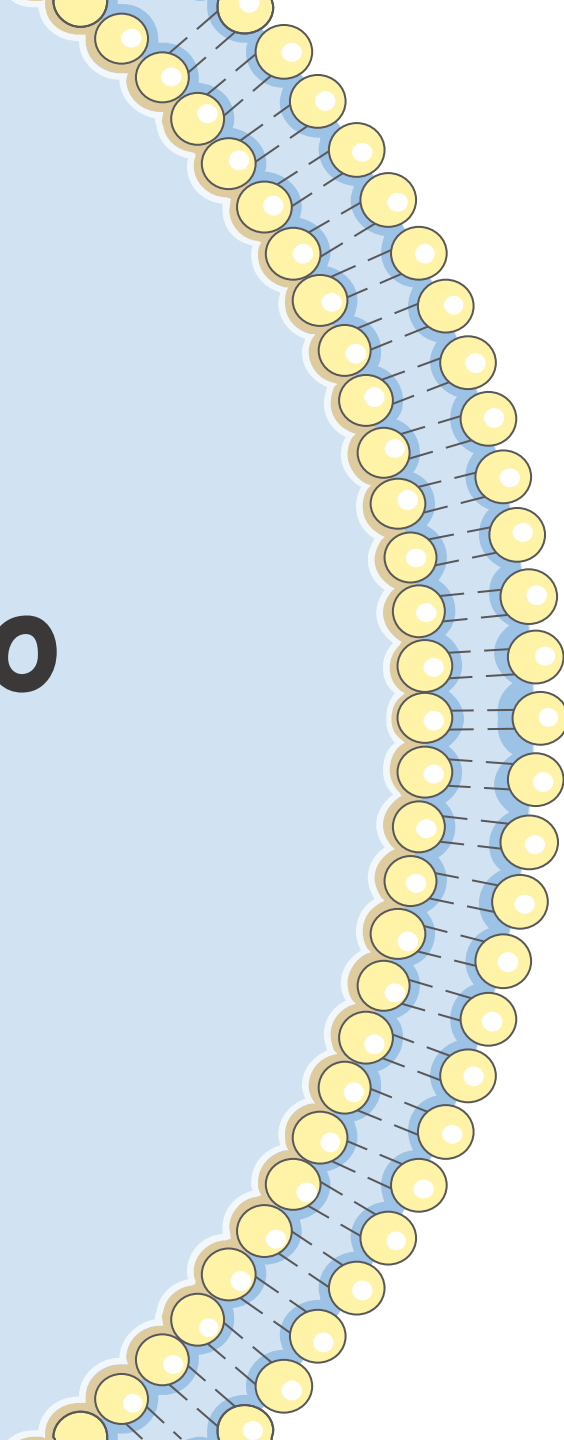
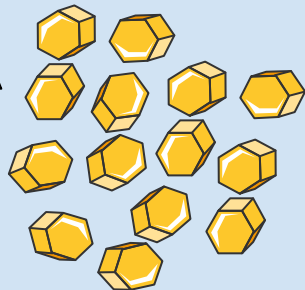
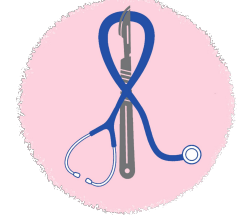


# Introduction to Metabolism



**MED441**  
KING SAUD UNIVERSITY

Revised & Reviewed  
by  
Abdulaziz & Bahammam  
Faye Wael Sondi



6  
V1

Foundation  
Block - KSU

## Color Index:

- Main text
- Important
- Notes
- Boys slides'
- Girls slides'
- Extra

Editing File



# Objectives

By the end of this lecture you should be able to:

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



# Metabolism

[Helpful video](#)

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

Metabolism consists of:

catabolic	anabolic
Energy <b>producing</b> pathways (Exergonic) "Breaking down"	Energy <b>consuming</b> pathways (Endergonic) "Building up"



## Amphibolic Pathways

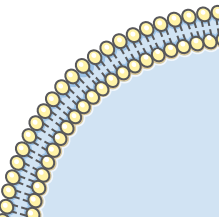
- **Amphi** means dual (ثنائي)
- **Amphibolic**: dual pathway (both catabolic and anabolic)

e.g. **Krebs cycle**

Krebs cycle is mainly a **catabolic** cycle but with some **anabolic** features.

