Good morning! You are at the end of this beginning on the road to metabolism. You have learned over three hundred terms, hundreds of reactions, and come to see that life is an astonishing, self-regulating blizzard of molecular transactions. Every time I teach this class I learn something (for example: it is possible to get tired of eating steak…). Really, it is a pleasure and an honor to teach you these things, so thanks for your attention and interest.

You should have one seat between you and your neighbors on each side. Not 2, not 3. One. That way all can have a seat with a writing surface.

For all questions, choose the BEST answer from those offered, and enter it onto the appropriate space of the scantron sheet.

**Use a number 2 pencil only.**

You can keep this question sheet after the exam. I advise you to write the correct answer beside each question, and only then to enter the number on the scantron sheet. That way, you will be more careful in making your entries, also you will have a reference for the answers you chose for post-test learning. Good luck!
1. Fully reduced ubiquinol
   A) Is a substrate for complex II
   B) Is a substrate for complex IV
   C) is a substrate for complex III
   D) is a product of complex IV

2. Fatty acids derived from the foods we eat most often
   A) Are hydrolyzed from the foods we eat and then used to synthesize triglycerides
   B) Are hydrolyzed from the ingested molecules and then enter the bloodstream directly
   C) Are transferred directly from the gut to the bloodstream
   D) Are absorbed directly and then packaged as free fatty acids into lipoprotein

3. Lesch-Nyhan disease
   A) Is a genetic defect in pyrimidine salvage
   B) Is a genetic defect in de novo purine synthesis
   C) Is a genetic defect in amino acid catabolism
   D) Demonstrates the importance of salvage pathways

4. What type of molecule does not bind to the active site of an enzyme
   A) A homotropic allosteric regulator
   B) A product that causes inhibition by slow dissociation
   C) A heterotropic allosteric regulator
   D) A competitive inhibitor

5. The fatty acid synthase (FAS) complex in mammals
   A) Uses NADPH in both reduction steps
   B) Uses a free ACP as part of the complex
   C) Has more proteins than the bacterial complex
   D) Has the same number of proteins as the bacterial complex

6. A spontaneous chemical reaction
   A) Must have a negative $\Delta H$ and a positive $\Delta S$
   B) Must have a positive $\Delta H$
   C) Must have a negative $\Delta S$
   D) Can have a negative $\Delta H$ or a positive $\Delta S$

7. Glucose monomers are added to a growing glycogen chain by the action of glycogen synthase on:
   A) glucose-1-P
   B) CDP-glucose
   C) AMP-glucose
   D) UDP-glucose
8. What feature of chloroplast glyceraldehyde-3-phosphate dehydrogenase (GAPDH) is different from cytosolic GAPDH?
A) The chloroplast version catalyzes production of G3P whereas the cytosolic one catalyses the consumption of G3P
B) The chloroplast version uses P, P (pyrophosphate) whereas the cytosolic one uses Pi
C) The cytosolic one uses NAD+/NADH, whereas the chloroplast one uses NADP+/NADPH
D) The chloroplast version is a rate-limiting enzyme

9-12 Is it nada, or ENADA?.. You be the judge...

9. What is the main function of NADH in the cell
A) It serves as the main source of electrons for respiration
B) It is the main anabolic reducing agent in cells
C) It is consumed by the Krebs cycle as a substrate
D) It is a substrate of a glycolytic reaction

10. What would the effects of “ENADA” (NADH) be on the Krebs cycle?
A) It would slow the Krebs cycle
B) It would stimulate the Krebs cycle
C) It would hasten the Krebs cycle by increasing respiratory electron flow
D) It would have no effect on Krebs because that cycle uses NADP+ as a substrate

11. What are the effects of consumption of large amounts of ethanol on the levels of NADH, our natural “ENADA” (from the problem set)
A) A large increase in glycolytic rate
B) A large increase in Krebs cycle activity
C) A large decrease in the NADH/ NAD+ ratio
D) A large increase in the NADH/ NAD+ ratio

12. Could “ENADA” affect the biochemistry of the mitochondrial matrix, assuming it can get into the cytosol?
A) No! It is impermeable to the mitochondrial inner membrane
B) Yes! It will directly react with complex I
C) No! It is not a substrate for any of the matrix-localized reactions
D) Yes! It will send its electrons in by the malate-aspartate shuttle

