

Introduction to metabolism



Color index :

Main text

IMPORTANT

Extra Info




Drs Notes

Foundation Block - Biochemistry Team



MED439
U.S.S. COLLEGE OF HEALTH SCIENCES

Objectives:

-  Understand the concept of metabolic pathways.
-  Identify types and characteristics of metabolic pathways: (anabolic and catabolic)
-  Identify ATP as the energy source for cells

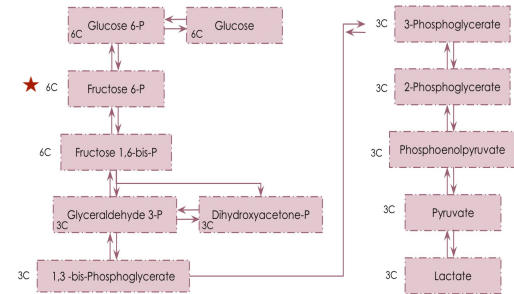
Metabolism

- All the chemical reactions taking place inside a cell are collectively known as **Metabolism**.



Pathway VS chemical reaction

- Pathway is a Sequence of reactions .
- Metabolic Pathway:**
 - A multi-step sequence of chemical reactions.
 - ★ A product of first reaction becomes a substrate for second reaction.
 - e.g. $A \rightarrow B$
 $B \rightarrow C$
 $C \rightarrow D$
 - Each product is a substrate for another reaction .
 - Integrated pathways: Metabolism.



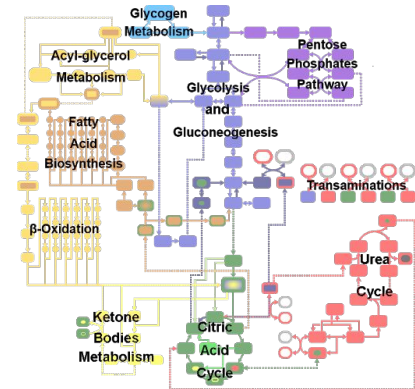
Glycolysis , an example of metabolic pathway

The metabolic MAP

- Different pathways can intersect (تتقاطع مكونين شبكة متكاملة) forming an integrated and purposeful network of chemical reactions “The Metabolic Map” .
- Pathways that regenerate or produce a component are called **cycles** .
- The porpoises of metabolic map:
 1. to get a clear vision .
 2. if there are any changes in one pathway it will help us to know what other pathways will be affected .

- About the metabolic map :

- فكرتها زي قوغل ماب لو واحد وصف لك تروح مكان بيقول لك تمشي لين جامعة الملك سعود من طريق الامام وبعدين تاخذ يمينا , كذا ما راح تقدر تجبه الا من طريق واحد لكن لما يعطيك خريطة او اللوكيشن بالجوال راح يعطيك قوغل ماب اكثر من طريق عشان تصل



Classification of pathways

Anabolic

it will make more complex and multiple different molecules from few building blocks

Precursor molecules into complex molecules

Energetic reaction require ATP
Energetic = energy consuming

Divergent process
Divergent = means We can make complex molecules from few building blocks

