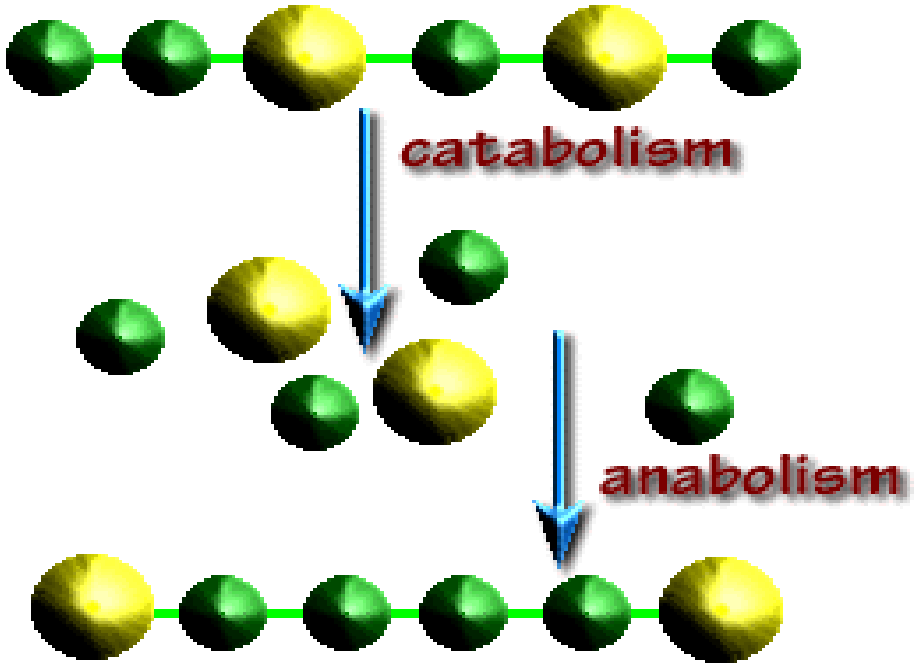
Metabolism

breaking down and building up



Objectives

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

Red = Is Important

Black = From the slides

Orange = General Explanation

Purple = Extra Notes

Metabolism (الأيض)

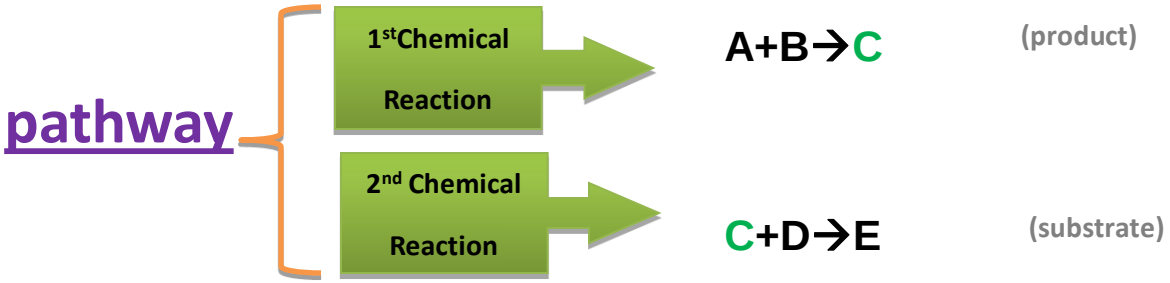
- All the chemical reactions taking place inside a cell are collectively known as METABOLISM

- Metabolism consists of
  - Anabolic (energy consuming) Building up بناء
  - Catabolic (energy producing) Breaking down هدم

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



Another definitions :

- **A pathway** :is a set of multiple reactions working in as sequence (series) – it is different from a single chemical reaction
- **Integrated** :combining separate elements so as to provide a balanced whole.

(integrated pathway : combining separate pathways)

Metabolic Map

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

(يوصف للمجموعات المتداخلة من مسارات التفاعلات)

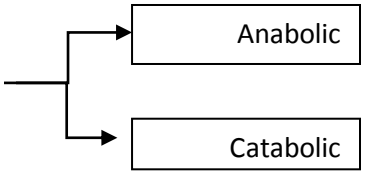
أهميتها : لو كان انزيم معين يؤثر على عدة عمليات .. فأي تغيير يصير له راح أثر على هالعمليات او التفاعلات وبالتالي فعند تصنيع الدواء يراعى ذلك

Two kinds of Pathways : (Depends on the substrate and final production)

- خطي : بحيث المنتج الأول يختلف عن المنتج الأخير في سلسلة التفاعلات
- دائري : بحيث تتوالى التفاعلات بشكل دائري و يعاد تكون المنتج الأول في آخر السلسلة

Classification of pathways

(Depends on the function)



Note: Pathways that regenerate a component are called cycles

(Because when these pathways end they repeat the first component again making it a never ending process (doesn't need a stimulus)