End of: Is it nada, or ENADA?.. You be the judge
13. When describing the involvement of the chemiosmotic gradient in chloroplast ATP synthesis
   A) The electrical potential across the membrane is more important
   **B) The H⁺ concentration gradient is more important**
   C) The two components are of equal importance
   D) The concentration of H⁺ ions is higher in the stroma than in the lumen

14. How many adenine nucleotide binding sites are there in the assembled F1 ATP synthase?
   A) one
   B) two
   **C) three**
   D) none

15. Ketone body synthesis
   A) Shares the first two steps of cholesterol synthesis
   B) Occurs in the mitochondrial matrix
   C) Is caused by excessive glycolysis when Krebs cycle activity is low
   D) Involves malonyl-CoA as an intermediate

16. Insulin regulates the glycogen processing enzymes by:
   A) increasing phosphorylation of both glycogen synthase and glycogen phosphorylase
   B) increasing phosphorylation of glycogen synthase but decreasing phosphorylation of glycogen phosphorylase
   C) decreasing phosphorylation of glycogen synthase but increasing phosphorylation of glycogen phosphorylase
   **D) decreasing phosphorylation of both glycogen synthase and glycogen phosphorylase**

17. Type 2 diabetes
   A) is less prevalent than type 1 diabetes
   B) occurs at a fairly constant frequency in people over time
   **C) has strong but complex genetic determinants in people**
   D) is usually observed early in a person’s life

18. An inhibitor of mitochondrial ATP synthase would
   A) increase electron flow through the respiratory chain
   **B) stop electron flow through the respiratory chain**
   C) activate the Krebs cycle
   D) have no effect on the respiratory chain

19. The fatty acid most directly involved in inflammation is
   A) Archangelic acid
   **B) Arachidonic acid**
   C) Oleic acid
   D) Linolenic acid
20. Fructose 2,6 bis-phosphate is
   A) a glycolytic intermediate
   B) controlled by both insulin and glucagon
   C) produced in response to elevated glucagon
   D) a direct regulator of glycogen breakdown

21. Behold! A Lineweaver-Burke plot!! For the two enzymes depicted (A and B) decide which is true in comparing A to B
   A) A has a smaller Km and a smaller Vmax
   B) A has a smaller Km, and a larger Vmax
   C) A has a larger Km, and a smaller Vmax
   D) A has a larger Km and a larger Vmax

22. The fatty acid in the picture, called heptadecanoic acid, has the indicated carbon labeled with $^{14}$C. After complete $\beta$-oxidation of this molecule, but before any further metabolism of the products, where would you expect to find this carbon?
   A) In the CH$_3$ group of acetyl-CoA
   B) In the carbonyl group of acetyl CoA
   C) In a CH$_2$ group of succinyl-CoA
   D) In the carbonyl group of pyruvate

23. What is the function of the $F_o$ subunit of ATP synthase
   A) Allows H$^+$ ions to flow across the membrane in a manner that enables use of the released energy
   B) Allosterically regulates ATP hydrolysis by the $F_1$ subunit
   C) Spans the outer membrane of the mitochondrion
   D) Binds ADP and P$\_i$ to allow catalysis of ATP synthesis

24-27 Pictures at a glycogen exhibition For the next 4 questions, use the schematic picture of glycogen shown to figure out the best answer. Each circle is a glucose monomer.

24. How is B bound to the glucose next to it?
   A) An alpha 1-4 linkage
   B) An alpha 1-6 linkage
   C) A phosphate connects them
   D) A hydrogen bond connects them
25. Which glucose would you expect to be bound to glycogenin
   A) none of them
   B) B
   C) F
   D) all the free 4-OH ends, including B

26. If this little glycogen molecule was put in a solution of glycogen phosphorylase which glucose would most likely modified first
   A) A
   B) B
   C) C
   D) F

27. Which of the circles is connected to another by an alpha 1-6 glycosidic bond?
   A) all of circles are connected with this bond
   B) B
   C) C
   D) F

