UNIT THREE: BIOCHEMISTRY/ ENZYMES

Upon completion of this unit you will be able to:

1. Name the four elements which make up over 95% of the living material in a cell.
2. Distinguish between organic and inorganic compounds.
3. Identify the primary molecules.
4. Provide examples of mono-, di- and polysaccharides.
5. List the components of a fat molecule.
6. Distinguish between saturated and unsaturated fats.
7. Know the major functional groups found in organic molecules (carboxyl, amino)
8. Distinguish between amino acids and fatty acids.
9. Explain bonding patterns of carbon, condensation and the formation of a peptide bond.
10. Provide examples of fibrous and globular proteins.
11. Describe the primary, secondary, tertiary and quanternary structure of proteins.
12. List ways in which protein denaturation can be accomplished.
13. Provide examples of simple and complex organic molecules (compare and contrast basic subunits and large organic materials they make).
14. List and discuss the roles of carbohydrates, lipids and proteins in living organisms.
15. State the components of a nucleotide and tell how they are joined to form a nucleic acid.
16. Describe the structure, characteristics and functioning of enzymes.
17. Discuss the naming of enzymes.
18. Define energy of activation in regard to enzyme activity.
19. Describe the influences of environmental factors such as temperature, pH, and concentration of enzyme and substrates on enzyme activity.
20. Discuss enzyme specificity (absolute specificity) and relate this to enzyme activity with regard to the "Lock and Key" theory.
21. Explain the mechanisms of competitive and noncompetitive inhibition of enzymes.
22. Discuss the role of co-enzymes in chemical reactions.
23. List some human conditions which are linked to the absence of enzymes.

Unit References: **Text Chapters 3, 5 & 25**;

http://www.mhhe.com/enger13

An Online Biology Text Book

Unit 3: Biochemistry

Review: 95-98% of living matter is C H O N
Primary Molecules: H_2O, CO_2, NH_3

Chapter 25 is valuable addition to reading material.

Organic Chemistry Objective #2 **(Text pg 46-47)**

Organic compounds contain carbon and hydrogen

Inorganic compounds do not contain carbon and hydrogen together, more often than not covers the rest of The Periodic Table

Ex. Organic $C_6H_{12}O_6$ Inorganic CO_2, H_2O, NaCl

Carbon- plentiful, versatile, four bonding sites, organic and inorganic substances

Check Out: **Chemistry of Carbon**

Organic Chemistry

Organic Chemistry Help!

Virtual Textbook of Organic Chemistry

Carbon

It's Elemental - The Element Carbon

Carbon Skeleton and Functional Groups **(text pg 51)**
Short hand **(text pg 50)**

Key groups
Carboxyl group- -COOH
Gas- CH_3
Alcohol- -OH

Carbon Based Compounds

Carbohydrates- **(Text pg 52-54, 562-564)** (Objective #4, 13, 14) chains or rings of carbon atoms with hydrogen and oxygen atoms bonded to them

Check Out:

Carbohydrates

Carbohydrates - What Should You Eat? - The Nutrition Source

Learning About Carbohydrates

Nutrition Basics - Carbs - Carbohydrates Explained

Carbohydrates

Carbohydrates & Sugars

Simple Sugars (covalent/ non-electrolyte)
MONOSACCHARIDES- single ring sugars (Ex. glucose, fructose), Isomers
DISACCHARIDES- double ring sugars (Ex. sucrose = glucose + fructose)

Polysaccharides- many rings, chains of simple sugars (usually glucose)

COMPLEX CARBOHYDRATES- types differ in linkages between glucose
Starch, Glycogen, Cellulose, Chitin

Why do we need this stuff? Energy, fiber, etc.

