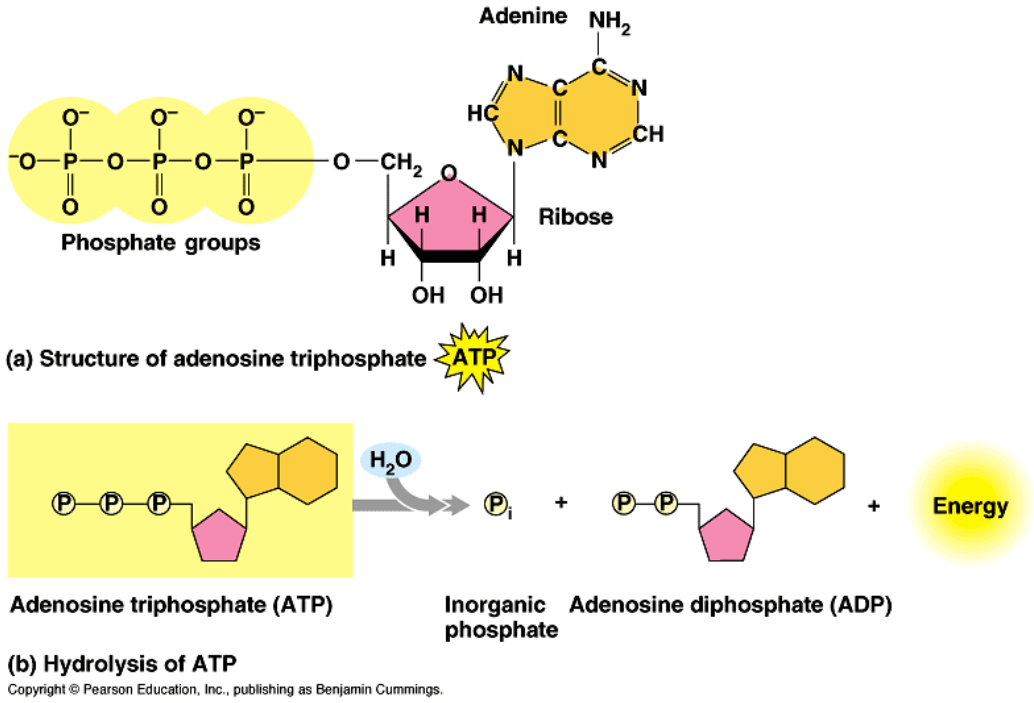
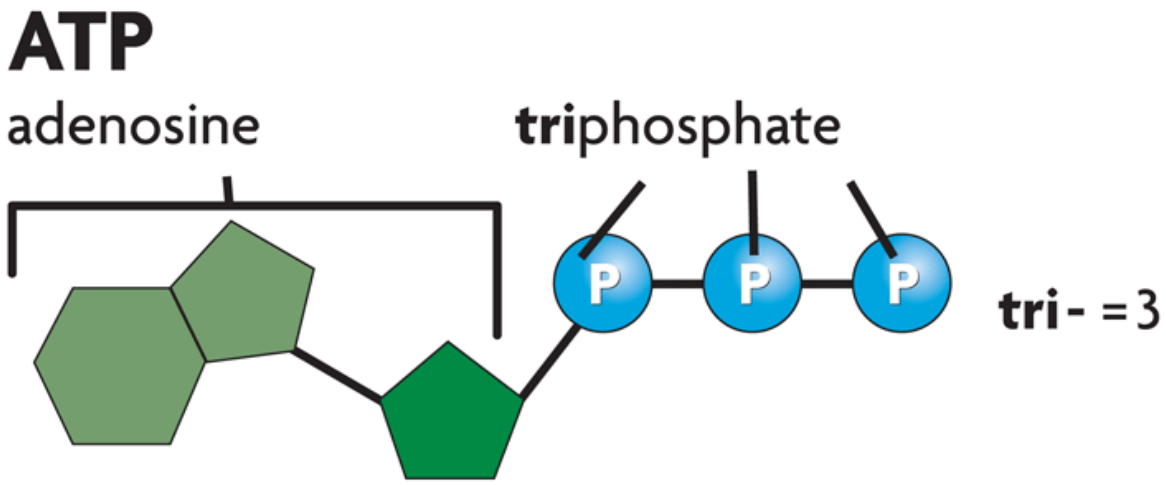
Biochemistry Unit

