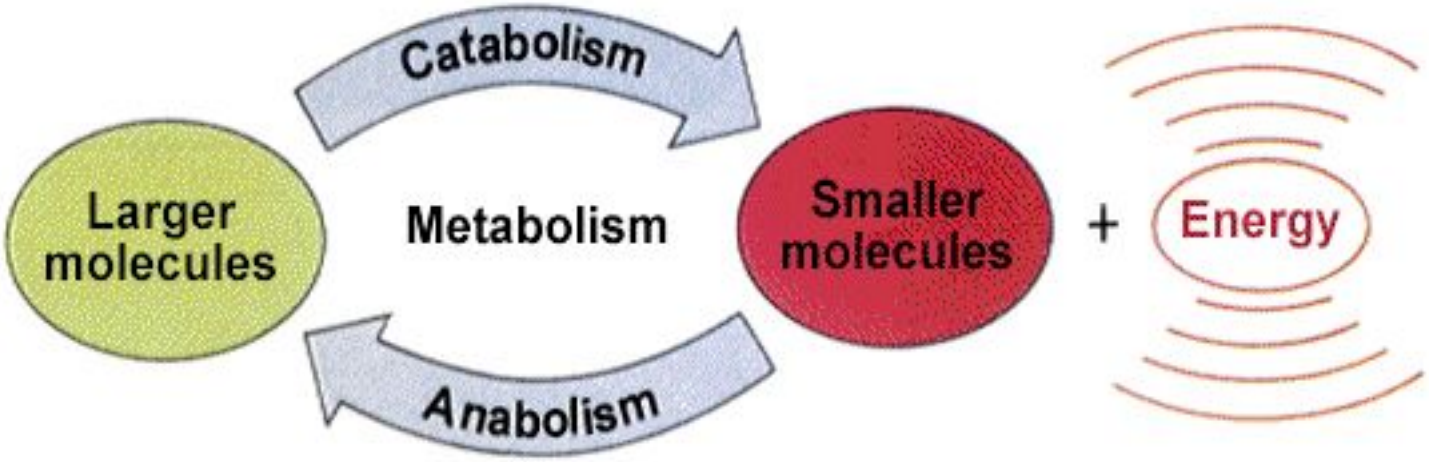
AN INTRODUCTION TO METABOLISM

Metabolism, Energy, and Life

- 1. The chemistry of life is organized into metabolic pathways
- 2. Organisms transform energy
- 3. Organisms live at the expense of free energy
- 4. ATP powers cellular work by coupling exergonic reactions to endergonic reactions

