Study Guide for Unit 3

1. Define kinetic and potential energy.
2. Define chemical, transport, and mechanical work. What molecule is used as the energy in most of these?
3. Define calorie and joules.
4. Know the first and second law of thermodynamics and how it related to the metabolism.
5. Define ΔG, ΔH, T and ΔS in the free energy equation and understand how they relate to each other. When will reactions occur spontaneously?
6. Define chemical equilibrium and equilibrium constant.
7. Define $\Delta G^{o'}$.
8. What is ATPs role in metabolism?
9. What is a reductant? Oxidant? E_O? E'_O?
10. How do redox couples relate to each other? How does this affect organisms with difference electron acceptors?
11. Where does electron come from in heterotrophs, photoautotrophs, and chemoautotrophs?
12. Know the following electron carriers and their function in metabolism: NAD, NADP, FAD, FMN, CoQ, Cytochromes, and nonheme iron proteins (ferrodoxin).
13. What are enzymes and what is their function? Include apoenzyme, cofactor, holoenzyme & coenzymes.
14. What are the functions of enzymes and how do they work? Transition state?
15. How does pH and temperature affect enzymes?
16. Define K_m, V_{max}, 1/2 V_{max} and velocity.
17. What is a competitive and uncompetitive inhibitor? How do they affect K_m, V_{max}, 1/2 V_{max} and velocity?
18. Define metabolic channeling. How does it affect K_m, V_{max}, 1/2 V_{max} and velocity?
19. How are enzymes controlled and regulated?
20. What effect does allosteric regulation have on K_m, V_{max}, 1/2 V_{max} and velocity?
21. Define covalent modification of enzymes.
22. Describe feedback inhibition. Relate to ATP production.
23. Define metabolism, catabolism and anabolism.
24. What is the ultimate source of energy in an ecosystem?
25. Describe where electrons come from in metabolism. Include chemotrophic metabolism.
26. What the electron acceptors in chemotrophic processes?
27. Describe aerobic respiration by including energy source degraded, pathways involved, reduced, oxygen conditions, and ATP produced.
28. Describe anaerobic respiration by including the energy source degraded, pathways involved, reduced, oxygen conditions, and relative amount of ATP produced.
29. Define amphibolic pathway and give an example.
30. Know and diagram glycolysis or Embden-Meyerhof pathway. Include enzymes and names of all intermediates. Where does it occur in prokaryotes and eukaryotes? How much energy is produced in the form of NADH and ATP?
31. Know and diagram the Pentose Phosphate or hexose monophosphate pathway. Can it operate the same time as the glycolytic pathway? Why is it amphibolic? Know the transketolase and transaldolase steps. What sugars and molecules are produced from this pathway? How much energy is produced and in what forms? (i.e. NADH, NADPH, ATP)
32. Know and diagram the Entner-Doudoroff pathway. How much energy is produced and in what forms? How does it differ from the glycolytic pathway? Know some of the organisms it is found in.
33. Describe fermentation by including the pathways involved, energy source oxidized, reduced, oxygen conditions, ATP produced, and cellular location.
34. What are a homolactic fermenter, heterolactic fermenter, alcohol fermenter, and list microbial examples of each.
35. What are the fermentation products?
36. What is mixed acid fermentation and what lab test would you use to determine if it exists. Hint: I used *E. coli* as a control.
37. What test is used to test for butanediol fermentation? Know some examples of butanediol fermenters.
38. How are amino acids used in fermentation and by what reaction/pathway? What organisms do this?
39. Know and diagram the citric acid, TCA, or Kreb's cycle. Why is it amphibolic? What are the molecules throughout the cycle? What energy is given off and in what forms? What waist products are eliminated? Where does it take place in the cell (cellular location)?
40. Be able to summarize each pathway and cycle according to what goes in and what comes out. NADA, ATP, CO_2, etc…
41. What is the function and purpose of the electron transport chain? Where does it take place in eukaryotes and prokaryotes?
42. What determines how much energy is produced from the electron transport chain? Hint: anaerobic respiration and FADH2 produce less ATP per molecule.
43. Summarize the energy obtained from complete oxidation of one glucose molecule after the electron transport system. Include both ideal and realistic summaries.
44. How are prokaryotic ETCs different from eukaryotic ETCs? *E. coli* and *Paracoccus*.
45. Explain the chemiosmotic hypothesis and how it produces ATP.
46. What are the functions and subunits of an ATPase?
47. How do blockers and uncouplers inhibit ATP synthesis? Know some examples of each.
48. What are some of the functions of the proton motive force in addition to ATP synthesis?
49. Describe the Pasteur effect.
50. Know what anaerobic respiration is and some of the final electron acceptors.

