

# INTRODUCTION TO METABOLISM

## Color Index:

- Original slides.
- Important.
- 436 Notes
- 438 notes
- Extra information

رابط التعديل:

<https://docs.google.com/document/d/1WvdeC1atp7J-ZKWOUSukSLsEcosjZ0AqV4z2VcH2TA0/edit?usp=sharing>



Biochemistry team 438

# Objectives:

Slide No.3

1. Understand the concept of metabolic pathways.

Slides (5,6)

2. Identify types and characteristics of metabolic pathways  
(anabolic and catabolic)

Slide No.7

1. Identify ATP as the energy source for cells



# METABOLISM

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

There are two types of metabolism:

**Anabolic:-** بناء

Energy consuming pathway: Endergonic function (ياخذ طاقة)

**Catabolic:-** هدم

1- Energy producing pathway: Exergonic function (يعطي طاقة)

## PATHWAY VS CHEMICAL REACTION

**Metabolic pathway:**

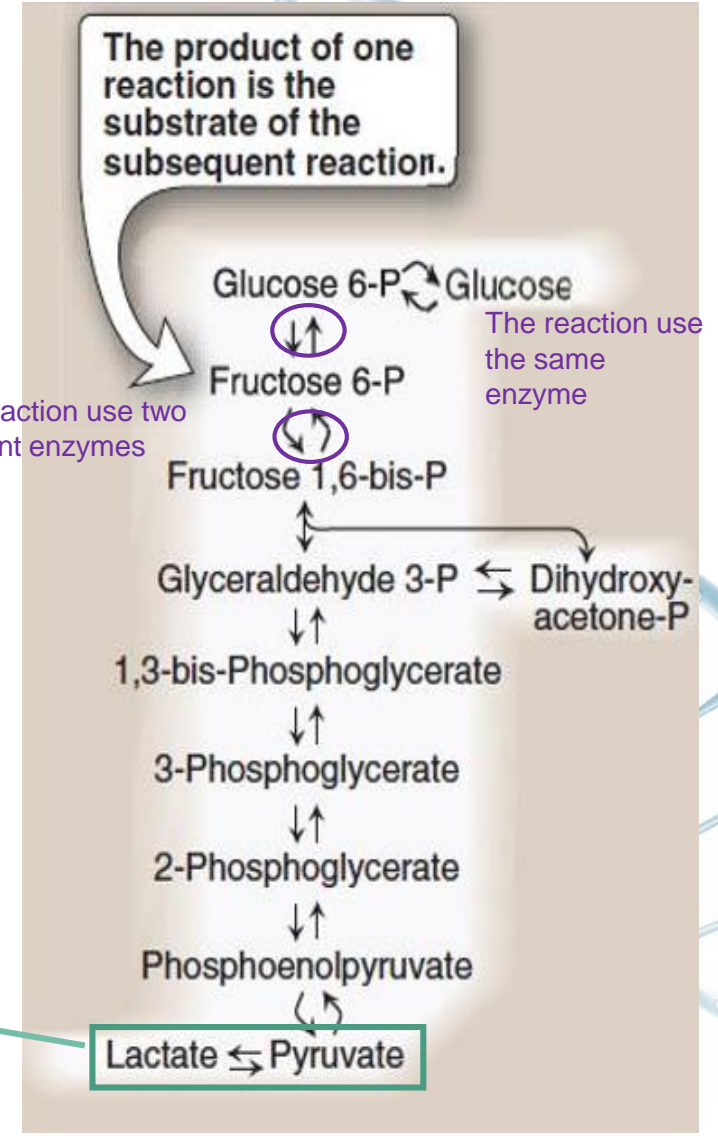
- A multi-step sequence of chemical reactions.
- A Product of first reaction becomes a substrate for second reaction.

**Integrated pathways: Metabolism** (Work together for one purpose)

A pathway has many steps for example: A is converted B (product) then B (substrate) is converted to C..

Glycolysis is an example of a metabolic pathway

**Cycles:** Pathways that regenerate a component



# METABOLIC MAP

No need to memorize it

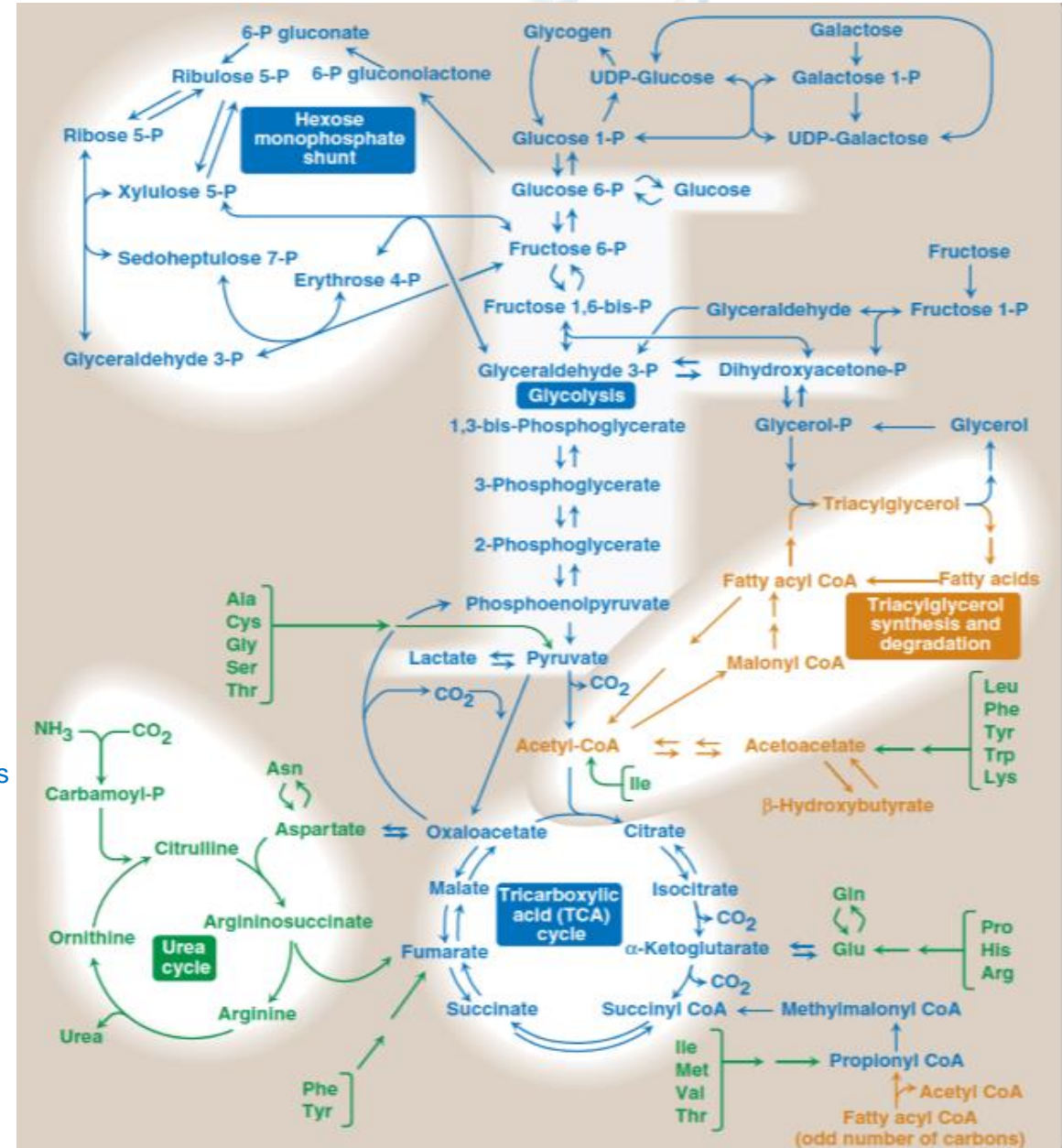
## Metabolic Map :

