Name _____ Key _____

Chem 150 - Fall 2015
Exam III

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1. Given the structure shown below,

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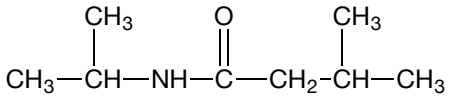

a. Name this molecule *N*-isopropyl-3-methylbutanamide

b. *Using structural formulas*, draw a *balanced chemical equation* for the hydrolysis of this molecule

c. Name the two organic products of this reaction

isopropyl amine _____ 3-methylbutanoic acid _____

2. Given these two structures,

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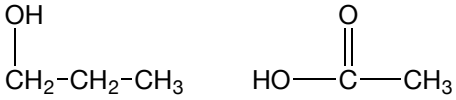

a. Name each molecule 1-propanol _____ ethanoic acid (acetic acid) _____

b. *Using structural formulas*, draw the *balance chemical equation* for the condensation of these molecules

c. Name the organic product of this reaction propyl ethanoate (propyl acetate) _____

3. Polylactic acid is a biodegradable, condensation polymer that is used to make the compostable plastic utensils that are available in the Davies Center foodcourt. The polymer is made from the condensation of lactic acid monomers. *Using a structural formula*, draw a tetramer for polylactic acid made from four lactic acid molecule.

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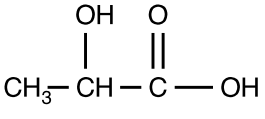
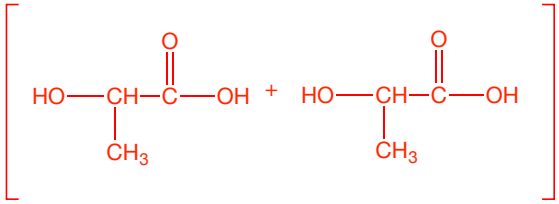
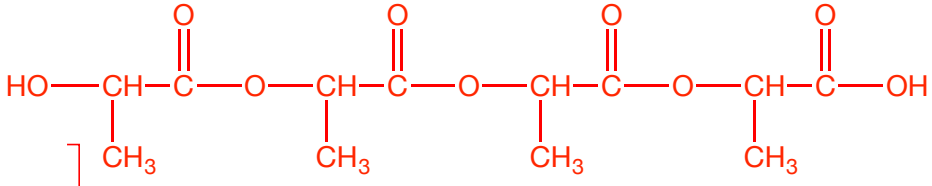


lactic acid





4. *Using structural formulas*, complete the balanced chemical equations for the *hydrolysis* of the following molecules and show the products as they exist under *physiological conditions* (*pH* 7). Place the name for each organic molecule on the lines provided.

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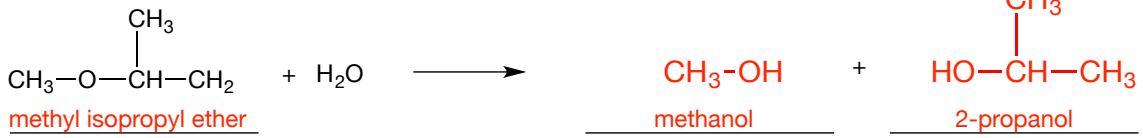
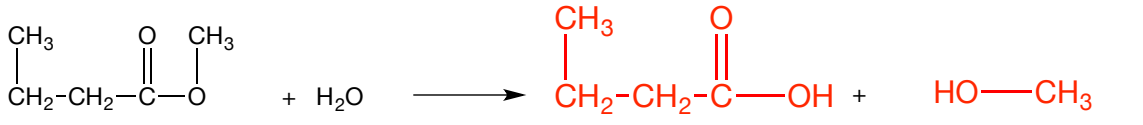
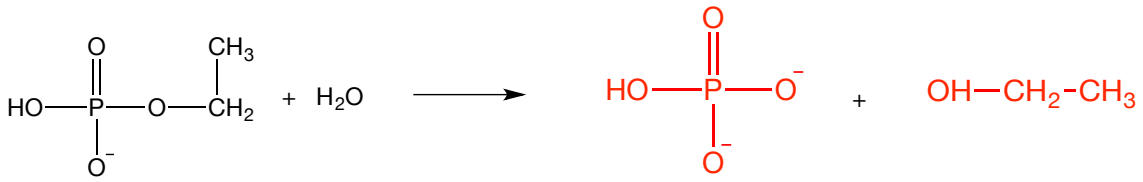
a. 

