Introduction to metabolism

Editing File

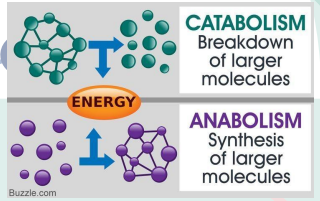
Color Index:
- Main Text (black)
- Female Slides (Pink)
- Male Slides (Blue)
- Important (Red)
- Dr's Notes (Green)
- Extra Info (Grey)

Objectives

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

Helpful video

Metabolism



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

Metabolism consists of:

catabolic "Breaking down"	**anabolic** "Building up"
Energy producing pathways (Exergonic) Exp: Complex carbohydrates to simple sugar	Energy consuming pathways (Endergonic) Exp: Amino acids to protein

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

From 439

e.g. A → B
B → C
C → D

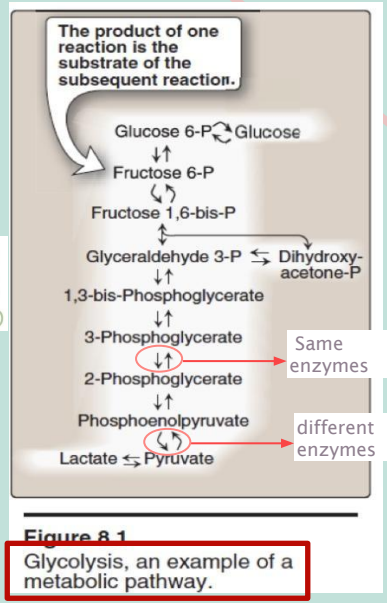


Figure 8.1
Glycolysis, an example of a metabolic pathway.

Note: Pathways that regenerate a component are called cycles.

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

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 .

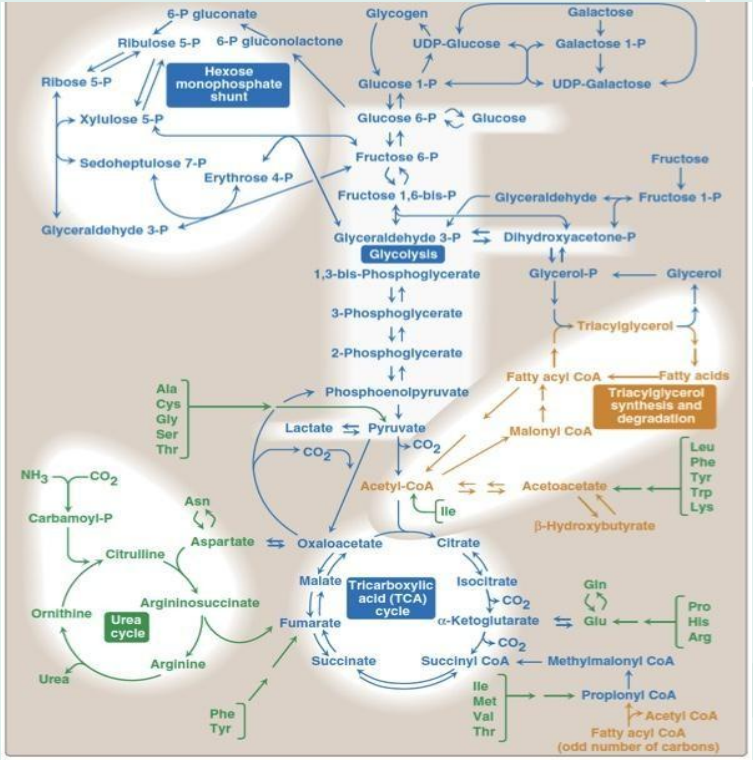
-If the reaction is reversible or irreversible.