Carbohydrates used for energy storage (usually short term) and strengthening of cell walls

***Check Out*: Caloric Confusion**

Proteins-

(Text pg 54-58, 564-565) (Objectives #7, 8, 9, 10, 11, 12, 13, 14) Chains of Amino Acids (often many chains, Polypeptides)

Check out: **Amino Acid Anatomy**
Amino Acid and Peptide Structures

Protein - Wikipedia, the free encyclopedia

Proteins

Proteins

The Structures of Life: Chapter 1: Proteins are the Body's Workers

The Biotechnology Project: Chapter 2: Protein Structure

~50,000 in humans, can be extremely large and complex

Amino Acids- (Objective #8) protein building blocks, there are about 20 essential AAs
generalized diagram **(Text Pg 54)** Amino Acids **(Text Pg 54)**

-each contains an amino group ($-NH_2$) Objective #7

-each contains a carboxyl group (acid, -COOH) Objective #7

-amino acids form Peptide bonds **(Text pg 55)** Objective # 9 by condensation, to create chains, chains make proteins

-body cannot make all amino acids, must acquire some from diet

-Genetic Disorders

What do Proteins do for us? **Text Pg 57-58**

Levels of Protein Structure: the 3D look **(Text pg 54-56)** (Objective #11)
Primary-simple chains
Secondary- folding; helix, hair, phone cord, rope
Tertiary- coils twist and combine; coiled phone cord; disulfide bonds
Quanternary- sub units; antibodies, hemoglobin

PROTEIN DENATURATION- (Objective #12) **(text pg 56)** alteration of structure leading to a protein that is nonfunctional, can be irreversible

Egg white, milk, globular, elastic of shorts

**Agents of denaturation: Heat, Chemicals (Hg, Pb, Cu), acids/bases

Proteins are both structural and metabolic in function (Objective #10)

Fibrous Proteins- simple chains; muscle, hair, fish scales, tendons

Globular Proteins- complex enzymes, antibodies, hemoglobin

Enzymes- speed chemical reactions

Nucleic Acids-

(Text pg 58-61) (Objective #15, 13) Make DNA, RNA; genetic code

Nucleotides- structural unit (Adenine, Thymine, Cytosine, Guanine, Uracil)

DNA uses Deoxyribose, RNA uses Ribose; each nucleotide also contains a phosphate group and a nitrogenous base

Refer to a diagram of the DNA molecule pg 59

We will spend much more time on this in Unit 6, Stay tuned

Check out **:**

Nucleic Acids

Nucleic Acids

Nucleic acid: Definition and Much More from Answers.com

Lipids-

(Text pg 61-65, Chapter 25) (Objectives #5, 6, 7, 13, 14) Fats (triglycerides), phospholipids, waxes, steroids

Check out **:** **Biochemistry of Lipids**

Triglycerides
American Heart Association

Health Tips

Triglycerides: Why do they matter? - MayoClinic.com

Triglyceride - Wikipedia, the free encyclopedia

Fat molecule contains two types of units:

Glycerol backbone with typically three **Fatty Acid** molecules attached

Attachments are created by Condensation/Dehydration synthesis Reactions **(unit 2)**

Fatty Acids- carbon chains of varying length with a Carboxyl Group **(indicative of an organic acid, pg 51)**

Saturated Fats- all possible carbon attachment sites filled w/Hydrogen
-animal fats; butter (usually solid/whitish), dietarily poor but energy rich

- Transfats

Unsaturated Fats- contain double bonds, not all sites filled w/Hydrogen

-vegetable oils (golden colored oils, liquid), dietarily O.K.

****Fats- long term storage of energy, Mother Nature has lots of things for fat to do (insulation, padding), not likely to lose it quickly.