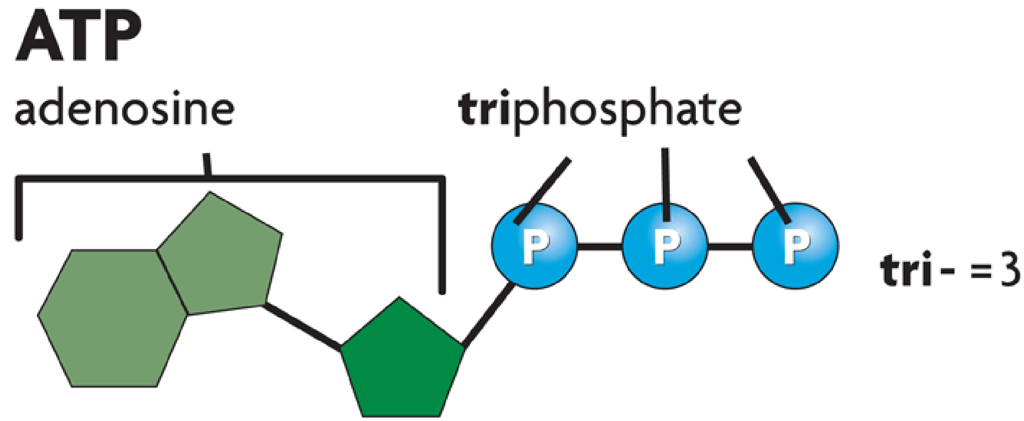
Chemical Reactions, Enzymes and **ATP**

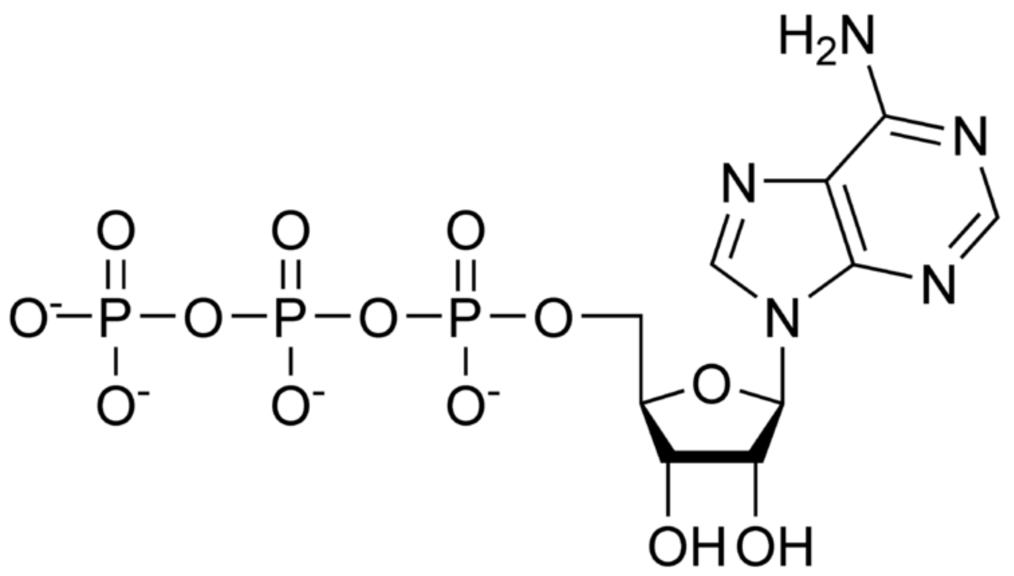


- All organisms use chemical energy
  - Build molecules, body of organism
  - Active transport
  - Other processes…
- The chemical energy used by ***all*** organisms is called ATP
  - ATP – Adenosine Triphosphate

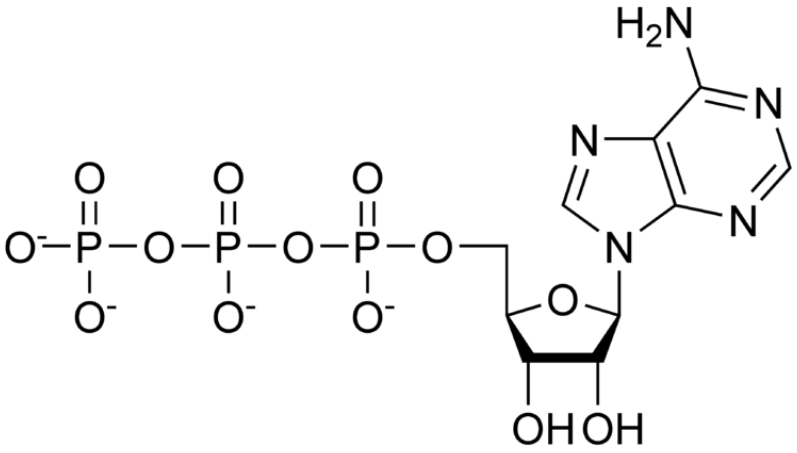
- ATP
  - High energy macromolecule
  - "carries" the energy of the cell
  - ATP consists of adenosine (adenine and ribose) and 3 phosphate groups
    - Similar to a nucleotide



