5.7 ATP: The Energy Currency of the Cell

- Adenosine triphosphate (ATP) is the main energy currency of the cell
- Each ATP molecule is composed of three parts:

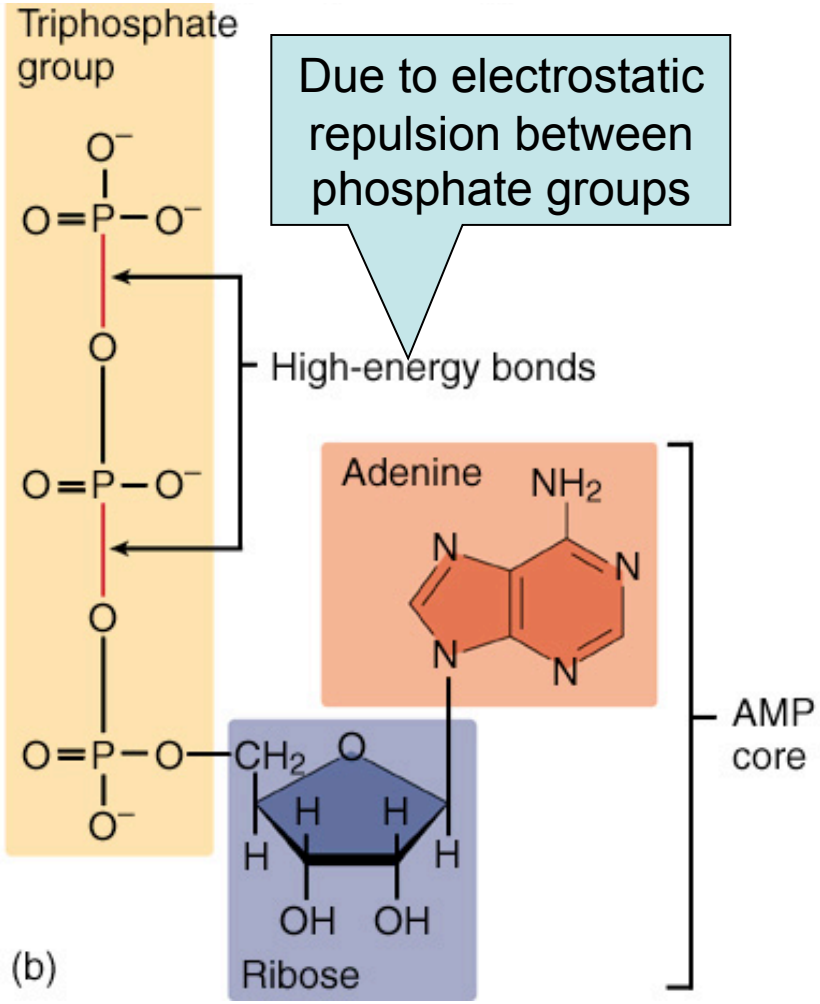


Fig. 5.11 (b)

5.7 ATP: The Energy Currency of the Cell

- Most energy exchanges in the cell involve cleavage of only the outermost bond in ATP