Breakdown

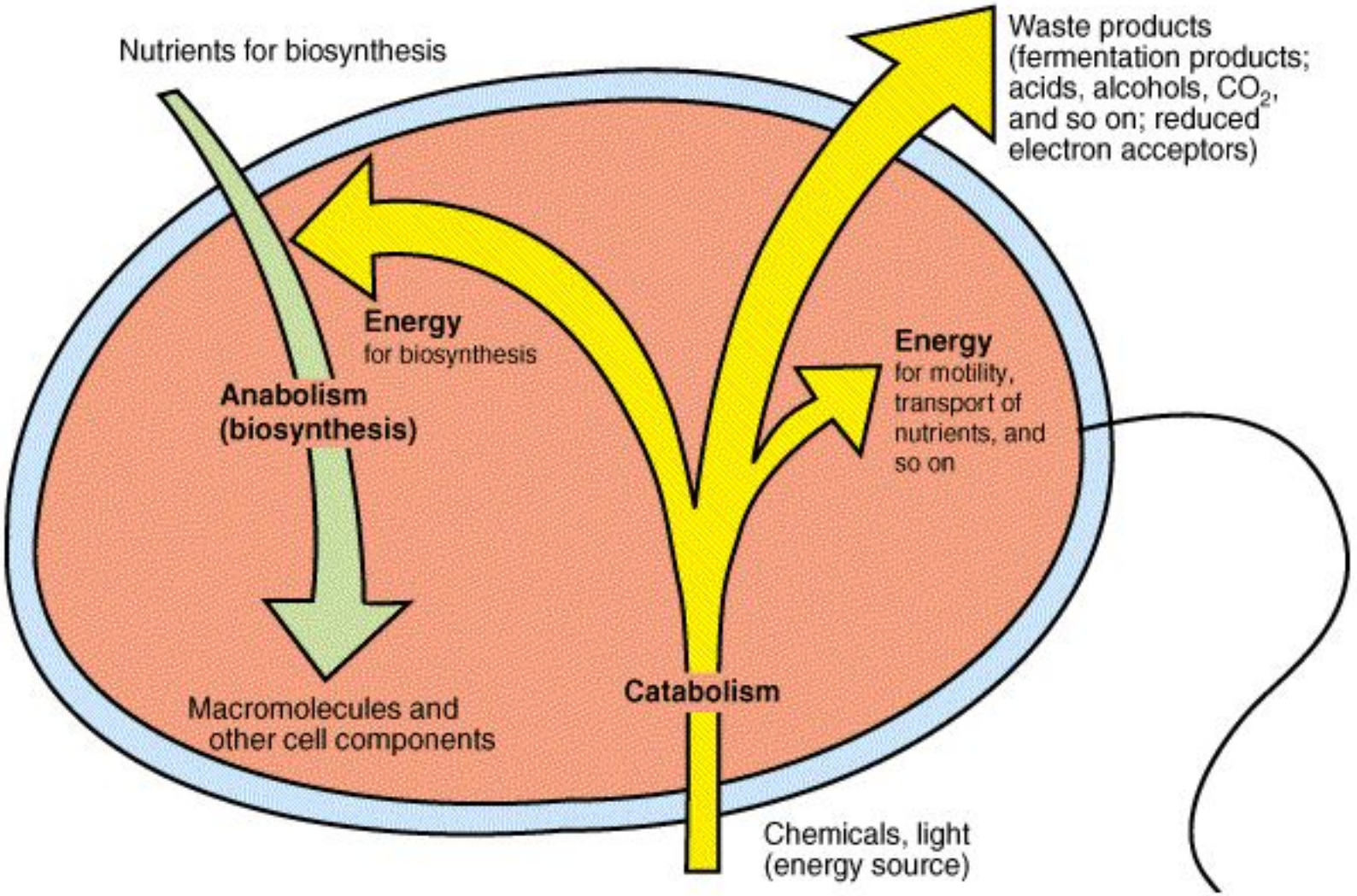
Proteins to Amino Acids, Starch to Glucose



Synthesis

Amino Acids to Proteins, Glucose to Starch

- **Catabolic pathways** release energy by breaking down complex molecules to simpler compounds.
  - This energy is stored in organic molecules until need to do work in the cell.
- **Anabolic pathways** consume energy to build complicated molecules from simpler compounds.
- The energy released by catabolic pathways is used to drive anabolic pathways.


Nutrients for biosynthesis
Waste products (fermentation products; acids, alcohols, CO_2, and so on; reduced electron acceptors)
Energy for biosynthesis
Anabolism (biosynthesis)
Energy for motility, transport of nutrients, and so on
Macromolecules and other cell components
Catabolism
Chemicals, light (energy source)

Organisms transform energy

- **Energy** is the capacity to do work - to move matter against opposing forces.
  - Energy is also used to rearrange matter.
- **Kinetic energy** is the energy of motion.
  - Objects in motion, photons, and heat are examples.
- **Potential energy** is the energy that matter possesses because of its location or structure.
  - **Chemical energy** is a form of potential energy in molecules because of the arrangement of atoms.

Organisms live at the expense of free energy

- Spontaneous processes can occur without outside help.
  - The processes can be used to perform work.
- Nonspontaneous processes can only occur if energy is added to a system.
- Spontaneous processes increase the stability of a system and nonspontaneous processes decrease stability.
- **Free energy** is the portions of a system's energy that is able to perform work when temperature is uniform throughout the system.

- Chemical reactions can be classified as either exergonic or endergonic based on free energy.
- An **exergonic reaction** proceeds with a net release of free energy and delta G is negative.