Krebs cycle is used for the synthesis of **glucose** from **amino acids**. it's **amphibolic**

[Helpful video](#)



# Pathway Vs Chemical Reaction

Metabolic pathway:

1 A multi-step sequence of chemical reactions

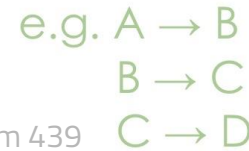
2 A product of first reaction becomes a substrate for second reaction

3 Integrated pathways: Metabolism

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

eg: TCA cycle (citric acid cycle) (**krebs cycle**)

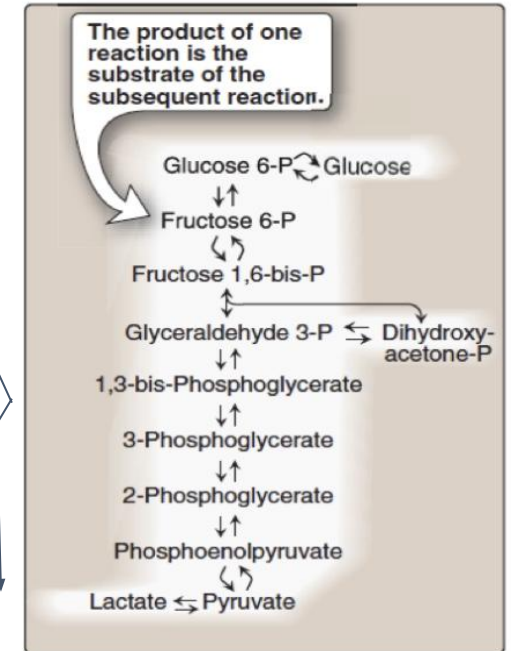
- Glycolysis is an example of a metabolic pathway



From 439

different enzymes

same enzyme



**Figure 8.1**  
Glycolysis, an example of a metabolic pathway.

# Metabolic Map

Different pathways can intersect to form an integrated and purposeful network of chemical reactions that intersect called **"The Metabolic Map"**. metabolic map help us to Understand the reactions and have a knowledge about how one pathway affects others pathways

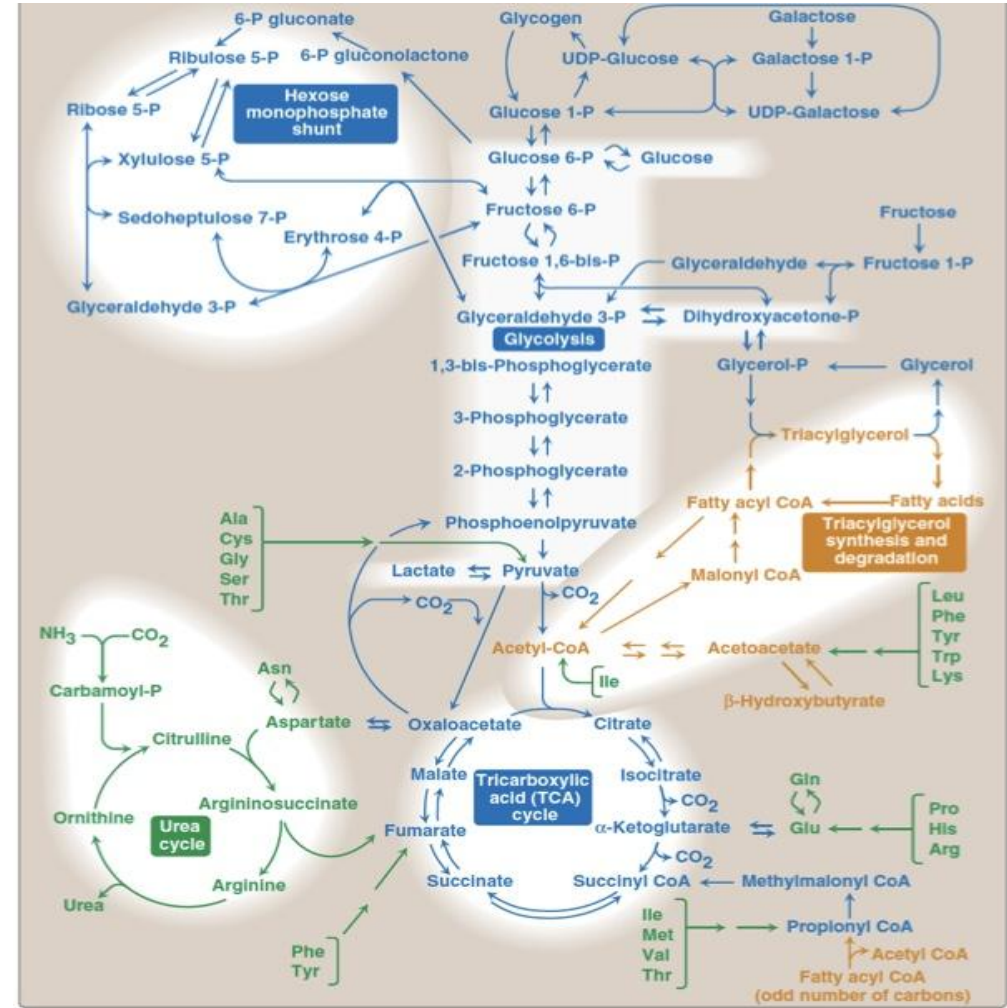
Benefits of metabolic map, To know:

