Name _____ Date _____ **Biochemistry Enrichment Extra Credit work**

For all chapters below: *Read* (or re-read) each relevant chapter of your textbook. *Take notes*, look up things you don't understand, and *write down questions* after you've tried to find the answer yourself (and also write down where you've looked for the answer).

Chapter 0: Chemistry and Biology Review

1. Define Biochemistry
2. Identify the following compounds as ionic or covalent, and draw the electron dot structures, including correct 3D orientation and polarity indicated.

   KBr H_2O CH_4 CO_2

3. Draw the structure of C_3H_7COOH. Is this molecule polar or non-polar? Explain.
4. List the following intermolecular forces from strongest to weakest, and describe the molecule type(s) required to participate in each interaction. (Van der Waals forces, Hydrogen bonds, Dipole-Induced dipole, electrostatic, Induced dipole – induced dipole, ionic)
5. Children's Tylenol (acetaminophen) comes in the bottle with a concentration of 160 mg / 5 mL. What is the concentration converted to micro grams per liter?
6. What is the molecular weight of $C_8H_9NO_2$ (acetaminophen)?
7. If 45.0 g of a solute (MW = 209 g/mol) is dissolved in 0.75 L of a solvent, what is the molarity of the solution?
8. How many g of $CaCO_3$ are needed to make 500. mL of a 2.5*M* solution?
9. 35 mL of a 3.0 *M* solution is diluted to 750 mL.
   a) What is the final concentration of the solution?
   b) Explain in words what you would do to physically make this dilution.

Chapter 1: Chemistry is the Logic of Biological Phenomena

10. Describe how cells display organization.
11. Describe how organisms display organization.
12. Explain, using two examples, how biological structures serve functional purposes.
13. Draw a diagram or explain in words how living systems (including individual cells) are engaged in energy transformations.
14. What are the properties of H, O, C, and N that allow them make up the majority of biological molecules?
15. Name and give a brief description of the organelles that are present in bacteria, plants, and animal cells (and know which ones have membranes or are membrane bound).
16. Which biomolecules are informational? What properties allow molecules to be informational?
17. Describe the polarity of polypeptides (proteins) and nucleic acids.

18. Which weak forces determine molecular structure and molecular interactions and why?
19. What are the three domains of life?
20. What are the similarities and differences between these three domains of life (including genome size)?
21. Describe virus structure and life stages.

22. The Beer-Lambert law relates concentration of a solution and absorbance. $A = \varepsilon * b * c$

    where **A** is the measured absorbance, ε is the wavelength-dependent molar absorptivity coefficient with units of M^{-1} cm^{-1}, **b** is the path length (usually in cm), and **c** is the concentration in units of molarity (M).

    a. Describe in words how absorbance of a solution is affected by concentration.
    b. Calculate the concentration of a solution with an absorbance of 0.794, a path length of 1.0 cm, and a molar absorptivity of 3.176 M^{-1} cm^{-1}

Chapter 2: Water, pH, and buffers

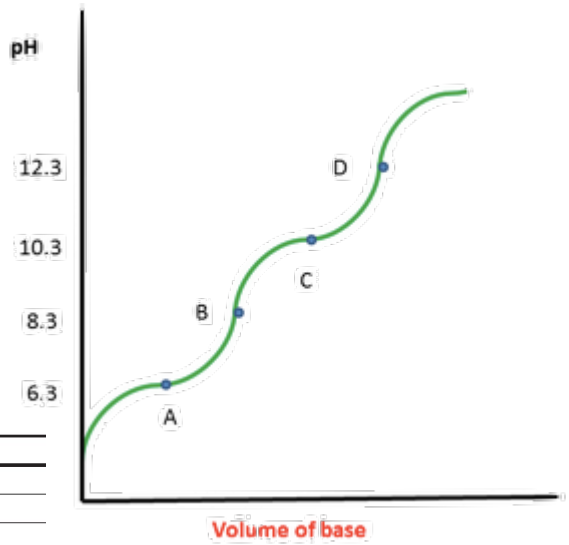
23. The properties of water underscore key biological processes. Explain, using key vocabulary from this unit, how water's structure and polarity impact:
    a) The density of ice versus the density of liquid water.
    b) Solvation of individual polar solutes versus individual non-polar solutes.
    c) Solvation of fatty acids at low concentrations, moderate concentrations, & high concentration.
    d) Explain what a clathrate is, and describe how the formation of a clathrate affects the entropy of water molecules.
24. Due to the strong electronegativity of oxygen, water ionizes. Write an equation for this ionization, and describe the identity and relative concentrations of the ionization products, including an equilibrium constant for this reaction.

25. Solve the following problems related to pH, pOH, Ka, and pKa:

    $Kw = 1 \times 10^{-14}\ M^2 = [H^+][OH^-]$ $\quad$ $HA \rightarrow H^+ + A^-$ $\quad$ $Ka = \frac{[H^+][A^-]}{[HA]}$

    a) If $[OH^-] = 4.8 \times 10^{-5}$ M, what is $[H^+]$?
    b) If the pH is 4.1, what is $[OH^-]$?
    c) What is the pH of a 0.65 M solution of an acid with a Ka of 4.83×10^{-7} M?
    d) What is the pKa of a 0.75 M solution that has a pH of 5.95? (Hint: calculate the $[H^+]$ first)
26. Explain the difference between and strong electrolyte and a weak electrolyte.
27. The Henderson-Hasselbalch equation states the relationship between the pH and pKa of a weak acid. When is the pH equal to the pKa of a weak acid?

