NESA Biochemistry Fall 2001
Review sheet for Exam 2

Here is a review sheet to help you prepare for the exam. Not all of the questions are reflective of the exam questions. Questions such as True and False, Multiple chose, and short answer are more designed to guide you to some of the topics that you should be familiar with. Try and do these questions without the assistance of the book to test your knowledge.

Overview of Metabolism

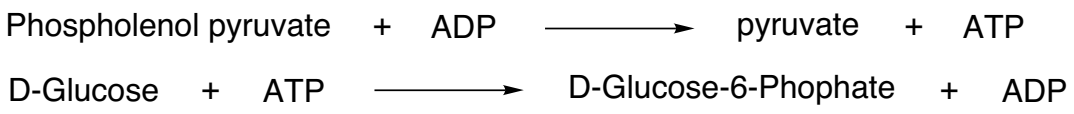
Sections to review: 21.1 – .7

Concept check questions:

1. A → B → C is known as a _____ _____.
2. _____ is the material that fills the inside of the cell.
3. ATP is a higher energy molecule than ADP. T/F
4. Anabolism is the breakdown of high-energy molecules. T/F
5. In a reaction that is energetically unfavorable, the energy of the products is less than the energy of the reactants. T/F
6. A reaction that is energetically unfavorable can use ATP as an energy source.
7. Which of the following is an oxidation.
   A. $Fe^{3+} \rightarrow Fe^{2+}$ B. $CH_3COOH \rightarrow CH_3CHO$ C. $CH_3CH_2CH_2COOH \rightarrow CH_3CH{=}CHCOOH$ D. $CH_3COOCH_3 \rightarrow CH_3COOH + CH_3OH$
8. Which coenzyme is not an oxidizing agent?
   A. FAD B. FMN C. Acetyl-SCoA D. NAD+
9. Which of the following does not occur in mitochondria?
   A. oxidative phosphorylation B. ATP synthesis C. citric acid cycle D. Degradation of carbohydrates.

Problems

1. Based off of Free Energies of hydrolysis (table in your book) find the free energy for the following reaction. We did not cover this directly in class, but we did think about the idea of energy used to break one bond can be "coupled" with the formation of another bond in an unfavorable reaction. What would be overall reaction? Remember if you reverse a reaction you the energy is multiplied by –1.

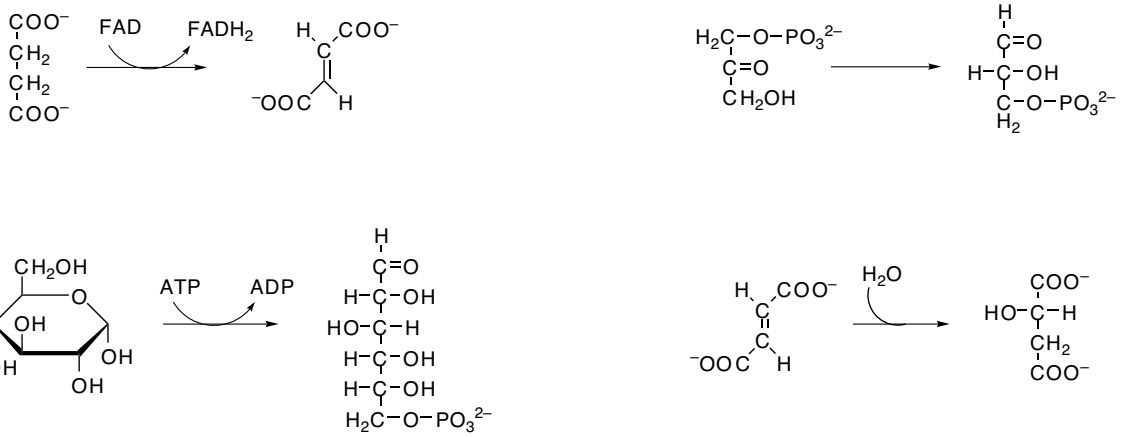


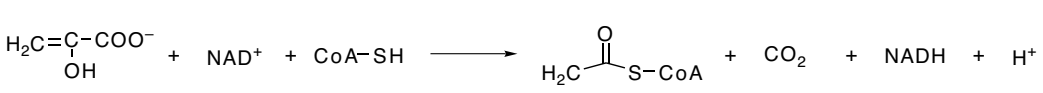
2. From the list, write what kinds of reactions are depicted. For redox reactions show which compounds are being oxidized (O) and which are being reduced (R). Please mark with the letters for clarity. All of these reactions are in a metabolic pathway. Not all

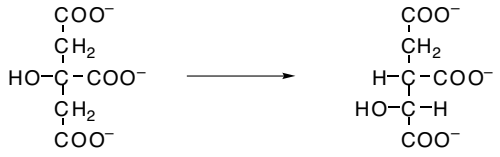
possible reactions will be used, some will be used more than once. All reactions are catalyzed by enzymes.

