AP Biology

Summer Assignment

TURN IN THIS PACKET

Your name:

_________________

This packet includes the following:

☐ Principles of Life Chapter 2 Review
☐ Principles of Life Chapter 2 Applying the Concept and Investigation sections
☐ Principles of Life Chapter 3 Review
☐ Principles of Life Chapter 3 Applying the Concept and Investigation sections
☐ Reading Scientific Articles (Discussion questions, Experimental Design and Article analysis)
☐ Data Skills, Statistics, and Graphing Practice

Need to complete but not in this packet:

☐ Edx AP Biology Ramp Up Course (online)
☐ Buy Graphing Composition lab notebook for first day
The Chemistry and Energy of Life

Chapter Outline

2.1 - Atomic Structure Is the Basis for Life's Chemistry
2.2 - Atoms Interact and Form Molecules
2.3 - Carbohydrates Consist of Sugar Molecules
2.4 - Lipids Are Hydrophobic Molecules
2.5 - Biochemical Changes Involve Energy

Living organisms, such as birds and fish, are made up of cells—collections of molecules that work together. Interacting atoms make up the molecules, and it is necessary for you to understand a few details about atoms and molecules if you are going to be able to understand life. All life exists at the expense of its surrounding environment and is dependent on biochemical transformations of matter. These transformations occur within the laws of thermodynamics, specifying that energy is neither created nor destroyed and that disorder (entropy) increases during transformations.

Chapter 2 continues the consideration of Big Idea 1. Specific parts of the AP Biology curriculum that are covered in Chapter 2 include:

- 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

This chapter also begins your exploration of Big Idea 2, wherein you examine energy use by cells as you begin to catalogue the molecular building blocks of life processes. Included are:

- 2.A.1: All living systems require constant input of free energy.
- 2.A.3: Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.

The chapter introduces Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties. Specifically, it addresses:

- 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.
- 4.B.1: Interactions between molecules affect their structure and function.
- 4.C.1: Variation in molecular units provides cells with a wider range of functions.

Chapter Review

Concept 2.1 reviews some details about atomic structure in order to understand how molecules function in living organisms.

1. For each of the following, provide the number of electrons, protons, and neutrons, and the atomic number in its elemental form. Look for the information in your textbook or on a periodic table of the elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Electrons</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Atomic Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. hydrogen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. carbon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. oxygen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. phosphorus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Concept 2.2 explains how molecules result from interactions between atoms.

2. Arrange the following atomic interactions from strongest to weakest: van der Waals forces, covalent bonds, hydrogen bonds, ionic bonds.

   _______ > _______ > _______ > _______

3. Define cation.

   ____________________________________________

4. Define anion.

   ____________________________________________

5. Using sodium chloride as an example, explain how electron imbalances cause atoms to interact with one another.

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

6. Name the molecule shown by the two models at the right.

   Explain how the electrons of these atoms are affected by their atomic interaction, and describe what this does to the distribution of charge around the molecule.

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

7. Drawings (A) and (B) are shown at different magnifications. They represent three molecules, two of which are interacting with each other and a third that is interacting with itself. Explain the interactions in each. Then explain why you think (A) and (B) have either the same number of atoms or a different number of atoms.

   a. Interactions in (A) __________________________
      __________________________________________
      __________________________________________
      __________________________________________
b. Interactions in (B)__________________________________________
__________________________________________________________


c. (A) and (B) have (the same/a different) number of atoms because__________________________________________
__________________________________________________________
__________________________________________________________


d. More atoms are represented in drawing _____ because__________________________________________
__________________________________________________________
__________________________________________________________


8. The two chemicals at the right are found in the body and differ in their solubility in water. One is quite soluble, and the other is much less soluble. Explain this by completing the sentences below.

   a. Choice _____ is more water-soluble because__________________________________________
__________________________________________________________
__________________________________________________________

   b. Choice _____ is less water-soluble because__________________________________________
__________________________________________________________
__________________________________________________________

Concept 2.3 explains how carbohydrates, or sugar molecules, yield chemical energy when catabolized (taken apart). Many organisms, including plants, catabolize glucose and other sugars to liberate energy for their own use. Plants also synthesize sugars by using solar energy and environmental sources of carbon dioxide and water.