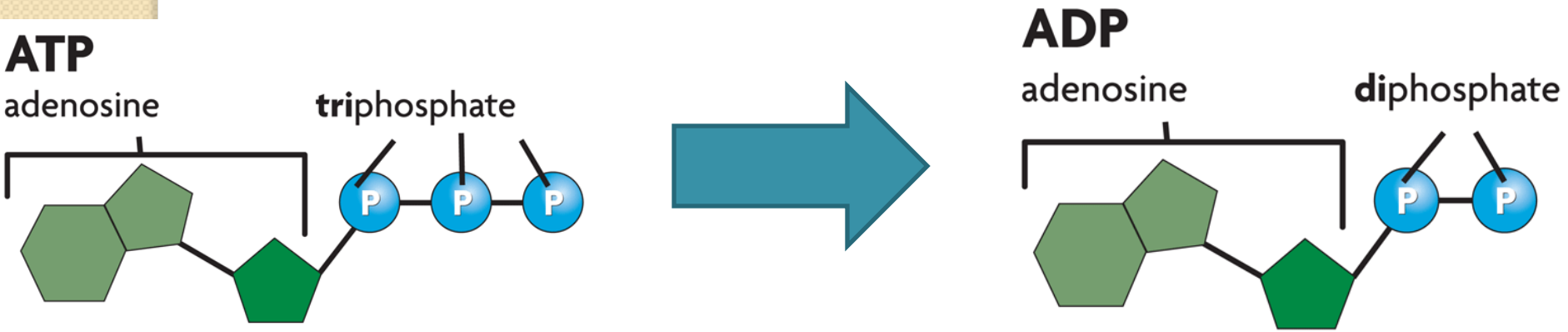

ATP
adenosine
triphosphate
P
P
P
tri- = 3



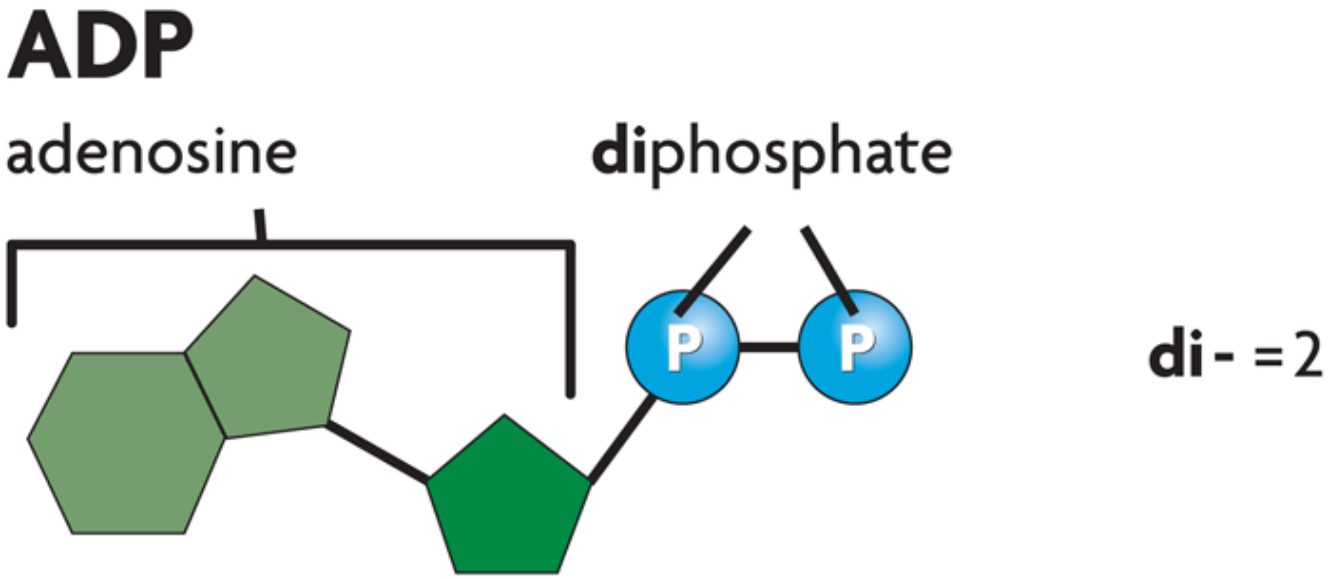
- ATP has 3 phosphate groups
  - The bonding holding the 3rd phosphate group is unstable and easily broken
    - Low energy needed to break bond
    - A lot of energy is released
      - A phosphorylated molecule is the recipient of a phosphate group when ATP loses it.



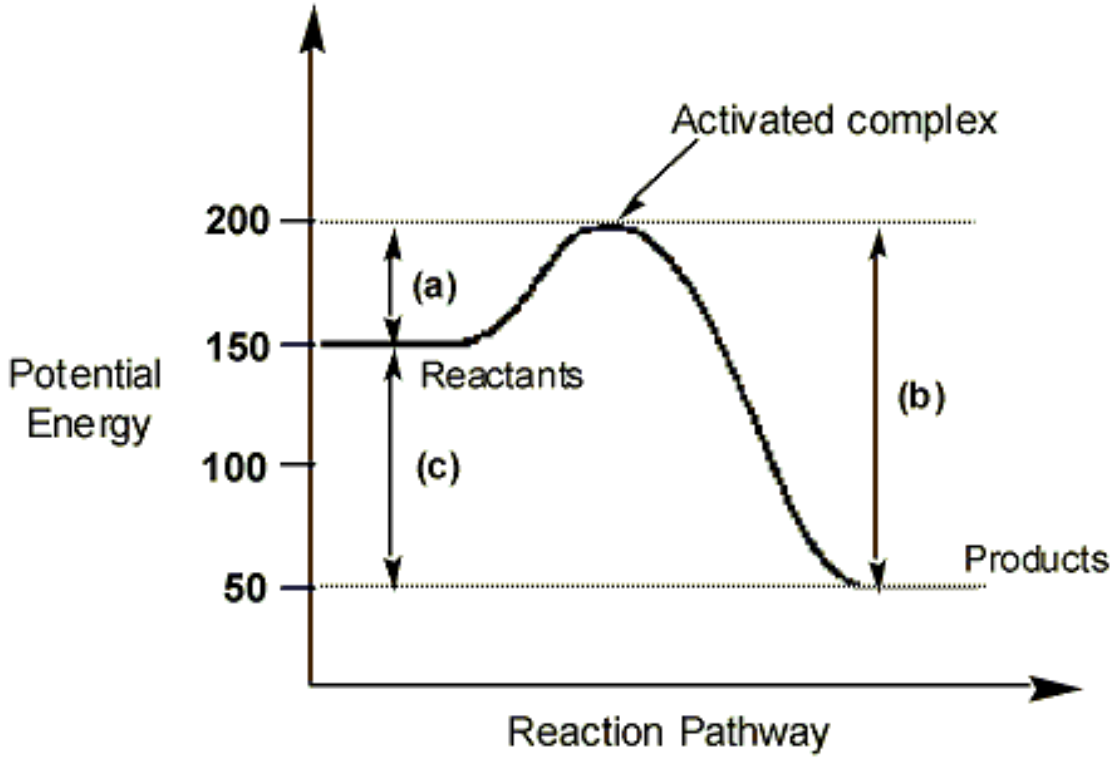
- Cells release and store energy using ATP and ADP
- The energy carried by ATP is released when this phosphate group is removed from the ATP molecule and bonded to another molecule
  - ATP then becomes ADP



