

Test #1
 Bio 366: Biological Chemistry II
 100 points + 2 bonus points (9 pages, including key)

READ THIS: Take a numbered test and sit in the seat with that number on it. Remove the numbered sticker from the desk, and stick it on the back of the last page of the test. Print your name on the top of each page and the last four digits of your social security number on the back of the test. When you have finished, hand in your test and sign your name on the sign-out sheet (according to number) by the door. The answers will be posted outside of Dr. Stewart's office (Bio 229) by tomorrow. If you wish to challenge an answer, please make a written explanation.

A. True or False. Circle the correct answer. (1 point each, 20 points total.)

1. T F HDL, the "good cholesterol", transports endogenous cholesterol and cholesterol esters from the tissues to the liver.
2. T F Saturated fatty acids are very flexible molecules, and thus cannot pack together tightly
3. T F Humans cannot biosynthesize the essential fatty acids.
4. T F Carbon dioxide fixation takes place in the TCA cycle.
5. T F Most fatty acids found in eukaryotes have an odd number of carbon atoms.
6. T F β -oxidation of fatty acid molecules produces water as a byproduct.
7. T F Many steroid hormones, such as *estrogen*, *testosterone*, and *insulin*, are synthesized from cholesterol.
8. T F Under conditions of starvation, the so-called "ketone bodies" can become the major source of metabolic fuel for the brain.
9. T F You have printed your name at the top of each page and your social security number on the back of the last page. (If you do not do this, you will lose 1 point!)
10. T F Cellulose accounts for about 1/2 of the carbon found in the biosphere.
11. T F NADPH and ATP are consumed in the dark reactions of photosynthesis.
12. T F EPA (5,8,11,14,17-eicosapentaenoic acid) is an ω -6, C₂₀ fatty acid.
13. T F Glycogen, amylopectin, and amylose have one reducing end per molecule.
14. T F Biosynthetic and degradative pathways of metabolism are almost always different (that is, involve different enzymes).
15. T F Carbon dioxide is evolved and oxygen is consumed during photorespiration.
16. T F The light reactions of photosynthesis take place in the thylakoid membranes of plant cells, whereas the dark reactions take place in the lumen.
17. T F Leukotrienes are transported in the bloodstream to their sites of action.
18. T F Bile acids are synthesized in the pancreas from cholesterol.
19. T F Low density lipoproteins have densities less than water (1.0 g/mL).
20. T F Oxygen is the ultimate electron donor for photosynthetic NADP⁺ reduction.

B. Using the attached key (p. 3), match the enzyme/protein/process: Write the letter of the correct answer(s) in the blank next to the statement. Some have more than one correct answer; list them all for full credit. The same letter may be used for more than one answer, or may not be used at all. Note that #54 is NONE OF THE ABOVE. (1 points each; 25 points total)

1. _____ Photolysis occurs at its manganese complex.
2. _____ Binds and transports short-chain fatty acids through the bloodstream.
3. _____ Patients with McArdle's disease lack this enzymatic activity in their muscles.
4. _____ An endoglycosidase.
5. _____ Is inhibited by cholesterol and drugs such as Lovastatin.
6. _____ Hydrolyzes triacylglycerols *within* adipocytes.
7. _____ Is directly involved in pumping protons *from the stroma to the lumen*.
8. _____ An extracellular enzyme that is activated by apoprotein C-2.
9. _____ Hydrolyzes triacylglycerols at both the C-1 and C-3 positions.
10. _____ An enzyme that is *directly* involved in carbon dioxide fixation.
11. _____ Binds to the LDL receptor on the surface of liver cells, thus initiating receptor-mediated endocytosis.
12. _____ During cyclic photophosphorylation, electrons are cycled back from ferredoxin to it.
13. _____ Catalyzes the hydrolysis of pyrophosphate to 2 P_i.
14. _____ P700 is its photosynthetic center.
15. _____ Has both amylo-(1,4→1,6)-transglycosylase and α(1→6) glucosidase activities.
16. _____ The three major enzymes involved in glycogen synthesis.
17. _____ Is inhibited by non-steroidal anti-inflammatory drugs (NSAIDS).
18. _____ The principal protein found in HDLs.
19. _____ Photosynthesis depends on these heme-like molecules that absorb light.
20. _____ Secreted from the endocrine (or islet) cells of the pancreas.
21. _____ Is the major structural carbohydrate found in plants.
22. _____ Isozymes that digest starch in the gastrointestinal tracts of humans.
23. _____ Comprises about 15% of the protein content of chloroplasts, and is believed to be one of the most abundant proteins on earth.
24. _____ Is activated by AMP and inhibited by ATP and glucose-6-phosphate.
25. _____ Acts as a primer for glycogen synthesis.

