Learning Objectives

Chapter 8

1. Distinguish between the following pairs of terms: catabolic and anabolic pathways; kinetic and potential energy; open and closed systems; exergonic and endergonic reactions
2. In your own words, explain the second law of thermodynamics and explain why it is not violated by living organisms
3. Explain in general terms how cells obtain the energy to do cellular work
4. Explain how ATP performs cellular work
5. Explain why an investment of activation energy is necessary to initiate a spontaneous reaction
6. Describe the mechanisms by which enzymes lower activation energy
7. Describe how allosteric regulators may inhibit or stimulate the activity of an enzyme

Chapter 9

1. Explain in general terms how redox reactions are involved in energy exchanges
2. Name the three stages of cellular respiration; for each, state the region of the eukaryotic cell where it occurs and the products that result
3. In general terms, explain the role of the electron transport chain in cellular respiration
4. Explain where and how the respiratory electron transport chain creates a proton gradient
5. Distinguish between fermentation and anaerobic respiration
6. Distinguish between obligate and facultative anaerobes

Chapter 10

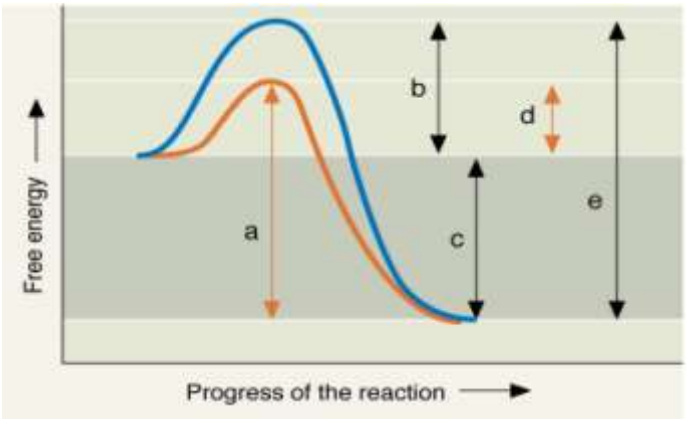
1. Describe the structure of a chloroplast

2. Describe the relationship between an action spectrum and an absorption spectrum
3. Trace the movement of electrons in linear electron flow
4. Describe the similarities and differences between oxidative phosphorylation in mitochondria and photophosphorylation in chloroplasts
5. Describe the role of ATP and NADPH in the Calvin cycle
6. Describe the major consequences of photorespiration
7. Describe two important photosynthetic adaptations that minimize photorespiration

Ask Yourself

Chapter 8

1. How do living organisms create macromolecules, organelles, cells, tissues, and complex higher-order structures?
2. When sodium chloride (table salt) crystals dissolve in water, the temperature of the solution decreases. This means that, for dissociation of Na^+ and Cl^- ions entropy is increased or decreased? Why is it increased or decreased? What happens to the enthalpy of the system? Is it a closed or open system?
3. Are chemical reactions at equilibrium in living cells? Why or why not?
4. A reaction has a ΔG of -5.6 kcal/mol. Is it spontaneous or non-spontaneous? Why?
5. In the energy diagram below, which of the lettered energy changes would be the same in both the enzyme-catalyzed and uncatalyzed reactions? Why?