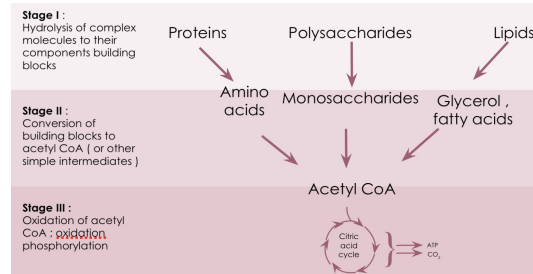
Catabolic

it can break down so many complex molecules

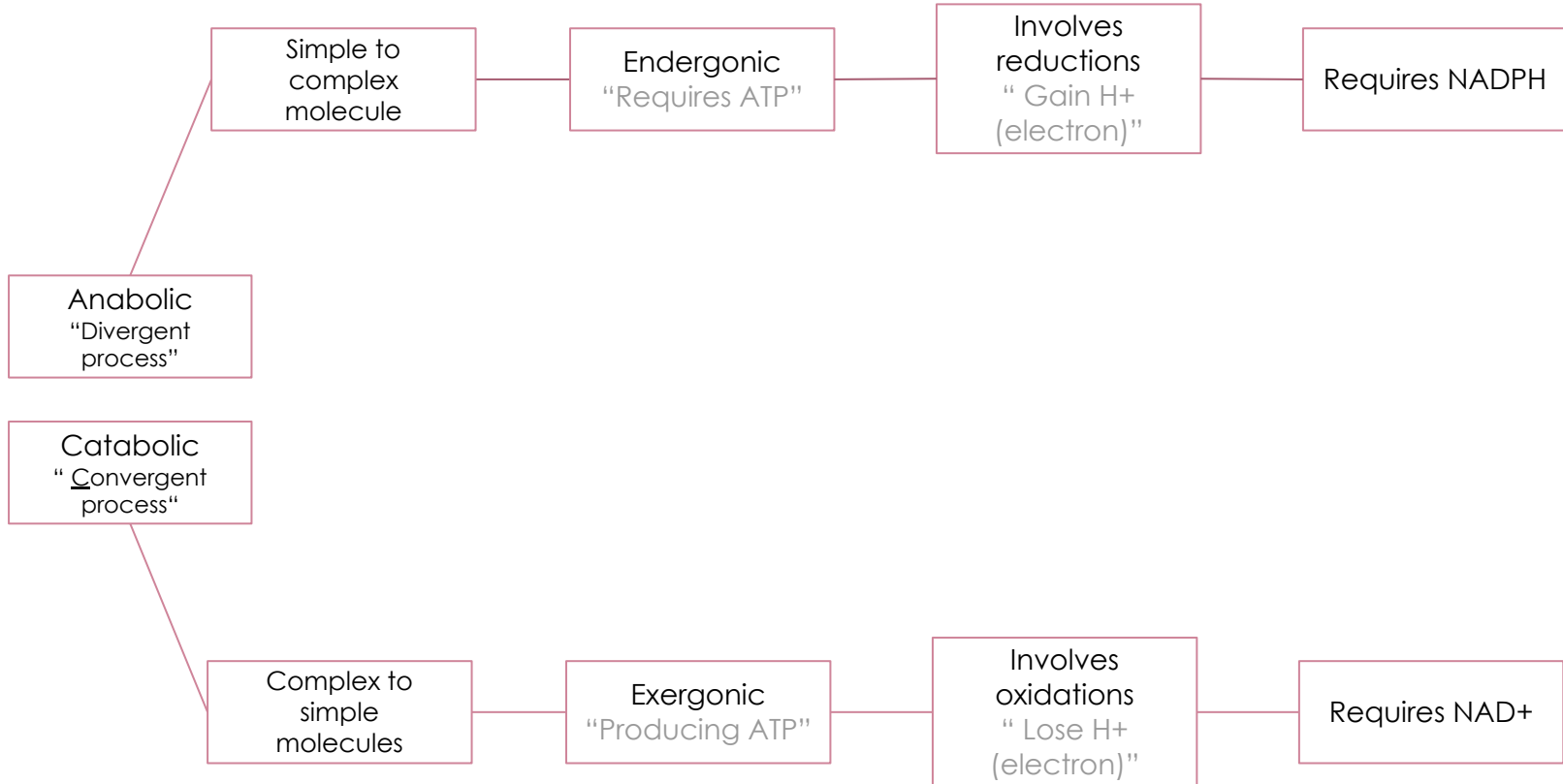
Stage 1 : hydrolyze the complex molecule to their components building blocks

Stage 2: convert the building blocks into Acetyl CoA

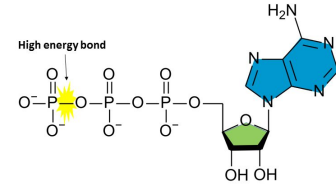
Stage 3: oxidation acetyl CoA, oxidative phosphorylation
"To produce ATP"



Comparison of catabolic and anabolic pathways



Energy currency : ATP



$\Delta G^\circ 7.3 \text{ kcal/mol/bond}$

- Adenosine Triphosphate= ATP
 - Which consists of (3 Phosphate groups + Nitrogen Base (Adenosine)).
 - When ATP loses its 3rd phosphate group, will become ADP + P group and the energy released (when fuel molecules are oxidized).
- The free energy liberated in the hydrolysis of ATP is used to drive the endergonic reactions means if you hydrolyze them , they will produce a lot of energy .
- 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 .

Amphibolic pathway

1. Amphi = Dual, amphibolic: dual pathway (both catabolic and anabolic).
2. 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**.

Regulation of metabolism

1. Intracellular signals (inside the cell):

- a. Substrate availability:
if the substrates needed are available in cell .
- b. Product inhibition:
a type of enzyme inhibition: it is ability of the products to control the metabolism .
- c. Allosteric activators:
allosteric regulation is the regulation of enzymes or other proteins by the binding of an effector molecule at the protein's allosteric site; that is, a site other than the protein's active site .

2. Allosteric activators:

- a. Chemical signaling :
 - hormones or neurotransmitters : first messenger .
- b. Second messengers :
 - (cAMP, cGMP) c= cyclic m= mono .
 - (Ca⁺⁺ /phosphatidylinositol) .