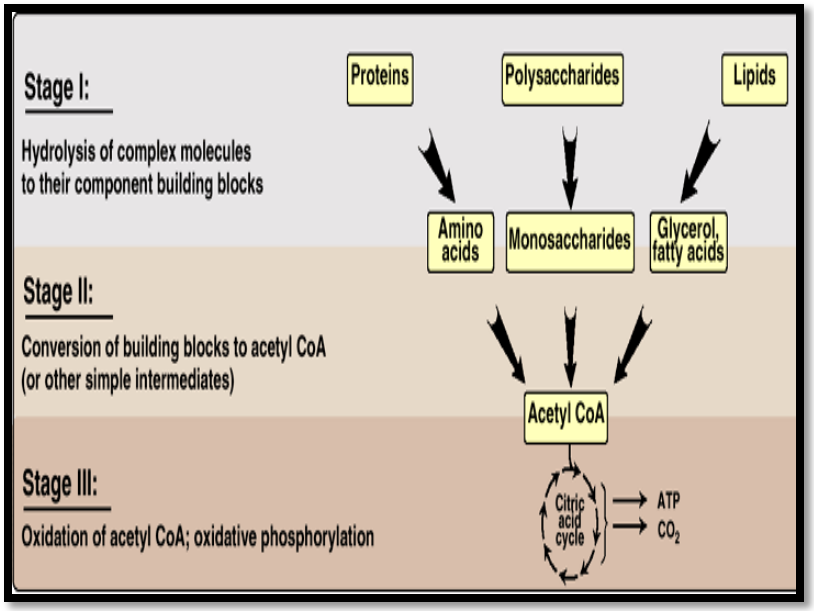
Catabolic Pathways

Catabolic Pathways : **(FROM complex TO simple)**
Producing energy in CATABOLIC PATHWAYS ,because of produced ATP in stage III

In short: the complex molecules break down to their smaller components by hydrolysis. Then, they convert to acetyl CoA to get oxidized by Krebs cycle and produce ATP and Co2

Polymer **monomer + energy**

Catabolism →



Anabolic Pathways

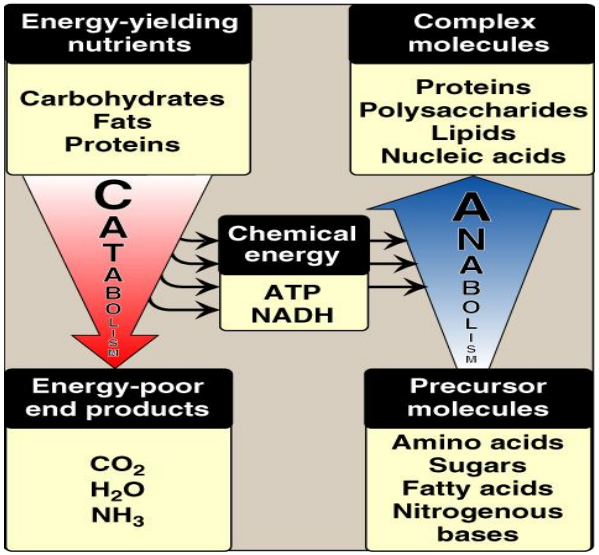
- **Precursor molecules into complex molecules**
- **Endergonic (reactions require ATP) Temperature is low**
  Exergonic (reaction produce ATP) Temperature is high → Catabolic
- **Divergent process (Starts from few substance to make it many)**
  Convergent process : start with many and end with few → Catabolic

Anabolic

1Simple to complex molecules
2Endergonic
3Involves reductions
4Requires NADPH
5Divergent process

Catabolic

1Complex to simple molecules
2Exergonic
3Involves oxidations
4Requires NAD+
5Convergent process



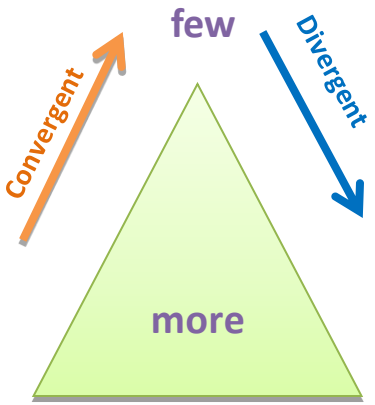
Oxidation:

Loss of hydrogen / electron

Reduction:

Gain of hydrogen / electron

NAD+ : Oxidized Form = reducing agent
(Catabolism oxidized and give H^+ to NAD^+ → NADH)
NADPH : Reduced Form = oxidizing agent



Amphibolic Pathways

Amphibolic Pathways = Catabolic +Anabolic

For example, Krebs cycle is mainly a catabolic cycle, but with some anabolic features,
e.g., Krebs Cycle : (mainly) complex form TO Simple form but there is a part of Krebs cycle that is used for the synthesis of glucose from amino acids → Therefore, Krebs cycle is amphibolic

Energy Currency: ATP

1. **$ATP + H_2O \rightarrow ADP + P_i$**

   hydrolysis of ATP breaks one of the 3 phosphates apart from the ATP molecule.