One gram of fat stores 6X more energy than one gram of glycogen/starch

Carbon/Hydogen bonds have more potential energy than Carbon/Oxygen bonds of carbohydrates

Other Fats-

Phospholipids- **pg 63** FA substituted with a Phosphate group (cell membranes)

Waxes- insoluble in water (protection, water conservation)

Steroids- **pg 65** four attached rings, Cholesterol is precursor for steroids
Risk factors w/ saturated fats (HDL, LDL)

*****Objectives #13 and 14 can be dealt with most effectively by using **pg. 66** in your text

ENZYMES- organic catalysts, globular **PROTEINS (Chapter 5)** (Objective #16)
-lower energy of activation, speed reactions **(pg 100)**

***Check out* : What the Heck is an Enzyme?**

How Stuff Works Feature Articles

HowStuffWorks "How Cells Work"

Enzymes

Enzyme - Wikipedia, the free encyclopedia

Enzymes

-NO REACTION CAN OCCUR IN A CELL UNLESS ITS OWN ENZYME IS PRESENT AND ACTIVE
(Objective #20)

-Enzymes are very specific, named after the job they do or the substrate they act upon
(Ex. zipperase, dehydrogenase, cellulase) **pg 103** (Objective #17)

Energy of Activation (Ea) (Objective #18) **(pg. 100)**
-amount of energy needed to run a reaction

-Ea usually provided by heat
-biological systems sensitive to increases in heat
-heat allows more movement but also denaturation

-Imagine how much energy we could save if we could add an enzyme to cake mix so it would cook at 100
degrees rather than 350 and in 5 minutes rather than 50!

-how much better off are we having reactions take place at 98.6 degrees rather than 350?

Conditions affecting Enzymatic Reactions (Objective #19) (pg. 104-105)

Substrate Concentration **(text pg 105)** (more material to work on or with)
-increased conc. usually means increased activity

-more substrate means more active sites are full more of the time

*when conc. becomes so great that active sites are continually full the rate of the reaction will level off

Rate of Reaction

Substrate concentration ------>

Temperature **(pg 104)**
-increased temp = increased activity

-at a point, activity will peak and then decrease rapidly

-At that point enzymes will Denature

Rate of Reaction

Temperature ------>

pH (pg 104-105)
-every enzyme has an optimum pH (pepsin in stomach pH 2, trypsin in sm. intestine pH 8)
-eventually will denature

Rate of Reaction

pH

How Enzymes do their thing (Objective #20) (pgs. 101-103)
1. Enzymatic action is VERY SPECIFIC
2. NO REACTION CAN OCCUR IN A CELL UNLESS ITS OWN ENZYME IS PRESENT AND ACTIVE

A ----------> B ----------> C ----------> D ----------> E

Enzyme/Substrate Complex
Complex formed when substrate binds to enzyme at "Active Site"

Enzyme allows reaction to take place

Binding dependent on "Fit"; "Lock and Key" Theory

When reaction complete:

1. active site returns to normal
2. enzyme unaltered, recycled

Enzymatic Competition (Objective 20) **(pg 106)**: Sometimes several enzymes per substrate
Please note each enzyme has different action

Regulation of Enzyme Activity: Homeostasis **(text pg 106-109)** (Objective # 21)

Inhibition: (Text pg 107-108)
Competitive Inhibition- mimics of normal substrate competes for active site (Identical Twins) , child protector plugs
Noncompetitive Inhibition- inhibitor binds to site other than active site, alters shape

Regulation/Inhibition usually reversible **pg 109** - feedback inhibition systems, negative feedback
-abundance of product ---> binds competitively
-lack of product ---> inhibition reversed

Product always kept within narrow limits

I rreversible inhibition does occur- carbon monoxide, penicillin, hydrogen cyanide

Coenzymes- (Objective #22) **(pg 104, Chapter 25)** organics bound to enzymes serving as carriers for chemical groups or electrons

-Vitamins, act as coenzymes or provide coenzymes

***Check Out*: Vitamins**

Coenzymes

Enzyme Cofactors

Vitamin	**CoEnzyme**
Niacin	NAD+
B_2	FAD+
Pantothenic Acid	CoEnzyme-A

-Deficiency in these results in lack of coenzyme (Chapter 25) (objective #23)

Back to General Biology at WNCC