Student Name: _____ Circle One: **1:40** or **3:05**

Homework 1 Due: **Tuesday September 19 at 12 pm** WSC 209

1. You are studying a single-celled organism and want to categorize it further based on cellular characteristics. Initial analysis indicates that the cell contains both **DNA** and **mitochondria**.

1a. Is this information sufficient to determine whether the organism is a prokaryote or eukaryote? Indicate Yes or No. ***[2 pts]***

1b. If yes, indicate what information led you to your conclusion. If no, indicate what additional information you would need to discriminate between the two possibilities. ***[3 pts]***

2a. The upward movement of water in a tree depends on water's chemical properties. Explain how the chemical properties of water can facilitate this movement. ***[3 pts]***

2b. Water can rupture plant cells if it freezes (and even boulders for that matter). Explain this observation based on your knowledge of the chemical properties of water. ***[3 pts]***

2c. Would the observations in 2a and 2b be likely to occur if the oxygen and hydrogen in a water molecule had the same electronegativity? Explain. ***[4 pts]***

3. Imagine that you have discovered a new element in the soil of Mars called Marsantium (Ms). Martian elements have slightly different properties than elements found on Earth – **full valence shells have 16**

electrons rather than 2 or 8. Ms contains 15 electrons in its valence shell. (Assume that the laws of physics still apply on Mars.)

3a. Is Ms likely to be reactive (form bonds with other atoms)? Why or why not? ***[3 pts]***

3b. You mix Ms together with another Martian element, Alenium (Am). Alenium has a valence shell with 1 electron. What type of bond is most likely to form between these two atoms? In your answer, describe how the electrons are shared or gained/lost. ***[5pts]***

4. Extremophiles, organisms that thrive in extreme areas such as hydrothermal vents, have some unique requirements for life processes. For example, they use **sulfur** (S) from the hydrogen sulfide in the environment to capture energy in a similar manner to how humans use **oxygen** (O). Using the periodic table, explain how sulfur could substitute for oxygen in biochemical reactions. ***[5pts]***

5. A hypothetical element Ec has an atomic number of 156 and an atomic mass of 300.

5a. How many **neutrons** and **electrons** would be found in a neutral Ec atom? ***[4 pts]***

5b. If one **proton** were removed from Ec, would it still be the same element? Why or why not? ***[5 pts]***

5c. If one **electron** were to be gained by an atom of Ec, would it still be the same element? Would anything change about the element? ***[5 pts]***

6a**.** Is oxygen gas (O_2) a hydrophobic or hydrophilic molecule? Explain your answer. ***[5 pts]***

6b. How is oxygen transported in the blood of vertebrates such as human? How is this related to your answer in 6a? ***[5 pts]***

7a. Is the ammonia molecule (NH_3) polar or non-polar? Explain your answer based on the electronegativity of nitrogen and hydrogen atoms. ***[5 pts]***

7b. Make a drawing to support your answer in 8a. ***[5 pts]***

8. Radioactive elements allow scientists to label and detect specific molecules by measuring the radioactivity. Which radioactive element (C / H / O / N / S / P) may be used to detect ONLY the DNA (but not carbohydrates, proteins or lipids) in a cell? Explain why you selected this option. ***[4 pts]***

9. Draw **three water molecules** forming the hydration shell around **a potassium ion**. Label the charge on the potassium ion and partial charges on the atoms of the water molecules. ***[8 pts]***

10. The four main biological molecules (carbohydrates, proteins, nucleic acids and lipids) are all carbon-containing (organic) molecules.

10a. Do they all qualify as polymers? Explain. ***[5 pts]***

10b. List one property of carbon that allows it to form so many structurally diverse molecules. ***[3 pts]***

11. Cholesterol is hydrophobic, and not soluble in water. Yet it's common to determine blood levels of cholesterol. What would be one way in which a hydrophobic compound, like cholesterol, can travel through aqueous blood even though the compound is not soluble in water? ***[5 pts]***

12. If a cell is placed in a cooler environment, the fluidity of the membrane can decrease. Would the cell increase the amount of saturated or unsaturated fatty acids in the phospholipid bilayer to restore the normal level of fluidity? Explain your answer. ***[4 pts]***

13. The first case study of the course textbook explores how the first cell may have arisen given the complexity required for life and limited chemicals present on early Earth. The origin of life is still very much an active area of research. Read the following *Science* news article to learn about a recent discovery in this field, and answer the questions below.
http://www.sciencemag.org/news/2016/05/rna-world-inches-closer-explaining-origins-life

13a. What are two important properties of RNA that may suggest it is one of the first biological molecules (i.e. supporting the "RNA world" hypothesis)? ***[4 pts]***

13b. What is the major result demonstrated by Carell and colleagues? ***[3 pts]***

13c. Formaic acid or formamide are important for the reactions described by Carell and colleagues. What was a possible source of these chemicals on early Earth? ***[2 pts]***

STUDENTS: PLEASE INCLUDE THIS PAGE FOR CORRECTORS

Question	Points
1a, b	/5
2a, b, c	/10
3a, b	/8
4	/5
5a	/4
5b	/5
5c	/5
6a, b	/10
7a, b	/10
8	/4
9	/8
10a, b	/8
11	/5
12	/4
13a, b, c	/9

FINAL TOTAL /100