Name ____Key____

Chem 352 - Spring 2011 - Exam IV

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1. In photosynthesis,

   a. Light energy is used to excite electrons in the photoreaction systems and remove them from a pair of chlorophyll molecules called the ____"special pair"____.

   b. For purple bacterial, the energetically excited electrons from Photosystem II are used to reduce a mobile electron carrier named ____Coenzyme Q (Q)____.

   c. For green sulfur bacteria, the excited electrons from Photosystem I are used to reduce one of either two mobile carriers, ____Coenzyme Q (Q)____ or ____$NADP^+$____.

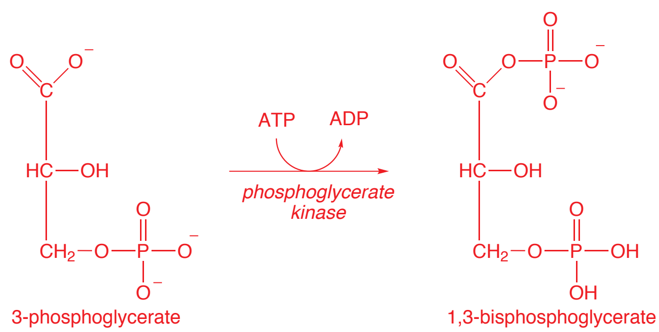
   d. For both the purple bacteria and the green sulfur bacteria, describe, in one or two sentences, how the absorption of light energy is coupled to the synthesis ATP from ADP and P_i.

   The reoxidation of Coenzyme Q involves cytochrome *bc*, which passes the electrons to cytochrome *c* using the "Q-cycle". The free energy that is released in the process is used to pump protons up a concentration gradient across the cell membrane. The enzyme ATP synthase then uses the electrochemical energy stored in this gradient to synthesize ATP from ADP and P_i.

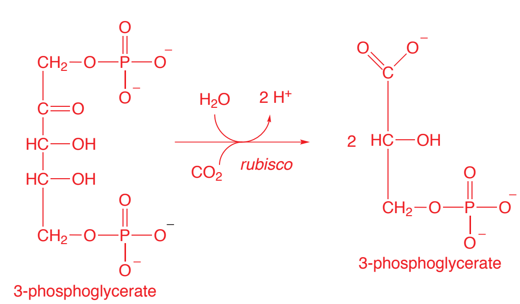
   e. What two products from the light reactions of photosynthesis in plants are used to fix CO_2 in the *Calvin Cycle*?____ATP____ and ____$NADPH + H^+$____

   f. Pick an example of a reaction from the Calvin Cycle *that illustrates the use of one of these two products* and another reaction *that does not*. *Use structural formulas* to write a balanced chemical equation for your two chosen reactions. Name the intermediates and the enzymes involved in each.

   i. Uses ATP:



   ii. Does not use ATP or NADPH:



   g. What other metabolic pathway shares the same reactions found in the reduction phase of the *Calvin cycle*? gluconeogenesis

2. Fatty acids are synthesized by adding two carbon units to a growing acyl chain.

a. *Using structural formulas*, show the reactions involved in elongating an acyl chain by two carbon atoms.

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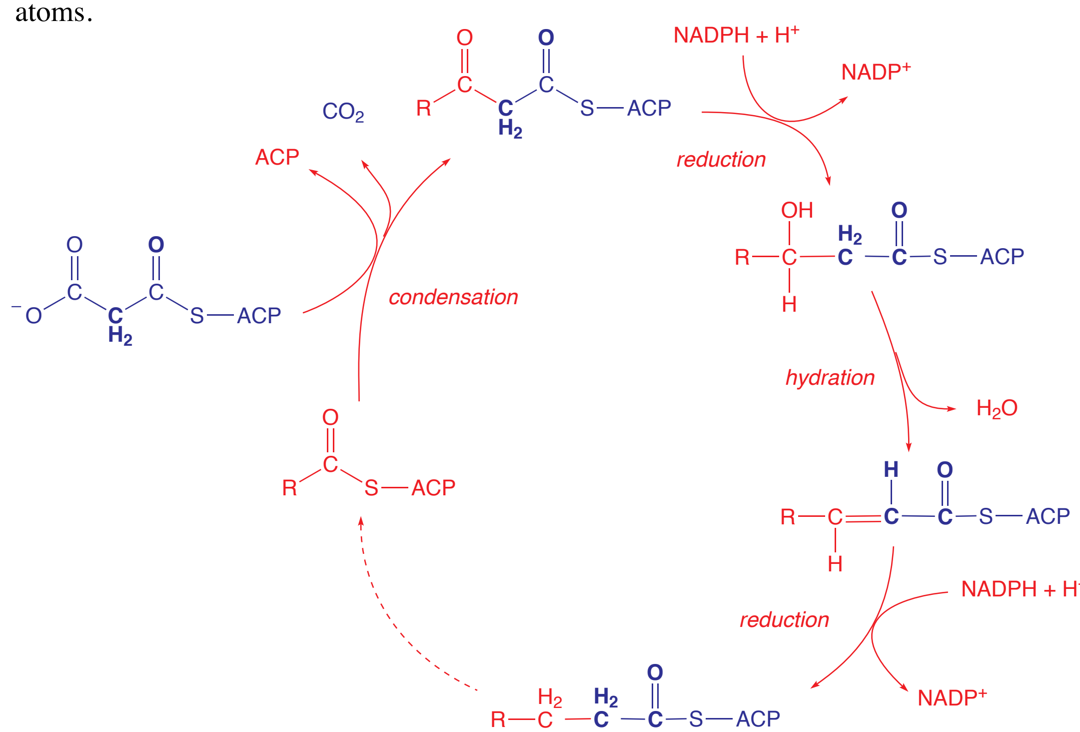