Possible reactions:

- Isomerization (Rearrangement)
- Oxidative decarboxylation
- Reduction
- Oxidation
- Hydration
- Phosphorylation







3. For the reduction of NAD+ to NADH, show the gain or loss of electrons using in Lewis Dot notation. (This is a mental exercise and would not be on an exam)

Carbohydrate Metabolism

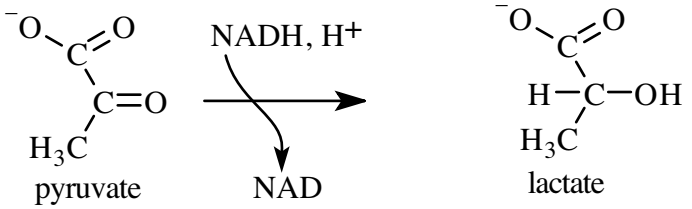
Sections to review: 23.1 – .4, .5, .6, .10, .11
Homework assigned: Chapter 23: 31, 32, 56, 68

Concept check questions

1. The synthesis of glucose form small molecules is called: a. glycolysis b. glucogenesis c. glyconeogenesis d. glycogenesis
2. Which of the following can cross cell membranes? a. glucose-6-phosphate b. ATP c. glucose d. acetyl-SCoA
3. Which of the following is not a route for pyruvate metabolism in the human body? a. conversion to acetyl-SCoA b. reduction to lactate c. fermentation to alcohol d. reformation of glucose
4. When pyruvate is converted to acetyl-SCoA, one molecule of _____ is lost.
5. Conversion of glucose-6-phosphate to fructose-6-phosphate requires ATP. T/F
6. Gluconeogensis is the exact reverse of glycolysis. T/F
7. Cleavage of fructose 1,6-diphosphate yields two molecules of glyceraldehydes-3-phosphate. T/F

Problems

1. A pathway, which we did not discuss in class, is the **pentose phosphate shunt**. In this pathway, glucose-6-P is converted to ribulose-5-P and CO_2, and in the process, 2 NAD produce 2 NADH. Since all enzymatic processes are reversible, how many ATPs are produced when ribulose-5-P is converted to CO_2 and H_2O via glycolysis and the Krebs cycle?
2. In anaerobic bacteria, glycolysis does not lead to the Krebs cycle. Instead, pyruvate is reduced to lactate:



This process also occurs in muscles when there is an insufficient amount of O_2 present. If lactate is the end result, what is the net amount of ATP produced during glycolysis?

3. What is the purpose of formation of lactate under anaerobic conditions?

Citric Acid Cycle, Electron-Transport Chain and ATP Production

Sections to review: *21.8, .9*
Homework assigned: Chapter 21: 48, 49, 50, 53, 54, 60

Concept check questions

1. The citric acid cycle and electron transport take place in the cytosol. T/F
2. All of the following statements about electron transport are true except:
    a. A concentration gradient is established between the inner membrane and the mitochondrial matrix.
    b. Electrons are passed from weaker electron acceptors to stronger electron acceptors
    c. A greater amount of energy is produced from oxidation of NADH than from oxidation of $FADH_2$

   d. Some of the enzyme cofactors in the electron transport chain are mobile
3. The citric acid cycle is also known as the _____ and as the _____ - _____ cycle
4. A complete citric acid cycle yields _____ molecules of ATP
5. The citric acid cycle and electron transport are connected by _____ _____.

Problems

1. Ethanol, CH_3CH_2OH, is oxidized in the liver to form acetate, which is then converted to acetyl CoA, and two NADH are produced in the process. The acetyl CoA can now be used in the Krebs cycle, and the NADH and $FADH_2$ can be oxidized via the phosphorylation pathway we have already studied. How many ATP molecules can be produced when 1 ethanol molecule is completely catabolized?
2. How does the acetyl group from glucose enter the citric acid cycle and what happens to it during the completion of the citric acid cycle.
3. What use have we seen for oxygen in aerobic metabolism?
4. What would happen to the citric acid cycle if NADH and $FADH_2$ were not reoxidized?
5. What does the term "oxidative phosphorylation" mean? How does it differ from substrate-level phosphorylation?

Lipid Metabolism

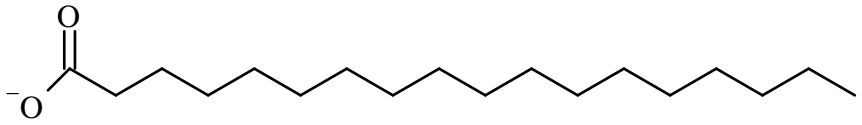
Sections to review: 25.1 – .3, .5 – .8 (maybe .4)
Homework assigned: Chapter 25: 21, 32, 34, 37, 39, 41

Concept check questions

1. Which of the following statements about lipogenesis is false?
   a. Synthesis occurs two carbons at a time.
   b. Formation of acyl-SACP intermediates requires ATP
   c. The coenzyme NADPH is needed
   d. Lipogenesis occurs when acetyl-SCoA is in abundance.
2. One _____ and one ___ are needed for each β oxidation cycle
3. Bile salts help to _____ lipids.
4. Triacylglcerols are hydrolyzed by pancreatic lipases to gylcoerol and fatty acids. T/F
5. A fatty acid with n carbonds requires n/2 – 1 cycles of β oxidation for complete breakdown. T/F
6. Fatty acid synthesis occurs in the mitochondria. T/F
7. Most naturally occurring fatty acids have an even number of carbon atoms. T/F

Problems

1. Consider the following fatty acid:



If this molecule underwent complete catabolism (i.e. ß-oxidation, Krebs cycle, and oxidative phosphorylation), how many ATP would be produced?