1. ADP : Adenosine diphosphate reductive form
2. ATP : Adenosine triphosphate oxidative form
3. The free energy liberated in the hydrolysis of ATP is used to drive the endergonic reactions.
4. Free energy = energy of ATP – energy of ADP
5. ATP is formed from ADP and P_i when fuel molecules are oxidized

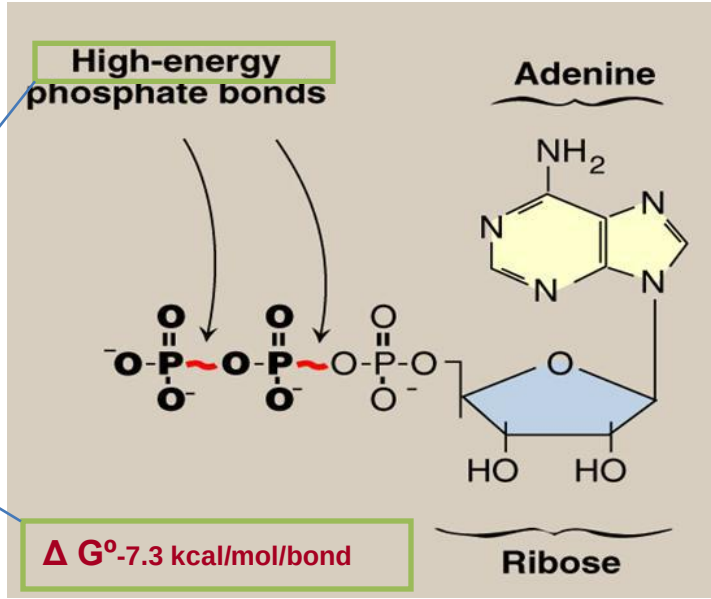
This ATP-ADP cycle is the fundamental (أساسية) mode of energy exchange in

Adenosine Triphosphate (ATP)

Adenosine = adenine + ribose

Triphosphate = 3 atoms of phosphate

The doctor concentrated on these boxes and the components of ATP



E =energy
NADH and FADH2 are in reduced form coenzymes

NAD+ ------reduction-------> NADH
NADH ------oxidation-------> NAD+

Electron transport chain
Oxidative Phosphorylation: uses energy released by the oxidation of nutrients to produce ATP

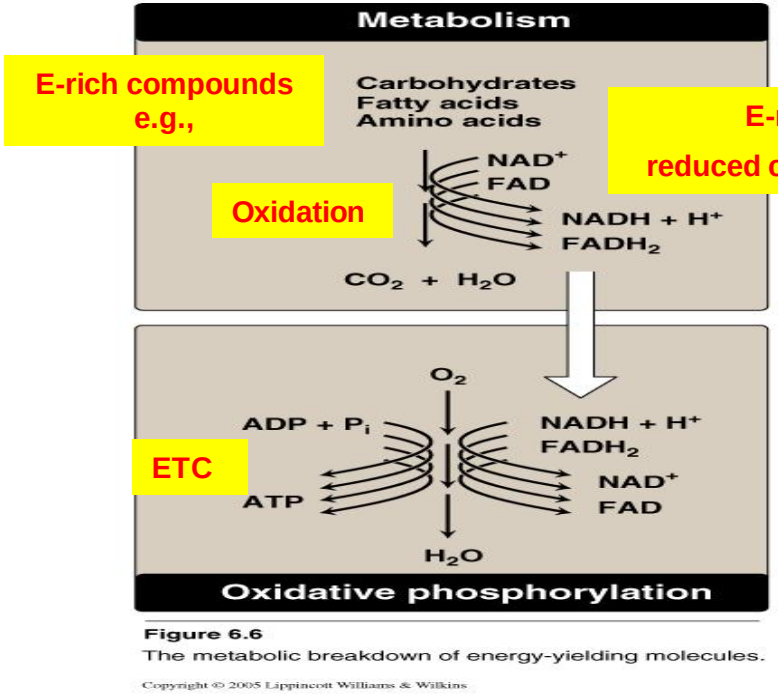


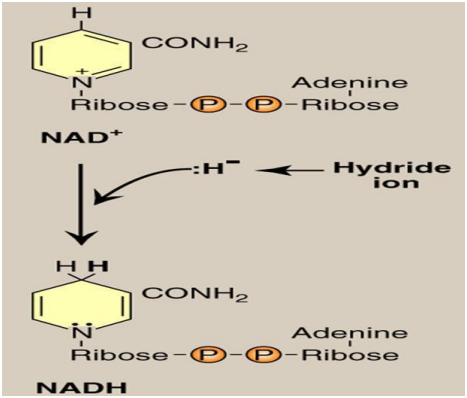
Figure 6.6
The metabolic breakdown of energy-yielding molecules.

NAD+/ NADH

NAD+ = Nicotinamide adenine dinucleotide+

Regulation of Metabolism

Intracellular signals: (inside cell)
Substrate availability (all nutrients needed are available in cell)
Product inhibition (ability to control the products within the cell)
Allosteric activators (allosteric regulation is the regulation of an enzyme or other protein by binding an effector molecule at the protein's allosteric site; that is, a site other than the protein's active site)
Intercellular communications: (between cells)
Chemical signaling (hormones) from outside the cell:
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