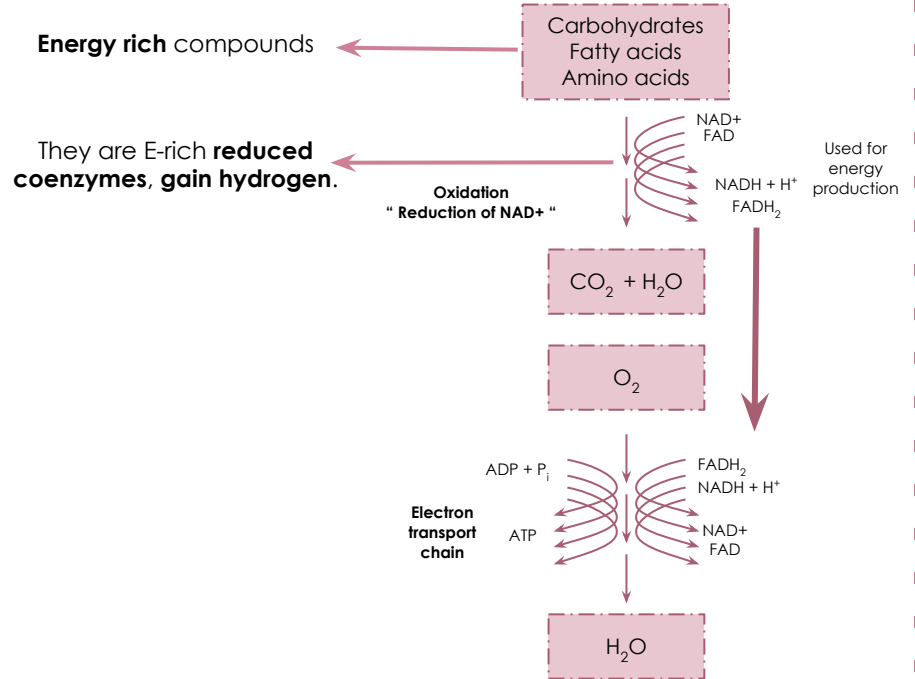


A hormone (1st) binds to a receptor outside the cell, leading to the activation of cell messengers (2nd) inside the cell .

Oxidation and Reduction in metabolism







- Metabolic fuel :
 - Carbohydrates and lipids (**mainly**) and proteins (**little extent**) are used for energy production.
 - In metabolism there will be transfer of electrons from food (**reducing agent** or **oxidized**) to coenzyme (**oxidation agent** or **reduced**)
 - **Glucose** and **fatty acids** are a **major** source of energy.
 - **Amino acids** are a **minor** source of energy .
 - Glucose is the major metabolic fuel of most tissues .
 - **NAD= N**icotin-**A**denine **D**i-nucleotide

1. Oxidation " catabolic " :
 - a. Loss of Hydrogen .
 - b. Loss of electron .
2. Reduction " anabolic " :
 - a. Gain of hydrogen .
 - b. Gain of electrons .



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

Take home messages

-  Metabolism is the sum of all biochemical pathways that occur inside the cells.
-  A metabolic pathway is a multistep sequences of enzyme-catalyzed reactions.
-  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.
-  ATP is the energy currency of the cells.

Quiz

Q1 : what is the pathway that Producing energy ?

- | | | | |
|----------------------|-----------------------|--------------|------------------|
| A) Anabolic Pathway | B) Catabolic Pathway | C) Both A&B | D) None of them |
|----------------------|-----------------------|--------------|------------------|

Q2 : ATP is ?

- | | | | |
|----------------------------|----------------------------|----------------------------|--------------------------|
| A) Adenosine twophosphate | B) Adenotine Triphosphate | C) Adenosine Triphosphate | D) Adrenal Triphosphate |
|----------------------------|----------------------------|----------------------------|--------------------------|

Q3 : Which types of pathways that Krebs cycle use ?

- | | | | |
|----------------------|-----------------------|------------------------|------------------|
| A) Anabolic pathway | B) Catabolic pathway | C) Amphipolic pathway | D) None of them |
|----------------------|-----------------------|------------------------|------------------|

Q4 : From NADH to NAD⁺ by ?

- | | | | |
|------------------------|------------------------|--------------|------------------|
| A) Oxidation reaction | B) Reduction reaction | C) Both A&B | D) None of them |
|------------------------|------------------------|--------------|------------------|

Q5 : All the chemical reactions taking place inside a cell are known as :

- | | | | |
|----------------|------------------|----------------|----------------|
| A) Metabolism | B) Glycogenesis | C) Catabolism | D) Glycolysis |
|----------------|------------------|----------------|----------------|

Q6 : Fat are catabolized into then into Acetyl CoA ?

- | | | | |
|---------------------|-----------------|----------------------------|-------------------|
| A) monosaccharides | B) Amino acids | C) Glycerol , fatty acids | D) Peptidoglycan |
|---------------------|-----------------|----------------------------|-------------------|

SAQs :

Q1: What is the pathway that consumes ATP ?

Q2: Define the pathway reaction and give an example .

Q3: What is the reduction reaction ?

Q4: Hydrolysis of ATP will produce ?

★ MCQs Answer key:

1) B 2) C 3) C 4) A 5) A 6) C

★ SAQs Answer key:

- 1) Anabolic pathway
- 2) multi-step sequence of chemical reactions like glycolysis
- 3) gains electron or H⁺
- 4) ADP+P_i (free energy)



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"Opportunities don't happen , you create them."
* Chris Grosser

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