-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 وكذا ما راح تقدر تجيبه 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:

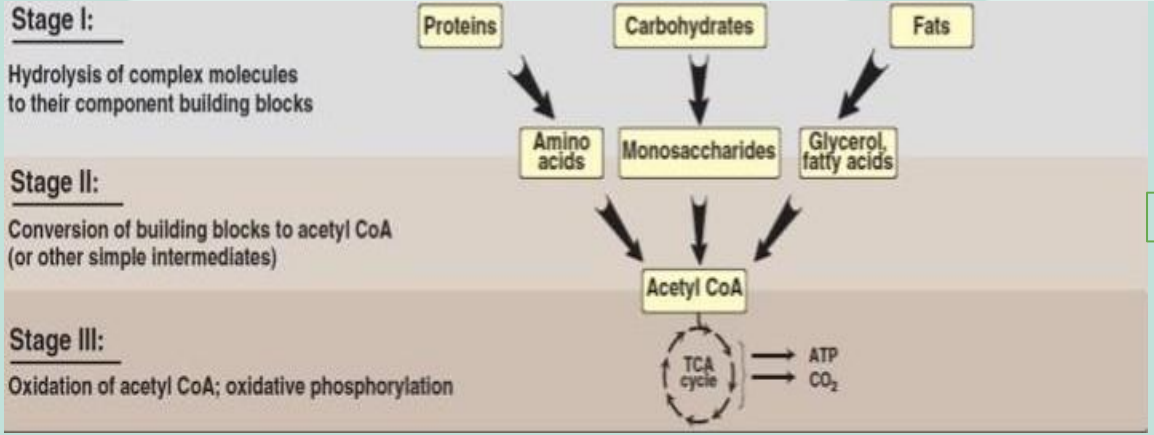
Catabolic

Has **three** stages to produce energy

1) Hydrolysis of complex molecules to their component building blocks
2) Conversion of building blocks to acetyl COA (or other simple intermediates)
3) Oxidation of acetyl CoA; oxidative phosphorylation

Anabolic (Stage II to I)

- Formation of precursor molecules into complex molecules
- Endergonic reactions (require ATP) or sometimes GTP
- A divergent process (few precursors form more complex products)



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

- 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 reduction Gain H+	Involves oxidation Loss H+
Requires NADPH Reducing agent	Requires NAD+ Oxidising agent
Divergent process	Convergent process

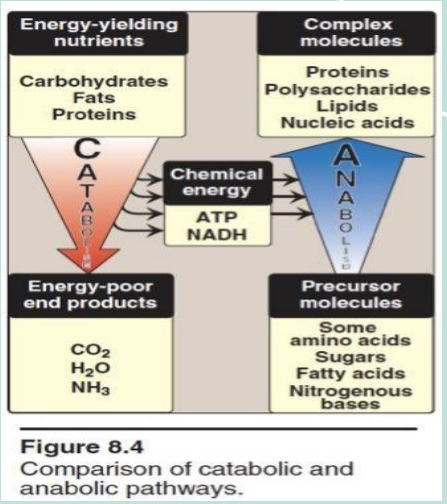


Figure 8.4
Comparison of catabolic and anabolic pathways.

Amphibolic Pathways

Helpful video

- Amphi = dual (ثنائي)
- **Amphibolic**= dual pathway

(both catabolic and anabolic)

Example: Krebs cycle (TCA Cycle)

Krebs cycle is mainly a catabolic cycle but with some anabolic features.
part of Krebs cycle is used for the synthesis of glucose from amino acids.Therefore it's amphibolic