methyl isopropyl ether | methanol | 2-propanol

b. 

methyl butanoate | butanoic acid | methanol

c. 

ethyl phosphate | phosphate ion | ethanol

5. The structure for the fatty acid lauric acid is shown below.

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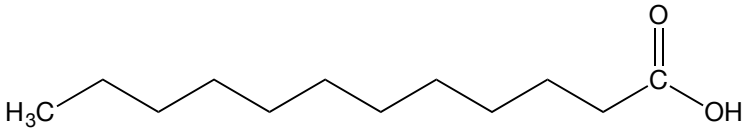
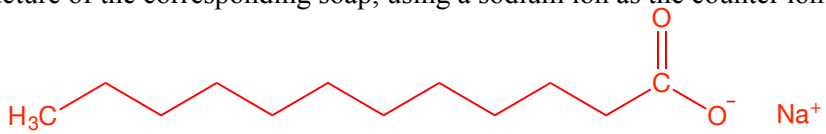
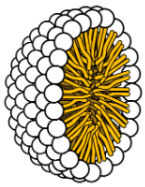


a. Draw the structure of the corresponding soap, using a sodium ion as the counter ion.



Micelle



b. Describe the structure that forms when sodium laurate is mixed with water. Include in this discussion a description of the intermolecular interactions that are responsible for this structure.

Soaps have both a highly hydrophobic region (the long hydrocarbon chain) and a highly hydrophilic region (the charged carboxylate ion. When mixed with water it looks for ways to remove the hydrophobic region from the water while at the same time leaving the hydrophilic region in contact with water. The solution is to form a spherical aggregate called a micelle that places the hydrophobic regions on the inside while leaving the hydrophilic regions on the surface.

6. Your body uses ATP molecules as one way of storing chemical energy that is released by catabolic reactions. You body then it uses ATP molecules to power anabolic reactions.

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a. Energy is stored as ATP by having ADP and an inorganic phosphate ions (P_i) undergo a condensation reaction to form the ATP. Using the abbreviations ATP, ADP and P_i, write a *balanced chemical equation* for this condensation reaction and include the word "Energy" to show that it is being stored as ATP in this reaction.

$$ADP + P_i + Energy \rightarrow ATP + H_2O$$

b. In words, what does the abbreviation ATP stand for adenosine triphosphate

c. The stored energy is released from ATP by hydrolyzing the phosphate anhydride bond that was formed in the reaction described above. Using the same abbreviations, write a balanced chemical equation for this reaction and include the word "Energy" to show that it is being released in this reaction.

$$ATP + H_2O \rightarrow ADP + P_i + Energy$$

d. Describe what *catabolic reactions* do. The catalytic reactions break down the larger molecules that we obtain from the foods we eat and store the energy released in usable forms, such as ATP. Many of the reactions involved are oxidation reactions similar to combustion.

e. Describe what the *anabolic reactions* do. The anabolic pathways use the smaller molecules and energy released from the catabolic pathways to synthesize the new molecules needed by the organism.

7. Both the *hydration* and the *hydrolysis* reactions add water to organic molecules. How do these two reaction types differ from one another? In dehydration reactions, the H- and -OH that combine to form the water that is removed come from neighboring carbon atoms in the same molecule. In condensation reactions they come from different molecules and lead to the joining together of those two molecules.

