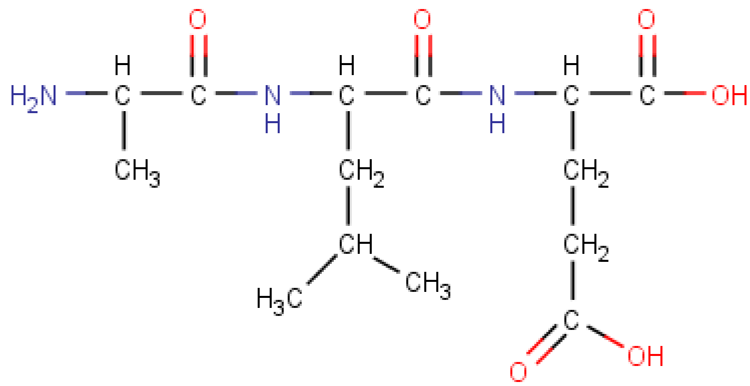
Bioenergy Due: Mar 8th by 5:00 PM

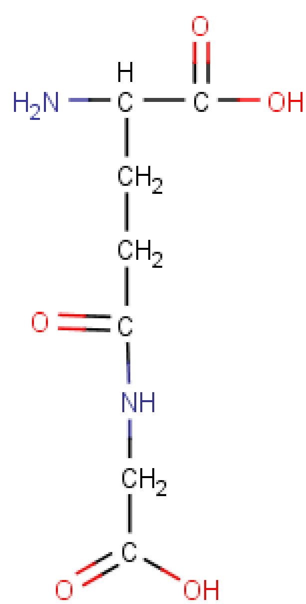
Bring your work with you to class to submit.

1. Clearly explain the role of enzymes. Make sure to include the four key components that we discussed in class. They are important for optimizing biochemical reactions and ensuring that chemical reactions in living cells occur efficiently and when they are supposed to. Specifically, enzymes enable increased reaction rates, confer selectivity, reduce requirements for harsh chemical conditions, and enables regulation of reactions based on cellular need.

2. Look up the structure of alanine, leucine, and glutamic acid. Show a tripeptide that forms with these three amino acids.