helpful video

Energy Currency: ATP

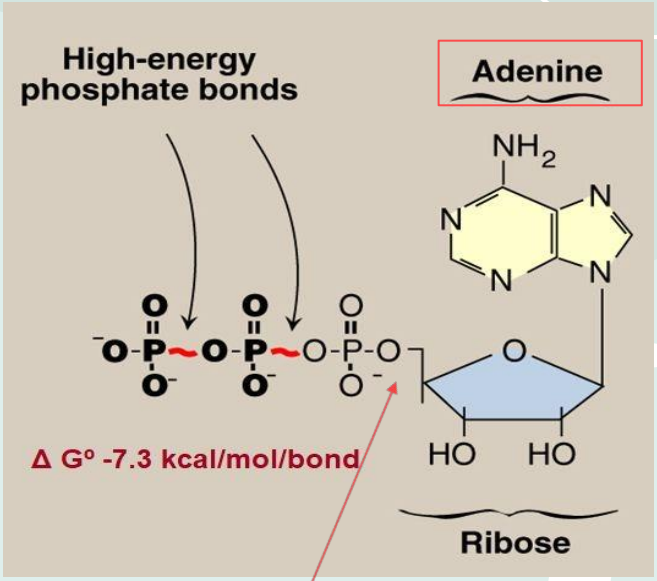
$ATP + H_2O = ADP + P_i + Energy$

- The free energy liberated by 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 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)



phosphoester bond

- the phosphoester bond between the PO4 group and the Ribose sugar is very stable and very hard to break. thus, it's not considered as a high energy bond

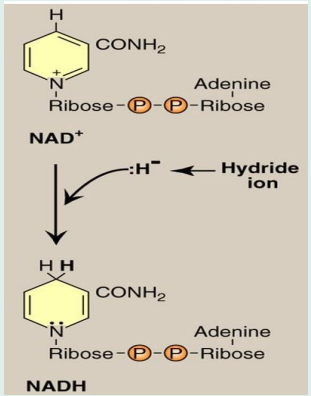
Oxidation-Reduction in Metabolism

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

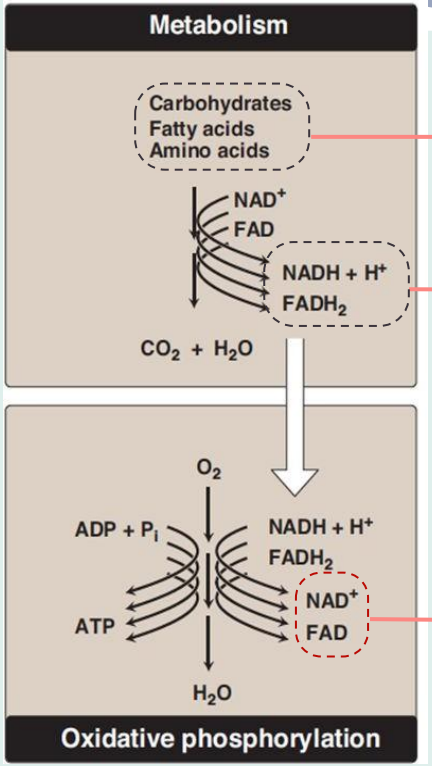
Mnemonic:

"Oil Rig"

Oxidation is loss - Reduction is gain



FAD, NAD⁺: oxidizing agents (Accept electron)**FADH2, NADH: reducing agents** (loss electron)didn't understand?-when the oxidizing agents enter a reaction (eg;NAD^+). they will oxidize the other molecule (oxidizing agents) but they will reduce themselves NAD^+ 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^+



