Chem 135: Second Midterm

October 29th, 2008

*Please provide all answers in the space provided. Extra paper is available if needed. Including the title page, there should be **5** pages in this exam. You may use previously unassembled model kits, but calculators are not allowed.*

Good Luck!

Name Key

(1) _____ (20 points)

(2) _____ (10 points)

(3) _____ (10 points)

(4) _____ (10 points)

(5) _____ (15 points)

(6) _____ (35 points)

TOTAL _____ (100 points)

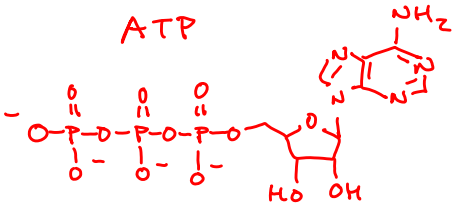
1. Provide the full chemical structures for ANY TWO compounds from the following list (10 points each):

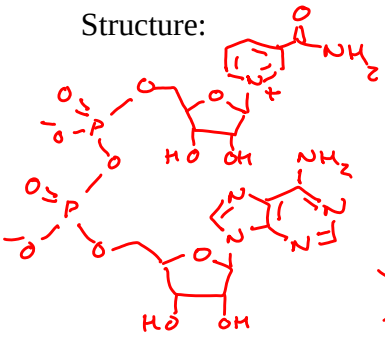
   ATP AcetylCoA NAD^+ FAD

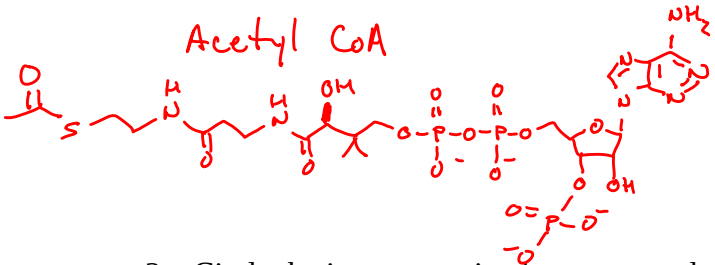
   Do not abbreviate any of the functional groups.

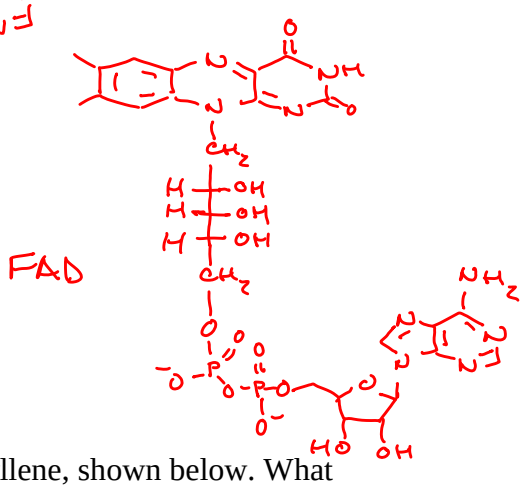
   Name of Compound 1: _____ Name of Compound 2: _____

   Structure: Structure:

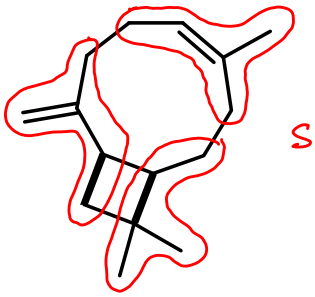








2. Circle the isoprene units that were used to biosynthesize caryophyllene, shown below. What is the name for this class of terpene? (10 points).



it is a sesquiterpene

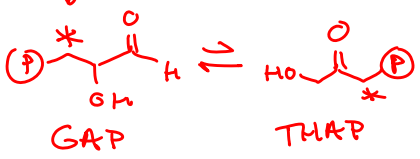
c

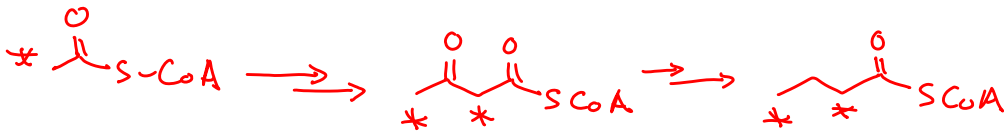
3. It is possible to isolate intact mitochondria from cells using centrifugation techniques. If a sample of mitochondria is suddenly placed in a pH 9.0 solution *that does not disrupt the structure of the membranes or the proteins inside*, what do you think would happen? Briefly explain your answer (10 points).