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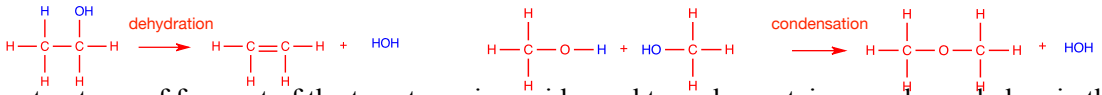

8. The structures of four out of the twenty amino acids used to make proteins are shown below in their unionized form.

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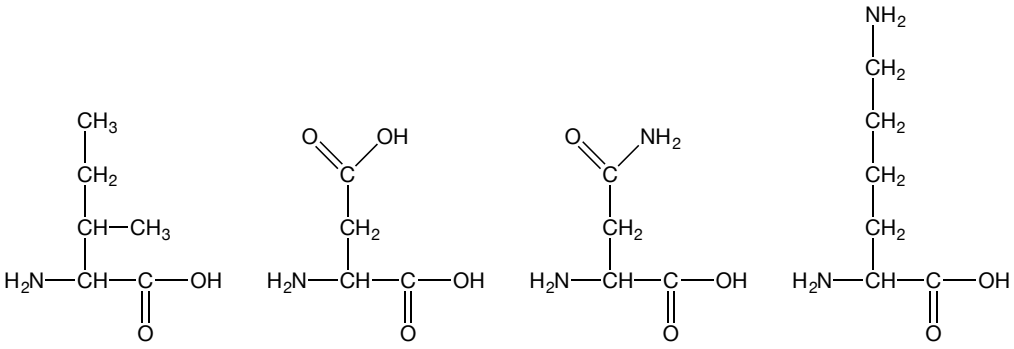
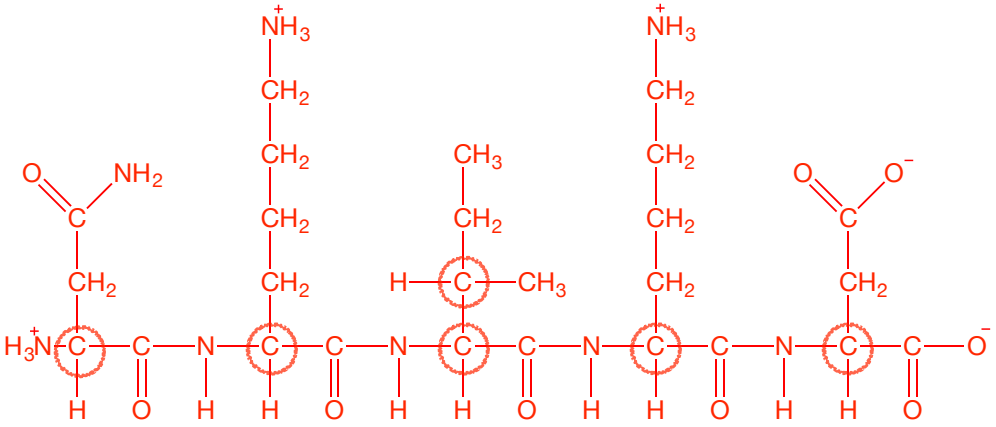


Isoleucine (Ile) Aspartic acid (Asp) Asparagine (Asn) Lysine (Lys)

a. Draw the structure of the pentapeptide with the sequence Asn-Lys-Ile-Lys-Asp in the charged form that it exists as at physiological conditions (*pH* 7).



b. Circle each of the chiral carbons in your structure.
c. What level of protein structure does the character string Asn-Lys-Ala-Lys-Asp represent?

The *primary structure*, which is the sequence of amino acids in a protein joined together by peptide (amide) bonds.

d. If this pentapeptide is part of a globular protein, list, using the three-letter abbreviations, where each of the amino acid side chains would prefer to be located.
   i. Those that prefer to be on the inside are Ile
   ii. Those that prefer to be on the outside are Asp, Asn, Lys

e. In humans, the amino acids isoleucine and lysine are considered *essential* amino acids, while aspartic acid and asparagine are considered *nonessential*. Since a human needs a supply of all twenty amino acids to synthesize proteins, why are some amino acids considered essential when others are not? The essential amino acids are the ones that humans are unable to synthesize on their own. It is *essential*, then, that these amino acids be included in our diet.