End of glycogen pictures at an exhibition questions

28. Aspirin
   A) Is an inhibitor of the synthesis of an unsaturated fatty acid
   B) Is an inhibitor of the oxidation of an unsaturated fatty acid
   C) Is an inhibitor of the transport of an unsaturated fatty acid
   D) Is an inhibitor of the reduction of an unsaturated fatty acid

29. In the liver, insulin
   A) stimulates both glycogen synthesis and glycolysis
   B) stimulates glycogen synthesis and inhibits glycolysis
   C) inhibits both glycogen synthesis and glycolysis
   D) inhibits glycogen synthesis and simulates glycolysis

30. The “good leaving group” carrier most directly involved in phospholipid synthesis is
   A) UDP
   B) ADP
   C) CDP
   D) CoA-SH

31. RUBISCO is an enzyme that functions most directly in:
   A) The harvesting of energy from light
   B) The production of ATP in the thylakoid
   C) The fixation of carbon
   D) The oxidation of water
32. **Glucagon regulates the glycogen processing enzymes by:**
   A) decreasing phosphorylation of both glycogen synthase and glycogen phosphorylase
   B) increasing phosphorylation of glycogen synthase but decreasing phosphorylation of glycogen phosphorylase
   C) decreasing phosphorylation of glycogen synthase but increasing phosphorylation of glycogen phosphorylase
   D) increasing phosphorylation of both glycogen synthase and glycogen phosphorylase

33. **HMG-CoA lyase**
   A) Is inhibited by the class of drugs called statins
   B) Is a key enzyme in cholesterol synthesis
   C) Is critical for ketone body synthesis
   D) both A and B

34-39 **Name that pathway!!** The picture to the right is a schematic of one of the pathways that we have studied in class. It is not glycolysis, but something else that happens to glucose, and is represented by letters. Let’s think about that pathway.

34. **What is the name of this metabolic pathway?**
   A) The ribose shunt
   B) The pentose phosphate pathway
   C) The Calvin-Hobbs pathway
   D) The phosphogluconate pathway

35. **What is the name of the final product**
   A) ribulose-5-phosphate
   B) ribose-5-phosphate
   C) deoxyribose-5-phosphate
   D) ribose-1-phosphate

36. **Which step involves opening a ring structure?**
   A) Glu-6P to A
   B) A to B
   C) B to C
   D) C to product

37. **What product is produced twice in the reaction with letters?**
   A) NADPH
   B) CO₂
   C) NADH
   D) ATP
38. What product is produced once in the reaction \text{PATHWAY} with letters?
   A) NADPH  
   B) CO$_2$  
   C) NADH  
   D) ATP

39. Which molecule is directly involved (in plants) in carbon fixation?
   A) A  
   B) B  
   C) C  
   D) final product  

End of name that pathway!!

40. The inner membrane of the mitochondrion
   A) Is more permeable than the outer membrane  
   B) Is the site of porins that allow free diffusion of many molecules  
   C) Is completely impermeable  
   D) Has transporters for citrate, malate and pyruvate

41. The rate-limiting step for fatty acid oxidation is
   A) Transport of fatty acids into the mitochondrion  
   B) Oxidation of acyl-CoA to enoyl-acyl-CoA by NAD$^+$  
   C) Transport of fatty acids into the cytosol  
   D) Cleavage of \(\beta\)-keto-acyl-CoA into acetyl-CoA and acyl-CoA

42. In the liver, glucagon
   A) stimulates both glycogen breakdown and glycolysis  
   B) stimulates glycogen breakdown and inhibits glycolysis  
   C) inhibits both glycogen breakdown and glycolysis  
   D) inhibits glycogen breakdown and stimulates glycolysis

43. A yeast cell with a null mutation in fructose1,6 bisphosphatase is discovered. This strain would
   A) Not undergo glycolysis and not undergo gluconeogenesis  
   B) Be unable to regulate glycolysis, but would still regulate gluconeogenesis  
   C) Not undergo gluconeogenesis, but would undergo glycolysis  
   D) Be unable to regulate glycolysis and unable to regulate gluconeogenesis