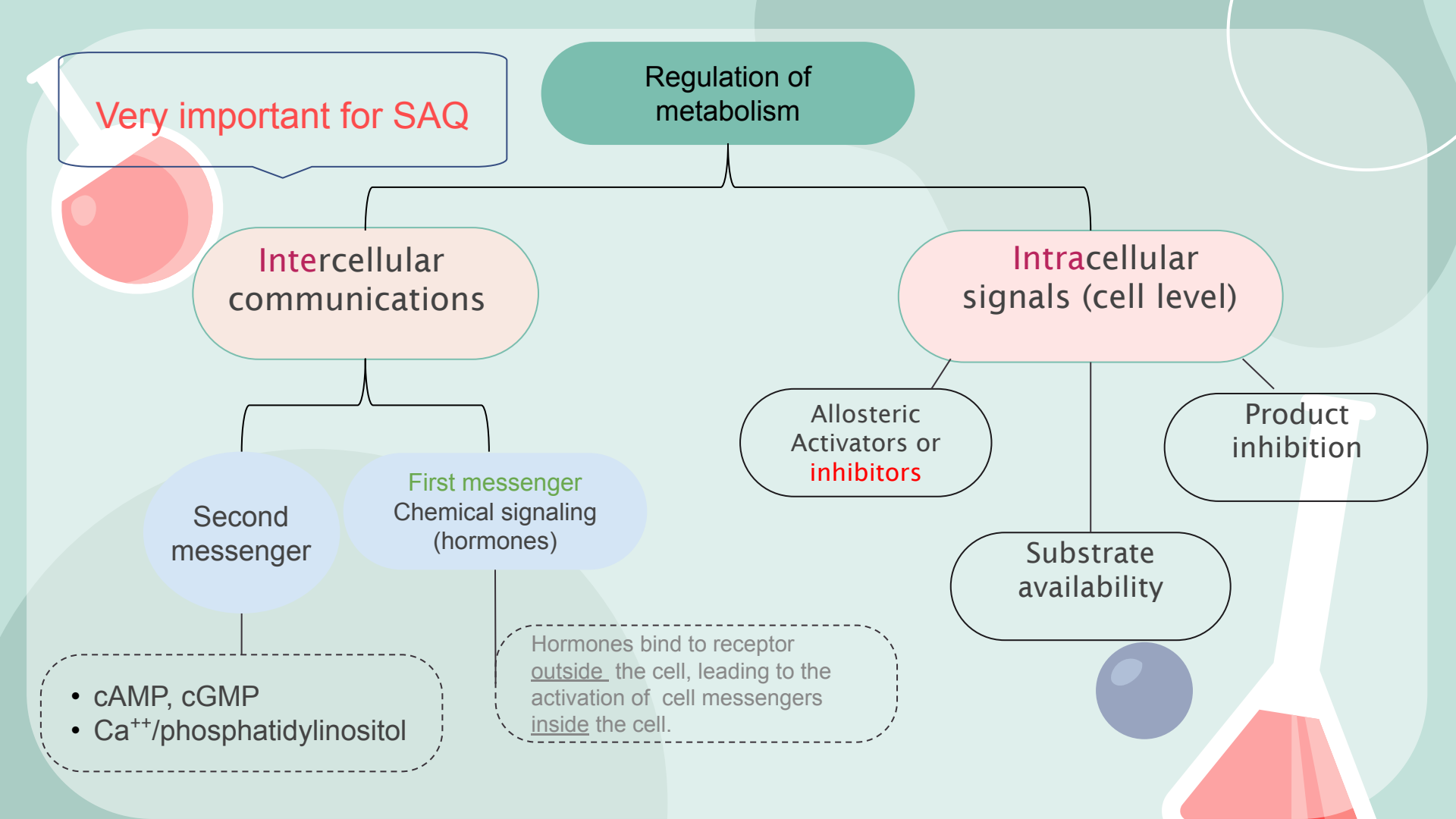
Energy rich compounds

Energy-rich Reduced coenzymes

Transfer of electrons

Oxidized coenzymes

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


Very important for SAQ
Regulation of metabolism
Intercellular communications
Intracellular signals (cell level)
Second messenger
First messenger
Chemical signaling (hormones)
Allosteric Activators or inhibitors
Product inhibition
Substrate availability
• cAMP, cGMP
• Ca++/phosphatidylinositol
Hormones bind to 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 major sources of energy.