Different pathways can intersect to form an integrated and purposeful network of chemical reactions called "The Metabolic Map"

Blue color : Carbohydrates

Green color: Proteins

Orange color: Fats



### Purposes of a metabolic map:

- 1- to get a clear vision
- 2- to know if you make any changes it will affect which part of the pathway

فكرتها زي قوقل ماب : لو واحد وصف لك تروح مكان بيقول  
تمشي لين جامعة الملك سعود من طريق الامام وبعدين تاخذ يمين...  
كذا ما راح تقدر تجيه الا من طريق واحد لكن لما يعطيك خريطة  
او اللوكيشن بالجوال راح يعطيك قوقل ماب اكثر من طريق عشان  
تجي منه مو بس طريق واحد.

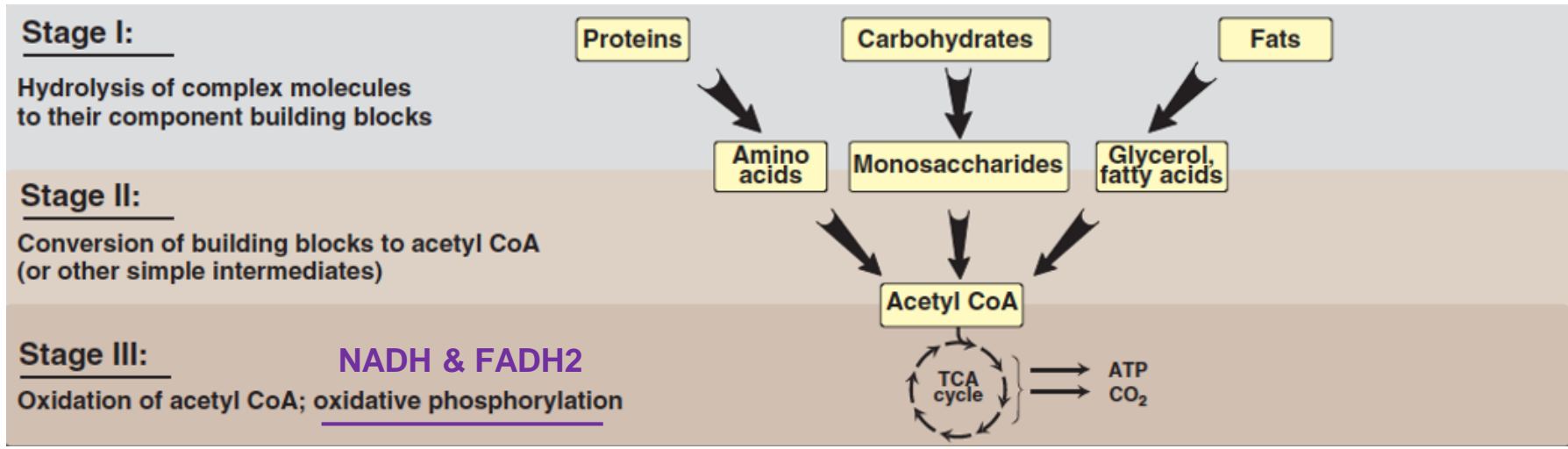
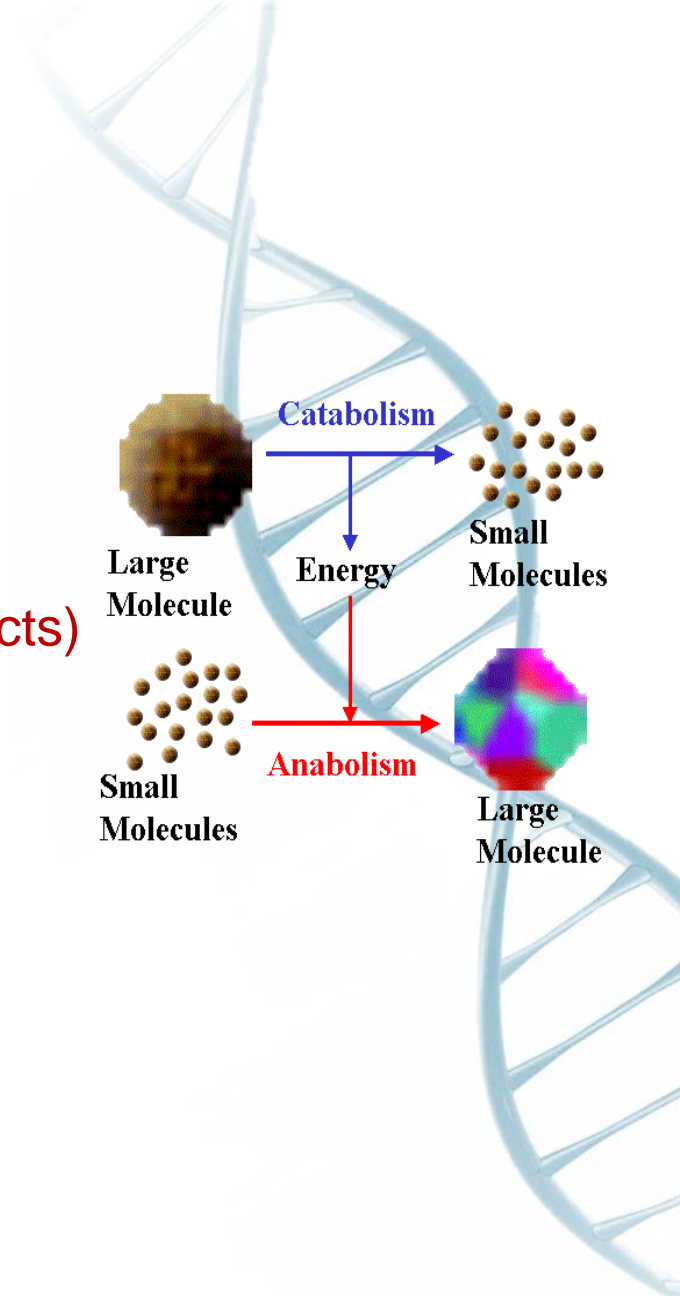
# CLASSIFICATION