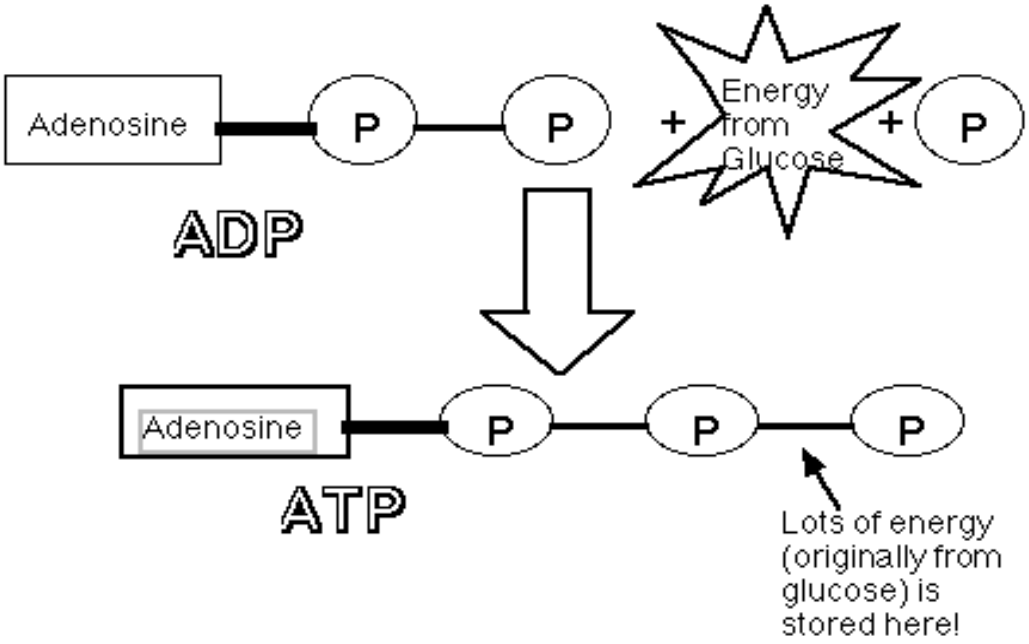
- Adenosine Diphosphate
- ADP consists of adenosine (adenine and ribose) and 2 phosphate groups.



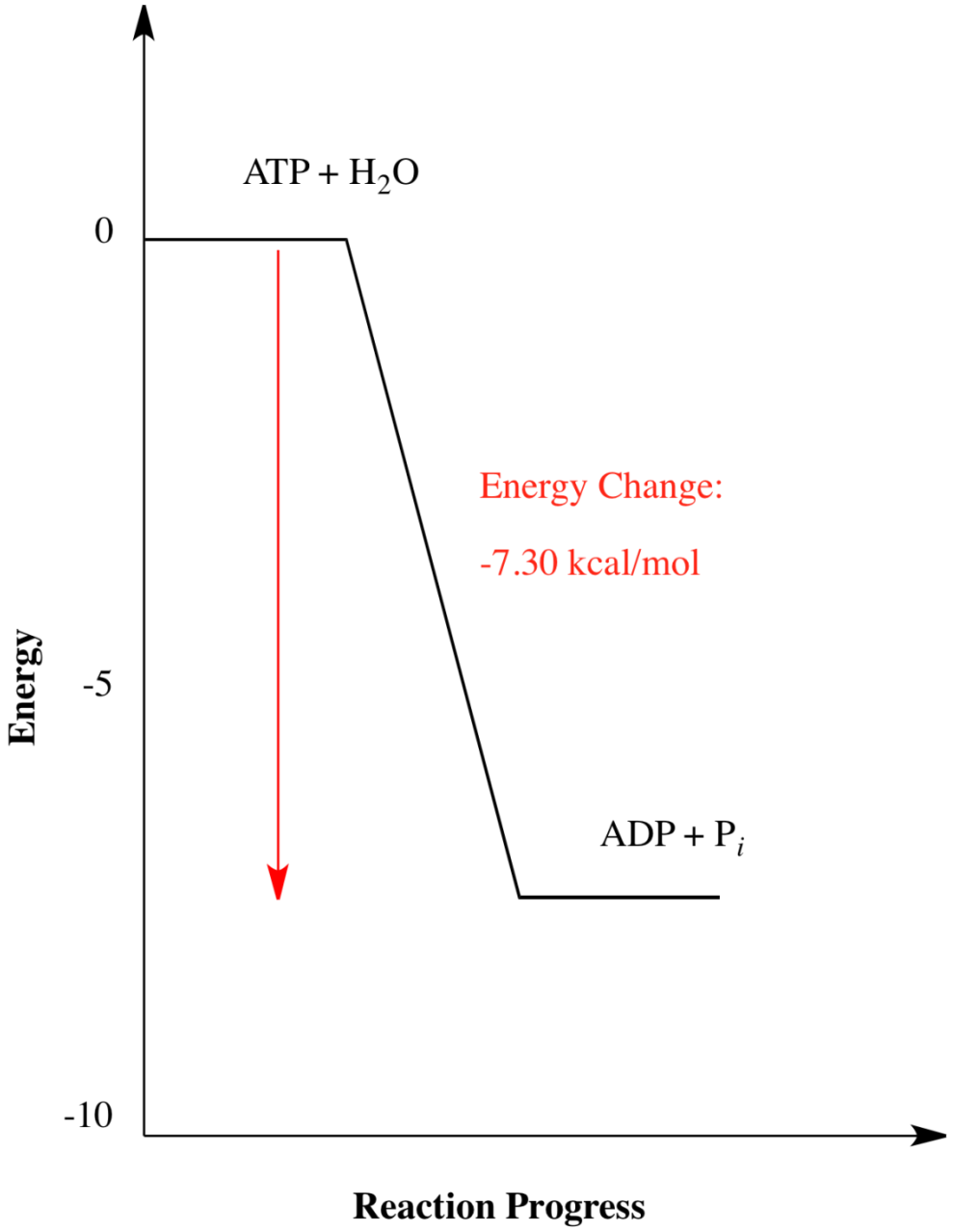
- ATP → ADP + Pi
  - This reaction is very exothermic
  - Provides needed energy for cell