9. Solar energy drives ________________ in green plants, resulting in the synthesis of ________________, a monosaccharide. Sucrose is a disaccharide resulting from the formation of a ________________ linkage between two monosaccharides. The starch molecule, also known as ________________, is an even larger polymer of the products of these synthetic processes, and the most abundant member of this group on Earth is ________________.
10. Number the carbons in the figure at the right. What are the names of these two monosaccharides?

Concept 2.4 explains that lipids (fats) are large storage molecules that do not dissolve readily in water.

11. Refer to the models below.

a. Provide labels for the four different areas of the molecule, indicated by the four shaded blocks on each representation. (Two models are shown.)

b. The hydrophobic tail includes

c. The hydrophilic head includes

12. Steroids and other fatty substances pass readily through most cellular membranes because
Concept 2.5 explains how energy for life comes from biochemical changes in molecules.

13. Anabolic steroids are drugs that are sometimes misused by people who want to increase their athletic prowess. Describe what is meant by anabolic in this term.

Science Practices & Inquiry

There are seven Science Practices in the AP Biology Curriculum Framework. In this chapter, we focus on Science Practice 6: The student can work with scientific explanations and theories. More specifically, we look at Science Practice 6.2: The student can construct explanations of phenomena based on evidence produced through scientific practices.

Questions 14–17 ask you to construct explanations based on evidence of how variations in molecular units provide cells with a wider range of functions (Learning Objective 4.22).

In 1953, Stanley Miller and Harold Urey set up an apparatus, depicted at the right, to simulate Earth’s early atmosphere. The gases they added in their original setup were methane (CH₄), ammonia (NH₃), hydrogen (H₂), water (H₂O), carbon dioxide (CO₂), and nitrogen gas (N₂). Energy was added by passing a spark across two electrodes and by boiling the reactants. After one week of continuous sparking and boiling of this “primordial soup,” several amino acids—including aspartic acid, glycine, and alanine—were found in the condensed fluid from the apparatus.

The final lines from the original paper state:

In this apparatus an attempt was made to duplicate a primitive atmosphere of the earth, and not to obtain the optimum conditions for the formation of amino acids. Although in this case the total yield was small for the energy expended, it is possible that, with more efficient apparatus ... this type of process would be a way of commercially producing amine acids. A more complete analysis of the amino acids and other products of the discharge is now being performed and will be reported in detail shortly.


15. Define biogenesis.
16. Explain whether or not abiogenesis and biogenesis were demonstrated in the Miller–Urey experiment.

__________________________________________________________________________

17. Discuss this claim: "The Miller–Urey apparatus proves that life originated in a primordial sea."

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
Summer Assignment: Principles of Life Chapter 2

Applying the concept (pg. 22)

Applying the concept (pg. 31)

Investigation: Analyze the Data (pg. 32)

Please write you answers here and turn in this packet on the first day of school.
3

Nucleic Acids, Proteins, and Enzymes

Chapter Outline

3.1 – Nucleic Acids Are Informational Macromolecules
3.2 – Proteins Are Polymers with Important Structural and Metabolic Roles
3.3 – Some Proteins Act as Enzymes to Speed Up Biochemical Reactions
3.4 – Regulation of Metabolism Occurs by Regulation of Enzymes

As you saw in Chapter 2, smaller molecules (monomers) can bond together to form larger molecules (macromolecules). Chapter 3 focuses on the relationships between two related groups of monomers: the nucleic acids and the proteins. In later chapters, you will see that proteins form the structural components of many cells and serve as the enzymes that speed up many metabolic processes in the cells.

Chapter 3 continues the consideration of Big Idea 1 and investigates Big Idea 3 and Big Idea 4. You study the structure of RNA and DNA and examine proteins and enzymes. Specific parts of the AP Biology curriculum covering Big Idea 1: The process of evolution drives the diversity and unity of life, include:

- 1.D.2: Scientific evidence from many different disciplines supports models of the origin of life.