The high pH will reverse the proton gradient. The protons will now flow into the matrix, which will turn the ATP synthase in the opposite direction. This will convert ATP to ADP.

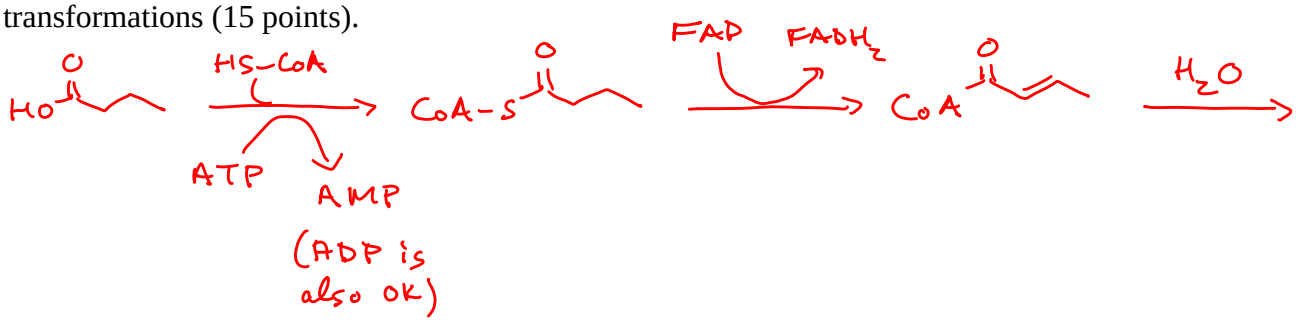
4. In a laboratory feeding experiment, a mouse was fed nothing but glucose that was ^{13}C-labeled at carbon 1. After a period of two weeks, a sample of the fat tissue was obtained through murine liposuction (I actually made that technique up), broken into the fatty acid components, and analyzed by ^{13}C NMR. The obtained spectrum indicated that the label only occurred in certain positions along the fatty acid chain of palmitate. Where would you expect them to be? (10 points).

