Advanced Biology

Energy

Learning Objectives:

- An organism's metabolism transforms matter and energy, subject to the laws of thermodynamics.
- The free-energy of a reaction tells us whether the reaction occurs spontaneously.
- ATP powers cellular work.
- Most biochemical reactions are redox reactions.

Major Terms:

ADP	Electron transport system	Exergonic reaction	Oxidation
ATP	Endergonic reaction	Free energy	Phosphorylation
ATP synthase complex	Energy	Metabolism	Product
Chemiosmosis	Entropy	NAD	Reactant
		NADP	Reduction

Read: Chapter 6

Lecture:

Energy

I. Review

A. _____ – all of an organism's chemical reactions

B. _____ – _____ energy by breaking complex into simple compounds

C. _____ – _____ energy to build complex out of simple compounds

D. Excess free energy goes to _____

E. Insufficient energy can cause _____

II. Thermodynamics

A. First Law of Thermodynamics

1. Energy _____… it is neither created nor destroyed, but can only be transformed

B. Second Law of Thermodynamics:

1. The entropy of the universe _____.
2. _____entropy reactions are coupled with _____entopy reactions.

III. Enzymes

A. Enzymes are catalytic proteins without which biochemical reactions would be so slow as to make life as we know it energetically impossible. Enzymes are critical for most biochemical reactions.

IV. ATP

A. _____ (ATP): The universal energy storage molecule. The energy is stored in the form of _____.

B. $ATP + H_2O \xrightarrow{ATPase} ADP + Pi + 7.3$ kcal/mole

C. How ATP is Utilized:

1. _____: Synthesis and Degradation
2. _____: Movement
3. _____: Electrochemical gradients
4. The inorganic phosphate (Pi) released from the <u>exergonic</u> reaction can then be used in phosphorylating other molecules in an <u>endergonic</u> process.

D. Cycle

E. Parts

1. _____

2. _____

3._____

F. Releasing energy

1. If one phosphate is removed, _____ results.
2. If two phosphates are removed, _____ is the result.
3. If adenylate cyclase is present, cyclic AMP (_____) is produced.

V. ReDox

A. Most biochemical reactions are oxidation-reduction reactions (redox) where electrons are gained by one substance (which is thereby _____) and lost by another substance (which is thereby _____).

B. __xidation __s __oss of electrons __eduction __s __ain of electrons

C. During aerobic respiration, the coenzymes NAD+ and FAD _____ electrons (are reduced) and carry the electrons to the _____ located on the cristae. The chain is a stepped-down system — every time an electron is transferred, energy is _____ and made available to produce ATP. During respiration, carbohydrates are oxidized to CO_2 and water.

D. During photosynthesis, high-energy electrons (from water…the energy for this process is ultimately from solar energy) _____ CO_2 to carbohydrate. The coenzyme used in photosynthetic cells is NADP,+ is _____to NADPH. This chain is also a stepped-down system — every time an electron is transferred, energy is _____and made available to produce ATP.

VI. The Electron Transport Chain: found in Mitochondria and Chloroplasts

A. In Mitochondria (Aerobic Respiration), the Electron Transport Chain oxidizes substrates to CO_2 and water.

B. In Chloroplasts (Photosynthesis), the Electron Transport Chain reduces CO_2 to a carbohydrate.

C. ATP and the Chemiosmotic Theory

1. The Chemiosmotic Theory
   a. A H+ (proton) gradient is established across the mitochondrial/chloroplast membrane by an H+ pump. This electrochemical gradient provides the energy necessary for the phosphorylation of _____ to _____by the _____ complex. The reaction is NOT light-dependent.

Do Practice : Reviewing the chapter pg 112