AL-RASHEED UNIVERSITY COLLEGE

DEPARTMENT OF MEDICAL LABORATORY TECHNIQUES

Introduction to Metabolism and Glycolysis

Lecture 5

Prepared By

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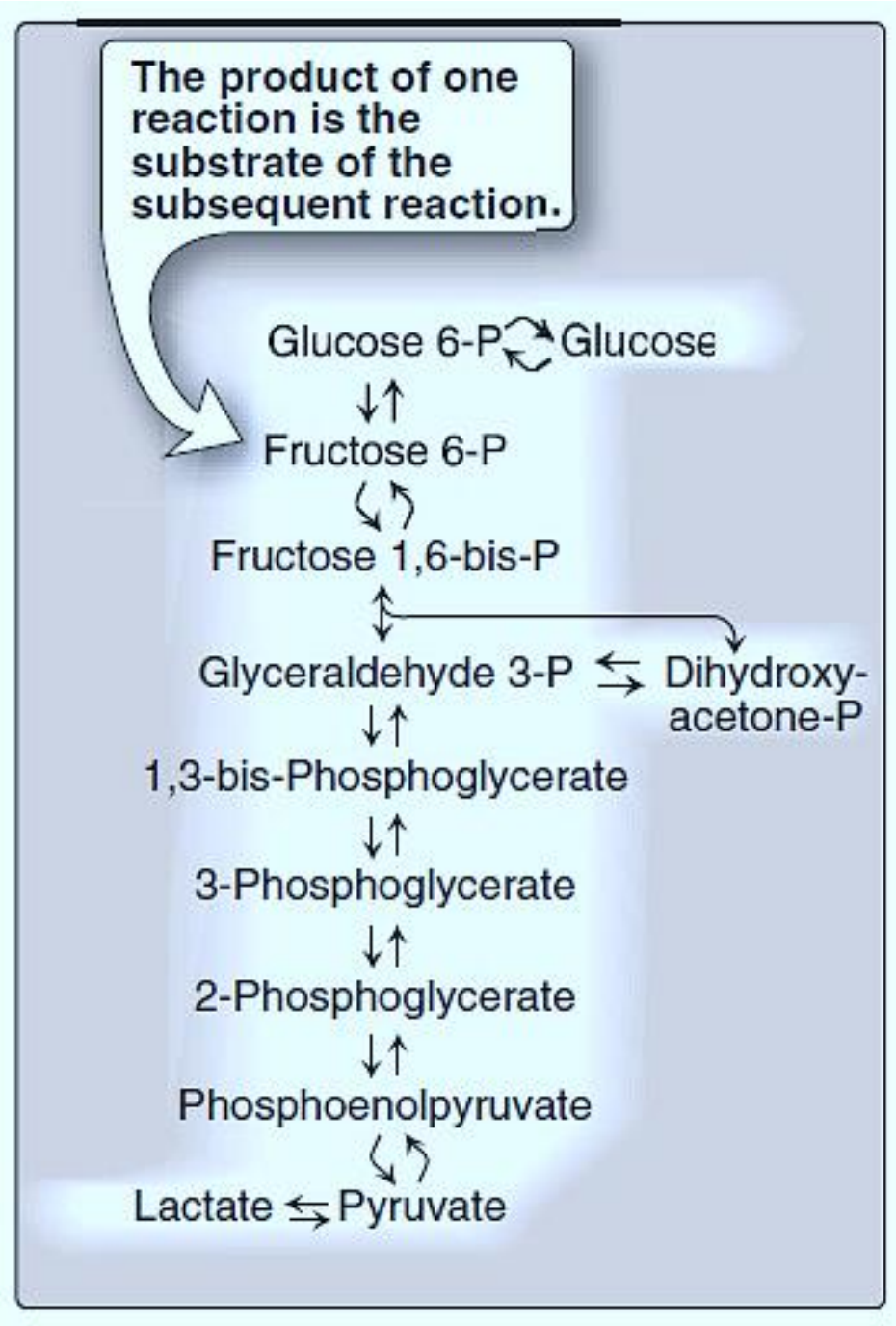


الوحدة الثانية - المحاضرة الاولى - الزمن: 90 دقيقة

أهداف المحاضرة الاولى:

يتوقع في نهاية المحاضرة أن يكون الطالب قادراً على:

By the end of the lecture, the student should be able to:

1. Define the following terms: (Metabolism, Catabolic Pathways, Anabolic Pathways).
2. To provide the student with the "big picture," a metabolic map containing the important central pathways of energy metabolism
3. Compare between catabolic and anabolic pathways.
4. Discuss the three stages of catabolism