44. The carbon in urea is derived from
   A) CO$_2$  
   B) serine  
   C) succinate  
   D) alanine
45-47 Sketchy ATP synthesis  Look at the little picture of an ATP-synthesizing entity. The “lollipops” represent ATP synthase molecules. The letters indicate the different compartments. Using the little sketch, answer the next few questions

45. **This picture could represent**
   A) Either a chloroplast or a mitochondrion
   B) Either a mitochondrion or a chloroplast in a plant cell
   C) A chloroplast but not a mitochondrion
   D) Either a gram negative bacterium or a chloroplast

46. **In order for this organelle to synthesize ATP, what has to be true?**
   A) The concentration of H\(^+\) ions is greater in Y than X
   B) The concentration of H\(^+\) ions is greater in X than Y
   C) The concentration of H\(^+\) ions is greater in Y than Z
   D) The concentration of H\(^+\) ions is greater in Z than Y

47. **Suppose that the little picture is indeed a chloroplast. Which statement is true**
   A) X is the stroma, Y is the lumen and Z is the cytosol
   B) X is the cytosol, Y is the stromosol, and Z is the lumen
   C) Y is the lumen, X is the matrix and Z is the cytosol
   D) X is the lumen, Y is the stroma and Z is the cytosol

End of Sketchy ATP synthesis

48. **Look at the picture of the lipid molecule. Which statement is true?**
   A) This is a diglyceride with an unsaturated fatty acid
   B) This is a diglyceride with a saturated fatty acid
   C) This is triglyceride
   D) This is a monoglyceride

49. **Suppose an enzyme had a Km of 20 \(\mu\)M. At what concentration of S would the enzyme rate be 1/3 of the maximum rate?**
   A) 20/3 \(\mu\)M
   B) 20 \(\mu\)M
   C) 10 \(\mu\)M
   D) Can not discern with this information

50. **For that enzyme with the Km of 20 \(\mu\)M, what is the kcat?**
   A) It approaches Km at high substrate concentration
   B) The kcat is equal to the Vmax
   C) 20 \(\mu\)M
   D) Can not discern with this information
51. Chylomicrons
   A) Are produced in the liver to send lipids to peripheral tissues
   B) Are storage particles in the cytosol
   C) Are generated in the gut to deliver dietary lipids to the bloodstream
   D) Are storage particles in the stroma

52. An enzyme critical in de novo purine synthesis is
   A) glutamine-amidotransferase
   B) alanine transaminase
   C) PRPP transaminase
   D) Ribose aminotransferase

53. The synthesis of phospholipids can occur
   A) By the direct addition of diacylglycerol to a free head group
   B) By the addition of head groups attached to a carrier to free diacylglycerol
   C) By addition of acyl chains to head groups attached to a carrier
   D) By both A and C

54. Urea produced by the urea cycle
   A) Has one nitrogen, and that nitrogen is derived directly from aspartate
   B) Has two nitrogens that are derived directly from aspartate and glutamine
   C) Has one nitrogen, and that nitrogen is derived directly from free ammonium
   D) Has two nitrogens that are derived directly from aspartate and free ammonium

55. Which enzyme functions in the Calvin cycle
   A) Pyruvate dehydrogenase
   B) Ribonucleotide reductase
   C) Ribulose carbamoylase
   D) Glyceraldehyde-3-phosphate dehydrogenase

56. The order of the first three reactions of normal \(-\)-oxidation are
   A) Oxidation of acyl CoA, dehydration of enoyl-acyl-CoA, then a second oxidation
   B) Oxidation of acyl-CoA, Oxidation of enoyl-acyl-CoA, then hydration
   C) Oxidation of acyl-CoA, hydration of enoyl-acyl-CoA, then oxidation
   D) Oxidation of acyl-CoA, dehyrogenation of b-keto-acyl-CoA, then hydration

57. C4 plants have found a solution to the following biochemical problem
   A) Nitrogen fixation can not occur in oxygen
   B) Oxygen can compete for CO\(_2\) in carbon fixation
   C) The RUBISCO reaction will run backwards in some conditions in the cell
   D) Oxygen will inhibit the reactions of photosystem II