9. Complete the following sequence of reactions by drawing the structural formulas for Compounds 1 through 4 above the lines provided. Note, the oxidation reactions will not be written as balanced. (Hint: Compound 4 has the molecular formula $C_4H_6O_4$.)

(This is problem 13.96 from your textboook)

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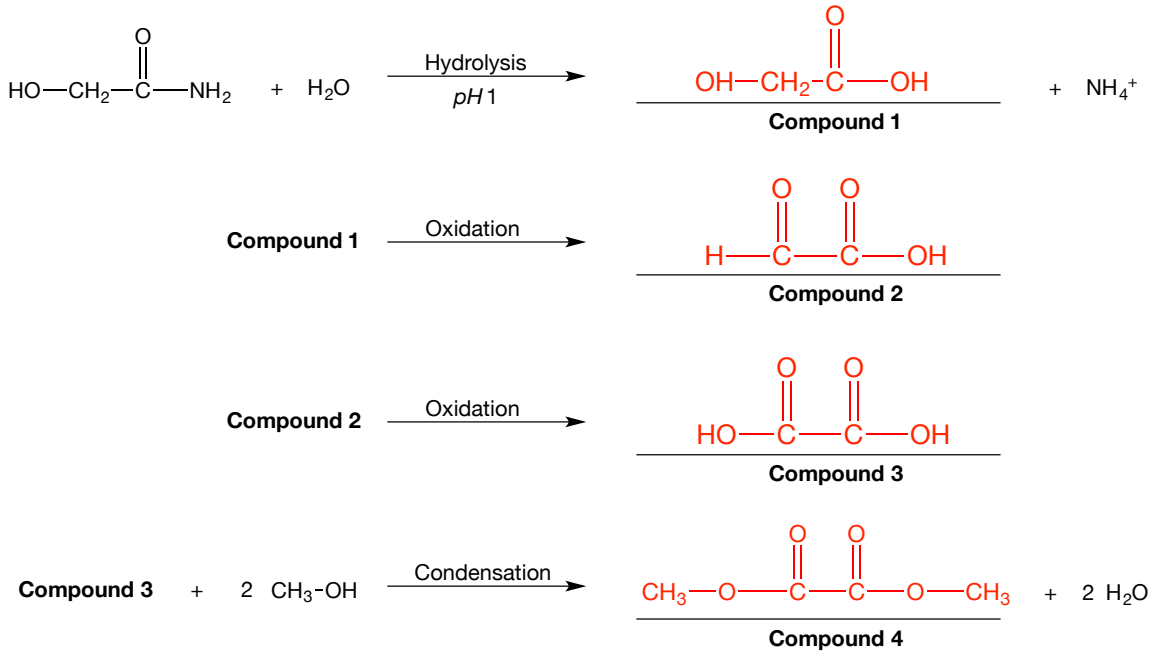

10. Shown to the right is a model of the 3-dimensional structure of the protein ubiquitin, in which a ribbon is used to trace the polypeptide backbone. Using this model to help illustrate your responses, describe, using sentences, the following levels protein structure

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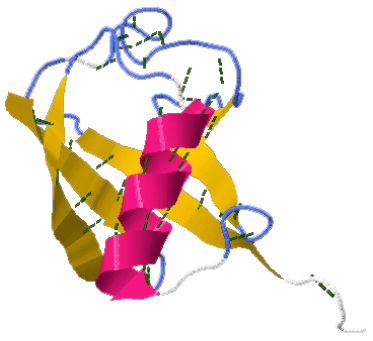
a. primary structure - This is the sequence of amino acids, which are linked together by peptide bonds to form a continuous chain that traces its way through the folded structure. It is represented here by different colored ribbons and strings.

b. secondary structure - This is where the backbone of the polypeptide either forms a corkscrew like structure (α-helix), which is colored magenta in the picture, or stretch out and lie down next to other strands to form a sheet-like structure (β-sheet), which is colored yellow. Both these structures allow the backbone amides to hydrogen bond to one another (green dotted lines)

c. tertiary structure - This describes the overall fold of the peptide, which defines the arrangement of the α-helices, β-sheets and other portions of the polypeptide relative to one another.