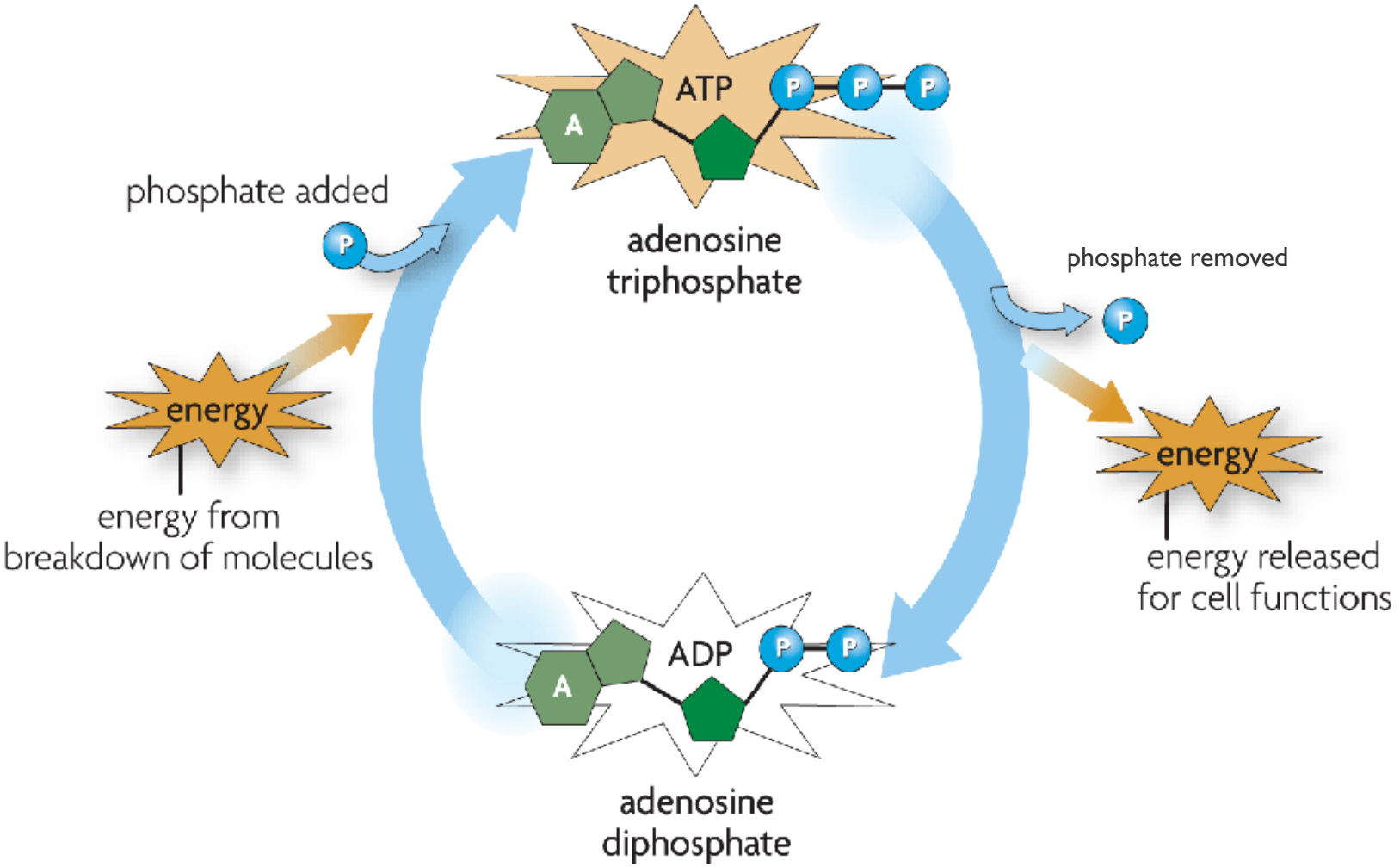


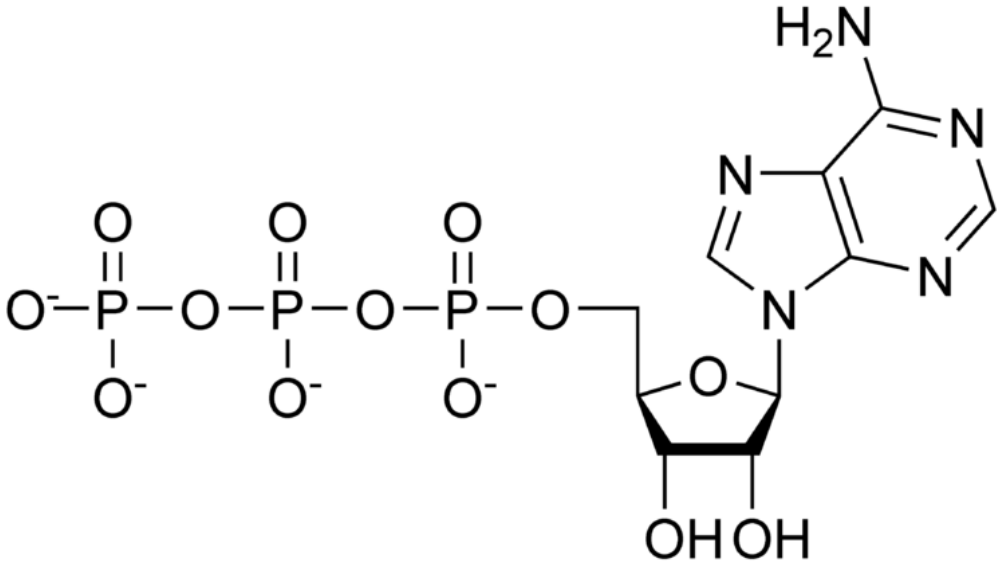
- The reaction is reversible
  - ADP can be turned back into ATP by adding a phosphate back on to ADP