58. Biochemical desaturation of fatty acids
   A) only occurs in mammals
   B) only occurs in plants
   C) can occur in both mammals and plants
   D) can create both cis and trans double bonds
59. Suppose the activation energy for a reaction increases by 20 kJ/mole. What is the ratio of the new rate constant to the old rate constant
A) Ratio = $e^{-(20/RT)}$
B) Ratio = $e^{20/RT}$
C) Ratio = $e^{-(\Delta G^\ddagger+20)/RT}$
D) Ratio = $e^{-(\Delta G^\ddagger)/RT}$

60. Addition of an ATPase inhibitor and an uncoupler to functioning mitochondria would
A) stimulate ATP synthesis
B) stop electron flow through the respiratory chain
C) inhibit the Krebs cycle
D) increase electron flow through the respiratory chain

61. The liver produces free glucose (with no attached phosphate) from glycogen by
A) no mean. The liver can not produce free glucose from glycogen
B) the action of phosphoglucomutase followed by the action of glucose-1-phosphatase
C) the direct action of the glycogen phosphorylase
D) the action of phosphoglucomutase followed by the action of glucose-6-phosphatase

62. The reaction written above is catalyzed by
A) Oxaloacetate synthetase
B) Citrate phosphorylase
C) Citrate lyase
D) Citrate synthase

63. The reaction written above has the main purpose of
A) being a “filling” or anpleurotic reaction
B) producing acetyl-CoA in the cytosol for anabolism
C) producing acetyl-CoA in the matrix for catabolism
D) lowering citrate to stimulate glycolysis

64. Which amino acid carries ammonia nitrogen from the muscles to the liver in a “safe” form
A) Glutamine
B) Ornithine
C) Aspartate
D) Glutamate
65. Which amino acid is part of the urea cycle but is not used as a structural amino acid in proteins
   A) aspartate
   B) ornithine
   C) arginine
   D) glutamine

66. Biotin is required for
   A) the oxidation of fatty acids
   B) the synthesis of fatty acids
   C) both the synthesis and oxidation of fatty acids
   D) neither the synthesis nor the oxidation of fatty acids

67. What cofactor is most important in the transfer and mobilization of amino groups in amino acid metabolism?
   A) biotin
   B) NAD⁺
   C) PLP
   D) TPP

68. Glycogen phosphorylase
   A) hydrolyses glycogen by adding water across a double bond
   B) removes phosphate from glycogen
   C) uses ATP as an energy source to produce glucose-1-P from glycogen
   D) uses free phosphate to produce glucose-1-P from glycogen

69. Muscle cells are not able to efficiently release glucose to the bloodstream derived from glycogen. This is because they lack
   A) the enzyme glucose-6-phosphatase
   B) a transporter for glucose
   C) the enzyme phosphoglucomutase
   D) debranching enzyme

70. Both type 1 and type 2 diabetes
   A) have shown dramatic rises in the past 20 years
   B) are caused by defective production of insulin
   C) are caused by poor muscle response to insulin
   D) are caused by defects in insulin regulation of metabolism

71. Glutamine synthetase
   A) catalyzes the formation of glutamate from a-ketoglutarate
   B) catalyzes the transfer of nitrogen from glutamine to a variety of molecules
   C) catalyzes the amidation of glutamate in an ATP dependent manner
   D) catalyzes the amination of glutamate in an NAD⁺ dependent manner
72. Fatty acid oxidation is regulated by fatty acid synthesis through
   A) production of fatty acid substrates that stimulate the pathway
   B) modification of acetyl-CoA to make an allosteric inhibitor
   C) modification of acetyl-CoA to make an allosteric activator
   D) covalent modification of carnitine acyl transferase I

73. Phosphoribosyl-pyrophosphate synthetase
   A) is a rate-determining enzyme in purine synthesis
   B) is a rate-determining enzyme in purine and pyrimidine synthesis
   C) is a key enzyme in the Calvin cycle
   D) is involved in the pentose phosphate pathway

74. Which is the correct order of appearance of molecules along the cholesterol
    synthetic pathway
   A) Acetoacetyl-CoA, mevalonate, squalene, cholesterol
   B) Isopentyl pyrophosphate, squalene, mevalonate, cholesterol
   C) Isopentyl pyrophosphate, mevalonate, squalene, cholesterol
   D) Mevalonate, b-OH-acetoacetate, squalene, cholesterol