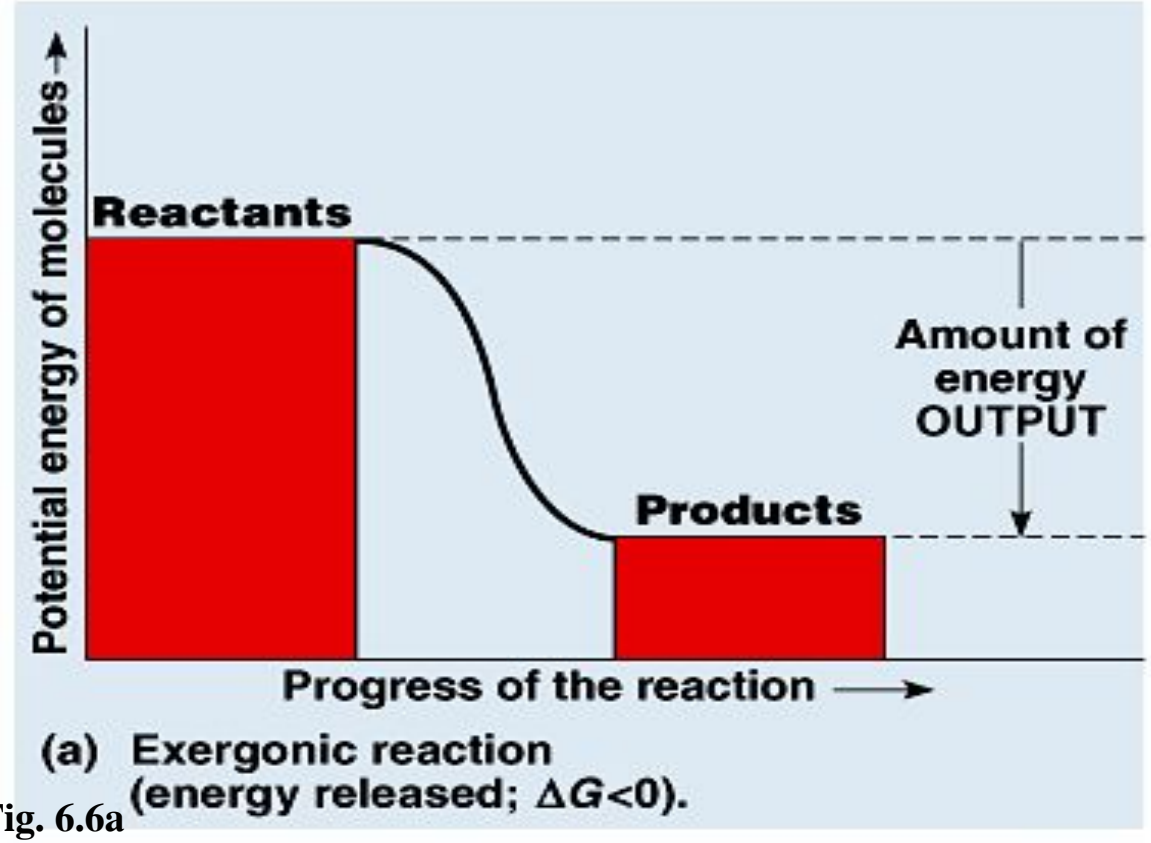


Fig. 6.6a

- An **endergonic reaction** is one that absorbs free energy from its surroundings.
  - Endergonic reactions store energy,
  - delta G is positive, and
  - reaction are nonspontaneous.