Most pathways can be classified as:

**Anabolic:** formation of precursor (Unit) molecules into complex molecules

- Endergonic reactions (require ATP)
- A divergent (متشعب أو متفرع) process (few precursors form more complex products)

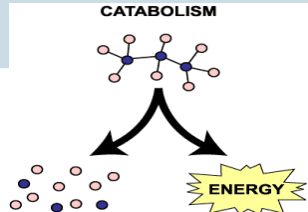
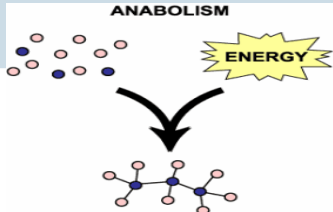
**Catabolic:** is converting complex molecule to simple one



TCA = citric acid cycle = Krebs cycle

# Catabolism Vs Anabolism

Anabolic	Catabolic
Simple (precursor) to complex molecules	Complex to simple molecules
Endergonic (energy consuming)	Exergonic (energy producing)
Involves reduction (gain H+ or electron)	Involves oxidation (Lose H+ or electron)
Requires NADPH (reducing agent)	Requires NAD <sup>+</sup> (oxidizing agent)
Divergent process	Convergent process

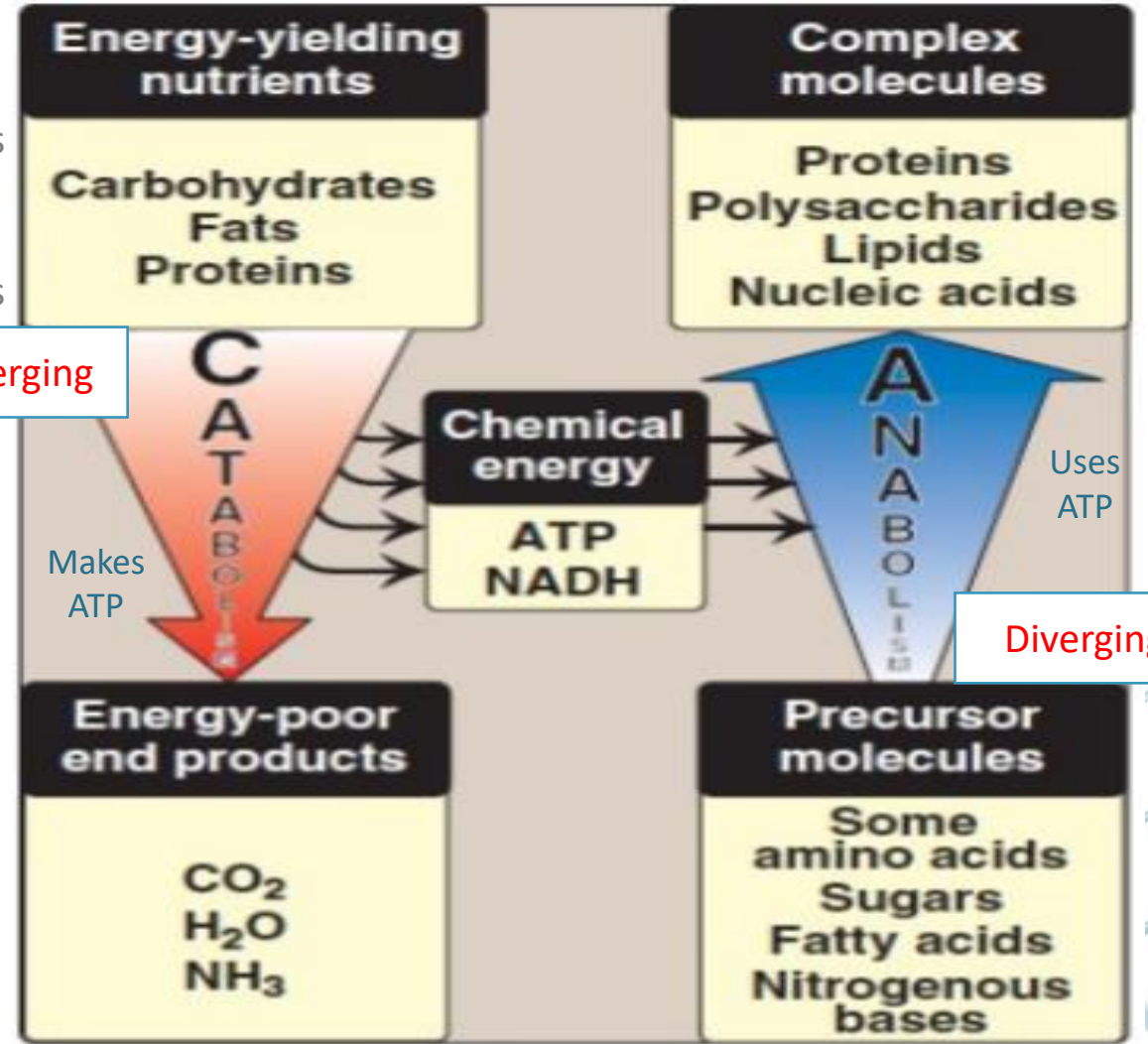


During catabolism process, the energy is released (broken down) as ATP and NADH, this is why it is exergonic.

Converging

Then this energy is used in anabolism process, this is why it is endergonic.

