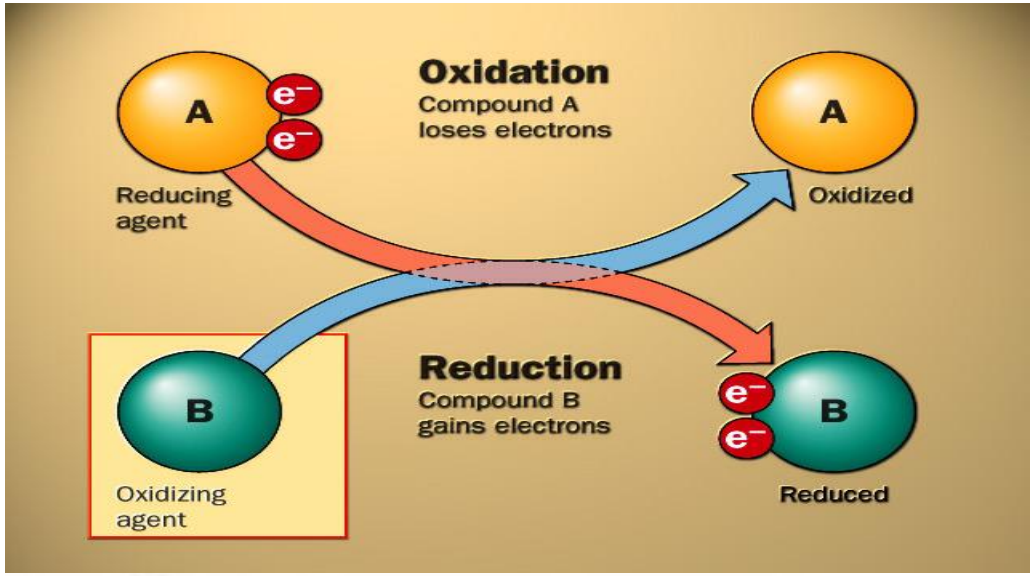
- The free energy liberated in the hydrolysis of ATP is used to drive the endergonic reactions
- ATP is formed from ADP and P_i when fuel molecules are oxidized
- This ATP-ADP cycle is the fundamental mode of energy exchange in biological systems
- ATP is the energy currency of the cells



Oxidation and Reduction

Oxidation: Loss of hydrogen - Loss of electrons

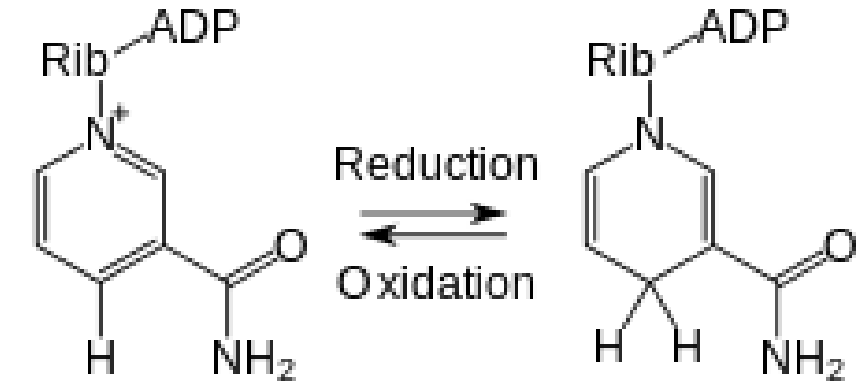
Reduction: Gain of hydrogen - Gain of electrons



NAD+ and NADH

"NAD= Nicotinamide Adenine Dinucleotide"

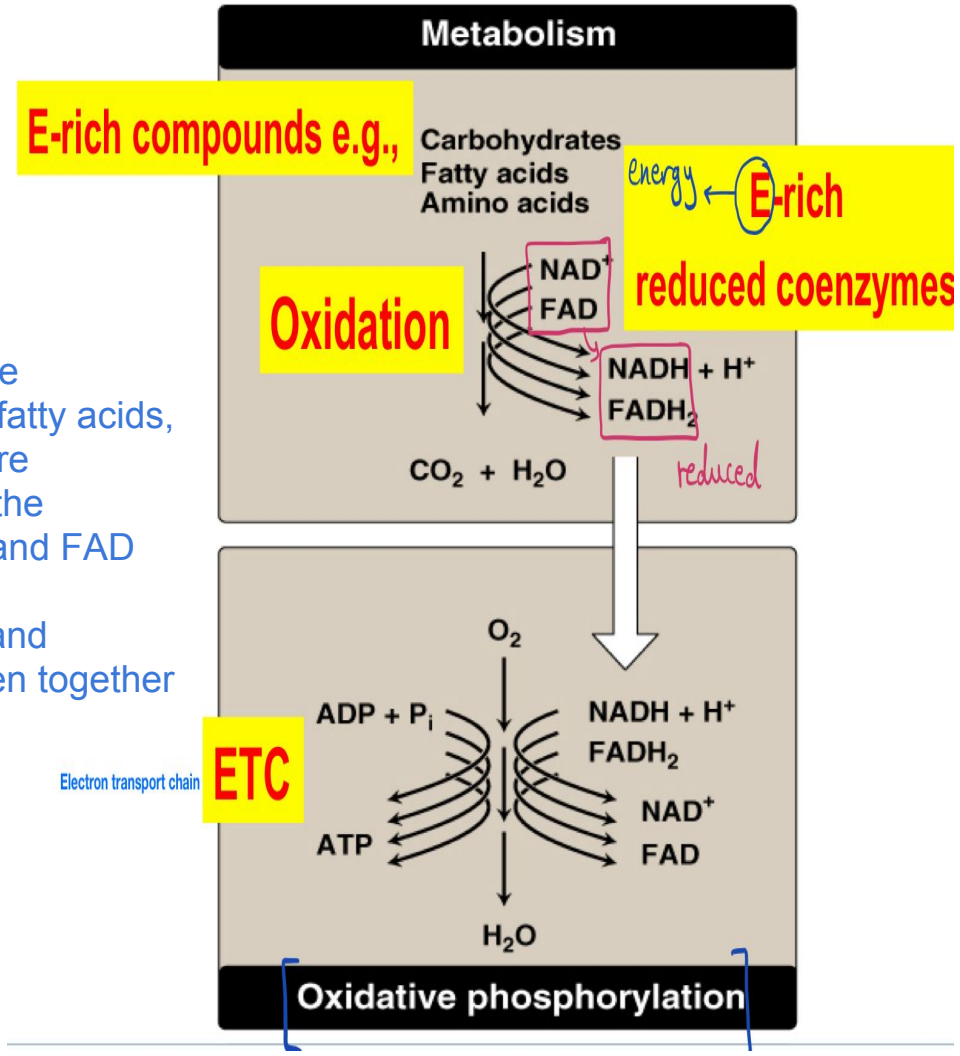
From NADH to NAD+ (oxidation) "loss of hydrogen"
From NAD+ to NADH (reduction) "gain of hydrogen"