75. The best description of the action of anti-cancer drug methotrexate is that it:
   A) Inhibits the reduction of dihydrofolate
   B) Inhibits the transfer of methyl groups to uridine
   C) Inhibits the reduction of ribose to deoxyribose
   D) Inhibits the synthesis of DNA

76. An example of a mitochondrial uncoupler is
   A) Ammonium ion
   B) Oligomycin
   C) Thermogenin
   D) Allopurinol

77. Deoxyribonucleotides are produced from ribonucleoties by the action of
   A) ribonucleotide reductase
   B) deoxyribonucleotide synthetases
   C) ribonucleotide dehydrogenase
   D) ribose deoxygenase

78. In normal green plant photosynthesis
   A) the electrons that leave photosystem II are returned to the photosystem
   B) the electrons that leave photosystem II are restored by oxidation of water
   C) the electrons that leave photosystem II are restored by photosystem I
   D) the electrons that leave photosystem II are replenished by generation of CO₂

79. The term BMI refers to
   A) A clinical measure of obesity
   B) An intermediate in the Calvin cycle
   C) A cofactor required for nitrogen metabolism
   D) Basal Metabolic Index
80. The water splitting complex uses the following metal ion
   A) cobalt
   B) manganese
   C) magnesium
   D) iron

81. Carbamoyl phosphate
   A) Is a critical substrate in purine formation
   B) Is a critical substrate in pyrimidine formation
   C) Is a critical substrate in purine and pyrimidine formation
   D) Is a critical substrate in purine and citrulline formation

82. The Pima native Americans
   A) Are strongly prone to obesity and type 2 diabetes
   B) Are unresponsive to diets that normally cause weight gain
   C) Have a defect in glycogen storage
   D) Have a natural diet rich in fish and unsaturated fatty acids

83. An inhibitor of complex II would
   A) block the reduction of cytochrome C
   B) block the conversion of succinate into fumarate
   C) stimulate the PDH complex
   D) stimulate the reduction of O₂

84. Which amino acid is part of the urea cycle and is also used as a structural amino acid in proteins?
   A) Glycine
   B) Ornithine
   C) Arginine
   D) Glutamine

85. HMG-CoA reductase
   A) is inhibited by the class of drugs called statins
   B) is a key enzyme in cholesterol synthesis
   C) is critical for ketone body synthesis
   D) Both A and B

86. HMG-CoA synthase
   A) is inhibited by the class of drugs called statins
   B) is a key enzyme in cholesterol synthesis
   C) is critical for ketone body synthesis
   D) Both B and C

87. Adenylylation of glutamine synthetase (GS)
   A) is regulated by uridylylation of the GS protein
   B) is allosterically regulated by uridine
   C) is regulated by uridylylation of the adenylylation enzyme
   D) is allosterically regulated by glutamine
88. **Glucagon causes the liver to**
   A) increase gluconeogenesis
   B) increase glycogenolysis
   C) decrease glycolysis
   D) All of the above

89. **Adipocytes**
   A) store and synthesize fatty acids
   B) take up fatty acids to convert them to acetyl-CoA
   C) store fatty acids and use them for their own metabolism
   D) take up fatty acids synthesized in the liver

90. **Which statement is true concerning the involvement of the chemiosmotic gradient in mitochondrial ATP synthesis**
   A) The electrical potential is more important
   B) The $H^+$ concentration gradient is more important
   C) The $H^+$ concentration gradient and electrical potential are of equal importance
   D) The concentration of $H^+$ ions is higher in the matrix than in the intermembrane space

91. **Suppose a redox reaction has a $\Delta G^o$ that is negative. What will determine whether that reaction will be spontaneous in the cell?**
   A) The reactions that come before and after it
   B) The number of electrons transferred
   C) The concentration of the enzyme that catalyzes the reaction
   D) The cellular concentrations of reactants and products

92. **A mitochondrial uncoupler would**
   A) increase electron flow through the respiratory chain
   B) stop electron flow through the respiratory chain
   C) inhibit the Krebs cycle
   D) stimulate ATP synthesis

93. **When exercising, the first way that ATP is replenished in muscle is by**
   A) glycolysis
   B) transfer of Pi from phosphocreatine to ADP
   C) oxidation of acetyl-CoA followed by respiration
   D) mobilization of glycogen stores
94-98 What a long, strange 'tryp its been…the next few questions pertain to the picture of the chymotrypsin active site, below.