#الربط  
 Exergonic= Exit energy  
 Endergonic= Enter



\* Divergent: to start with a small amount and break into a large amount e.g. 20 amino acids make up hundreds of proteins

# Amphibolic Pathway

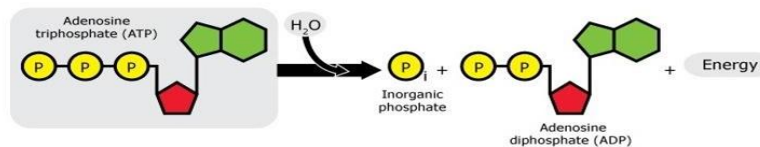
- Amphi = Dual, amphibolic: dual pathway (both catabolic and anabolic)

- **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



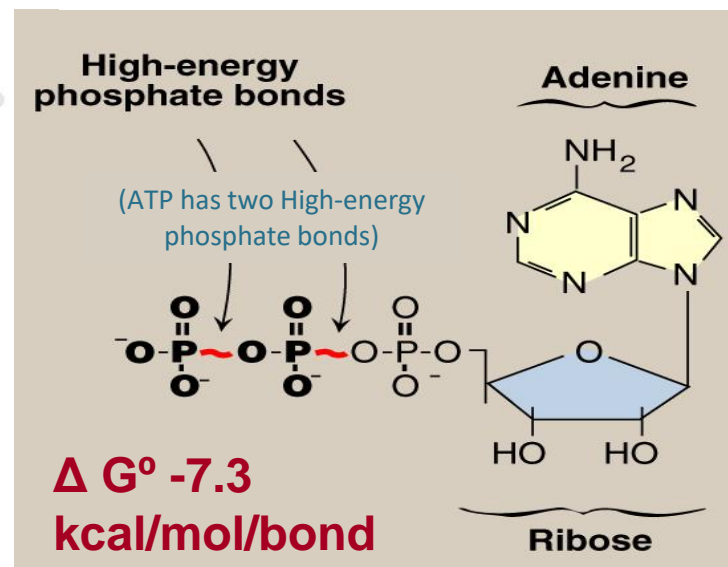
❖ This **ATP-ADP** cycle is the fundamental mode of energy exchange in biological systems:

1- The free energy liberated (**generated**) by the hydrolysis of ATP is used to drive the endergonic reactions.

2- ATP is formed from ADP and P<sub>i</sub> when fuel molecules are oxidized.



Adenosine Triphosphate (ATP)



# Oxidation & Reduction in metabolism

**Oxidation:** (catabolic)

Loss of hydrogen and loss of electrons.

**Reduction:** (anabolic)

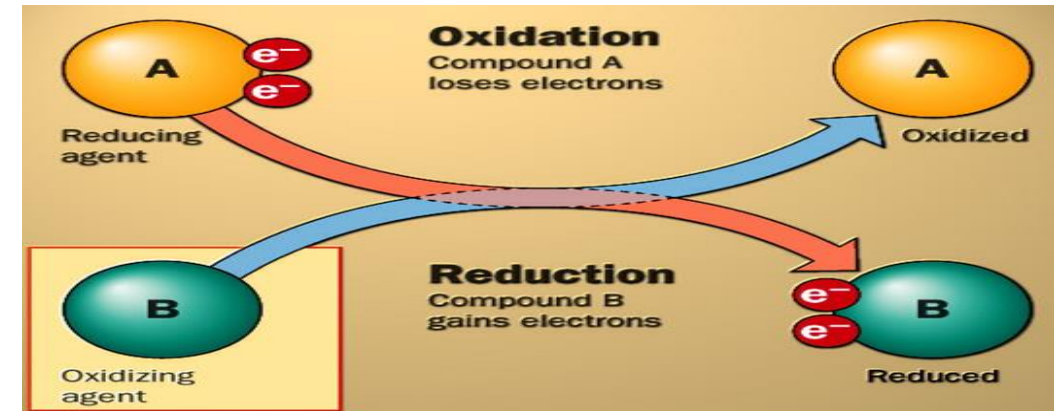
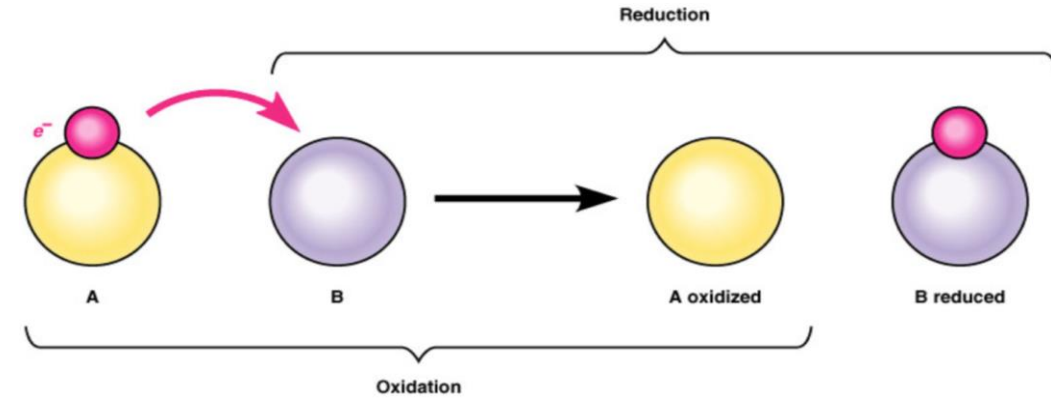
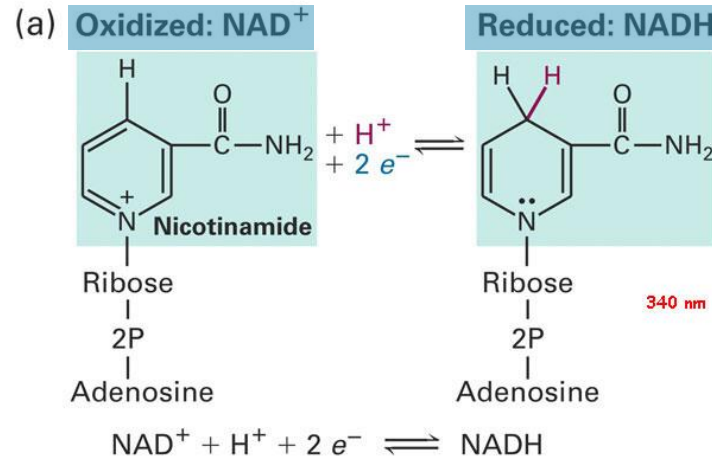
Gain of hydrogen and gain of electrons.

- Energy rich compounds:

carbohydrates, fatty acids, amino acids.

➤ Energy rich compounds are oxidized and they lose their electron.

➤ When coenzymes NAD + is reduced (gains hydrogen) it'll become NADH



## NAD<sup>+</sup> and NADH

“NAD= Nicotin-amide Adenine Di-nucleotide”

From NADH to NAD<sup>+</sup> (oxidation) “loss of hydrogen”

From NAD<sup>+</sup> to NADH (reduction) “gain of hydrogen”

في عمليات الأيض (metabolism) يحدث نقل للإلكترونات من الغذاء (oxidized) إلى الكواينزاييمز (reduced).