- How the substance is formed .
- Which enzyme is used .
- If the reaction is reversible or irreversible.
- If there is defect in any enzyme.

About the metabolic map:

فكرتها زي قوقل ماب لو واحد وصف لك تروح مكان بيقول لك تمشي لين جامعة الملك سعود من طريق الامام وبعدين تاخذ يمين و كذا ماراح تقدر تجيه الا من طريق واحد لكن لما يعطيك خريطة او اللوكيشن بالجوال راح يعطيك قوقل ماب اكثر من طريق عشان تصل

Thank to 439



الصورة للتوضيح

# Classification: Most pathways can be classified as:

## ■ Catabolic

Has **three** stages to produce energy

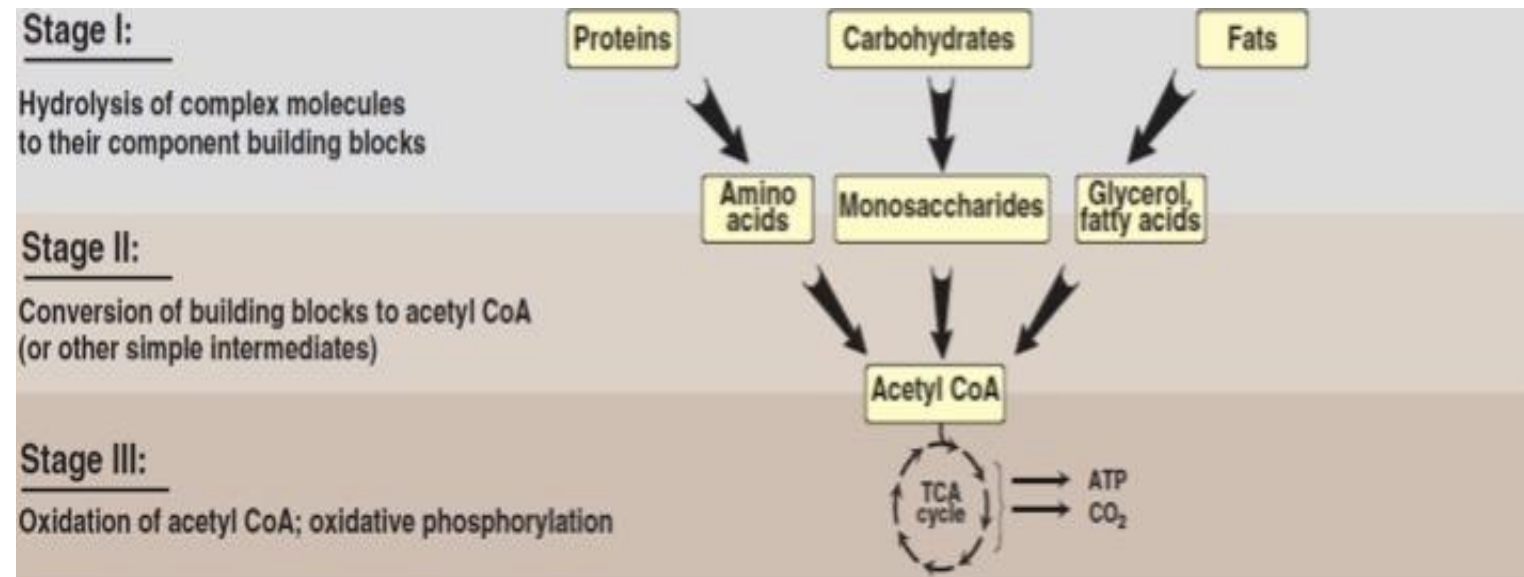
- 01** **Hydrolysis** of complex molecules to their component building blocks
- 02** **Conversion** of building blocks to acetyl CoA (or other simple intermediates)
- 03** **Oxidation** of acetyl CoA; oxidative phosphorylation