94. The region labeled “hydrophobic” functions to
   A) stabilize the reaction product
   B) promote cleavage of specific bonds in proteins
   C) bind a nucleotide cofactor
   D) bind an allosteric regulator

95. The region called “+” is
   A) a proton donor site
   B) the carbanion pocket
   C) the oxyanion hole
   D) the specificity pocket

96. A nucleophile in this system is provided by
   A) The nitrogen on histidine
   B) A residue in region “+”
   C) The aspartate carboxyl group
   D) The serine OH

97. The function of the Asp and His are
   A) to facilitate acid base catalysis
   B) to provide and stabilize a nucleophile
   C) to ensure the pH of the active site is correct
   D) to activate water to begin the reaction

98. Is a covalent intermediate formed in this active site?
   A) Yes, bound to a residue in the “+” region
   B) Yes, attached to the His
   C) No, the enzyme does all its catalysis through non-covalent interactions
   D) Yes, to the serine OH

This is the end of the chymotrypsin picture questions

99. The rate-limiting step for fatty acid synthesis is
   A) Attachment of acetyl-CoA to the correct fatty acid synthase protein
   B) Transfer of acetate groups to the cytosol by carnitine
   C) Carboxylation of acetyl-CoA
   D) Production of methylmalonyl -CoA

100. Channeling
   A) Refers to the transport of molecules across the mitochondrial inner membrane
   B) Refers to the direct passage of molecules from one enzyme to another without entering solution
   C) Refers to regulation that causes metabolites to preferentially go down one branch of a metabolic pathway
   D) Refers to the preferential flow of electrons from photosystem II to photosystem I
101. There are two enzymes which we lack that allow plants and microorganisms to make glucose from fat. What are they called?
   A) Isocitrate lyase and malate synthase
   B) Isocitrate dehydrogenase and malate synthase
   C) Isocitrate mutase and malate synthase
   D) Isocitrate lyase and glyoxalate synthase

102-123 Metabolism, actually… the true/false section
for each question, choose the best answer. A is TRUE, B is FALSE

__F__ 102. Glyoxalate is produced when RUBISCO uses O₂ instead of CO₂

__F__ 103. Purines and pyrimidines are synthesized de novo by assembly of the base on the 1 carbon of PRPP

__T__ 104. Gluconeogenesis is a spontaneous reaction in cells

__T__ 105. Gluconeogenesis requires expenditure of ATP to run in cells

__F__ 106. Electrons excited by photosystem I always end up in NADPH

__F__ 107. A prochiral molecule can exist as two distinct enantiomers

__F__ 108. Complex I is an enzyme of the Krebs cycle

__T__ 109. There are large animals that depend solely on glycolysis for glucose-derived energy

__F__ 110. The human brain can only use glucose as a fuel

__F__ 111. Some Calvin cycle reactions are light-dependent

__F__ 112. The “shuffling reactions” of the Calvin cycle that restores the original substrate only occur in plants
113. Fatty acid synthesis and fatty acid breakdown communicate through levels of carboxylated acetyl-CoA

114. The CO₂ that is attached to pyruvate at the beginning of gluconeogenesis becomes part of the glucose carbon skeleton

115. Lipoic acid serves as both a functional group carrier and an electron carrier

116. TPP is a cofactor that reacts with the N of amino acids

117. NADP⁺ and NAD⁺ have very similar E°⁺ values

118. In synthesis of 16 carbon fatty acid from 8 acetyl groups, the carbons from the 6th acetyl group would be in positions 5 and 6 on the carbon skeleton

119. The chloroplast carries out gluconeogenesis in the stromal compartment

120. ob/ob mice have a deficiency in leptin action

121. The urea cycle occurs in the matrix of the mitochondrion

122. During intense exercise, phosphocreatine stores can last for approximately 30 minutes

123. At 8 am, my brain feels like it has no interest in taking up glucose, let alone information…