موضوعات المحاضرة الاولى:

- INTRODUCTION TO METABOLISM
  - Metabolic Map
  - Catabolic Pathways
    - Hydrolysis of complex molecules
    - Conversion of building blocks to simple intermediates
    - Oxidation of acetyl coenzyme A
  - Anabolic Pathways

I. INTRODUCTION TO METABOLISM

- In Chapter 1, individual enzymic reactions were analyzed in an effort to explain the mechanisms of catalysis.
- However, in cells, these reactions rarely occur in isolation but, rather, are organized into multistep sequences called pathways, such as that of glycolysis (Figure 2.1).
- In a pathway, the product of one reaction serves as the substrate of the subsequent reaction.
- Different pathways can also intersect, forming an integrated and purposeful network of chemical reactions.
- These are collectively called metabolism, which is the sum of all the chemical changes occurring in a cell, a tissue, or the body.

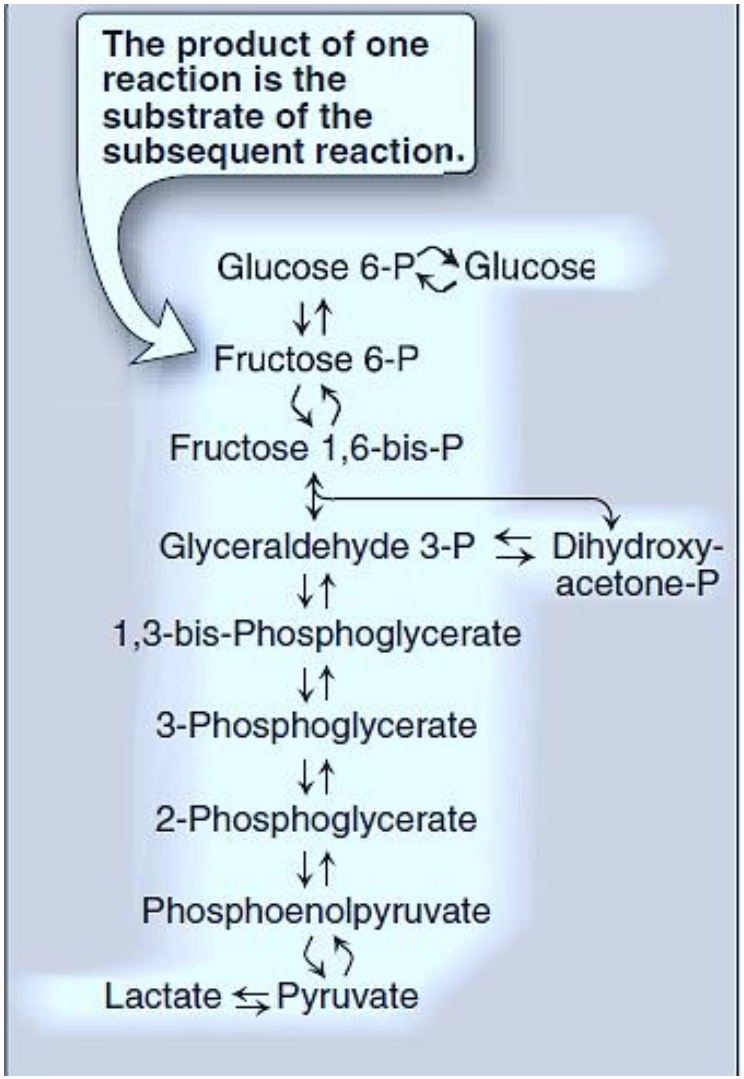


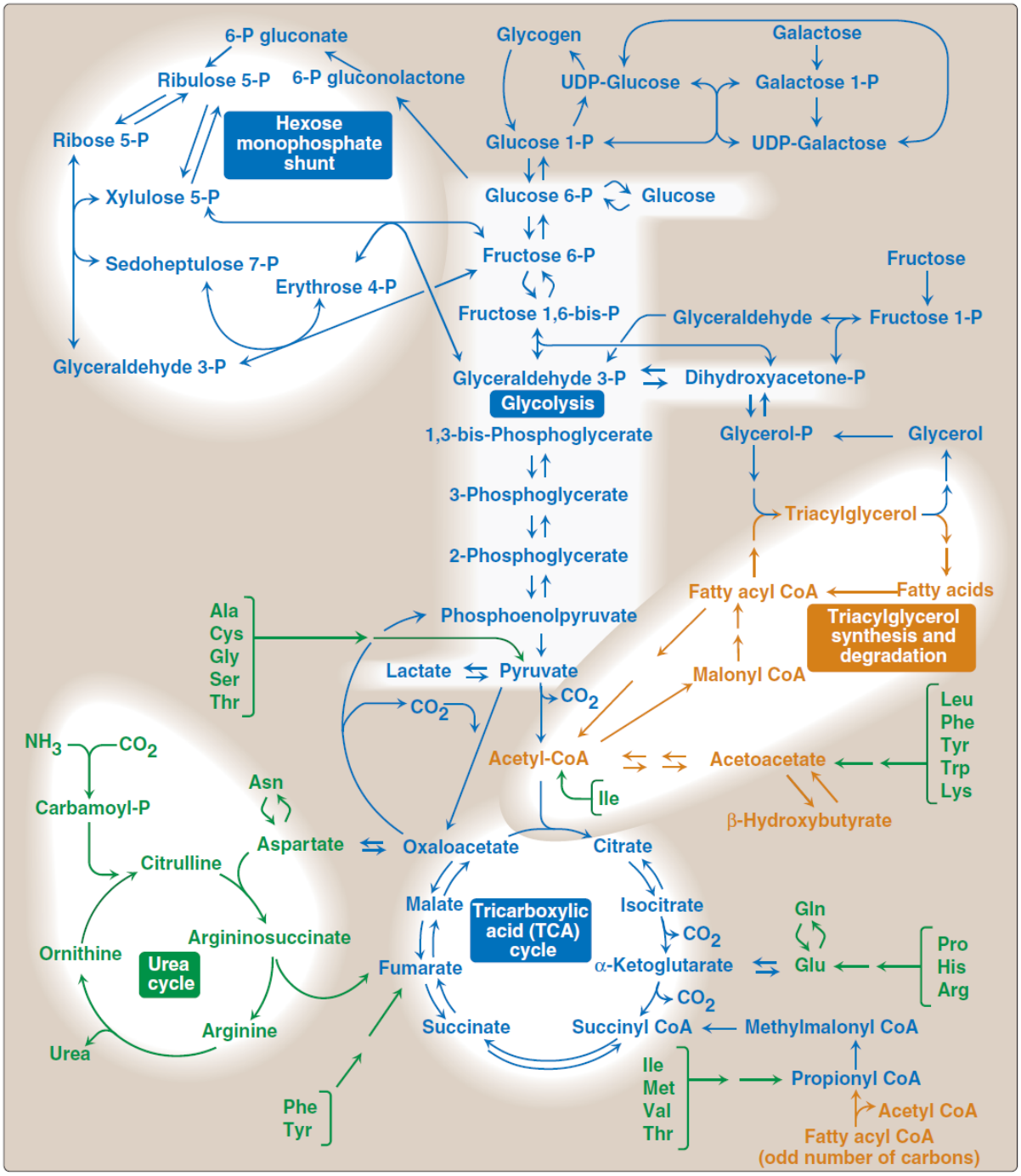
Figure 2.1 Glycolysis, an example of a metabolic pathway.

- Most pathways can be classified as either catabolic (degradative) or anabolic (synthetic)
- Catabolic reactions break down complex molecules, such as proteins, polysaccharides, and lipids, to a few simple molecules (for example, CO_2, NH_3 and H_2O).
- Anabolic pathways form complex end products from simple precursors, for example, the synthesis of the polysaccharide, glycogen, from glucose.
- [Note: Pathways that regenerate a component are called cycles.]

A. Metabolic map

- It is convenient to investigate metabolism by examining its component pathways.
- Each pathway is composed of multienzyme sequences, and each enzyme, in turn, may exhibit important catalytic or regulatory features.
- To provide the reader with the "big picture," a metabolic map containing the important central pathways of energy metabolism is presented in Figure 2.2.
- This map is useful in:
  - tracing connections between pathways
  - visualizing the purposeful "movement" of metabolic intermediates
  - depicting the effect on the flow of intermediates if a pathway is blocked (for example, by a drug or an inherited deficiency of an enzyme).

Figure 2.2 Important reactions of intermediary metabolism. Several important pathways to be discussed in later chapters are highlighted. Curved reaction arrows ( ) indicate forward and reverse reactions that are catalyzed by different enzymes. The straight arrows ( ) indicate forward and reverse reactions that are catalyzed by the same enzyme. **Blue text** = intermediates of carbohydrate metabolism; **brown text** = intermediates of lipid metabolism; **green text** = intermediates of protein metabolism. UDP = uridine diphosphate; P = phosphate; CoA = coenzyme A.