## ■ Anabolic (Stage II to I)

Formation of **precursor** molecules into **complex** molecules

Endergonic reactions (**require ATP**)

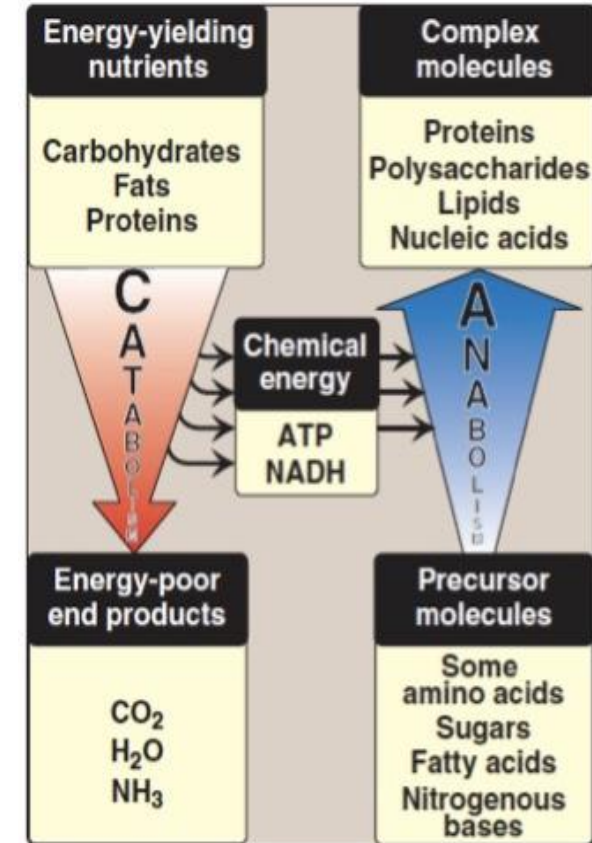
A **divergent** process (few precursors form more complex products)



- the stages are very important

# Comparison of catabolic and anabolic pathways

Anabolic		Catabolic	
Simple to complex molecules		Complex to simple molecules	
Endergonic	Requires energy	Exergonic	Produce energy
Involves reductions	Gain H <sup>+</sup>	Involves oxidations	loss H <sup>+</sup>
Requires NADPH	Reducing agent	Requires NAD <sup>+</sup>	Oxidizing agent
Divergent process		Convergent process	