51. Define dissimilatory nitrate reduction in terms of electron acceptor and final reduction product. What effect does it have on soil fertility?
52. Understand how polysaccharides are metabolized. What cleaves these molecules?
53. How are the polymers starch, glycogen, and PHB metabolized?
54. How are lipids metabolized?
55. How are proteins and amino acids metabolized? How does transamination work?
56. What are the key differences in chemolithotrophic and chemoheterotophic metabolism? Energy sources, metabolism…
57. What are the key functions of nitrifying bacteria?
58. What are the key functions of sulfur-oxidizing bacteria?
59. Are all chemolithotrophic organisms strictly chemolithotrophic?
60. How can many chemolithotrophs produce NADH needed for the Calvin cycle?
61. Define the light reactions and dark reactions.
62. What are the differences between oxygenic and anoxygenic photosynthesis?
63. List the photosynthetic eukaryotes and prokaryotes and define a oxygenic or anoxygenic.
64. What are chlorophylls and accessory pigments and their functions?
65. What are antenna complexes? Photosystems?
66. Describe green plant photosynthesis. Both cyclic and non-cyclic. What is produced in each?
67. Note the similarities between eukaryote photosynthesis and contrast it with the differences in Green and Purple bacteria.
68. How do purple and green non-sulfur bacteria generate NAD(P)H for CO_2 fixation? How is it similar to chemolithotrophic bacteria? Which photosystems do these bacteria have?
69. What advantages does using a limited number of amino acid in biosynthesis confer to the organism? How is using the same enzyme for anabolism and catabolism an advantage?
70. Are catabolism and anabolism pathways 100% identical? Explain. How are these pathways regulated since they share the same enzymes?
71. What advantages does coupling biosynthesis to ATP breakdown confer?
72. How does eukaryotic organism all catabolic and anabolic reactions take place in the same cell?
73. How do cofactors such as NADPH help control anabolic and catabolic reactions?
74. What are the three ways of CO_2 fixation and know some examples of each?
75. Where does the Calvin cycle take place in eukaryotes and prokaryotes?
76. What is the function of Rubisco and describe the carboxylation phase of the Calvin cycle?
77. What happens in the reduction phase of the Calvin cycle?
78. What happens in the regeneration phase?
79. Summarize the Calvin cycle?
80. Describe gluconeogenesis and how does it differ from glycolysis?
81. Describe sugar nucleoside diphosphates and how it functions in the synthesis of polysaccharides.
82. Describe the three ways inorganic phosphorus and one way organic phosphorus is assimilated.
83. Describe how organic and inorganic sulfur is assimilated.
84. How is the amino acid cysteine synthesized?
85. How is ammonia assimilated? Describe the amination/transamination pathway for alanine and glutamate. How is glutamate synthesized?
86. How is nitrate assimilated?
87. Describe nitrogen fixation and know some examples of organisms that fix nitrogen. What is the enzyme that fixes nitrogen?
88. Know where the amino acid precursors come from in the metabolic pathway.
89. What are anapleurotic reactions? Anaplerotic CO_2 fixation? Glyoxalate cycle?
90. Define and know a purine, pyrimidine, nucleoside, nucleotide and examples of each.
91. Understand purine and pyrimidine synthesis.
92. Describe fatty acid synthesis. Describe triacylgycerol and phospholipids synthesis.
93. How is peptidoglycan synthesized? What mechanisms previously discussed is involved?
94. What is the mechanism of action of penicillins? Where do they act? What step?
95. How do autolysins contribute to cell wall formation?
96. What are the two patterns of cell wall development as seen in Gram positive and many rod-shaped bacteria?
97. Define clone, genome genotype, and phenotype
98. How do we know that DNA is the genetic material for the cell? Cite Griffith's; Avery MacLeod & McCarty's; & Hershey and Chase.
99. What the differences between DNA and RNA? Diagram a DNA molecule, RNA molecule, and the bases for each.
100. Diagram a replicon. Note the location and function of the following enzymes: Helicase, Topoisomerase (DNA gyrase), Primase, DNA Pol III, DNA Pol I, & DNA ligase.
101. Diagram a replicon. Define the following: ss-binding protein, Okazaki fragments, leading strand, lagging strand, 5'⇒3', 3'⇒5', ori site, replication fork, & primer.
102. Define semi-conservative and rolling circle replication.
103. Note the differences between eukaryote replication and prokaryote (i.e. speed, numbers of ori sites).
104. DNA Pol III **actually** has an error frequency of 10-6 per base pair, why do we say that the polymerase has an error frequency of 10-9 per base pair?

105. Know replication of base pairs from DNA to DNA, transcription from DNA to mRNA, and translation from mRNA to protein. What role does tRNA play?