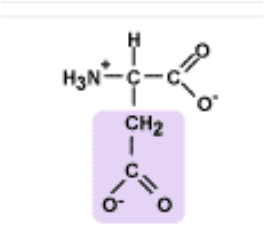
28. On the titration curve to the right, what point(s) represent(s) the pKa(s) of the buffer?
29. Explain why the pKa of a buffer is a useful tool when choosing a buffer.
30. What is a buffer, and what do they do?
31. Name three biological buffering systems.
32. What are "Good" buffers?
33. Using the table to the right, what is the effective buffering range of the following buffers:
    a) PIPES
    b) Bis-Tris
    c) MOPS
    d) HEPES



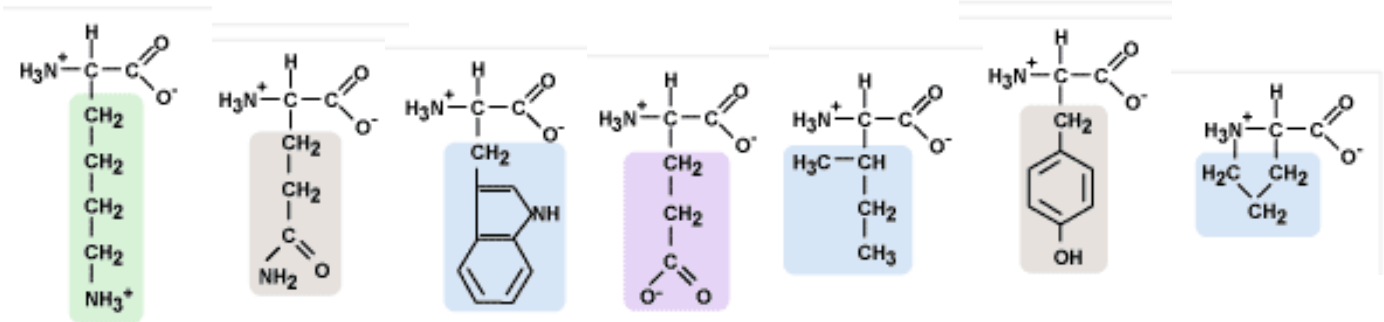
Good's Buffer	pKa (20 °C)
MES	6.15
Bis-Tris	6.46
ADA	6.60
PIPES	6.80
ACES	6.90
MOPSO	6.95
BES	7.15
MOPS	7.20
TES	7.50
HEPES	7.55
TAPSO	7.70

Chapter 4: Amino Acids and the Peptide Bond

34. Draw and label the structure of a generic amino acid?
35. How is a peptide bond formed between two amino acids? Draw the reactants and products of this reaction.
36. The amino acid aspartic acid (shown to the right) has carboxyl, amino, and R-group pKa's of 1.9, 9.6, and 3.7, respectively. At pH 13, what is the charge on aspartic acid?



37. Which of the following amino acids are…. Non-polar? Polar but uncharged? Acidic? Basic? Aromatic? Explain (give evidence for) each of your choices



38. How can amino acids be separated using liquid chromatography? Explain the methods Ion Exchange (either cation or anion), Size Exclusion, and Reverse Phase chromatography.
39. What are the spectroscopic methods by which amino acids can be analyzed? How, on a basic level, do they work? (Hint – can we use light / electromagnetic radiation to analyze proteins/amino acids?)

Chapter 5-6: Protein Structure

40. Define and explain the differences between primary, secondary, tertiary, and quaternary structure of proteins.
41. What are the characteristics of an alpha helix?
42. What are the characteristics of a beta sheet?
43. Would the peptide: L N A S M T F K be likely to be an alpha helix or a beta sheet? Explain why.
44. Write down the sequence of a peptide (8-10 amino acids) that would be likely to form an amphipathic alpha helix. Explain why you chose the amino acids in the order you did.
45. What are three common tertiary/quaternary protein folds?
46. What is the nomenclature of quaternary structure of proteins?
47. What is the secondary structure of an amino acid with phi & psi angles of:
    a) -100, 100 b) -90, -50 c) 90, -100

Review Chapters 9-10: Membranes & Membrane transport

48. Explain the differences between extrinsic and intrinsic membrane proteins.
49. Explain the differences between passive diffusion, facilitated diffusion, and active transport
50. Explain the "fluid mosaic" model of a membrane.
51. Explain the difference between lateral and transverse asymmetry in a membrane.
52. Describe three kinds of active transport in cells.

Chapters 11-12: Nucleic Acid Structure, Nucleic Acid Chemistry & Characteristics

53. Describe the "Central Dogma" of biology.
54. Explain the differences between, numbering systems and nomenclature of, and conformations of nitrogenous bases, nucleosides, nucleotides.
55. Explain why nucleotides are high energy molecules, and how cells use nucleotides for different purposes.
56. Summarize the experiments done by the following scientists to contribute to our understanding of DNA structure: Chargaff, Franklin, Pauling and Corey, Watson and Crick
57. What are some important consequences of the DNA model proposed by Watson and Crick?
58. What are some features of: mRNA, rRNA, tRNA?
59. Explain why DNA is more chemically stable than RNA.
60. What are the differences between exonucleases and endonucleases?

61. Why are polynucleotides at least three times as long as proteins?
62. Define and explain (compare/contrast) different types of DNA duplexes.
63. Why is ethidium bromide carcinogenic? (What does carcinogenic mean?)
64. Explain the factors that influence why different DNA duplexes/sequences have different denaturation/renaturation temperatures.
65. How and why is DNA packaged/folded in the cell? Be sure to name structures present at each stage of folding.
66. Why can't RNA form a duplex like typical B-form DNA?
67. What is the main type of secondary structure that RNA forms? Why/How does it do this?
68. Describe and name (you may also draw) the secondary structure features of tRNA.
69. Explain the process of PCR, include the purpose of each "ingredient"
70. Explain the products of the first three PCR cycles from ONE original template copy.