Specific parts of the AP Biology curriculum that address Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes, include:

- 3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

Specific parts of the curriculum covering Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties, include:

- 4.A.1: The subcomponents of biological molecules and their sequence determine the properties of that molecule.
- 4.B.1: Interactions between molecules affect their structure and function.

Chapter Review

Concept 3.1 explains how the nucleic acids DNA and RNA are polymers of nucleotides connected each to the next by a bond called a phosphodiester linkage. These macromolecules are used by cells to code genetic information because the sequence of nucleotides determines the sequence of amino acids in proteins. The structures of proteins, in turn, determine their structural, enzymatic, and other functions.

1. Identify the three major differences between RNA and DNA.

   a. ______________________________________________________

   b. ______________________________________________________

   c. ______________________________________________________

2. Explain the difference between a polynucleotide and an oligonucleotide. Give an example of each.

   ______________________________________________________

   ______________________________________________________

   ______________________________________________________
3. In the diagram at the right, identify and label all of the following:
   - two 3' ends
   - two 5' ends
   - four purine bases
   - four pyrimidine bases
   - ten hydrogen bonds
   - six phosphodiester bonds

   This drawing is an example of (circle one): DNA RNA

4. DNA sequences are frequently compared between two groups of organisms to determine how closely they are related in terms of their evolutionary past. For example, the Asian and African elephants were believed to be the only two living species of elephants. However, recent DNA testing showed enough DNA differences between Africa's forest and savanna elephants to identify them as two separate species. Explain why DNA sequences, but not carbohydrates or lipids, are used for this type of taxonomic analysis.

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Concept 3.2 explains how proteins are macromolecules comprised of amino acids linked together by peptide linkages. Proteins serve many diverse roles, including structural, metabolic, enzymatic, and regulatory. There are at least four levels of protein structure.

5. There are 20 different amino acids in humans. You do not need to memorize all 20, but you should know the structure of a generalized amino acid. At the right, draw a generic amino acid, using the letter "R" to designate a generic side chain, and be sure to include and label the carboxyl group and the amino group.

6. Explain how 20 different amino acids permit 75,000 different proteins to be found in humans.
7. Most proteins have at least four levels of physical structure. Briefly describe each level below, and identify where it is found in a protein molecule.

a. Primary: 

b. Secondary: 

c. Tertiary: 

d. Quaternary: 

8. Draw structural representations of glutamic acid and lysine.

a. Which has two carboxyl groups? 
Circle and label all carboxyl groups.

b. Which has two amino groups? 
Circle and label all amino groups.

c. In the space below, draw a dipeptide composed of lysine and glutamic acid bound together by a peptide bond. Identify the peptide bond with an arrow.
9. Different sequences of amino acids in proteins are the cause of different structures and functions of various proteins. A mutational change in the genetic code for a protein can change the sequence of amino acids that are peptide-bonded together during protein synthesis. Using the amino acids shown, explain what might happen to the structure of a protein for each of the substitutions described below.

<table>
<thead>
<tr>
<th>Leucine (Leu; L)</th>
<th>Cysteine (Cys; C)</th>
<th>Arginine (Arg; R)</th>
<th>Phenylalanine (Phe; F)</th>
<th>Alanine (Ala; A)</th>
<th>Aspartic acid (Asp; D)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Leucine" /></td>
<td><img src="image" alt="Cysteine" /></td>
<td><img src="image" alt="Arginine" /></td>
<td><img src="image" alt="Phenylalanine" /></td>
<td><img src="image" alt="Alanine" /></td>
<td><img src="image" alt="Aspartic acid" /></td>
</tr>
</tbody>
</table>

a. Leucine substituted for cysteine:

b. Arginine substituted for phenylalanine:

c. Alanine substituted for aspartic acid:

10. Identify which one of the two proteins shown at the right includes quaternary structure, and explain your choice.

(A) ![Protein A](image)  
(B) ![Protein B](image)

11. A solution was made of water, salts, and enzymes (functional proteins). After adding a strong acid, the enzymes no longer functioned as reaction catalysts. Explain how adding the strong acid altered the proteins' structures and functions. Be sure to include the following terms in your answer: protons, three dimensional structure, carboxyl groups, polarity, tertiary structure, and denaturation.