    - This phosphate group is removed from a previously phosphorylated molecule

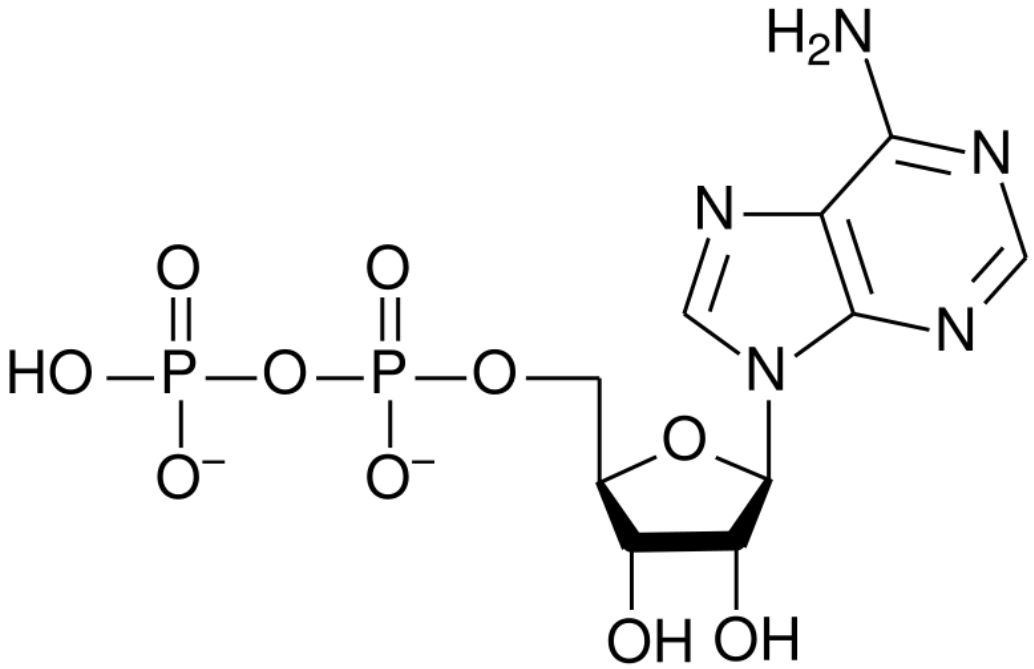


This is then an endothermic reaction!!!


