

Review for Chem 30B Midterm Exam 3
(McMurry 7th ed Chpts 20-22 or McMurry 6th ed Chpts 21-23)

Ch 20. Generation of Biochemical Energy

1. Understand overview of metabolism: major steps, major goal, catabolism/anabolism.
2. Understand relationship between free energy change ΔG and the spontaneity of a reaction (signs, endergonic/exergonic). Be able to draw energy diagrams for spontaneous and nonspontaneous reactions.
3. Understand how coupling of reaction can make an unfavorable reaction go forward. Write equation for the net coupled reaction given two reactions. Calculate overall ΔG for coupled reaction, and predict whether a couple reaction is spontaneous or not.
4. Be able to draw structure of the mitochondria (their membrane boundaries) and indicate where citric acid cycle and electron transport/oxidative phosphorylation takes place.
5. Explain reasons why ATP is the primary energy-carrier in cells.
6. Know the roles of NADH and FADH₂, and recognize their oxidized and reduced forms. Also recognize the oxidized and reduced forms of the compounds that reacted with those coenzymes in a redox reaction.
7. Citric Acid Cycle
 - Know overall reaction equation, including how many ATP (GTP), NADH, and FADH₂ are formed.
 - Given the structure of each intermediate in the pathway, explain what is happening each step: the type of reaction(s), the type of enzyme that catalyzes the reaction (particularly dehydrogenase), number of carbons in the intermediate, and where the CO₂, GTP, NADH, and FADH₂ are produced.
8. Electron transport chain/oxidative phosphorylation
 - Explain what is occurring overall, which compounds are oxidized and reduced, how electrons are passed through different coenzymes/proteins, and how energy is generated.
 - Explain how ATP is formed through proton gradient and ATP synthase.
 - Know how many molecules of ATP are formed from a molecule of NADH, FADH₂.

Ch 21. Carbohydrates

9. Know the definition of carbohydrates, monosaccharides, disaccharides, and polysaccharides.
10. Classify monosaccharides according to type of functional group and number of carbons (eg. aldopentose).
11. Understand stereoisomerism of monosaccharides:
 - Understand the terms "optically active," chirality, enantiomers, and diastereomers.
 - Draw Fischer projections for enantiomers and diastereomers of monosaccharides; conversely, given structures, be able to identify D- and L enantiomers and diastereomers of monosaccharides.
12. Understand the cyclization reaction of monosaccharides:
 - Understand that the cyclization reaction is a hemiacetal formation.
 - Given the Fischer projection of a linear monosaccharide, be able to draw its cyclic structure.
 - Distinguish between α and β anomers.
 - Understand mutarotation.
13. Understand the oxidation reaction of monosaccharides and disaccharides:

- Understand why all monosaccharides are reducing sugars, even ketoses (We've learned that ketones cannot be oxidized) when under basic conditions.
 - Identify which monosaccharides and disaccharides are reducing sugars based on their structure.
14. Understand the reaction of monosaccharides with alcohols to form glycosidic bond and disaccharide:
- Know what a glycoside is.
 - Draw reaction equation for glycoside formation, and how this reaction relates to hemiacetals and acetals.
 - Draw reaction equation for the formation of a disaccharide, given the structures of the monosaccharide reactants. Also, be able to draw the equation (including catalyst required) for the reverse reaction: hydrolysis of a disaccharide.
 - Be able to identify and draw glycosidic linkages, using correct carbon-to-carbon linkage and α/β form.
15. Know general properties of, and similarities and differences among, the monosaccharides glucose, galactose, and fructose; the disaccharides maltose, lactose, and sucrose; and the polysaccharides cellulose, amylose, amylopectin, and glycogen.
16. Know experimental tests for reducing sugars and for starches: Fehling's test, Barfoed's test, Seliwanoff's test, and iodine test.

Ch 22. Carbohydrate Metabolism

17. Know the overall catabolic pathway for the complete catabolism of dietary carbohydrates:
- The major steps and the products of those steps (digestion, glycolysis, pyruvate oxidation, citric acid cycle, and electron transport/oxidative phosphorylation).
 - Be able to draw structure of the cell and the mitochondria (their membrane boundaries) and indicate the sites of the major steps in carbohydrate metabolism. Also know sites of digestion.
 - The number of ATP and reducing agents produced from each step.
 - Understand how and where carbohydrates are digested.
18. Explain why glucose is immediately phosphorylated to become glucose-6-phosphate when it enters a cell.
19. Explain the different pathways glucose-6-phosphate can take, depending on the needs of the cell.
20. Understand glycolysis:
- Know overall reaction equation, including how many ATP, NADH, and pyruvate are formed.
 - Given the structure of each intermediate in the pathway, explain what is happening each step, the type of reaction(s), and the type of enzyme that catalyzes the reaction (in particular kinase, isomerase, and dehydrogenase).
21. Explain the three different pathways that pyruvate can take, depending on the needs of the cell. Know reaction equation for each pathway.
22. Calculate the total yield of ATP from the complete catabolism of a molecule of glucose by adding up the ATP from each step (from glycolysis, pyruvate oxidation, citric acid cycle, and electron transport chain/oxidative phosphorylation). Also, be able to determine the ATP yield from a molecule of pyruvate and a molecule of acetyl-CoA.
23. Explain how the glucose level in the blood is maintained with insulin and glucagon.
24. Explain how the body gets energy during fasting and starvation (order of usage of major food molecules, how they are used).

*During the exam, you will have access to the diagrams of glycolysis and citric acid cycle from handouts, with the names of enzymes removed.

Check out Prof. Fossum's website for sample problems for the exam (NOTE: These are SAMPLES of question; they are not comprehensive!):

1) Questions #23-30 ONLY, from: <http://www.laney.edu/wp/cheli-fossum/files/2012/01/30B-Ex-2-S12503.pdf>

Key to above questions: <http://www.laney.edu/wp/cheli-fossum/files/2012/01/30B-Ex2-S12-Key645.pdf>

2) Questions #13-28 ONLY, from: <http://www.laney.edu/wp/cheli-fossum/files/2012/01/Exam-3-Sp12-30B.pdf>

Key to above questions: <http://www.laney.edu/wp/cheli-fossum/files/2012/01/30B-Exam-3-S12-Key662.pdf>