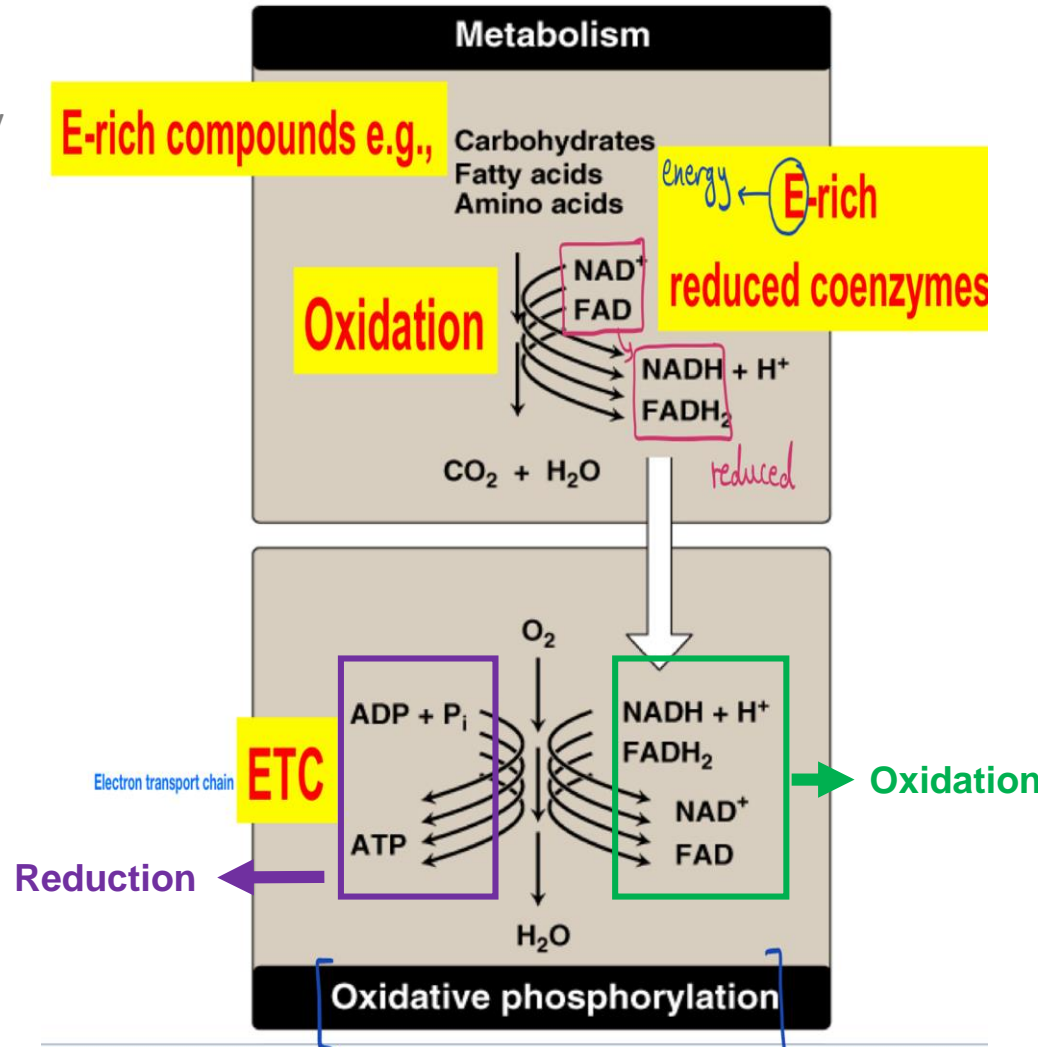
- Reducing agent: Food. يسبب اختزال الكواينزاييمز
- Oxidizing agent: coenzymes يسبب أكسدة الغذاء



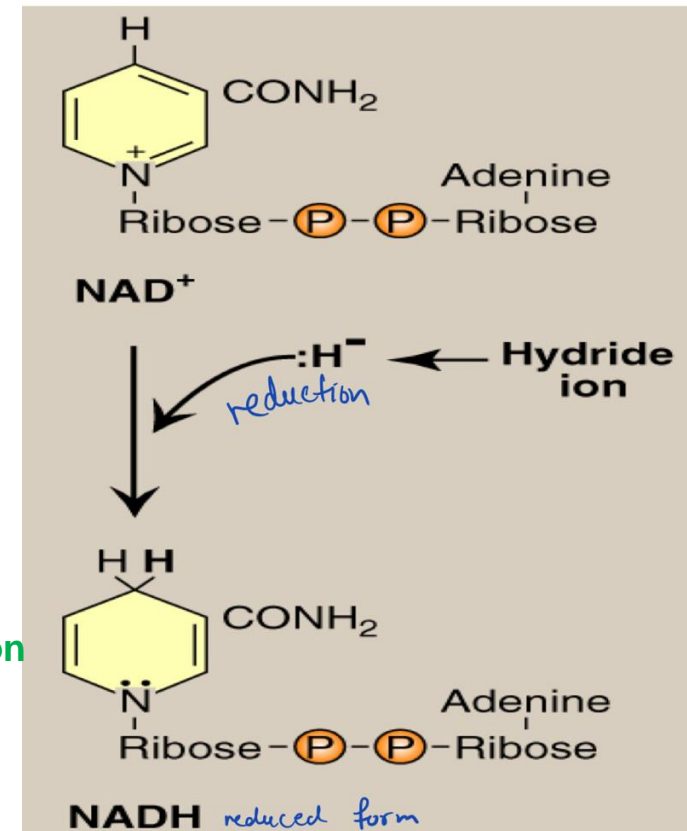
# Oxidation and reduction are present in metabolism

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



## NAD<sup>+</sup>/ NADH



# Regulation Of Metabolism

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

## Intracellular signals “inside the cell”

- **Substrate availability**  
(if the substrates needed are available in cell)
- **Product inhibition**  
- (a type of enzyme inhibition: it is ability of the products to control the metabolism)
- **Allosteric activators or inhibitors**  
(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)

\*a substance whose release within a cell, promoted by a hormone and which brings about a response by the cell

## Intercellular communications “between cells”

- **Chemical signaling**  
(hormones or neurotransmitters):  
first messenger
- **Second messengers\*:**  
(cAMP, cGMP) c= cyclic m= mono  
(Ca<sup>++</sup>/phosphatidylinositol)