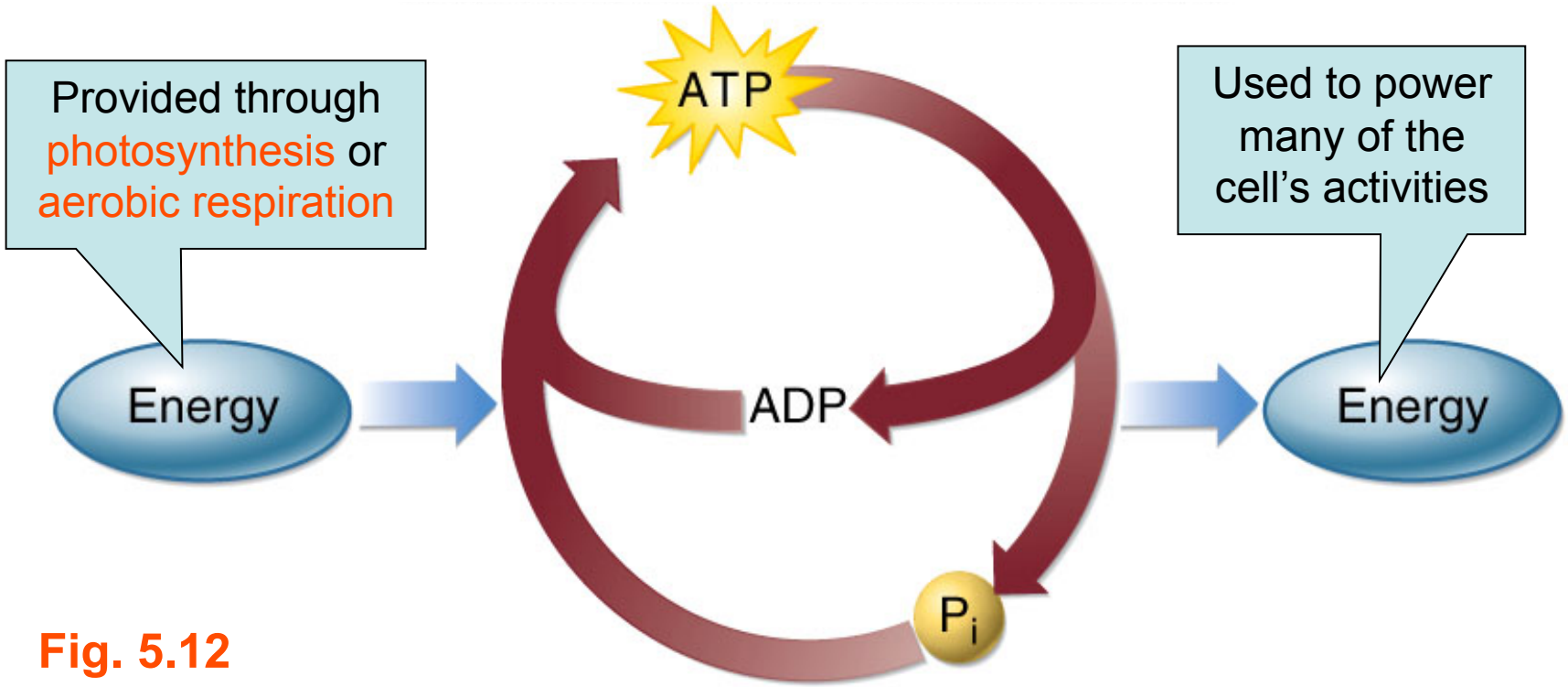
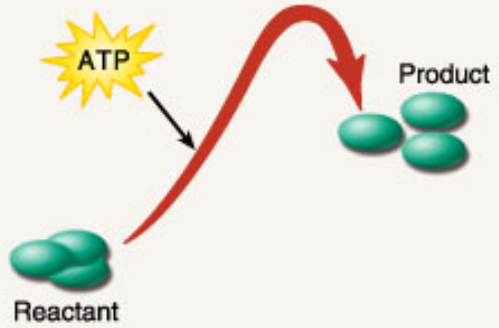
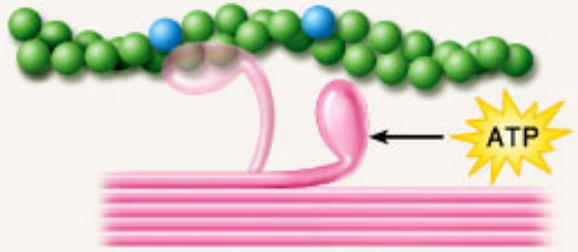


Fig. 5.12

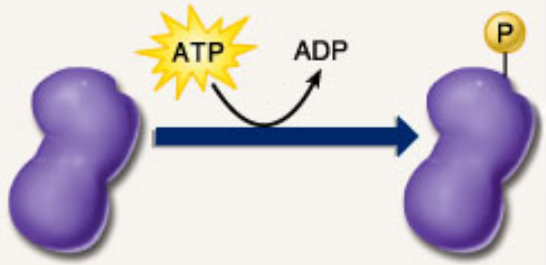
TABLE 5.1 HOW CELLS USE ATP ENERGY TO POWER CELLULAR WORK



Biosynthesis
Cells use the energy released from the exergonic hydrolysis of ATP to drive endergonic reactions like those of protein synthesis, an approach called energy coupling.