ATP + H_2O
0
Energy Change:
-7.30 kcal/mol
Energy
-5
ADP + P_i
-10
Reaction Progress


ATP
A
P
P
P
adenosine
triphosphate
phosphate added
P
energy
energy from
breakdown of molecules
phosphate removed
P
energy
energy released
for cell functions
ADP
A
P
P
adenosine
diphosphate


H2N
N
N
N
N
O
O
O
O
O
O
O
O
O
O
O
O
OH OH


H2N
N
N
N
N
HO
O
O
O
O
O
O
O
O
OH OH

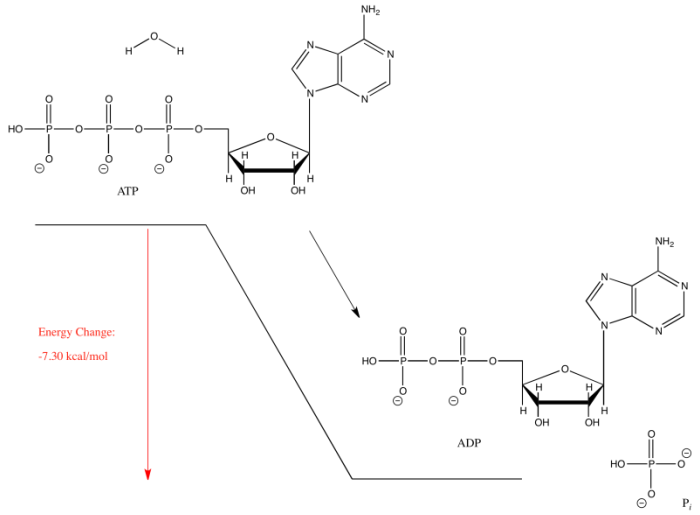
Food

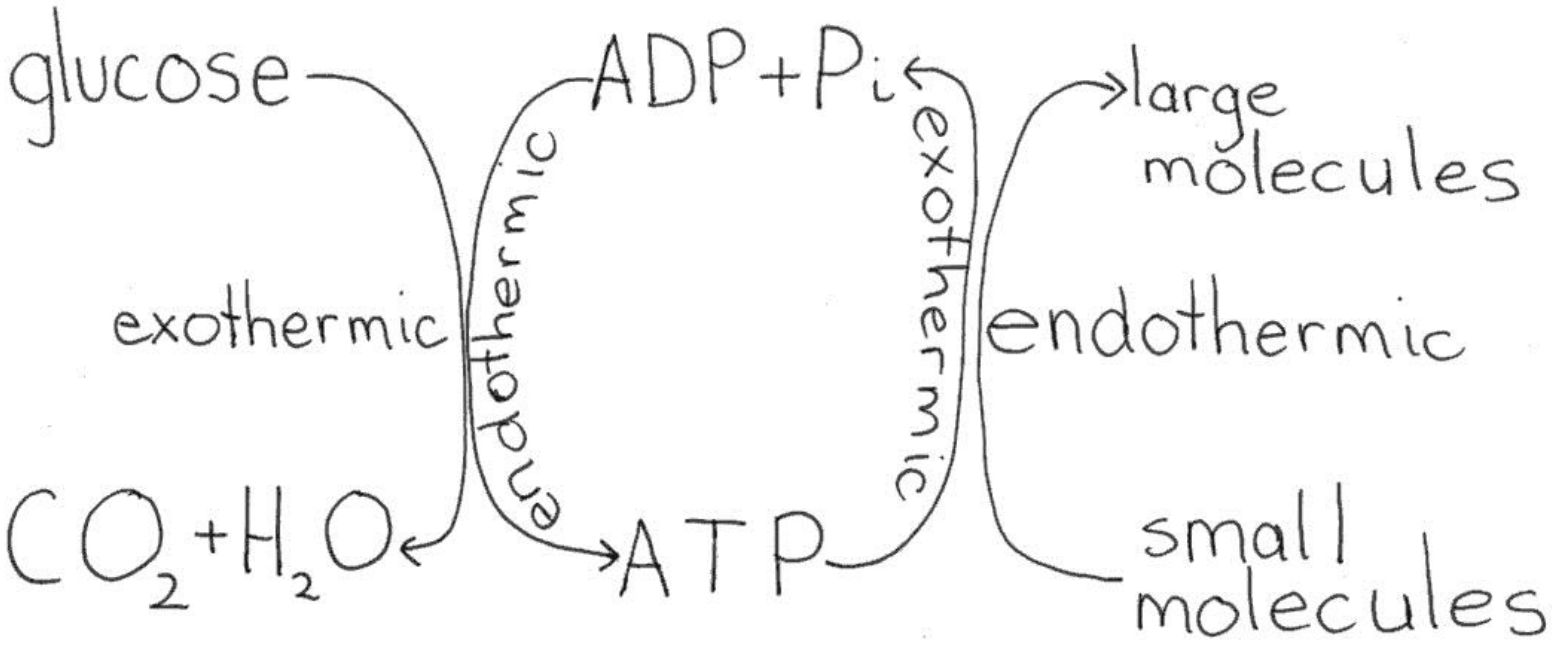
- Food does not contain ATP
  - Chemical energy used by organisms *indirectly* comes from the food they make or eat.
    - Solar energy (sun) or Chemicals energy (sulfides)
      - Producers, also called autotrophs, do this
      - Undergo photosynthesis or chemosynthesis to produce macromolecules
    - Food energy (macromolecules)
      - ALL organisms do this
      - Undergo cellular respiration to create ATP
    - Chemical energy (ATP)