### Explanation:

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

# Metabolic Fuel

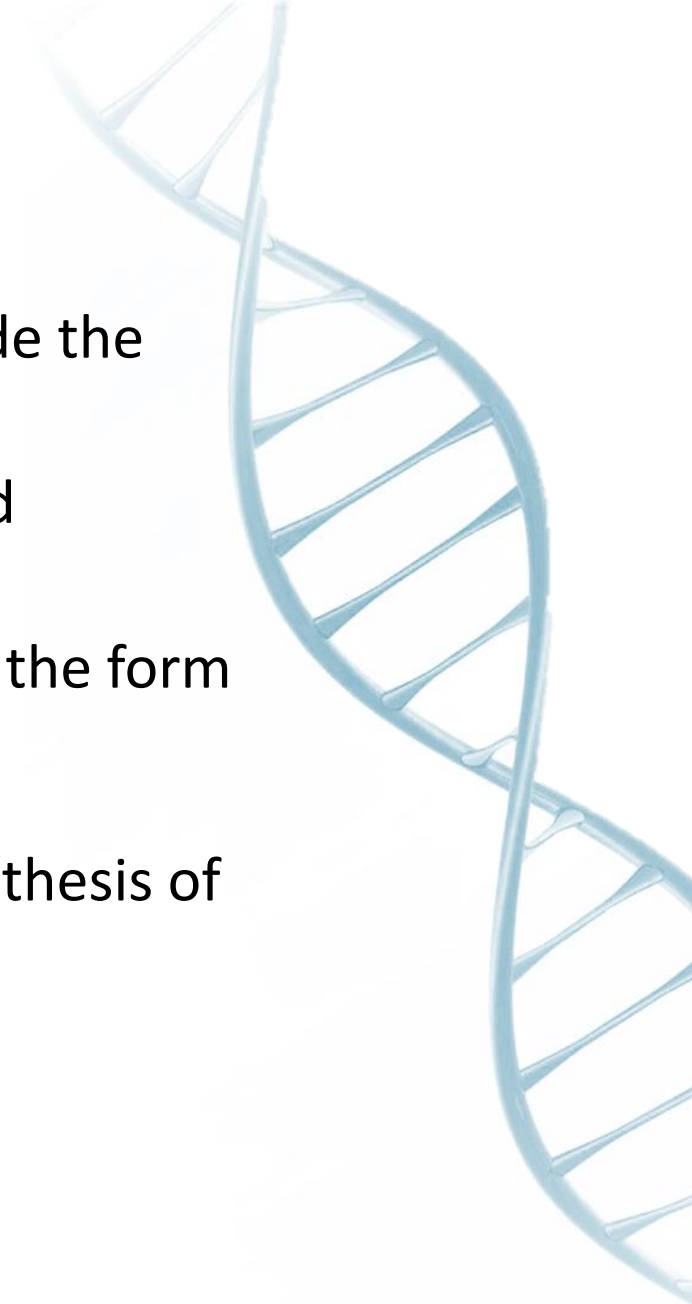
- Carbohydrates and lipids (**mainly**) and proteins (**little extent**) are used for energy production.
- **Glucose** and **fatty acids** are a **major** source of energy.
- **Amino acids** are a **minor** source of energy.
- **Glucose** is the major metabolic fuel of most tissues.

CARBOHYDRATES → LIPIDS → PROTEINS (little existent)

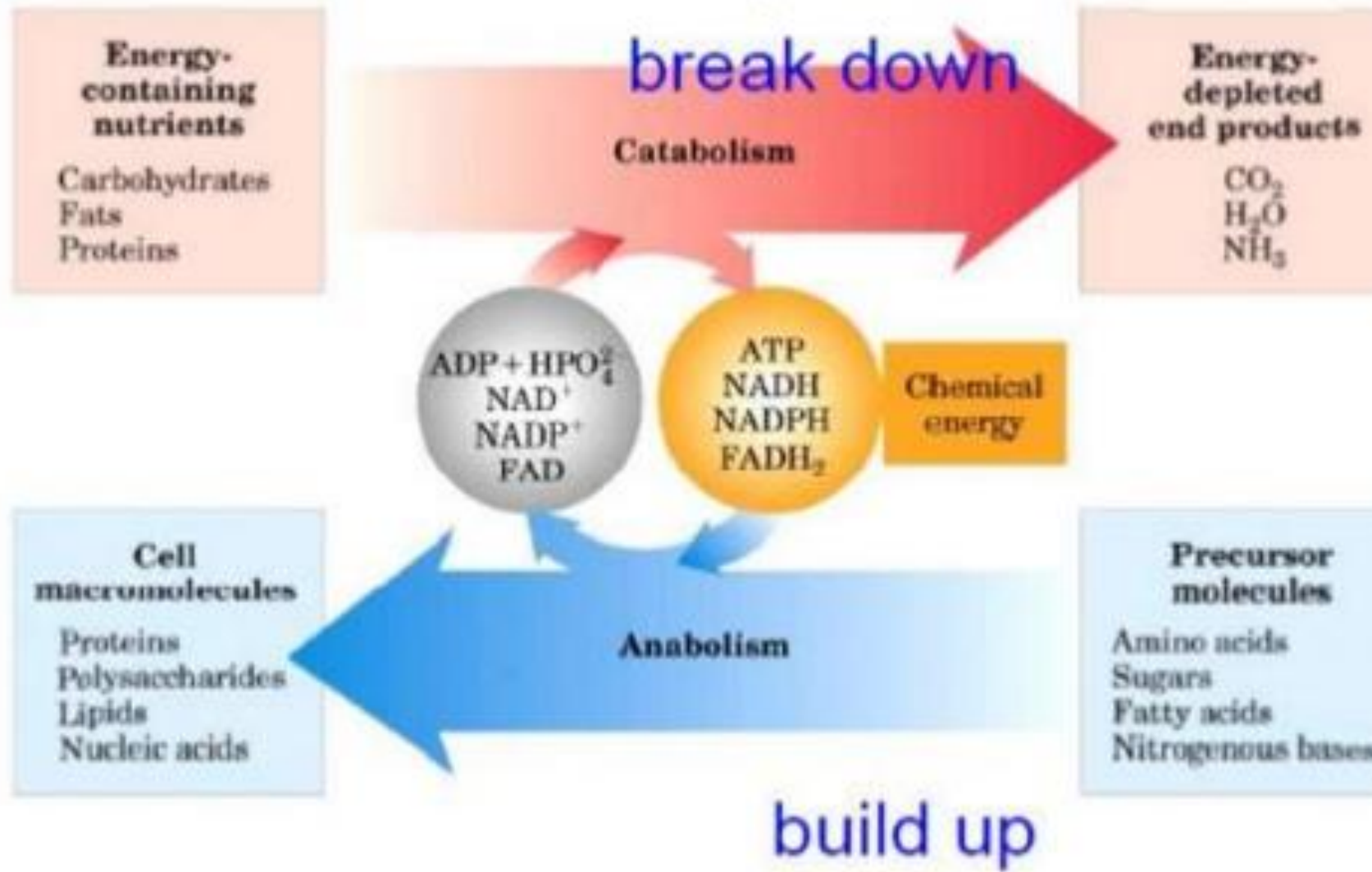


# Take home message

- 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.