(A) The strong acid protonated the enzymes, causing structural alterations.  
(B) The strong acid disrupted the tertiary structure, leading to denaturation.
Concept 3.3 focuses on one of the major roles of proteins, that of enzymes or biological catalysts. Enzymes speed up some of the biochemical reactions of life by lowering the activation rate of such reactions.

12. Explain how an enzyme can speed up a chemical reaction between two substrate molecules.

13. On the graph below, label the following: the energy state of the products, the energy state of the reactants, the amount of energy of activation for the catalyzed reaction, and the amount of energy of activation for the uncatalyzed reaction.

![Graph showing free energy vs. time course of reaction]

14. The diagram below represents the enzyme sucrase. The specificity of most enzymes is such that each only "recognizes" very particular substrates. Using your knowledge of protein structure, explain how sucrase binds to the disaccharide sucrose but does not bind to most other disaccharides.

![Diagram of enzyme sucrase]

15. An "induced fit" occurs when enzymes change their shape as a result of binding to a substrate. Explain how binding to a substrate can cause an enzyme to change its shape.
16. Which of these three molecules—DNA, RNA, and protein—most likely operated prior to the appearance of the other two molecules? Explain how your choice of the earliest "proto-life" chemical can serve more than one function.

17. Explain the difference between cofactors and coenzymes in relation to the different functions of different proteins.

Concept 3.4 notes that regulation of enzymes allows organisms to more precisely maintain a constant internal state, a process called homeostasis. In addition to regulation, enzymes are affected by many environmental factors, including pH and temperature.

18. Regulation is an important part of homeostasis. What is a benefit of an organism being able to regulate an enzyme's activity, such as the breakdown of glucose?

19. Which picture in the diagram below is an example of allosteric regulation? Explain.

(A) Competitive inhibition

(B) Noncompetitive inhibition
Science Practices & Inquiry

Chapter 3 addresses Science Practice 4: The student can plan and implement data collection strategies appropriate to a particular scientific question. This exercise is based more specifically on Science Practice 4.1: The student can justify the selection of the kind of data needed to answer a particular scientific question, and Science Practice 4.2: The student can design a plan for collecting data to answer a particular scientific question.

20. Edward Stone’s letter to the Royal Society, dated 1763, detailed his ideas on aspirin as a painkiller. Stone tested 50 people to formulate his ideas. Design a sample that a scientist like Edward Stone could use for modern-day research in the drug industry. You may wish to research double-blind studies and include this in your design.
Summer Assignment: Principles of Life Chapter 3

Investigation: Analyze the Data (pg. 44)

Apply the concept (pg. 45)

Apply the concept (pg. 53)

Please write you answers here and turn in this packet on the first day of school.
READING SCIENTIFIC ARTICLES—Three Papers, Three Parts

PART I: Discussion Questions for Wright et al. article, Caffeine in Floral Nectar Enhances a Pollinator’s Memory of a Rewards:

1. What are plant defense compounds and how have they been used by humans? What are some examples of plant defense compounds other than caffeine that you might encounter in your daily life?

2. What is a selective advantage?

3. Why did the authors of the paper expect to find caffeine in the nectar of the flowering plants tested?

4. Explain —classical conditioning as used by the study’s authors. How would this method help reveal the effect caffeine has on memory formation in honey bees?

5. What is an action potential firing threshold?

6. Related to Fig. 1: Describe the technique the authors used to measure caffeine concentrations in Figure 1. What could be some other potential uses for this technique?

Complete on paper and hand in on first day of school
7. Related to Fig. 2: How did adding caffeine affect honey bees’ ability to learn? (Be descriptive! For example, did it help with short- or long-term memory? Did it help them learn faster, cause them to learn more slowly, or neither?)

