

Chapter Review

Concept 6.1 introduces how ATP, reduced coenzymes, and chemiosmosis play important roles in biological energy metabolism. The energy needed for many biochemical reactions in cells is provided by the hydrolysis of ATP, yielding ADP and either phosphorylated proteins or free phosphate ions (HPO_4^-). As ATP is “used” in this way, it is also being continuously produced by two processes, substrate phosphorylation and oxidative phosphorylation.

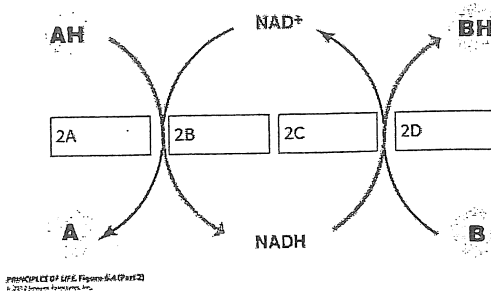
In substrate phosphorylation, phosphate groups on proteins and other molecules are transferred to ADP to quickly restore it to ATP. Although substrate phosphorylation rapidly delivers ATP, there is a limited supply of phosphorylated substrates that can “give up” phosphate groups in this manner.

In contrast, ATP production resulting from oxidative phosphorylation yields much more ATP, although oxidative phosphorylation requires more ingredients: oxygen, reduced coenzymes (NADH and FADH_2), and, of course, ADP and HPO_4^- . The mitochondrion is the intracellular organelle where most of the components of oxidative phosphorylation are found.

The catabolism of fuel molecules such as glucose supports both pathways of ATP production, yielding energy transfers resulting in substrate phosphorylation directly, and yielding the reduced coenzymes needed for oxidative phosphorylation. As NADH and FADH_2 are oxidized, this energy transfer develops a gradient of hydrogen ions (H^+) inside the mitochondrion. The gradient provides energy transfers to an enzyme, ATP synthase, accelerating its role in binding ADP and HPO_4^- to make ATP.

1. The hydrolysis of ATP to support an anabolic process includes both endergonic and exergonic reactions, depending on which perspective one takes: the hydrolysis of ATP versus the formation of anabolic products. Discuss this statement.

2. The diagram below shows the conversion of compound AH to compound A and the conversion of compound BH to compound B, with interconversions of NAD^+ and NADH . To each of the four boxes, add either “oxidation” or “reduction.” Explain your label choices.



Box 2A: _____

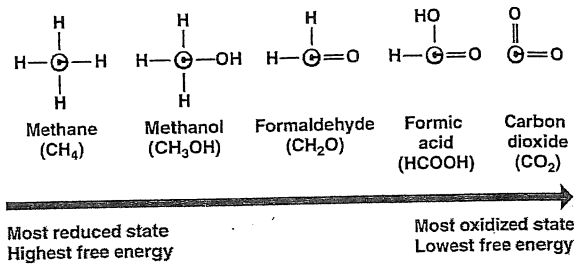
Box 2B: _____

Box 2C: _____

Box 2D: _____

3. Use the figure to the right to complete the following questions based on the molecules:

propanoic acid propanol propane
 C_2H_5COOH C_3H_7OH C_3H_8



PRINCIPLES OF LIFE, Figure 6.3
© 2012 Sinauer Associates, Inc.

Which compound is in the most reduced state?

_____ Which compound has the lowest free energy?

_____ Which compound is in the most oxidized state?

_____ Which compound has the highest free energy?

4. Explain how two different membrane-embedded proteins in mitochondria simultaneously influence the gradient of hydrogen ions and ATP synthesis.

Proton Pump _____

ATP Synthase _____