**Figure 8.4**  
Comparison of catabolic and anabolic pathways.

# Energy Currency: ATP

helpful video

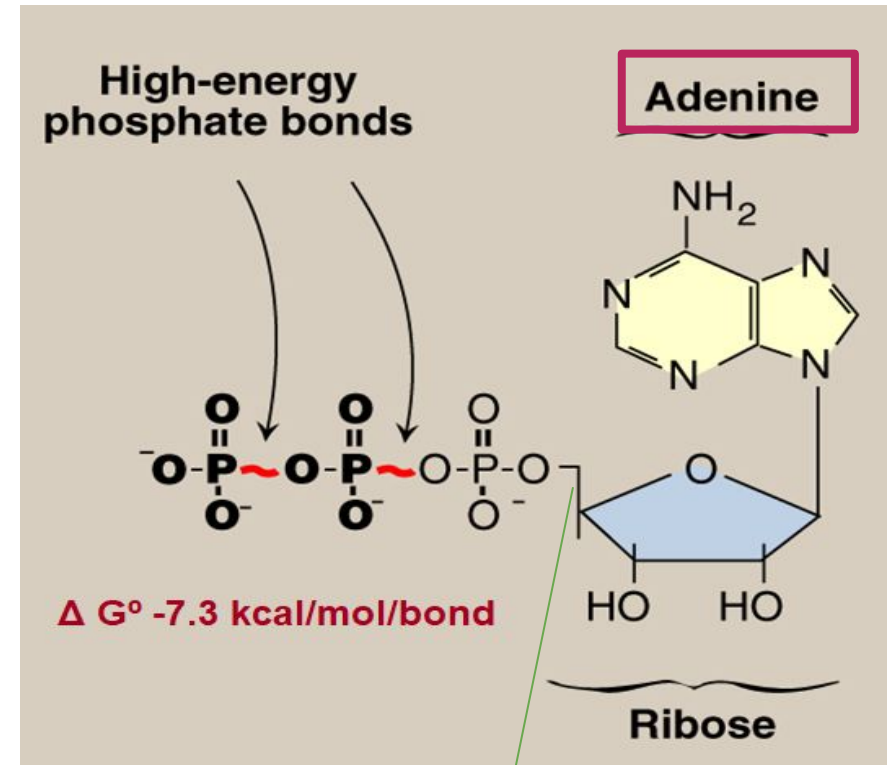


- The free energy liberated by the hydrolysis of ATP is used to drive the endergonic reactions
- ATP is **formed** from ADP and  $\text{P}_i$  when fuel molecules are **oxidized**
- This **ATP-ADP cycle** is the fundamental mode of energy exchange in biological systems

ATP has two bonds can produce energy. (less stable - easy to break)

Sometimes we break ADP to AMP if more energy is needed.

## Adenosine Triphosphate (ATP)



- the phosphoester bond between the  $\text{PO}_4$  group and the Ribose sugar is very stable and very hard to break. thus, it's not considered as a high energy bond

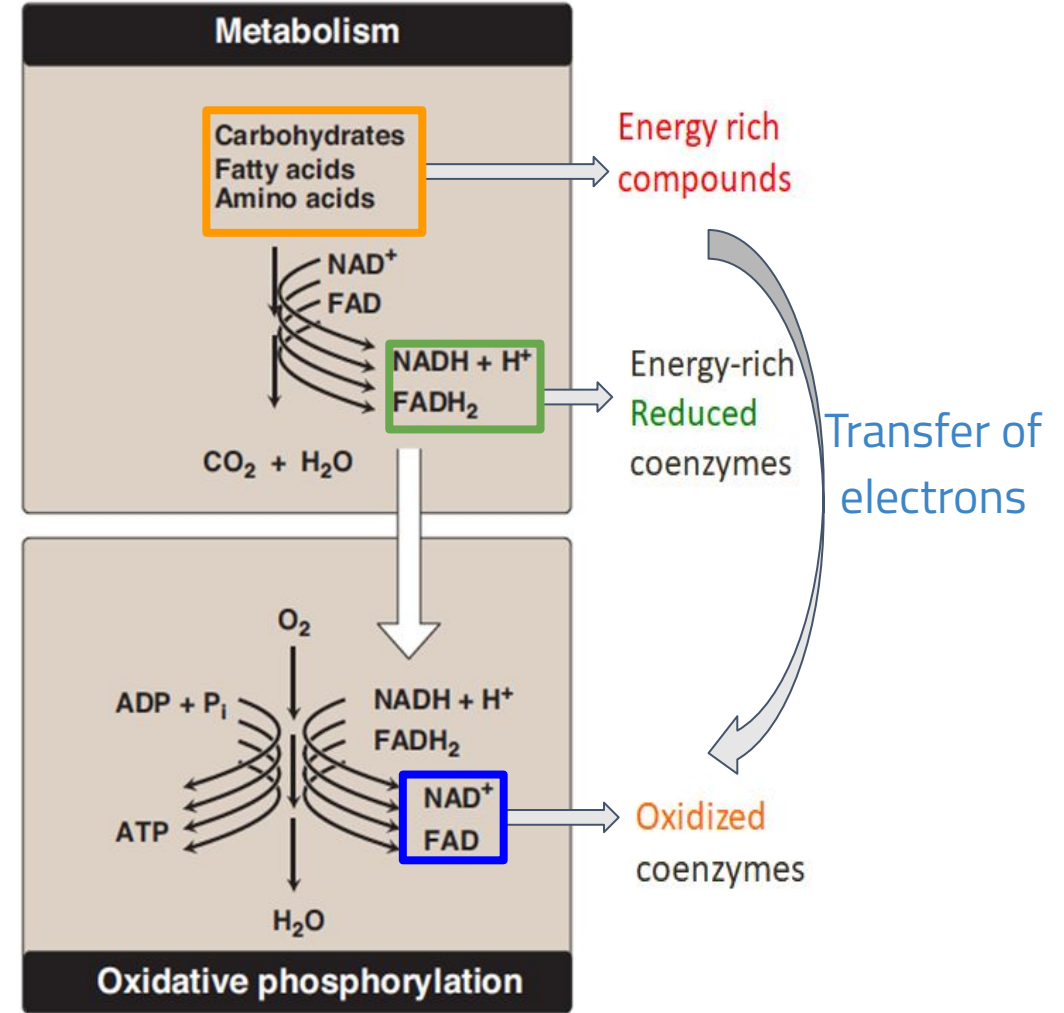
phosphoester bond





# Oxidation-Reduction in Metabolism

Oxidation	Reduction
Loss of hydrogen	Gain of hydrogen
Loss of electron	Gain of electron



