Todays Outline

Energy and Work
- ATP
- Metabolic Pathways
- Enzymes
  - Features
  - Factors Affecting Enzyme Activity

Membrane Transport
- Diffusion
- Osmosis
- Passive Transport
- Active Transport
- Bulk Transport

Metabolism
- Energy-Releasing Pathways
- Aerobic Respiration
  - Glycolysis
  - Krebs Cycle
  - Electron Transport Phosphorylation
- Anaerobic Pathways

Metabolism

The cells capacity to:

1. Acquire energy.
2. Use energy to build, degrade, store and release substance in a controlled manner.

How do cells acquire energy?

By breaking down high energy molecules in or food.

For example: when we eat carbohydrates:
1. Digestion breaks these complex sugars down to glucose.
2. Glucose, a high energy molecule, is absorbed across the gut into your bloodstream.
3. An increase in blood glucose triggers the pancreas to release insulin.
4. Insulin signals cells to start taking up more glucose.
5. Glucose in the cell is the beginning of metabolism.

Why do cells need energy?

Cells need energy to do work.

Type	Examples
Chemical	building, rearranging, breaking apart substances
Mechanical	moving flagella, cell structures, parts of or the whole body
Electrochemical	moving charged substances across membranes

Metabolism

1. To further understand how metabolism works we must introduce some concepts, processes and participants.

Concepts & Processes

1. Energy
2. Gradients
3. Phosphorylation
4. Membrane transport
5. Metabolic pathways
6. Aerobic respiration
7. Anaerobic pathways

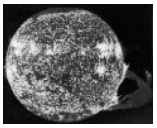
Participants

1. Glucose
2. Adenosine triphosphate (ATP)
3. Enzymes
4. Cofactors
5. Mitochondria

Energy

Energy is the capacity to do work and can't be created from nothing.

Where does energy come from?



Mostly from the sun

Energy

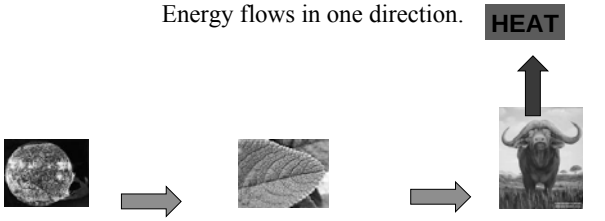
THERMODYNAMICS:

•1st Law: Any isolated system has a finite amount of energy that cannot be added to or lost, but can be converted from one form to another. (conservation of energy)

•2nd Law: Systems move from more ordered to less ordered. (entropy)

Energy

Energy flows in one direction.



Sun Photosynthetic producers consumers

Energy

Energy is stored and released by building and degrading molecules (energy is stored in chemical bonds).

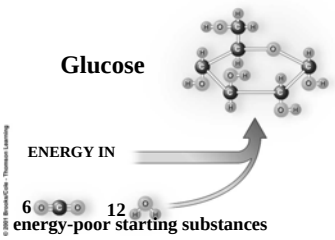
1. Endergonic reactions – Energy in.

2. Exergonic reactions – Energy out.

Energy

Endergonic reactions are required to produce energy-rich compounds like glucose (photosynthesis).

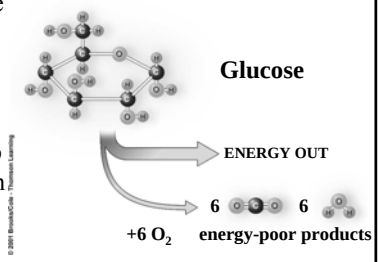
Energy must be added to the reaction to convert low-energy molecules into high energy molecules.



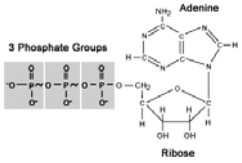
Energy

Exergonic reactions Result in the net release of energy (aerobic respiration).

Molecular bonds are broken in a step by step process so that cells can capture energy in a controlled fashion.



ATP Is the Cell's Energy Currency



← ATP
(a nucleotide)

ATP is used in numerous biological processes.

Examples: provides energy for heat, nerve electricity, light (fireflies), muscle movement, pumping substances across membranes against a gradient.

Metabolic Pathways

Most metabolic reactions occur in orderly, enzyme-mediated sequences. These are metabolic pathways.

- Metabolic reactions start with reactants.
- Intermediates are formed during the reaction.
- The substances at the end are known as products.

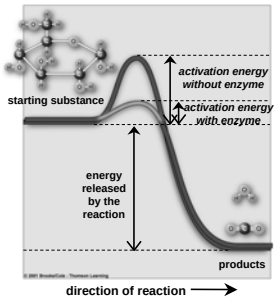
Many metabolic pathways are reversible with products being converted back to reactants. Reversible reaction help maintain an equilibrium.

Features of Enzymes

1. Nearly all enzymes are proteins.
2. Speed rate of reaction by lowering activation energy.

Enzymes Lower Activation Energy

Figure 5.8 from page 78 of your text

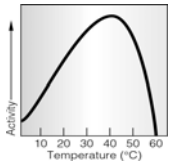


Features of Enzymes (Cont.)

3. Enzymes are not used up or permanently altered.
4. Enzymes are substrate specific.

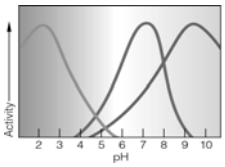
Factors Affecting Enzyme Activity

1. Temperature
2. pH
3. Salinity



Figures 5.13 &.14 from page 81 of your text.