Key for matching section B (page 2). You may remove this page, and need not hand it in.

1. acyl-CoA cholesterol acyltransferase (ACAT)
2. adenylyl cyclase
3. α -amylase, pancreatic
4. α -amylase, salivary
5. apoprotein B-100
6. apoprotein C-1
7. apoprotein C-2
8. apoprotein C-3
9. apoprotein E
10. cellulase
11. cholesterol ester transfer protein
12. chylomicron
13. clathrin
14. cyclooxygenase
15. cytochrome *b6* / cytochrome *f* complex
16. diacylglycerol acyltransferase
17. fatty acid synthase
18. ferredoxin
19. ferredoxin:NADP⁺ reductase
20. glucagon
21. glucokinase
22. glucose-6-phosphatase
23. glycogen branching enzyme
24. glycogen debranching enzyme
25. glycogenin
26. glycogen phosphorylase
27. glycogen synthase
28. glycosidase
29. HMG-CoA reductase
30. inorganic pyrophosphatase
31. insulin
32. LDL receptor
33. lecithin:cholesterol acyltransferase (LCAT)
34. lipase, diacylglycerol (DAG)
35. lipase, lipoprotein
36. lipase, lysosomal
37. lipase, monoacylglycerol (MAG)
38. lipase, pancreatic
39. lipase, triacylglycerol (TAG)
40. lipoxygenase
41. monoacylglycerol acyltransferase
42. nucleoside monophosphate kinase
43. nucleoside diphosphate kinase
44. plastocyanin
45. plastoquinone
46. phosphoglucomutase
47. phospholipase A2
48. prostaglandin (endoperoxide) synthase
49. photosystem I
50. photosystem II
51. rubisco (ribulose bisphosphate carboxylase)
52. serum albumin
53. UDP-glucose pyrophosphorylase
54. NONE OF THE ABOVE

C. Draw the structures of the following molecules, numbering and labeling their atoms appropriately (12 points total):

1. A generic triacylglycerol (TAG) molecule, with carbon and R groups numbered (3 points):

2. Sucrose (number the carbon atoms; 3 points):

3. Linoleic acid (Draw all carbon atoms, and number them; label the α and ω carbons; 3 points):

4. Stearic acid (Draw all carbon atoms, and number them; label the α and ω carbons; 3 points):

D. Describe the three ways by which carbon dioxide fixation is regulated indirectly by light. Be succinct. Do not write on the back of the page. (6 points)

E. Describe the *intracellular* catabolism of glycogen, including all major enzymatic reactions and explaining the energetics. Be succinct; do not write on the back of this page. (12 points)

F. Briefly explain the generation of the "ketone bodies" from acetyl-CoA, including the structures of the ketone bodies (1 point each structure). Explain the biological function of the ketone bodies, including the regeneration of acetyl-CoA. NOTE: You do not need to be able to draw both pathways and know all intermediates and enzymes to get full credit on this question. (7 points total)

G. Explain the creation of LDL and its receptor-mediated endocytosis. Start just *after* the formation of VLDLs by the liver and end with the formation of clathrin-coated vesicles. Use drawings to illustrate the process, as appropriate. Be succinct; do not write on the back of this page. (10 points)

H. "Olestra" (trade name: "olean") is a fat substitute developed by Procter & Gamble over the past 25 years at a cost of about \$200 million dollars. Olestra passes through the gut without being digested or absorbed, thus effectively has no calories (but—beware!—it can cause "distress"). The structure of olestra is a long carbohydrate chain with many fatty acids attached. Using your knowledge about lipid structures and their enzymatic digestion, come up with a reasonable hypothesis as to why olestra is not digested and absorbed in the guts of humans or other mammals. Explain this hypothesis, and how you might test it. (6 points).

I. You have purified a new enzyme from the pancreas of a plant-eating cichlid fish found in Lake Victoria. Careful characterization of this enzyme showed that it randomly cleaves internal glycosidic bonds between the glucose units of cellulose. You and your colleagues are very excited about this amazing result, and realize that it will result in a landmark paper that should make the news and change the textbooks. 1) Briefly explain what is so unique about this discovery (2 pts):

2) For 2 BONUS pts: You must give this new enzyme an appropriate name. The Enzyme Commission (EC) of the International Union of Biochemistry requires that an enzyme be given a formal name that accurately describes its enzymatic reaction. What would you name your new enzyme for the EC?