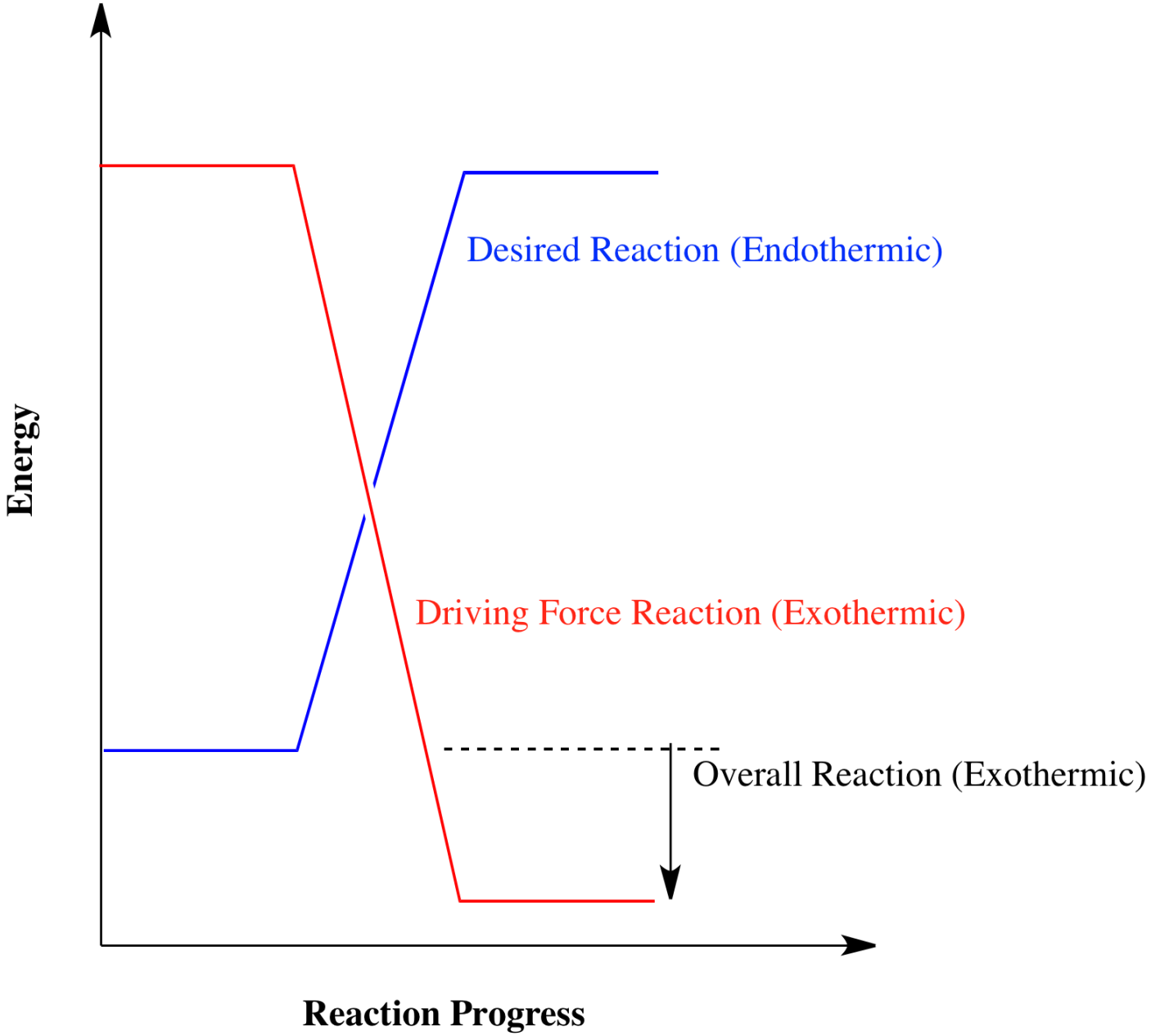
- Autotrophs (Producers)
  - "self food"
  - Photoautotrophs
    - Energy obtained from sun
    - Production of food through **photosynthesis**
      - The process by which some organisms use solar energy to make energy-storing carbon based molecules. (macromolecules)
  - Chemoautotrophs
    - Energy obtained from sulfide containing chemical compounds
    - Production of food through **chemosynthesis**
      - The process by which some organisms use chemical energy to make energy-storing carbon-based molecules. (macromolecules)

- Heterotrophs (Consumers)
  - "other food"
  - Food is obtained by eating other organisms

- Organism break down the food they make/eat into smaller and smaller molecules
  - This is an exothermic process
- The excess energy given off during these chemical reactions is used to make ATP




glucose
exothermic
$CO_2 + H_2O$
endothermic
ADP + Pi
ATP
exothermic
large molecules
endothermic
small molecules


Energy
Desired Reaction (Endothermic)
Driving Force Reaction (Exothermic)
Overall Reaction (Exothermic)
Reaction Progress

- The number of ATP molecules produced depends on the type of molecule that is broken down
  - Calorie – measure of energy
  - A food Calorie is 1000 calories or 1 kilocalorie
    - Amount of heat energy needed to raise the temperature of 1 kg water by 1° C.

MOLECULE	ENERGY
Carbohydrate	4 calories per mg
Lipid	9 calories per mg
Protein	4 calories per mg

- Carbohydrates
  - Not stored in large amounts in your body
  - Molecule most commonly broken down to make ATP
  - The breakdown of the simple sugar glucose yields enough energy to create about 36 molecules of ATP

- Lipids
  - Stored in large amounts in your body
  - 80% of the energy in your body comes from lipids
  - The breakdown of fats yields enough energy to create the most ATP
    - Typical triglyceride can be broken down to yield enough energy to make about 146 molecules of ATP.

- Proteins
  - Store about the same amount of energy as carbohydrates
  - Least likely to be broken down for energy to make ATP
  - The amino acids that cells can break down to make ATP are needed to build new proteins more than they are needed for energy