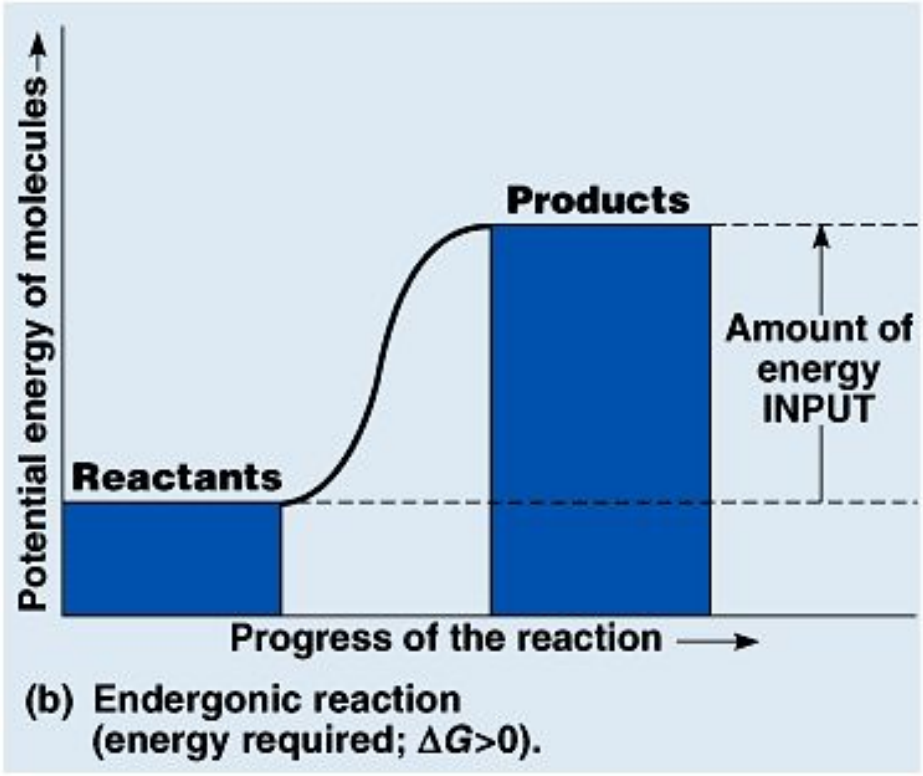
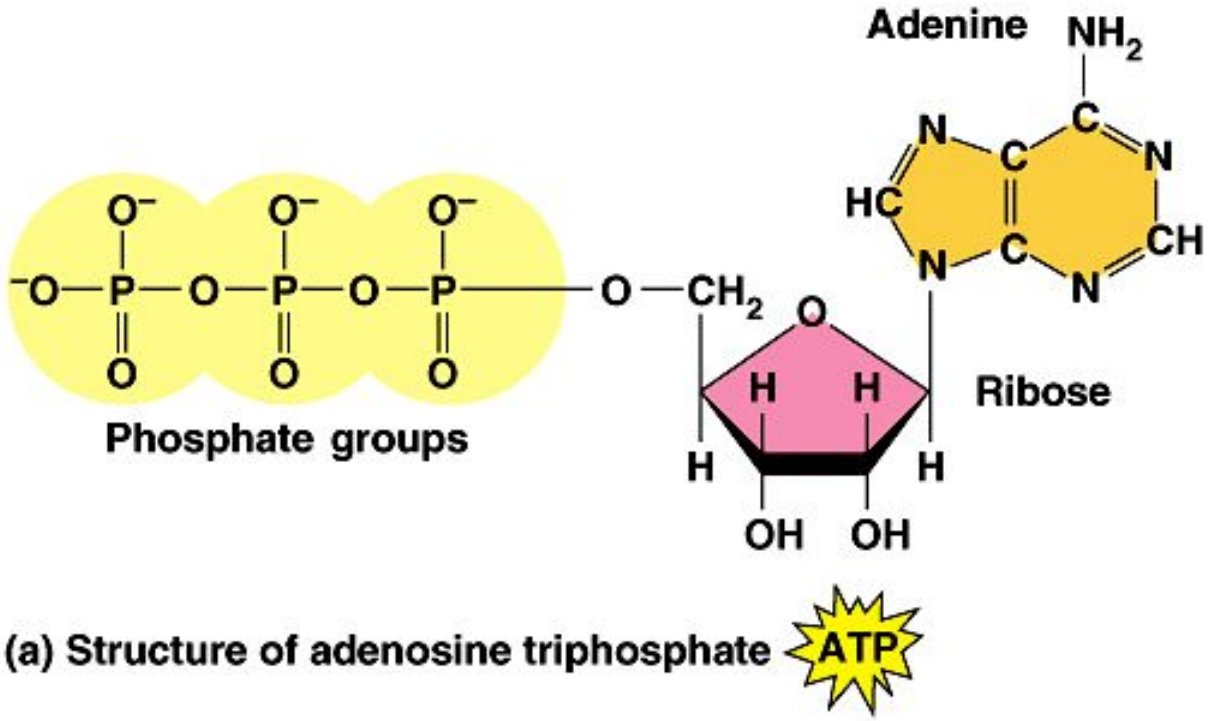


Fig. 6.6b

ATP

- **ATP powers cellular work**
- A cell does three main kinds of work:
  - *Mechanical work,* contraction of muscle cells, and movement of chromosomes
  - *Transport work,* pumping substances across membranes against the direction of spontaneous movement
  - *Chemical work,* driving endergonic reactions such as the synthesis of polymers from monomers

- **ATP** (**adenosine triphosphate**) is a type of nucleotide consisting of the nitrogenous base adenine, the sugar ribose, and a chain of three phosphate groups.