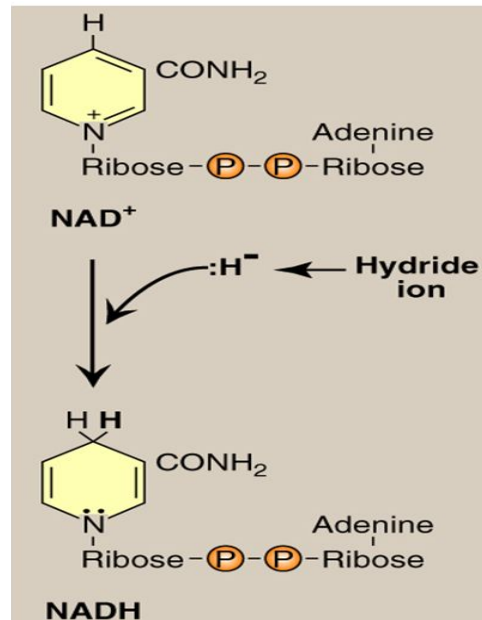
**FAD, NAD<sup>+</sup>: oxidizing agents** (Accept electron)

**FADH<sub>2</sub>, NADH: reducing agents** (loss electron)

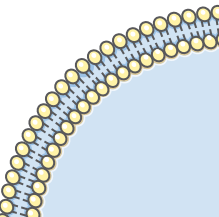
didn't understand?

- when the oxidizing agents enter a reaction (eg; NAD<sup>+</sup>). they will oxidize the other molecule (oxidizing agents) but they will reduce themselves NAD<sup>+</sup> will become NADH after the reaction

- the same for reducing agent (NADH). they will reduce the other molecule (reducing agent) but they will oxidize themselves NADH will become NAD<sup>+</sup>

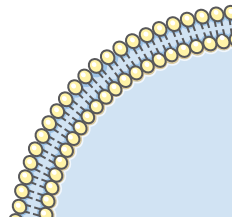
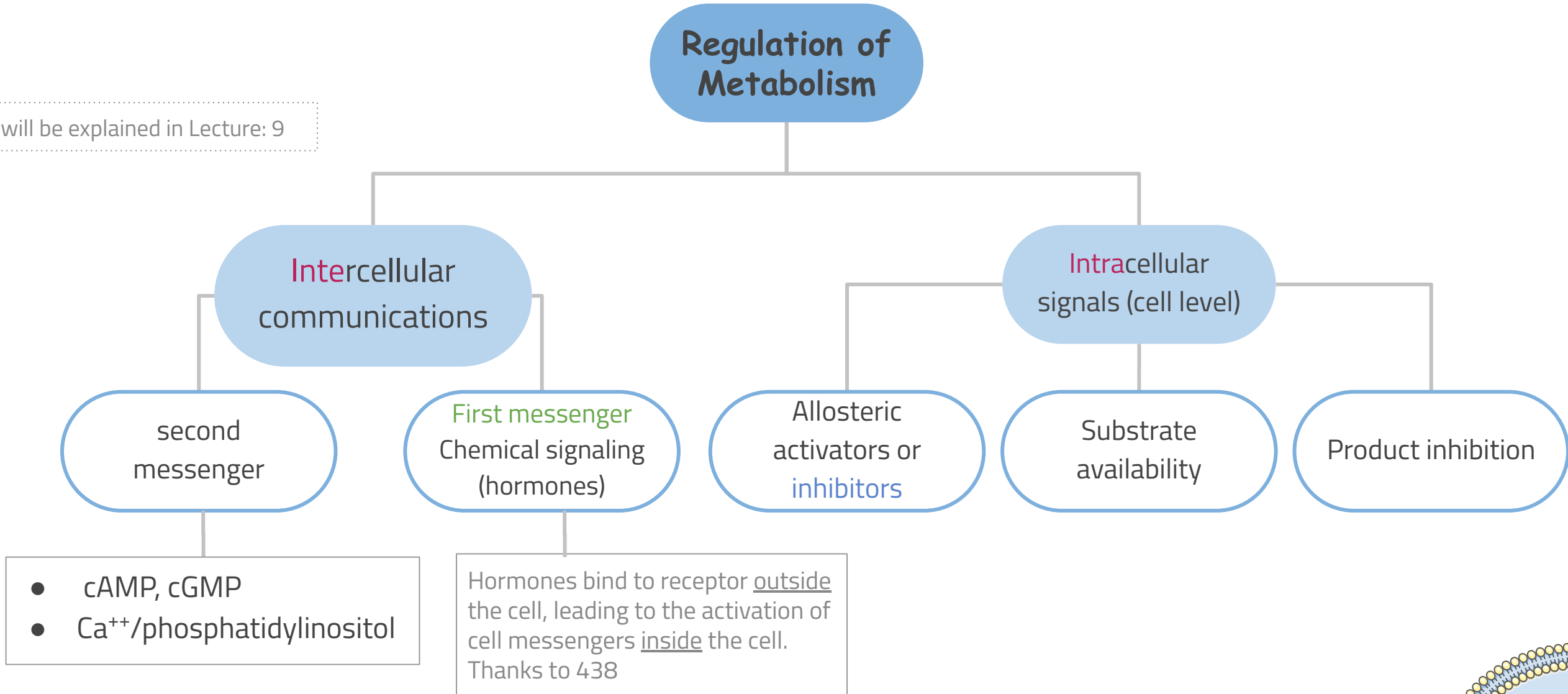