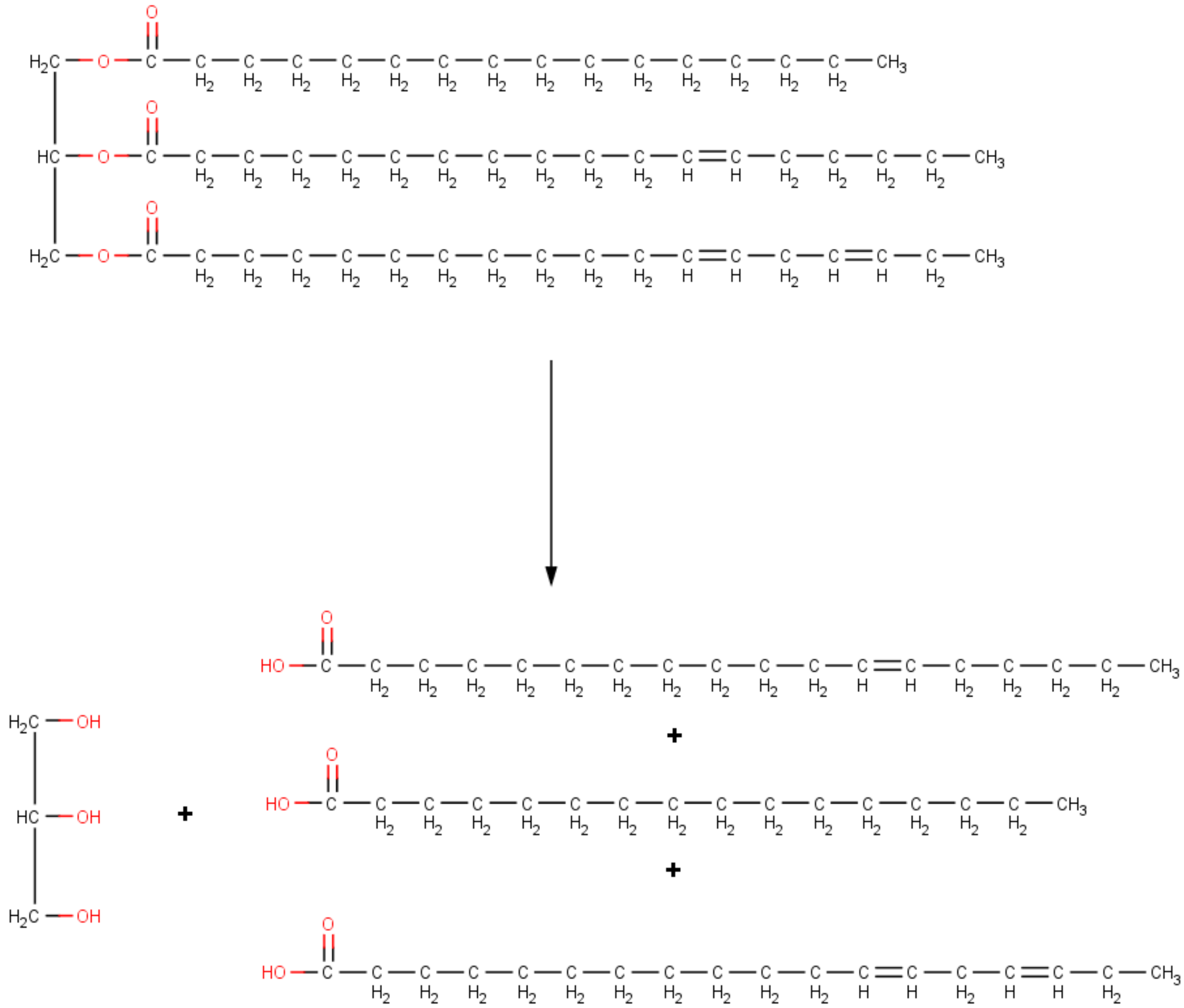


3. In class, we discussed how side chains have the potential of forming bonds through condensation reactions. Which of the amino acids from problem 1 can do this? Show a peptide bond with glycine using the side chain. Glutamic acid has a –COOH on the side chain. This can form a peptide bond with the nitrogen of glycine backbone.



Problems 4 - 8 will focus on the enzyme Lipase. Lipase catalyzes the hydrolysis of triglyceride molecules (reverse of condensation).

4. Consider a triglyceride that is made from 16:0, 18:1 n-6, and 18:2 n-3. Show the reactant and the products of this reaction.



5. Consider the reactant you drew in problem 3. What do you think the active site of Lipase looks like so that it will bind to a triglyceride molecule? It must be very hydrophobic so that the non-polar triglyceride will bind. There must also be a part that is exposed to water so that the water can react.

6. Are there any intermolecular forces that exist in the products that do not exist in the reactants? Yes, the products are polar and have H-bonds. What role do you think this plays in the enzyme function? Remember the enzyme must attract reactants are discard products. The H-bonds will repel the products from the substrate so that new reactants can come in.

7. What is activation energy? The energy barrier that reactions must overcome for a reaction to occur.

8. Lipase catalyzes the hydrolysis reaction with a rate of 141 μM/sec. What would the concentration of products be after 5 minutes? See below.

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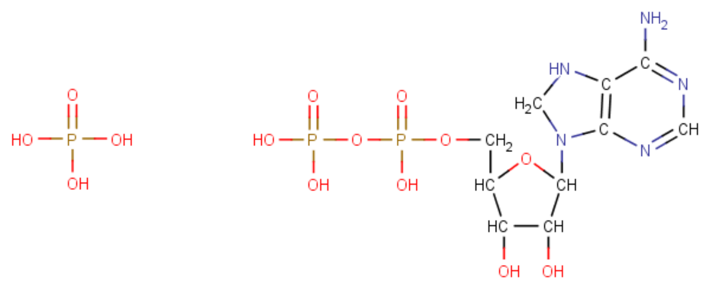
9. Describe the role of ATP in energy production. ATP is a central molecule in energy production/transfer. The hydrolysis energy is nicely placed between other phosphate compounds. High energy phosphate compounds are able to create ATP form ADP. ATP is recognized by many enzymes that catalyze reactions that need energy.