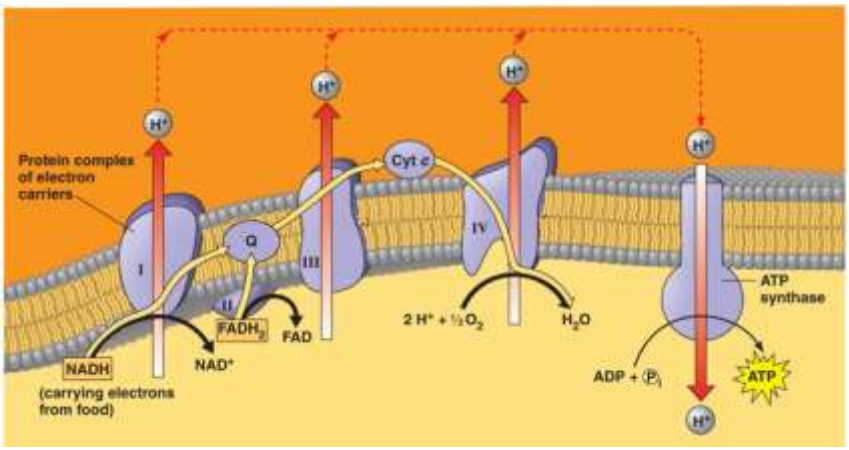
6. Vioxx and other prescription non-steroidal anti-inflammatory drugs (NSAIDs) are potent inhibitors of the cycloxygenase-2 (COX-2) enzyme. High substrate

concentrations reduce the efficacy of inhibition by these drugs. These drugs are what type of inhibitors? How do they work?

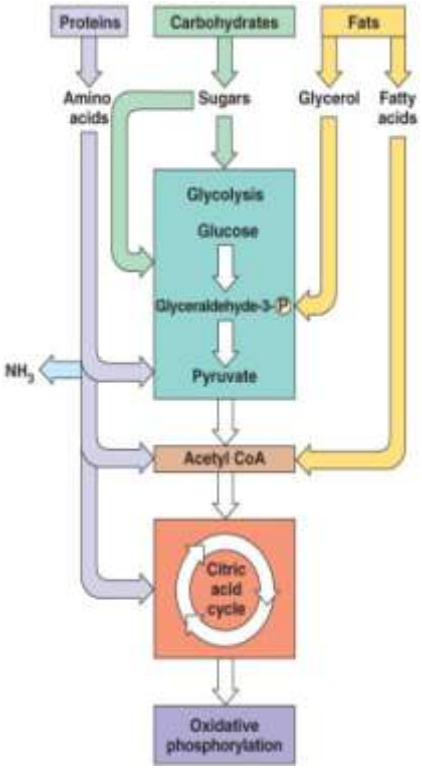
7. Adenosine monophosphate (AMP) activates the enzyme phosphofructokinase (PFK) by binding at a site distinct from the substrate binding site. What type of enzyme activation is this?

Chapter 9

1. Some drugs known as uncouplers facilitate diffusion of protons across the mitochondrial inner membrane. When such a drug is added, what will happen to ATP synthesis and oxygen consumption?
2. Rotenone inhibits complex I (NADH dehydrogenase). When complex I is completely inhibited, what happens? Does the synthesis of ATP increase or decrease? Why?



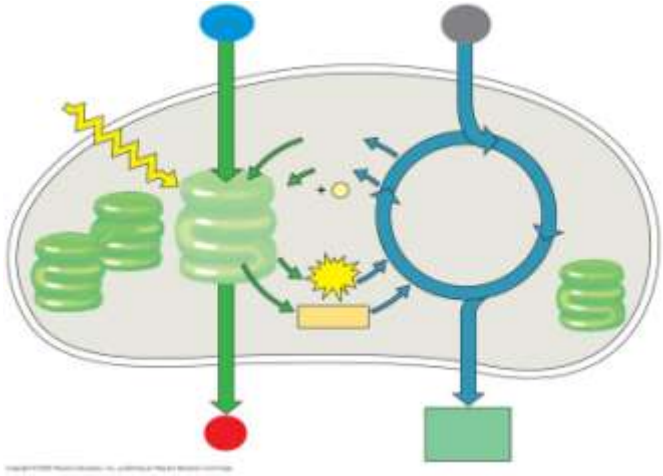
3. To sustain high rates of glycolysis under anaerobic conditions, cells require what properties? (hint, animal cells use lactic acid under these conditions, and yeast cells use fermentation).
4. During intense exercise, as muscles go into anaerobiosis,
the body will increase its consumption of fat, protein or glycogen in what order? Why does this occur based on a metabolic basis (hint, which molecule is most easily converted to pyruvate or a substrate for the citric acid cycle).