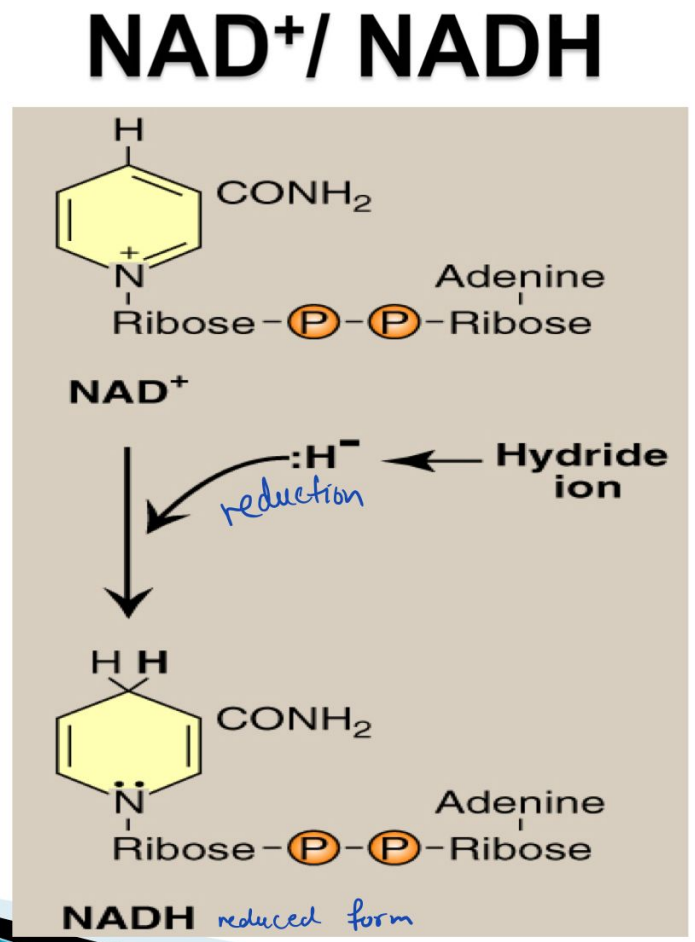


$NAD^+ + H^+ + 2e^- \rightleftharpoons NADH$

Oxidation and reduction are present in metabolism

Explanation: The carbohydrates, fatty acids, amino acids were oxidized, while the enzymes NAD and FAD were reduced =
Both oxidation and reduction happen together in metabolism





Regulation Of Metabolism

We regulate metabolism by regulating enzymes.

We need signals to control metabolism, these signals could be:

Intracellular signals (inside cells):
this kind of regulation is fast

- **Substrate availability**
  (If substrate needed is not available **>** it won't activate
  If substrate needed is available **>** it will activate and make product)
- **Product inhibition**
  (Feedback inhibition happens when the end product of a metabolic pathway exceeds its concentration limit, it inhibits the regulatory enzyme to normalize the pathway *-output used as input-*)
- **Allosteric activators or inhibitors**
  (Happens when an effector molecule binds at the protein's allosteric site *-which is a site other than the active site-* and that can either activate or inhibit the process)

Intercellular communications (between cells):

- **Chemical signaling**
  (hormones: first messenger)
- **Second messengers:**
  (cAMP, cGMP, Ca++/phosphatidylinositol)
  *c means cyclic

Explanation:
A hormone binds to a receptor outside the cell, leading to the activation of cell messengers inside the cell.

Some notes in this slide were taken from teams 435 & 436

Metabolic Fuel

Carbohydrates & lipids (mainly) and proteins (little extent) are used for energy production.

1- Carbohydrates (glucose)

2- Lipids (fatty acids)

3- Protein (amino acids)

Glucose is the major metabolic fuel of most tissues

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For editing file:

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