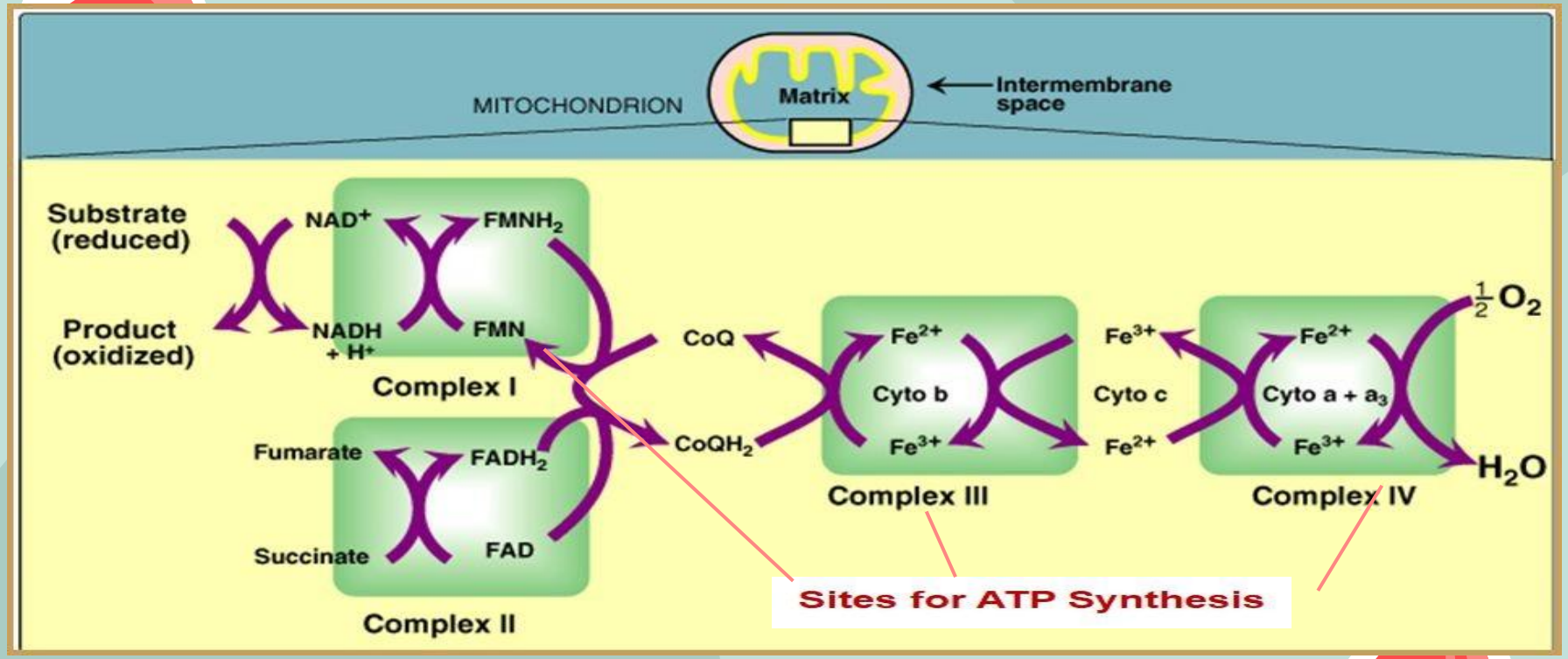
Amino acids are a minor source of energy.

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)

Figure For Illustration only



Electron transport and ATP synthesis are tightly coupled processes

MCQs

Q1: Characteristics of metabolic map:			
A)Purposeful	B)Integrated	C)Both A and B	D)None of them
Q2: which type of pathways does Krebs cycle use?			
A)Anabolic pathway	B) Amphibolic pathway	C)Catabolic pathway	D)None of them
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: All the chemical reactions taking place inside a cell are collectively known as:			
A)Pathways	B)Metabolic map	C)Metabolism	D)A and C
Q5: which of these regulation is an example of intracellular regulation?			
A)Substrate availability	B)Second messenger	C)Product inhibition	D)A and C

Answer key: 1)C 2)B 3)D 4)C 5)D.

SAQ

Questions:

Q6: what is the pathway that consumes ATP?

Q7: what does amphibolic pathway means? and give an example for it.

Q8:how can ATP produces energy?

Q9: Compare between Catabolic and Anabolic pathways.

Answers:

Q6 Anabolic pathway

Q7 it's a pathway that have both catabolic and anabolic features. Krebs cycle.

Q8 hydrolysis of ATP($ATP + H_2O \rightarrow ADP + P_i$ + Energy

Q9 slide 8

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