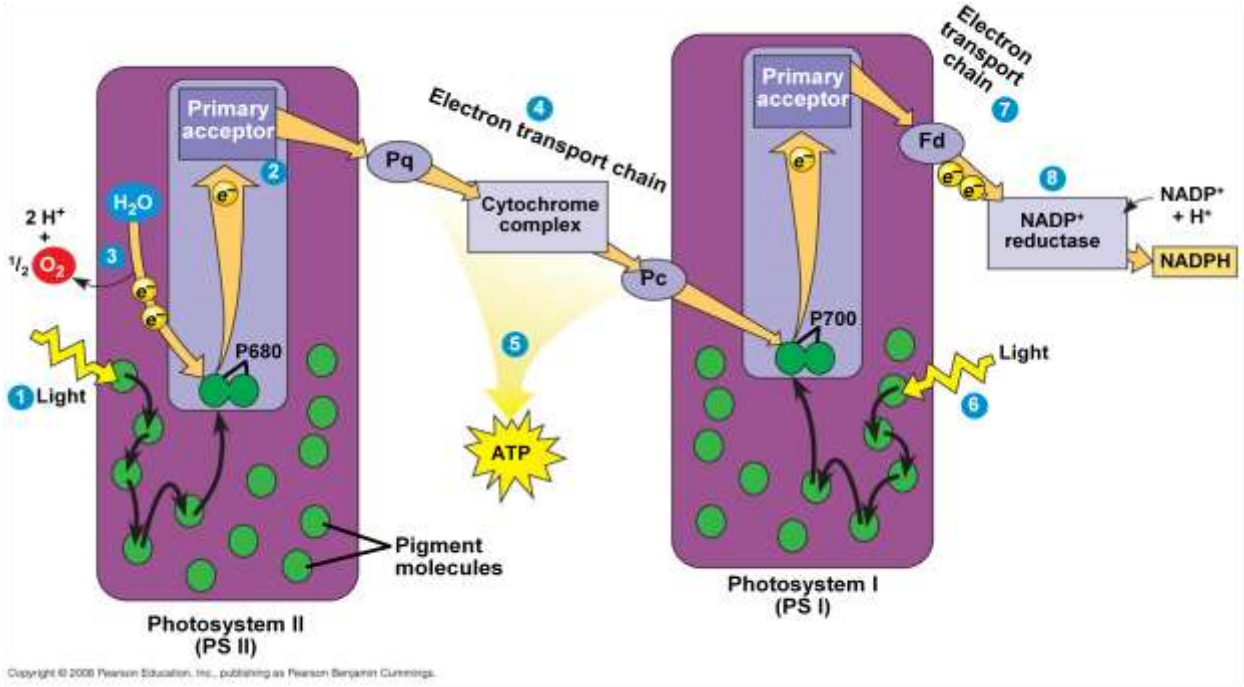
5. Glycolysis is found in all domains of life and is therefore believed to be ancient in origin. What can be said about the origin of the citric acid cycle, the electron transport chain, and the F1 ATPase?

Chapter 10

1. The biomass (dry weight) of a tree comes primarily from what source? Hint: remember the alternate name for organic chemistry? A very important element to all life? Why does the biomass of a tree use this source?
2. Why is photosynthesis performed only by producers? Are all producers plants? What source of energy do producers use?
3. How is photosynthesis similar and different from the citric acid cycle and oxidative respiration? Which organelles perform these important functions? Which enzymes are necessary for energy synthesis (i.e. formation of starches or formation of ATP) to occur?
4. Explain the process illustrated below and where within the chloroplast each process occurs. What are the end products of these processes?