Oxidative phosphorylation is the process to convert ADP to ATP. it happens in mitochondria.



# Regulation of Metabolism

will be explained in Lecture: 9

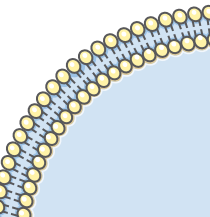




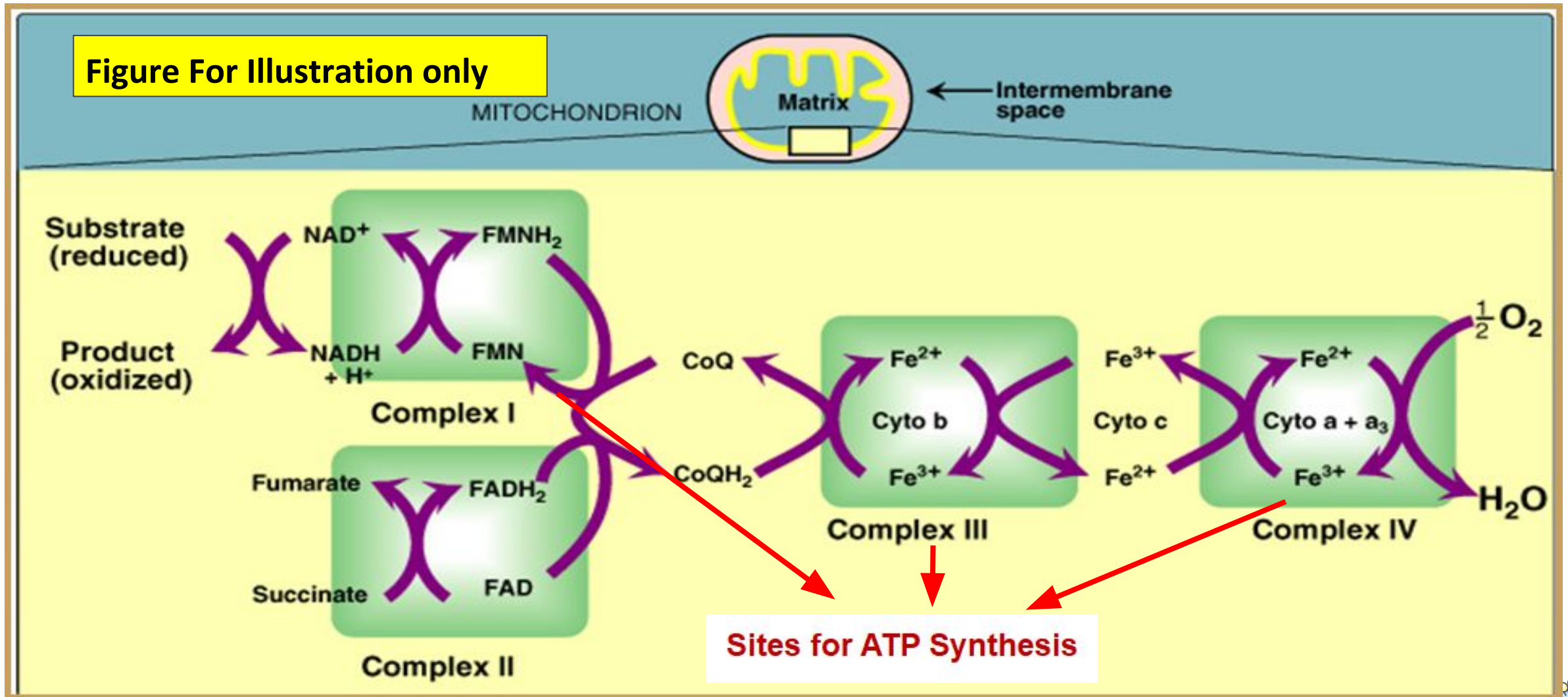
## Metabolic Fuel

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

- some tissues can't use fatty acid as metabolic fuel easily. As a result they prefer glucose.



# Electron Transport Chain (ETC)

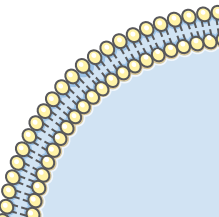


Electron transport and ATP synthesis are tightly coupled processes



# Summary

- ❑ **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: All the chemical reactions taking place inside a cell are collectively known as:

- A Pathways      B Metabolic Map      C Metabolism      D A & C

Q2: In which stage in catabolic pathway does the conversion to Acetyl CoA occurs:

- A stage II      B stage I      C stage III      D stage II and I

Q3: when an oxidizing agent enters a reaction, the outcome will be

- A oxidizing the other molecule and himself      B reducing the other molecule and himself      C reducing the other molecule and oxidizing himself      D oxidizing the other molecule and reducing himself

Q4: which of these regulation is an example of Intracellular regulation ?

- A substrate availability      B second messenger      C product inhibition      D A and C