B. Catabolic pathways

- Catabolic reactions serve to capture chemical energy in the form of adenosine triphosphate (ATP) from the degradation of energy-rich fuel molecules.
- Catabolism also allows molecules in the diet (or nutrient molecules stored in cells) to be converted into building blocks needed for the synthesis of complex molecules.
- Energy generation by degradation of complex molecules occurs in three stages as shown in Figure 2.3.
- [Note: Catabolic pathways are typically oxidative, and require oxidized coenzymes such as nicotinamide adenine dinucleotide (NAD^+).]

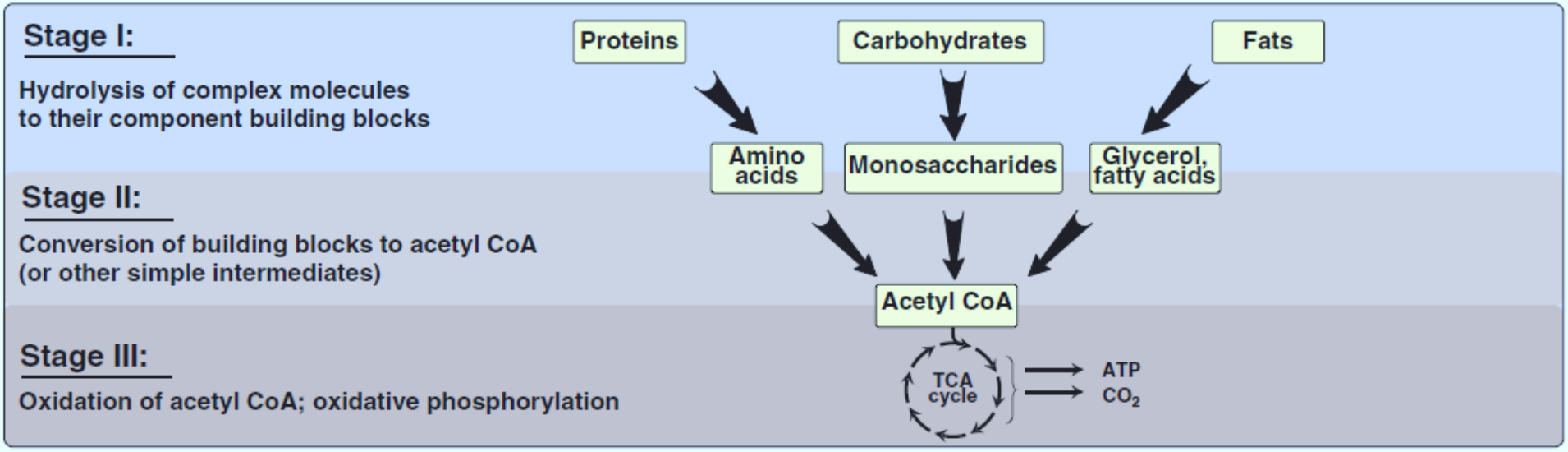


Figure 2.3 Three stage of catabolism. CoA = coenzyme A; TCA = tricarboxylic acid.

1. Hydrolysis of complex molecules:

- In the first stage, complex molecules are broken down into their component building blocks.
- For example, proteins are degraded to amino acids, polysaccharides to monosaccharides, and fats (triacylglycerols) to free fatty acids and glycerol.

2. Conversion of building blocks to simple intermediates:

- In the second stage, these diverse building blocks are further degraded to acetyl coenzyme A (CoA) and a few other simple molecules.
- Some energy is captured as ATP, but the amount is small compared with the energy produced during the third stage of catabolism.

3. Oxidation of acetyl coenzyme A:

- The tricarboxylic acid (TCA) cycle is the final common pathway in the oxidation of fuel molecules that produce acetyl CoA.
- Oxidation of acetyl CoA generates large amounts of ATP via oxidative phosphorylation as electrons flow from NADH and flavin adenine dinucleotide ($FADH_2$) to oxygen.

C. Anabolic pathways

- Anabolic reactions combine small molecules, such as amino acids, to form complex molecules such as proteins (Figure 2.4).
- Anabolic reactions require energy (are endergonic), which is generally provided by the hydrolysis of ATP to adenosine diphosphate (ADP) and inorganic phosphate (P_i).