2. When odd-number fatty acids are catabolized, succinyl-CoA is produced. If the succinyl-CoA enters the Krebs cycle, how many ATP can be produced?
3. Which carbon atoms in a triacylglycerol could be found in glycogen after lipid metabolism? Why would you not find the other carbon atoms in this location? Where would they end up?

Protein and amino Acid Metabolism

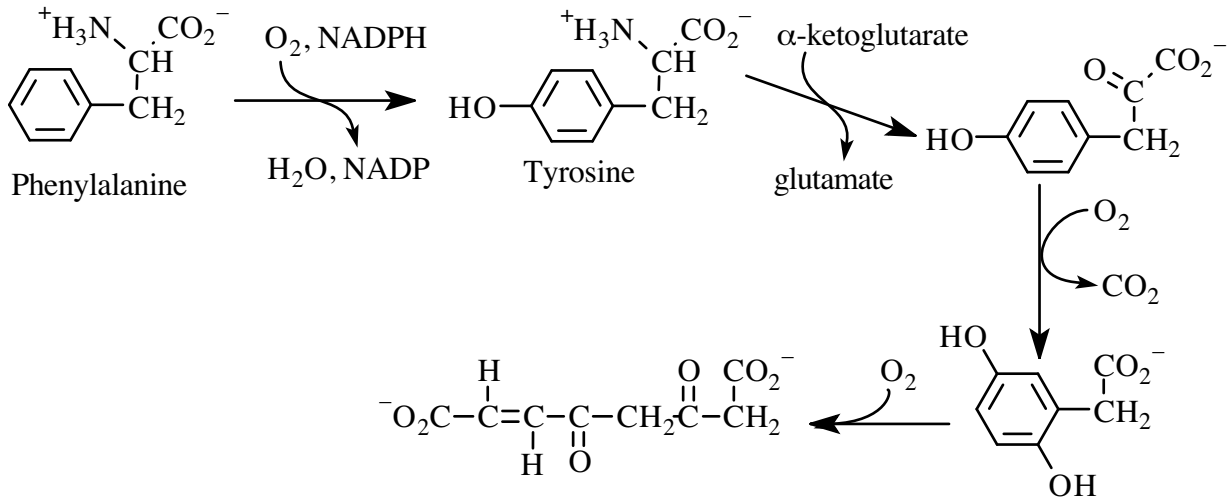
Sections to review: 27.1 – .6
Homework assigned: Chapter 27: 13,16,18, 26, 46, and 48

Concept check questions

1. Ornithine is: a. a urea cycle intermediate b. an amino acid c. an acceptor of a carbamoyl group d. all three.
2. Glucogenic amino acids enter glucogensis via: a. acetyl-SCoA b. oxaloacetate c. α-ketoglutarate d. fumarate.
3. Ketogenic amino acids are catabolized to _____ _____ or _____ _____.
4. A _____ is an enzyme that carries out peptide hydrolysis
5. Essential amino acids can neither be synthesized or catabolized in the human body. T/F
6. Some intermediates in the urea cycle also occur in the citric acid cycle. T/F
7. Both nitrogens of urea come from ammonium ion. T/F

Problems

1. Question a-e refer to the following metabolic pathway:



This corresponds to the first four steps of phenylalanine catabolism.

a. In the first step, Phe is converted into Tyr. This process is referred to as:

a. transamination. b. transhydroxylation.
c. reduction. d. oxidation.

b. In the second step, a-ketoglutarate is converted to glutamate by removing the amino group from TYR. This process is called:

a. transamination. b. transcarboxylation.
c. reduction. d. oxidation.

c. In humans under normal circumstances, the ultimate fate of the amino group transferred in step 2 is:

a. ammonium ion. b. uric acid.
c. nitric acid. d. urea.

d. In the fourth step of the pathway, the benzene ring is opened. One of the -OH groups on the ring contributes to the carboxylate group
(-CO_2^-). What is the fate of the other -OH?

a. It becomes water. b. It becomes a carbonyl.
c. It becomes a C=C. d. It also becomes a CO_2^-.

e. The final molecule shown is hydrolyzed in a subsequent step into two molecules found in the TCA cycle. Which two molecules?

a. Melavonate and Malate. b. Succinate and Citrate.
c. Oxaloacetate and Fumarate. d. Isocitrate and Aconitate.

2. How is tyrosine biosynthesized in the body? What disease prevents this biosynthesis, thereby making tyrosine an essential amino acid for those who have this condition?
3. Can an amino acid be both glucogenic and ketogenic? Explain why or why not.

4. What is the major hazard of a high-protein, low-carbohydrate diet? What is responsible for this condition? Might a person with such a condition have bad breath and why?