label from equilibration



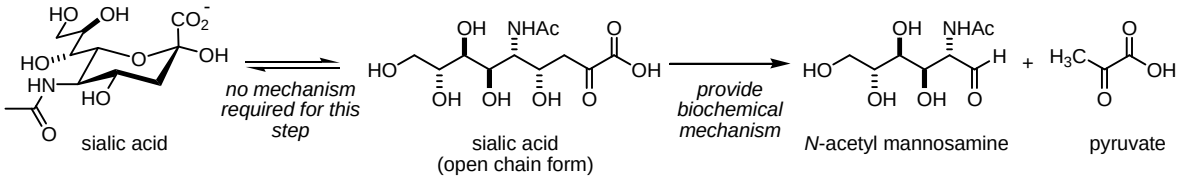


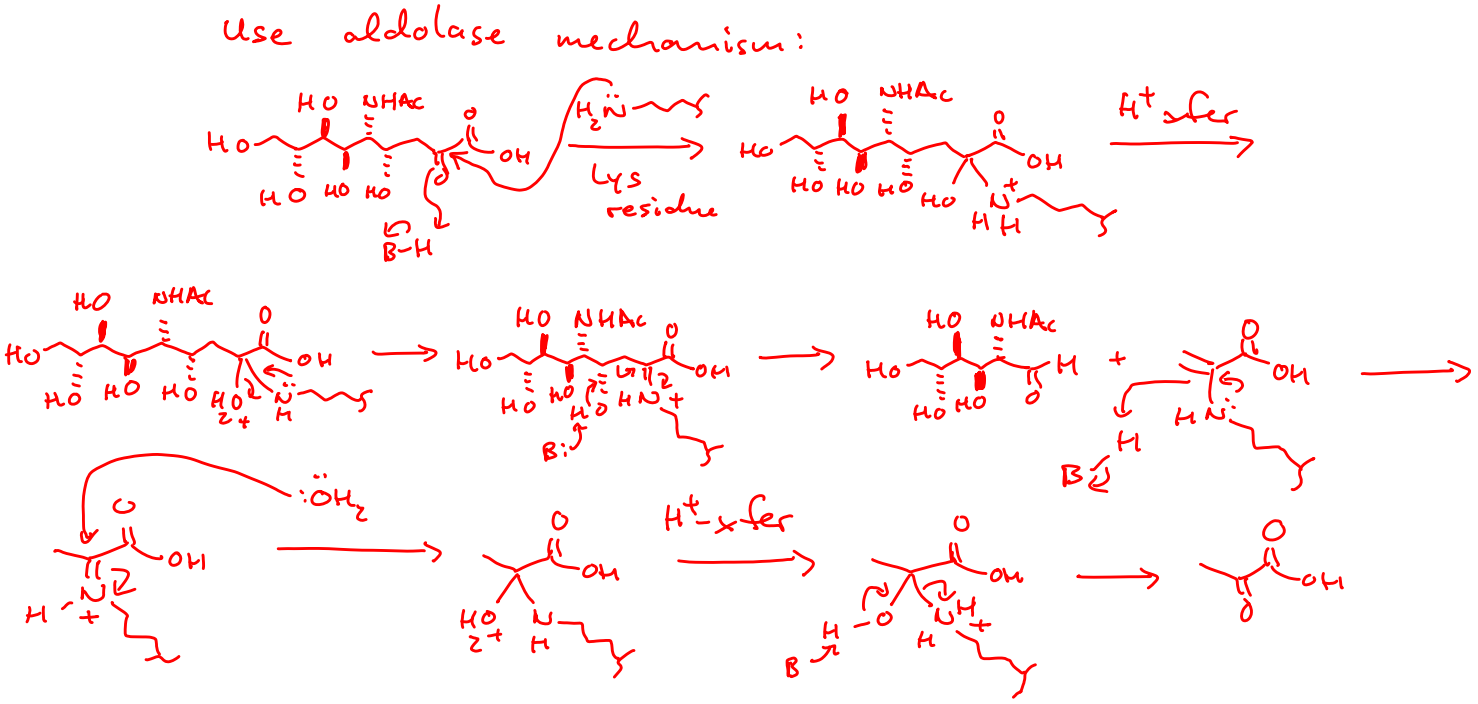
5. Provide all of the metabolic steps that are required to convert one molecule of a four carbon saturated fatty acid (butyric acid) into two molecules of acetyl-CoA. Be sure to include any cofactors that your transformations require. You do not have to provide mechanisms for your transformations (15 points).



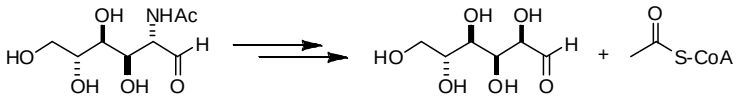
6. Suppose a new strain of bacteria has been discovered that metabolizes sialic acid as its primary food source. In order to study this unusual organism, you will need to develop hypotheses about the likely pathway by which this occurs.

   a) In the first step, the open chain form of sialic acid is broken into two individual fragments. By making an analogy to a specific enzyme that you have encountered in this course, propose a detailed arrow-pushing mechanism that could account for this transformation (15 points).





b) Following this step, the *N*-acetyl mannosamine is converted through a series of steps into a glucose molecule and a single molecule of acetyl CoA. No ATP or redox cofactors are required for these steps.



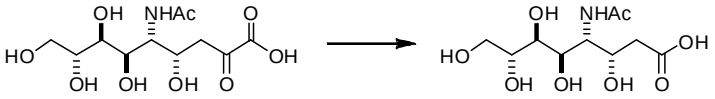
N-acetyl mannosamine glucose

Combined with the step shown in part (a), each molecule of sialic acid is converted into one pyruvate, one glucose, and one acetyl CoA. Based on this observation, how many total molecules of ATP can be generated from one molecule of sialic acid under aerobic conditions? (5 points).

1 glucose = 32 ATP
1 pyruvate → 1 acetyl CoA + 1 NADH = 12.5 ATP
1 Ac CoA = 10 ATP

54.5 ATP total

c) As you study this strain of bacteria more carefully, suppose you find that some of the sialic acid has been shortened by one carbon before it is metabolized. Based on reactions we have seen in class, propose a detailed arrow-pushing mechanism that would explain the formation of this product (15 points).



sialic acid

use TPP!