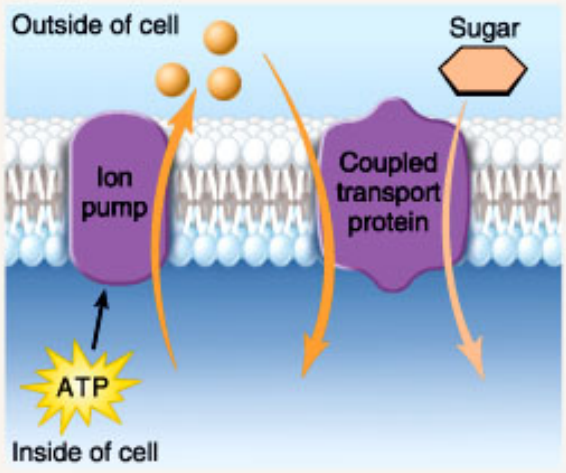


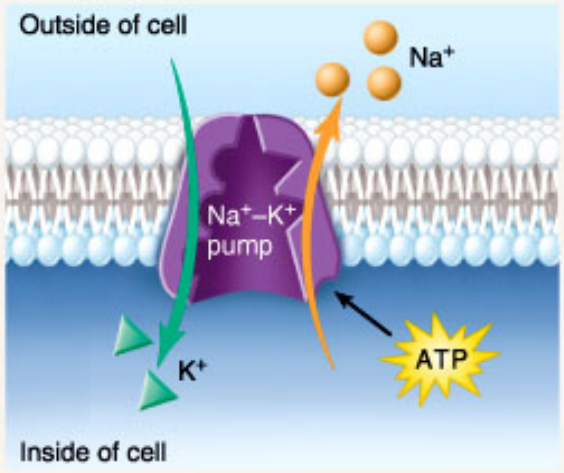
Contraction
In muscle cells, filaments of protein repeatedly slide past each other to achieve contraction of the cell. An input of ATP is required for the filaments to reset and slide again.

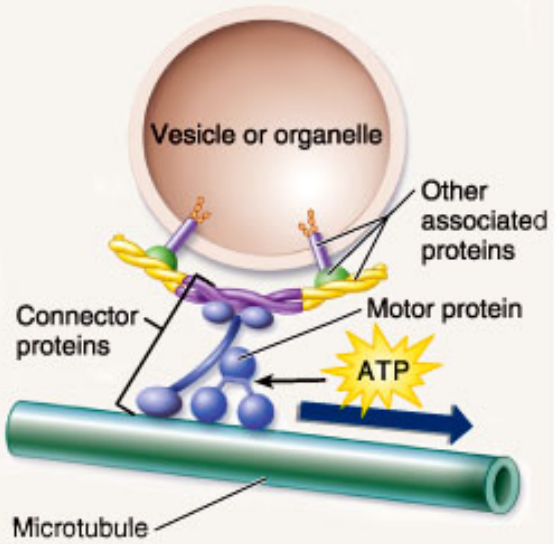


Chemical Activation
Proteins can become activated when a high-energy phosphate from ATP attaches to the protein, activating it. Other types of molecules can also become phosphorylated by transfer of a phosphate from ATP.