5. Label the diagram below and explain what happens to the electron at each step.



Key Terms (as an exercise fill these in yourself or make flash-cards)

activation energy
active site
adenosine triphosphate (ATP)
allosteric regulation
anabolic pathway
bioenergetics
catabolic pathway
catalyst
chemical energy
coenzyme
cofactor
competitive inhibitor
cooperativity
endergonic reaction
energy
energy coupling
entropy
enzyme
enzyme-substrate complex
exergonic reaction
feedback inhibition
first law of thermodynamics
free energy
heat
hemoglobin
induced fit
kinetic energy
metabolic pathway
metabolism
noncompetitive inhibitor
order
phosphorylated
potential energy
ribose
second law of thermodynamics
substrate
thermal energy
thermodynamics

acetyl CoA
aerobic respiration
alcohol fermentation
anabolic pathway
anaerobic respiration
ATP synthase
beta oxidation
catabolic pathway
cellular respiration
chemiosmosis
citric acid cycle
cytochrome
electron transport chain
facultative anaerobe
fermentation
glycolysis
lactic acid fermentation
nicotinamide adenine dinucleotide (NAD+/NADH)
obligate anaerobe
oxidation
oxidative phosphorylation
oxidizing agent
proton-motive force
reducing agent
reduction
substrate-level phosphorylation

absorption spectrum
action spectrum
adenosine triphosphate (ATP)
atom
autotroph

bundle-sheath cell
C3 plant
C4 plant
Calvin cycle/reactions
CAM plant
carbon fixation
carotenoid
chlorophyll
chlorophyll a
chlorophyll b
crassulacean acid metabolism (CAM)
cyclic electron flow
electromagnetic spectrum
glyceraldehyde-3-phosphate (G3P)
heterotroph
leaf
light reactions
light-harvesting complex
linear electron flow
mesophyll
mesophyll cell
nicotinamide adenine dinucleotide phosphate (NADP+/NADPH)
PEP carboxylase
photoautotroph
photon
photophosphorylation
photorespiration
photosynthesis
photosystem
photosystem I
photosystem II
primary electron acceptor

producer
reaction center complex
rubisco
spectrophotometer
stoma
stroma
thylakoid
visible light
wavelength

Word Roots

The word roots listed below are for your reference in learning the vocabulary necessary to understand these chapters. You will be tested on concepts which use the words from the chapter.

allo- = different (*allosteric site:* a specific receptor site on some part of an enzyme molecule remote from the active site)

ana- = up (*anabolic pathway:* a metabolic pathway that consumes energy to build complex molecules from simpler ones)

bio-= life (*bioenergetics:* the study of how organisms manage their energy resources)

cata- = down (*catabolic pathway:* a metabolic pathway that releases energy by breaking down complex molecules into simpler ones)

endo- = within (*endergonic reaction:* a reaction that absorbs free energy from its surroundings)

ex- = out (*exergonic reaction:* a reaction that proceeds with a net release of free energy)

kinet- = movement (*kinetic energy:* the energy of motion)

therm- = heat (*thermodynamics:* the study of the energy transformations that occur in a collection of matter)

aero- = air (*aerobic:* chemical reaction using oxygen)

an- = not (*anaerobic:* chemical reaction not using oxygen)

chemi- = chemical (*chemiosmosis:* the production of ATP using the energy of hydrogen ion gradients across membranes to phosphorylate ADP)

glyco- = sweet; **-lysis** = split (*glycolysis:* the splitting of glucose into pyruvate)

auto- = self; **-troph** = food (*autotroph:* an organism that obtains organic food molecules without eating other organisms)

chloro- = green; **-phyll** = leaf (*chlorophyll:* photosynthetic pigment in chloroplasts)

electro- = electricity; **magnet-** = magnetic (*electromagnetic spectrum:* the entire spectrum of radiation)

hetero- = other (*heterotroph:* an organism that obtains organic food molecules by eating other organisms or their by-products)

meso- = middle (*mesophyll:* the green tissue in the middle, inside of a leaf)

photo- = light (*photosystem:* cluster of pigment molecules)

**Some of the information in this study guide was supplied by Pearson from the Textbook Biology, 8th edition Campbell and Reece. The instructor has modified materials and added materials as she saw fit to enhance student learning.