Q5: which of these characteristics isn't a feature of anabolic pathways :

- A consume energy      B divergent process      C involves oxidations      D A and C

Answer Key:

(1) C      (2) A      (3) D      (4) D      (5) C

Q6: Enumerate two reducing agents.

Q7: Define a cycle pathway? and give an example for it.

Q8: how can ATP produces energy?

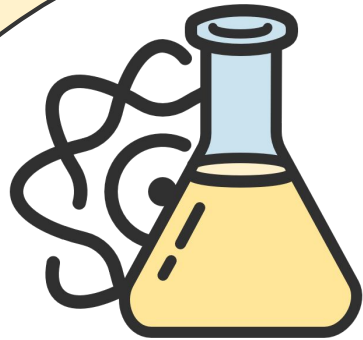
Q9: what does amphibolic pathway means? and give an example for it.

Q6 NADH, FADH<sub>2</sub>.

Q7 it's a Pathway that regenerate a component. TCA cycle.

Q8 hydrolysis of ATP  
 $ATP + H_2O \rightarrow ADP + P_i + \text{Energy}$

Q9 it's a pathway that have both catabolic and anabolic features. krebs cycle.



**Biochemistry 441**

**Girls**



★ **Ghadah Alarify - Leader**

Yara Almufleh  
Reema Alrashedi  
Wareef Almousa  
Joud Alangari  
Fay Alluhaidan  
Sarah Alhamlan  
Arwa Almobeirek  
Jumana AL-qahtani

Latifa Alkhdiri  
Alanoud Alhaider  
Futoon Almotairi  
Manal Aldhirgham  
Raaoum Jabor  
Norah alawlah  
Shahad Helmi  
Rand Aldajani

**Boys**



★ **Khalid Alhamdi - Leader**

Ahmed Alayban  
Sultan Alosaimi  
Abdullah Alomran  
Bassam Alghizzi  
Ibrahim Aljurayyan  
Mohammed Almutairi  
Turki Alkhalifa  
Malik Alshaya

Faisal Alhmoud  
Abdulrahman Alnoshan  
Ahmed Alqahtani  
Hamad Alshaalan  
Anas Alharbi  
Mohammed Alwahibi  
Saad Alghadir  
Firas Alqahtani



**BiochemistryTeam441@gmail.com**