# Overview of metabolism



# MCQs

**Q1: All the chemical reactions taking place inside a cell are known as :**

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

**Q3: Different pathways can intersect to form an integrated and purposeful network of chemical reactions called**

- A- Metabolic map
- B- Metabolic interactions
- C- Metabolic network
- D- Krebs cycle

**Q2: Metabolism consist of (classified into):**

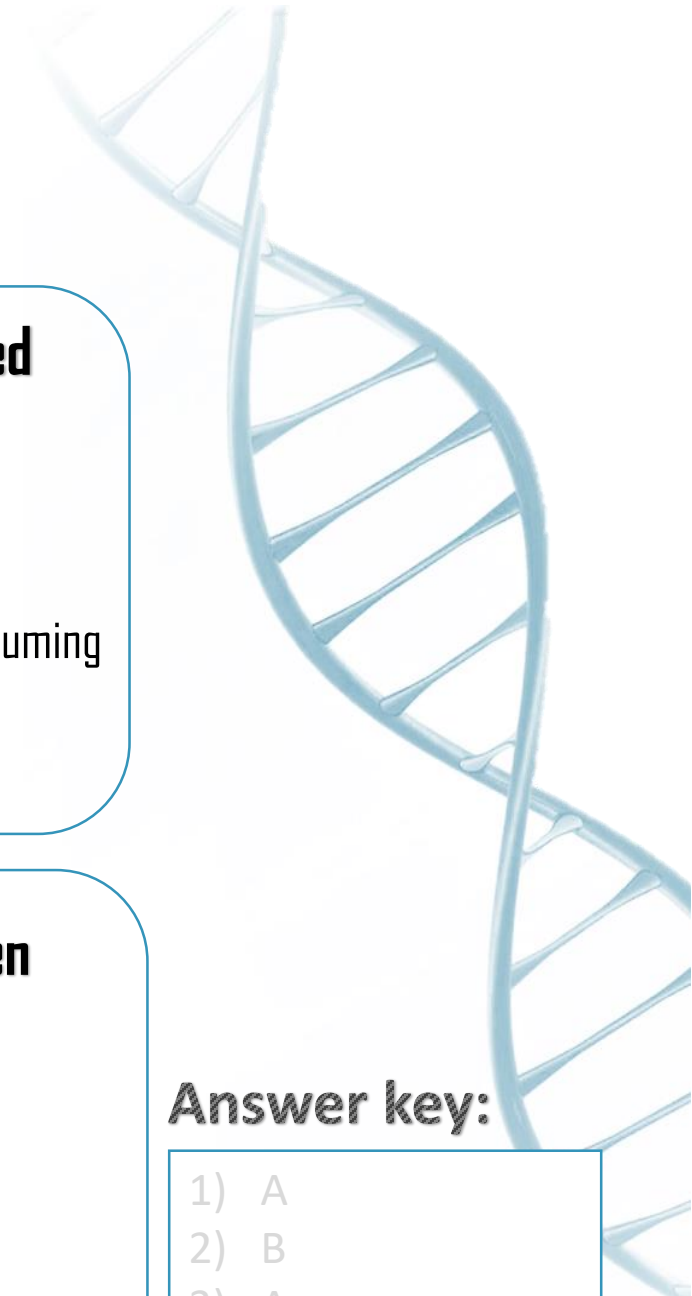
- A- Glycolysis, Glycogenesis
- B- Energy producing (catabolic), Energy consuming (anabolic)
- C- Glycogenolysis, glycogenesis

**Q4: Fat are catabolized into ..... then into Acetyl Coa**

- A- Monosaccharides
- B- Amino acids
- C- Glycerol, fatty acids
- D- peptidoglycan

**Answer key:**

- 1) A
- 2) B
- 3) A
- 4) C



# MCQs

**Q5: Endergonic reactions:**

- A- Anabolic
- B- protein catalyzing to amino acids
- C- Glycolysis
- D- Metabolism map

**Q6: which of the following Requires NAD<sup>+</sup>:**

- A- anabolic
- B- amphibolic
- C- catabolic
- D- anabolic, catabolic

**Q7; It's a convergent process:**

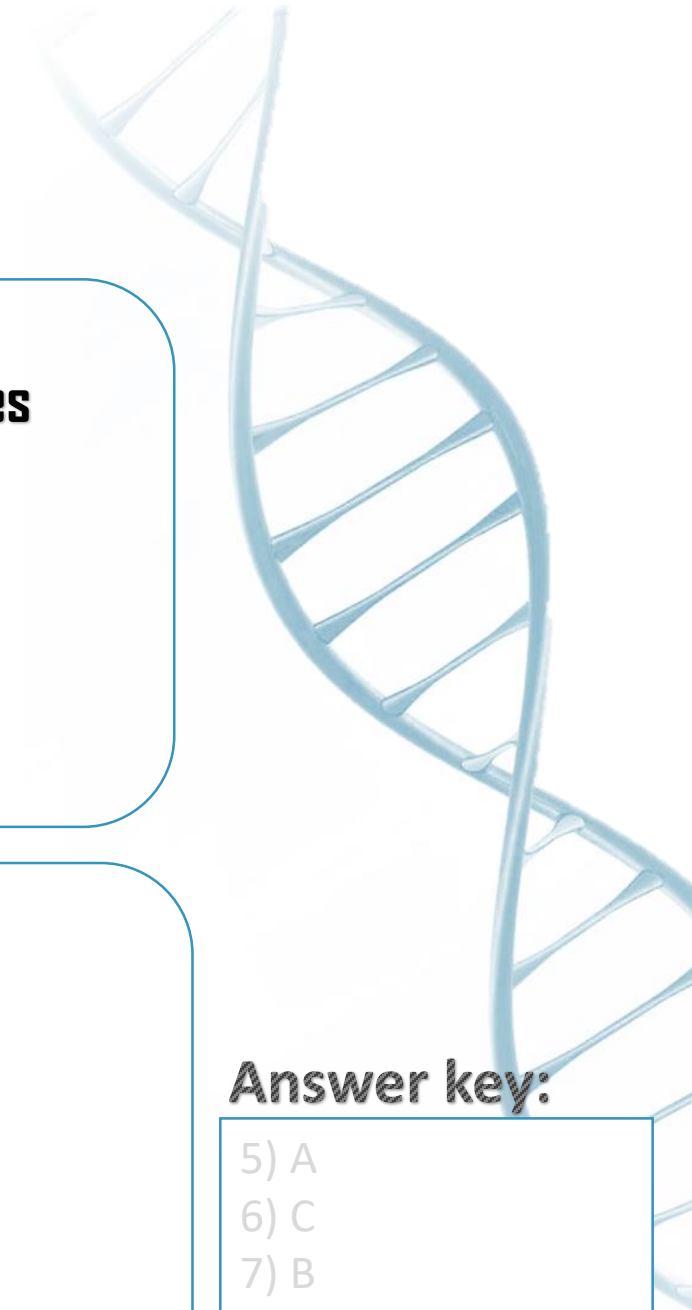
- A- anabolic
- B- catabolic
- C- amphibolic
- D- anabolic, catabolic