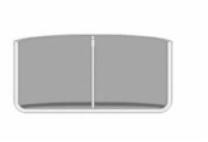
Actual ranges of activities differ among enzymes.



Crossing Membranes

1. Cell membranes are selectively permeable.
2. CO_2, O_2, and small nonpolar molecules pass through the membrane.
3. Polar water molecules slip though gaps in the cell membrane when the lipid bilayer flexes and bends.
4. Ions and large polar molecules such as glucose must pass through transport proteins in cell membrane.

Osmosis



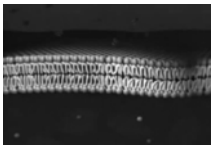
Osmosis – diffusion of water molecules in a concentration gradient across a selectively permeable membrane.

Water moves in the direction necessary to equalize the concentrations.

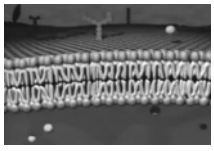
Passive and Active Transport

1. In both processes, solutes move through transport proteins in the cell membrane.
2. In passive transport, substances move passively (they diffuse).
3. In active transport, ATP is required to pump substances against a concentration gradient.

Passive and Active Transport Animations



Passive Transport: Solutes follow gradients

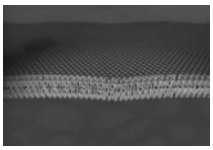


Active Transport: Solutes move against gradients

Bulk Transport

1. Cells use vesicles to expel or take in large items or large numbers of items.
2. Exocytosis – vesicle fuses with plasma membrane and contents are released outside cell.
3. Endocytosis – cell surrounds items at outer surface and brings them inside, creating a vesicle.

Endocytosis and Exocytosis Animation



Metabolism

1. All cells make ATP by pathways that release chemical energy from organic compounds such as glucose.
2. Cells store chemical energy as ATP to use in future reactions that require energy input.

Metabolism

There are two pathways for generating ATP from glucose:

Aerobic Respiration – requires O_2

Anaerobic Respiration – no O_2 needed

Aerobic Respiration

Three steps:

1. Glycolysis – In Cytoplasm
2. Krebs Cycle – In Mitochondria
3. Electron Transport Phosphorylation - Mitochondria

Glycolysis Movie

Overview of Aerobic Respiration

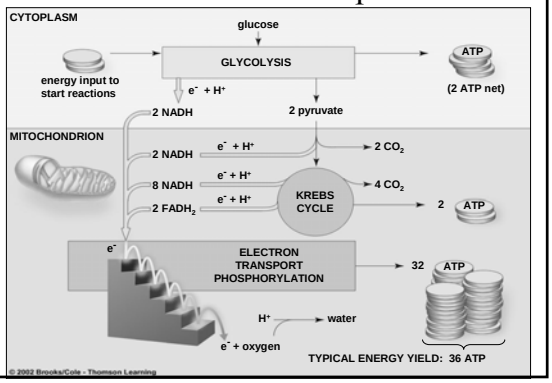
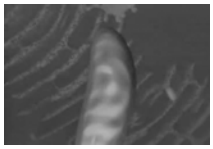


Figure 7.3 from page 111 of your text

Aerobic Respiration Overview Animation

Electron Transport Animation



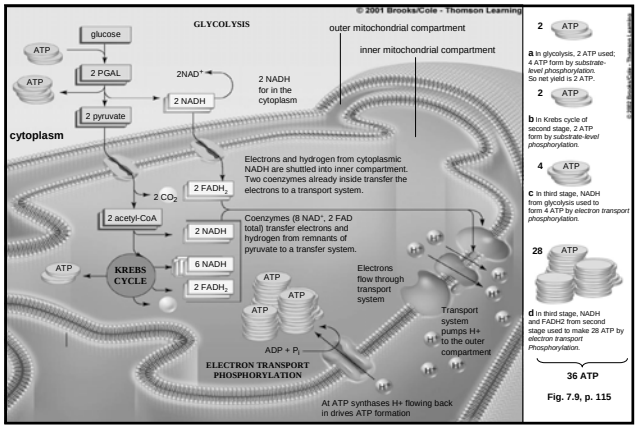


Fig. 7.9, p. 115

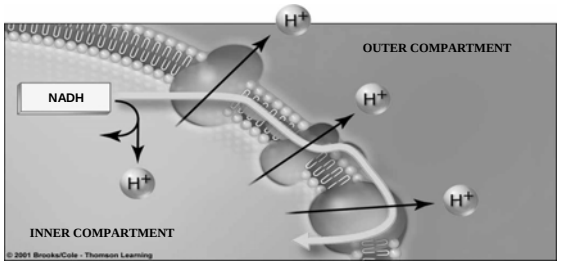


Fig. 7.8a, p. 114

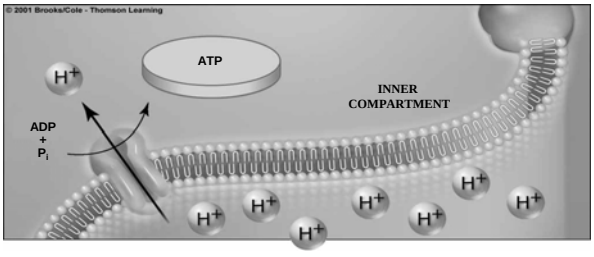


Fig. 7.8b, p. 114

Anaerobic Respiration Pathways

1. Bacteria and yeast use anaerobic respiration. Their metabolic pathways do <u>not</u> use oxygen as the final acceptor of electrons that ultimately form ATP.
2. In both lactate fermentation and alcoholic fermentation, only 2 ATP are produced from each glucose molecule.