10. Hydrolysis of 1 mole (remember, think of this as a dozen) of ATP → ADP is worth 50 kJ of energy.
    a. How much is this in kJ? 50 kJ
    b. How much is this in J? 50,000 J
    c. Draw the products of the hydrolysis reaction that is described.



11. Determine the oxidation state of each carbon in the following molecules (you may need to look up the structure): See below
    a. Galactose
    b. Oleic Acid
    c. Stearic Acid

12. Stearic Acid, Oleic Acid, and a glucose trisaccharide (α-glucose (1→4) α-glucose (1→4) α-glucose) all contain 18 carbons.
    a. Which of these molecules will produce more electrons upon complete oxidation? Stearic Acid
    b. Based on this, which of these molecules would you expect to provide more bioenergy? Stearci Acid

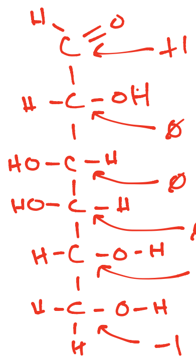
13. Using the approach you learned in class, determine the total number of ATP molecules that can be produced from the complete oxidation of:
    a. Glucose trisaccharide
    b. Stearic acid

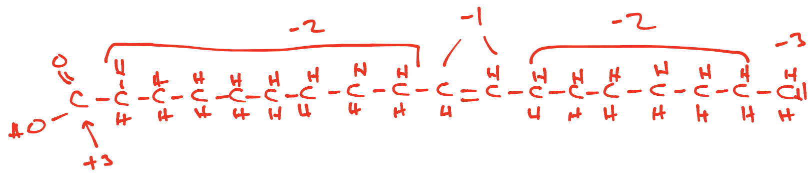
14. Using the information from problem 10 and 13, determine the total energy (in kJ/mol) that would be generated by metabolism of:
    a. Glucose trisaccharide 2700 kJ
    b. Stearic acid 3900 kJ

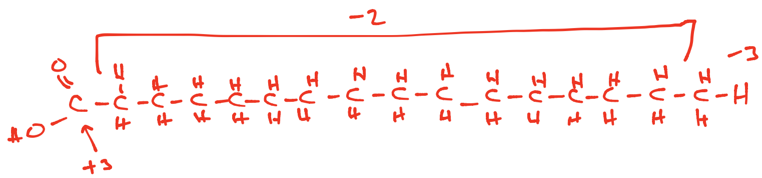
15. Compare and contrast the pros and cons of using fat as way of storing energy compared to sugar polymers. Fat stores more energy.

8. $5\,min\left(\frac{60\,sec}{1\,min}\right) = 300\ sec$ $\quad$ $\frac{141\,\mu M}{sec}(300\ sec) = 42{,}300\ \mu M$

11.







12. Steric → $C_{18}H_{36}O_2$ (−32, +36 +1(36), −4 −2(2)) $\quad$ $C_{18}^{-32} \longrightarrow 18\,C^{+4} + 104\,e^-$

oleic acid → $C_{18}H_{34}O_2$ (−30, +34, −4) $\quad$ $C_{18}^{-30} \longrightarrow 18\,C^{+4} + 102\,e^-$

glucose $C_6H_{12}O_6$ (∅, +12, −12) $\quad$ $C_6^{0} \longrightarrow 6\,C^{+4} + 24\,e^-$

24×3 (3 glucose) $= 72\,e^-$

Steric acid

13. Glucose $72\left(\frac{3}{4}\right) = 54$ ATP

Stearic Acid $104\left(\frac{3}{4}\right) = 78$ ATP

14. 54 ATP × 50 KJ = 2700 KJ

78 ATP × 50 KJ = 3900 KJ