**Q8; Krebs cycle is:**

- A- anabolic
- B- catabolic
- C- amphibolic

**Answer key:**

- 5) A
- 6) C
- 7) B
- 8) C



# MCQs

**Q9: Krebs cycle is used to produce:**

- A- Monosaccharides
- B- glycogen from amino acids
- C- glucose from amino acids
- D- protein from amino acids

**Q10: In the change of  $\text{NAD}^+$  to  $\text{NADH}$ .  $\text{NADH}$  is:**

- A- Oxidized
- B- Oxygenated
- C- Lost electrons
- D- Reduced

**Q11: A multi-step sequence of chemical reactions:**

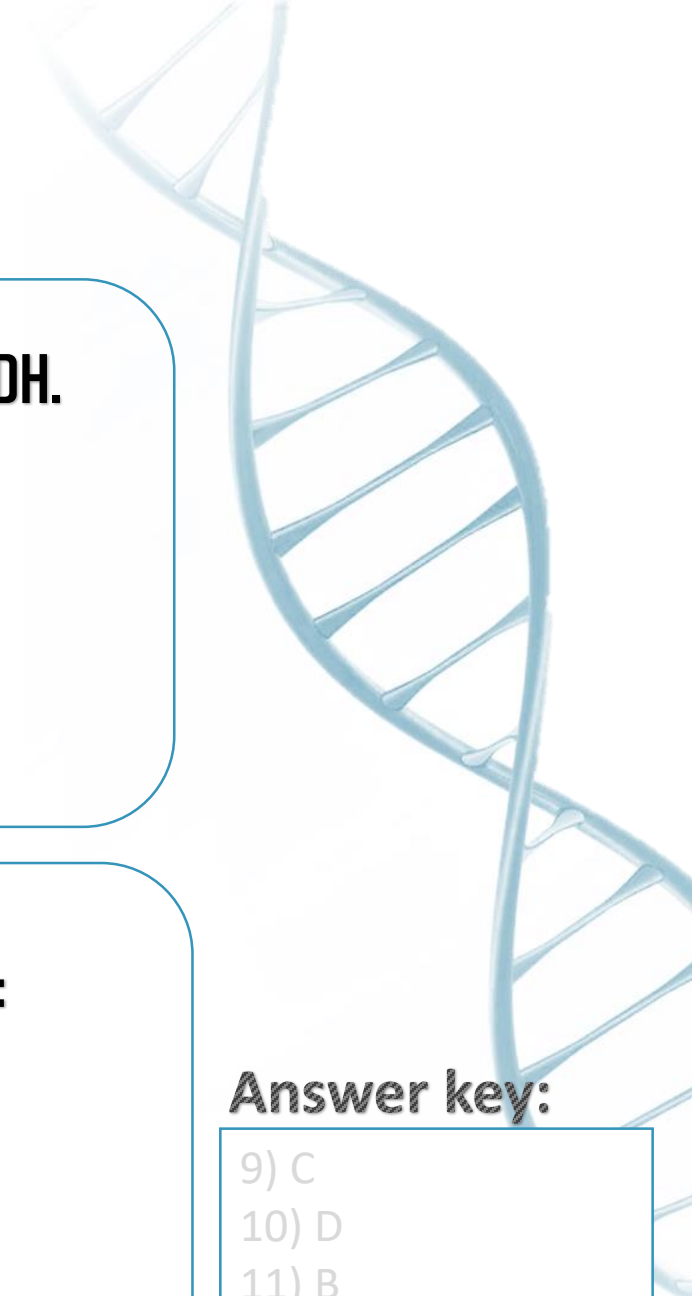
- A- Metabolic network
- B- Metabolic pathway
- C- Metabolic web
- D- Metabolic reaction

**Q12: Energy currency of the cell:**

- A-  $\text{AMP} + \text{P}_i$
- B- Glucose and fatty acids
- C- Carbohydrates and lipid
- D- ATP

**Answer key:**

- 9) C
- 10) D
- 11) B
- 12) D





# MCQs

**Q13: which of the following reactions requires energy?**

- A-Catabolic
- B-Anabolic
- C-None of the above

**Q2; Which of the following is a diverging reaction?**

- A-Anabolic
- B-Catabolic
- C-None of the above

**Answer key:**

- 13) B
- 14) A



## SAQs

**Q1; Krebs cycle is mainly.....**

Catabolic

**Q2;What is the fundamental mode of energy exchange in biological systems?**

ATP-ADP cycle

**Q2;What is the minor source of energy?**

Amino acids

**Q4; It's a convergent process that provides energy to cells in the form of ATP**

Catabolism



## ❖ Girls team:

- أجدد آل رشود
- الوئين البلوي
- إيلاف المسيدل
- جود الخليفة
- جود العتيبي
- ريم القرني
- سارة الهلال
- شهد السلامه
- طيف العتيبي
- عبير الخضير
- غيداء البرين
- لينا العصيمي
- نورة التركي
- نورة المزروع
- نوف الحميضي
- هيفاء الوايلي

## ❖ Boys team:

- بدر الشهري
- حميد حميد
- سهيل باسهيل
- عمر الغامدي
- مهند القرني
- نايف السبر

## ❖ Team leaders:

ديما المزيد  
رائد العجيري



@Biochemistry438



[Biochemistryteam438@gmail.com](mailto:Biochemistryteam438@gmail.com)

## ➤ Special thanks to:



BIO TEAM



Biochemistry Team<sup>435</sup>



Biochemistry team 436