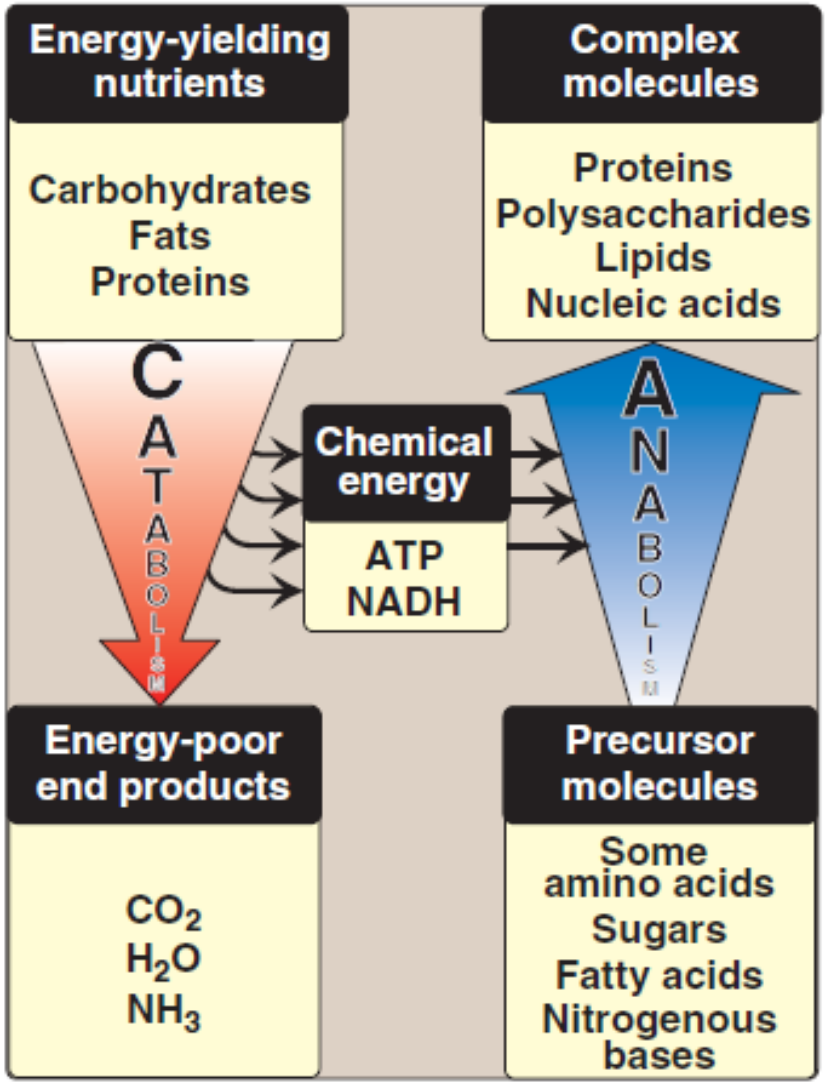


Figure 2.4 Comparison of catabolic and anabolic pathways. ATP = adenosine triphosphate; NADH = nicotinamide adenine dinucleotide.

- Anabolic reactions often involve chemical reductions in which the reducing power is most frequently provided by the electron donor NADPH.
- Note that catabolism is a convergent process (that is, a wide variety of molecules are transformed into a few common end products).
- By contrast, anabolism is a divergent process in which a few biosynthetic precursors form a wide variety of polymeric, or complex, products.

Catabolic pathways	Anabolic pathways
➢ Catabolic reactions break down complex molecules, such as proteins, polysaccharides, and lipids, to a few simple molecules (for example, CO_2, NH_3 and H_2O).	➢ Anabolic pathways form complex end products from simple precursors, for example, the synthesis of the polysaccharide, glycogen, from glucose.
➢ Catabolic reactions serve to capture chemical energy in the form of adenosine triphosphate (ATP) from the degradation of energy-rich fuel molecules.	➢ Anabolic reactions require energy (are endergonic), which is generally provided by the hydrolysis of ATP to adenosine diphosphate (ADP) and inorganic phosphate (P_i).
➢ Catabolic pathways are typically oxidative, and require oxidized coenzymes such as nicotinamide adenine dinucleotide (NAD^+).	➢ Anabolic reactions often involve chemical reductions in which the reducing power is most frequently provided by the electron donor NADPH.
➢ catabolism is a convergent process (that is, a wide variety of molecules are transformed into a few common end products).	➢ anabolism is a divergent process in which a few biosynthetic precursors form a wide variety of polymeric, or complex, products.

نشاط (1/1/2) نشاط فردي
عرف المصطلحات التالية

Define the following terms:

1. Metabolism
2. Catabolic Pathways
3. Anabolic Pathways

نشاط (2/1/2) نشاط فردي

Compare between catabolic and anabolic pathways.