11. Shown below are the structures for some monosaccharides that are common to biological systems

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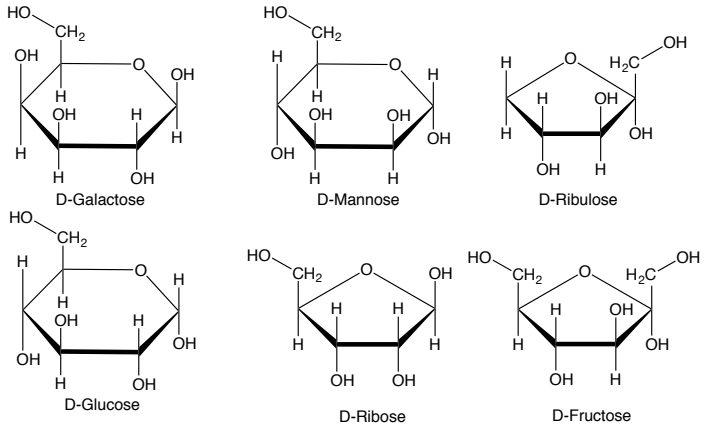
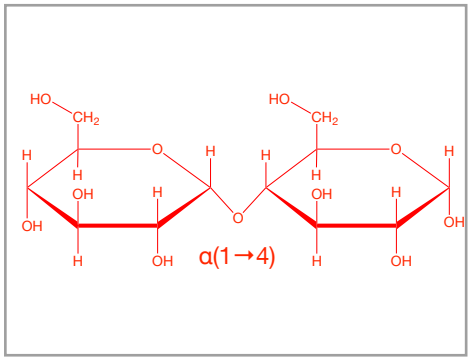


a. Circle the anomeric carbon in each structure and label it as either α or β.

b. For each, indicate whether it is a *tetrose*, *pentose* or *hexose*, whether it is an *aldose* or a *ketose*, and whether it is a *reducing* or *non-reducing* sugar.

Monosaccharide	Tetrose/Pentose/ Hexose	Aldose/Ketose	Reducing/ Non-reducing
D-Galactose	hexose	aldose	reducing
D-Mannose	hexose	aldose	reducing
D-Ribulose	pentose	ketose	reducing
D-Glucose	hexose	aldose	reducing
D-Ribose	pentose	aldose	reducing
D-Fructose	hexose	ketose	reducing

c. Draw the structure of the disaccharide obtained by connecting D-glucose to D-glucose using a α(1→4) glycosidic bond.



What is the common name for the disaccharide you drew.

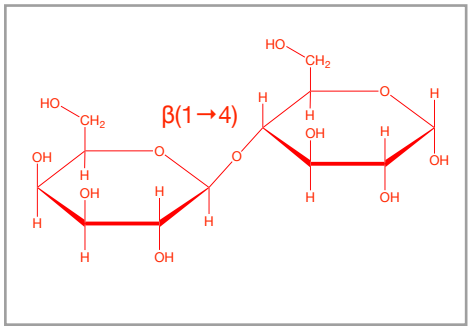
maltose

What polymer is obtained if many additional D-glucose monsaccharides are joined together in the same way

amylose (starch)

What is the biological function for this polymer?

d. Draw the structure of the disaccharide obtained by connecting D-galactose to D-glucose using an β(1→4) glycosidic bond.



What is the common name for the disaccharide you drew.

lactose

What is the name for the condition that some people have because they have lost the ability to synthesize the enzyme responsible for hydrolyzing this glycoside bond.

lactose intolerance

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