TABLE 5.1 HOW CELLS USE ATP ENERGY TO POWER CELLULAR WORK





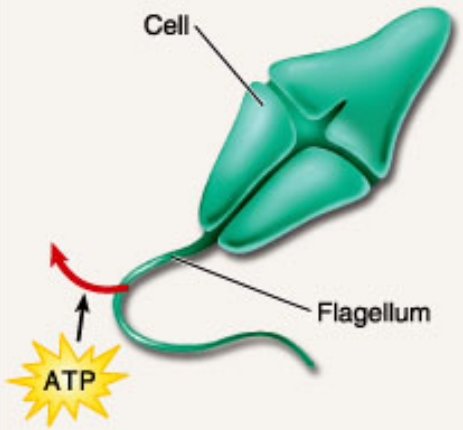


Importing Metabolites
Metabolite molecules such as amino acids and sugars can be transported into cells against their concentration gradients by coupling the intake of the metabolite to the inward movement of an ion moving down its concentration gradient, this ion gradient being established using ATP.

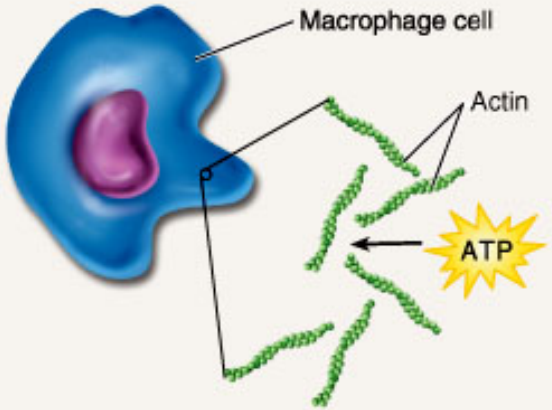
Active Transport: $Na^+ - K^+$ Pump
Most animal cells maintain a low internal concentration of Na^+ relative to their surroundings, and a high internal concentration of K^+. This is achieved using a protein called the sodium-potassium pump, which actively pumps Na^+ out of the cell and K^+ in, using energy from ATP.

Cytoplasmic Transport
Within a cell's cytoplasm, vesicles or organelles can be dragged along microtubular tracks using molecular motor proteins, which are attached to the vesicle or organelle with connector proteins. The motor proteins use ATP to power their movement.

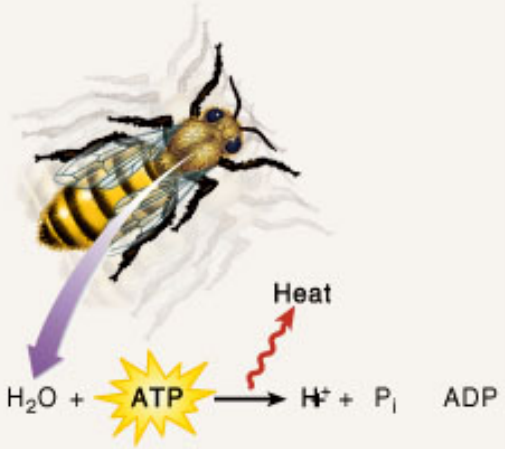
TABLE 5.1 HOW CELLS USE ATP ENERGY TO POWER CELLULAR WORK



Flagellar Movements
Microtubules within flagella slide past each other to produce flagellar movements. ATP powers the sliding of the microtubules.



Cell Crawling
Actin filaments in a cell's cytoskeleton continually assemble and disassemble to achieve changes in cell shape and to allow cells to crawl over substrates or engulf materials. The dynamic character of actin is controlled by ATP molecules bound to actin filaments.



Heat Production
The hydrolysis of the ATP molecule releases heat. Reactions that hydrolyze ATP often take place in mitochondria or in contracting muscle cells and may be coupled to other reactions. The heat generated by these reactions can be used to maintain an organism's temperature.

Oxidation-Reduction

- Many reactions involve the passage of electrons from one atom/molecule to another
  - Oxidation is the loss of electrons
  - Reduction is the gain of electrons

- Oxidation reduction reactions always take place together
  - Note that the transfer of electrons through these redox reactions also transfers energy

Fig. 5.13 Redox reactions