b. Fatty acid synthesis shares a number of similar features to β-oxidation (the degradation of fatty acids), but in reverse. Describe two features of fatty acid biosynthesis that distinguish it from the reverse of β-oxidation.

i.
- Fatty acid synthesis occurs in the cytosol, β-oxidation occurs in the mitochondrial matrix.
- Fatty acid synthesis uses NADPH + H^+ as a reducing agent, while β-oxidation uses NAD^+ and Q as oxidizing agents
- Fatty acid synthesis uses an acyl carrier protein (ACP), while β-oxidation uses Coenzyme A.

ii.
- The 3-hydroxyacyl intermediate is the D-enantiomer in fatty acid sythesis, while it is the L-enantiomer in β-oxidation.

c. Where in a eukaryotic cell does fatty acid synthesis occur? cytosol

d. When eukaryotes convert carbohydrates to fatty acids, the glycolytic pathway is used to convert glucose to pyruvate, which is then converted to acetyl-CoA using pyruvate dehydrogenase. Describe where in the cell this acetyl-CoA is produced and indicate how it is transported to the location where fatty acid biosynthesis is taking place.

The acetyl-CoA that is produced from the pyruvate dehydrogenase reaction is produced in the matrix of the mitochondrial. The citrate/pyruvate shuttle is used to transport the acetyl-CoA out to the cytosol where fatty acid synthesis occurs. In the matrix the acetyl-CoA combines with oxaloacetate to produce citrate. The citrate is transported by a membrane translocase to the cytosol, where it is converted back to acetyl-CoA and oxaloacetate. The oxaloacetate is decarboxylated to pyruvate and the pyruvate is transported back to the mitochonrial matrix by another translocase.

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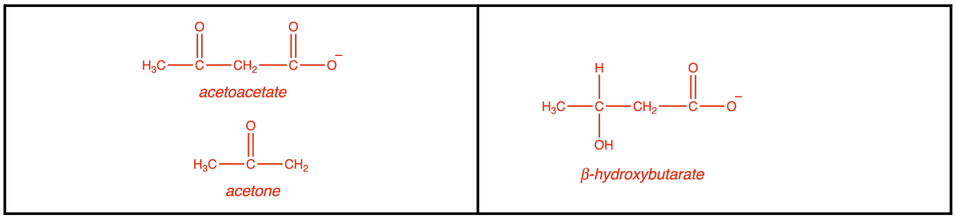
3. In humans, the acetyl-CoA produced from the β-oxidation of fatty acid cannot be used as starting material for the synthesis of glucose, however, under conditions of starvation, acetyl-CoA can be utilized by the liver to produce a group of molecules that circulate to the tissues and are used as an alternative to glucose as an fuel source.

   a. What is the name for this group of molecules? ketone bodies

   b. Draw the structural formulas for, and name two examples of molecules that are members of this group.



   c. The reactions in the pathway that leads to the synthesis of these molecules are also found in another important biosynthetic pathway. Name this pathway this? isopentenyl diphosphate and cholesterol biosynthesis

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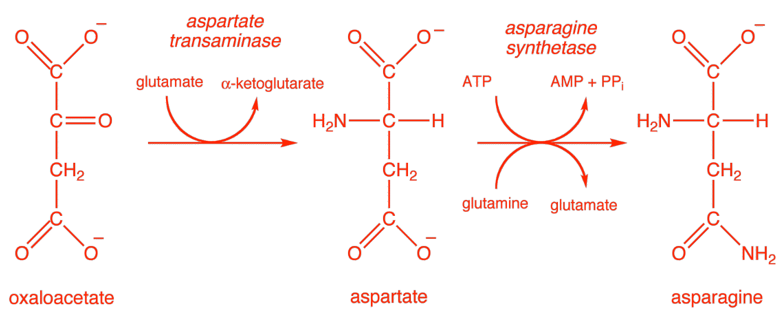
4. Name the *glycolytic* or *citric acid cycle* intermediate that is the starting point for the biosynthesis of each of the following amino acids:

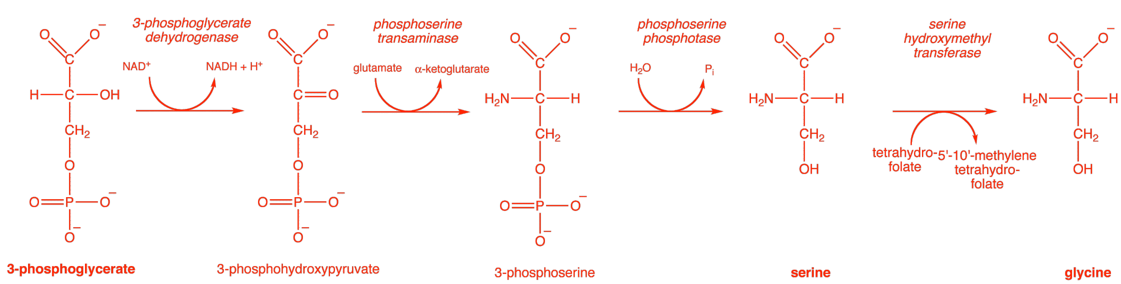
asparagine	oxaloacetate (citric acid cycle)
alanine	pyruvate (glycolysis)
aspartate	oxaloacetate (citric acid cycle)
glycine	3-phosphoglycerate (glycolysis)
serine	3-phosphoglycerate (glycolysis)
proline	α-ketoglutarate (citric acid cycle)
glutamate	α-ketoglutarate (citric acid cycle)

   a. Pick two of these, one from glycolysis and one from the citric acid cycle, and *using structural formulas*, draw out the pathway leading to their biosynthesis.

      i.



      ii.



5. Both adenosine monophosphate and guanosine monophosphate are synthesized from inosine monophosphate. Draw the structure of adenosine monophosphate and indicate the source of each of the atoms in ring of the nucleotide base.

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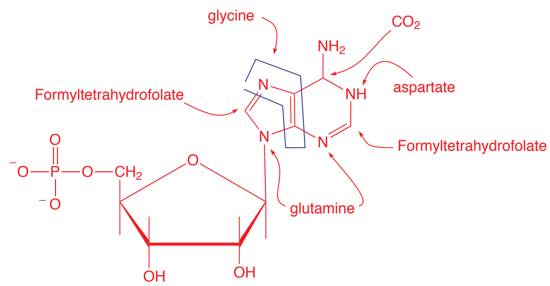
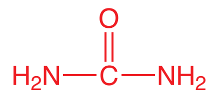
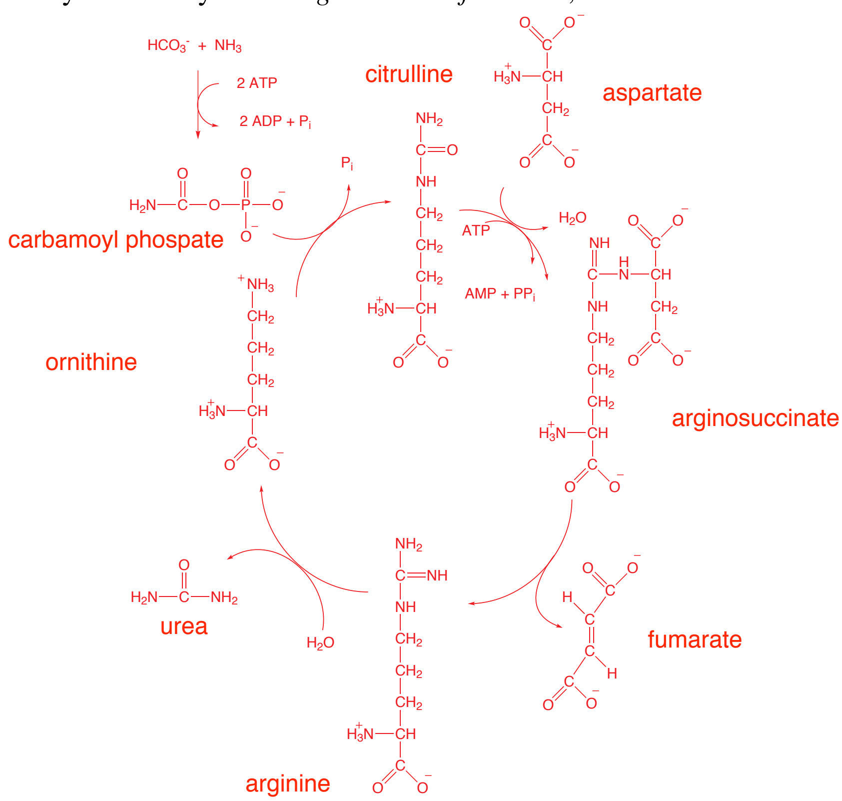


6. Terrestrial animals dispose of their excess nitrogen as urea.
   a. Draw the structural formula for urea



   b. Urea is made by the urea cycle. *Using structural formulas*, draw the reactions for the urea cycle:



   c. Two of the intermediates in the urea cycle are α-amino acids that are not members of the 20 used to make proteins. Name these:

      i. ornithine

      ii. citrulline

   d. As you showed above, one of the nitrogen atoms in urea comes from carbamoyl phosphate. What biosynthetic pathway also uses carbamoyl phosphate as a starting material?

      pyrimidine biosynthesis