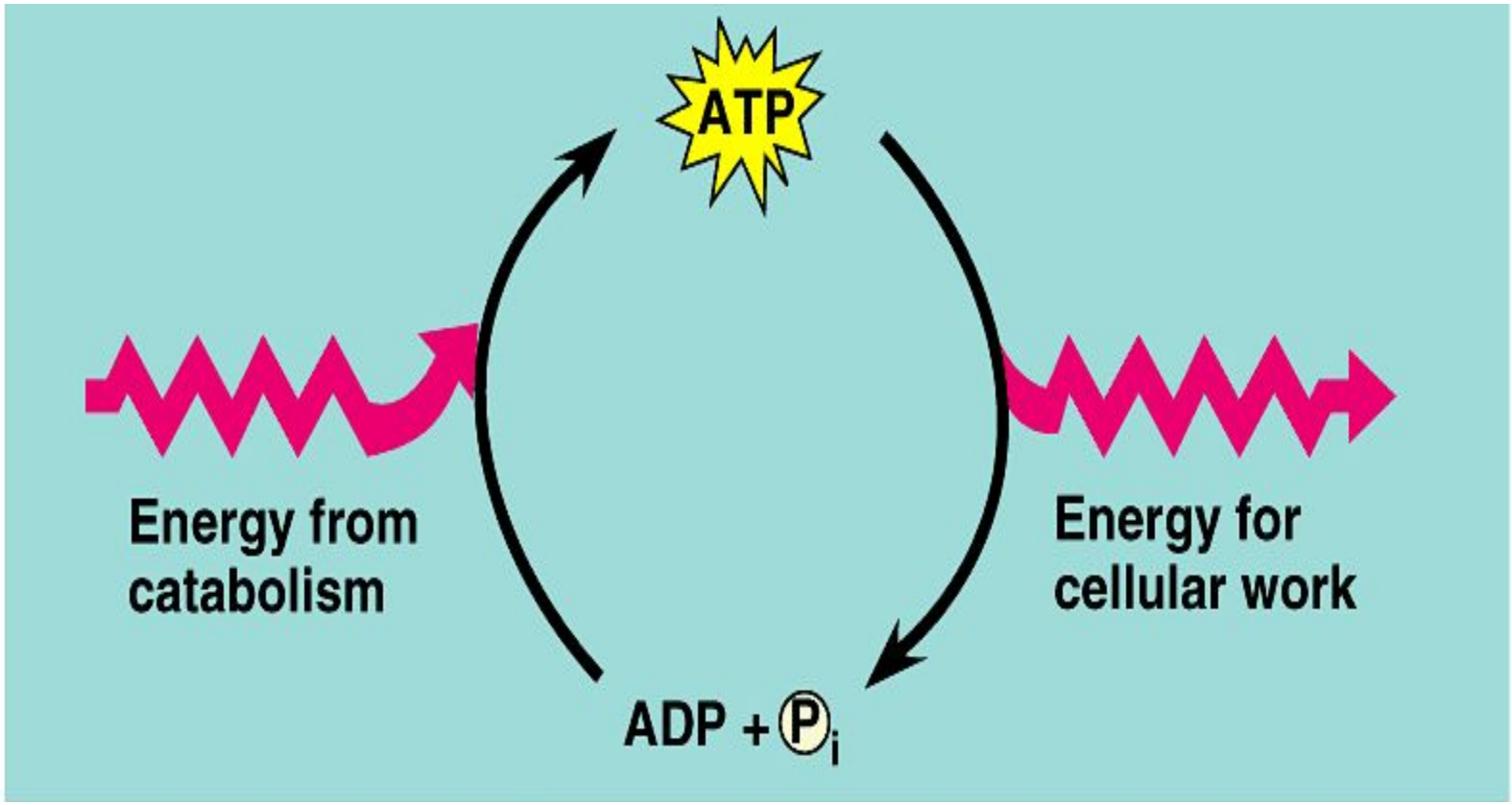


Fig. 6.8

Terminology

English	Russian	Kazakh
Metabolism	Метаболизм	Зат алмасу
Energy	Энергия	Энергия
Catabolism	Катаболизм	Катаболизм
Anabolism	Анаболизм	Анаболизм
ATP	АТФ	АТФ
Free energy	Свободная энергия	Бос энергия
Kinetic energy	Кинетическая энергия	Кинетикалық энергия
Potential energy	Потенциальная энергия	Потенциалды энергия