8. Related to Fig. 3: What is a representative sample? Why would a representative sample be shown instead of the sum of all the data available?

9. Related to Fig. 3: Why were the study’s authors interested to find that adding caffeine to honey bee neurons pushed the membrane potential toward the action potential firing threshold?

10. Related to Fig. 3: Why did adding DPCPX eliminate the changes in holding current and membrane potential induced by caffeine? What did the authors learn as a result of this observation?

11. Related to Fig. 4: What is the significance of a caffeine concentration of 1 mM? How does that concentration correlate to the concentrations observed in plant nectar in Figure 1?
12. Related to Fig 4: Explain the conclusions drawn by authors on the effect of honey bees on flowering plant selection based on the data presented in Figure 4. Do you agree with their reasoning? Why or why not? What evidence presented in this paper confirms their conclusion or calls it into question?

PART II: Experimental Design Paragraph about an experiment described in the Ridaura et al. article, *Gut microbiota from twins discordant for obesity modulate metabolism in mice.*

Identify the following components of the experimental design below:

13. Null Hypothesis:

14. Experimental Hypothesis:

15. Independent variable (s):

16. Dependent variable (s):

17. Describe at least 5 Constants/ controlled variables:

18. Control group vs Experimental Group:

19. Conclusion? What evidence/data collected supports this?

Complete on paper and hand in on first day of school
Complete on paper and hand in on first day of school
Part III: Article Analysis using the article by Xie et al, *Sleep Drives Metabolite Clearance from the Adult Brain*

20. Why is the research in this paper important?

21. Describe how this paper shows that cells work together as a system. Give examples from the paper to support that statement.

22. What is a follow up topic or question that could be an area of further study?
There are many basic math skills you must be able to do to work with the more complex math problems in AP Biology.

- Working with decimals, ratios, fractions and percentages
- Convert scientific notation to standard numbers
- Report your answers with the number of significant figures that the question requires

Complete these problems to the best of your ability. SHOW WORK! I will check them on the first day of school.

**Decimals, ratios, fractions and percentages**

In a monohybrid cross, when two heterozygotes are crossed, the phenotypic ratio in the offspring is predicted to be in a 3:1 ratio; approximately 75% will show the dominant phenotype, and 25% will show the recessive phenotype. If those two heterozygotes have 400 offspring...

1. What is the expected phenotypic ratio? ______________
2. How many individuals will have the expected dominant phenotype? ______________

After a genetic cross of parents with the genotypes Aa and aa, there are 826 offspring.

3. What percentage of individuals will have the dominant phenotype? ______________
4. How many individuals are expected to have the recessive phenotype? ______________

In a dihybrid cross between two heterozygotes (AaBb x AaBb), if you have 200 offspring...

5. What percentage of offspring will have one dominant; one recessive phenotype? ______________
6. What number of individuals will have both dominant phenotypes? ______________
7. What ratio of offspring will have both recessive phenotypes? ______________

A portion of cells were observed under the microscope. The following data was observed; fill in the missing values in the table.

8. What percentage of the cells listed above are in mitosis? ______________

<table>
<thead>
<tr>
<th>Stage of the Cell Cycle</th>
<th>Number of Cells in each stage</th>
<th>% of Cells in each stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interphase</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Prophase</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Metaphase</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Anaphase</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Telophase</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Name:

**Converting scientific notation to standard numbers**

On the AP Biology exam, you will only be allowed to use a four function calculator. You will not be able to enter numbers using scientific notation. You must convert to standard numbers, then simply add or subtract (and maybe convert to percentages) to get the correct answer.

Energy Flow in a Hardwood Forest (see diagram to right)

9. What percentage of the biomass in the forest community is tied up in the grass layer? *hint energy is not lost or gained. **Give your answer to the nearest whole number.**

Here’s a food pyramid that begins with producers and ends with tertiary consumers.

10. If the producer level contains 25000kJ and this pyramid follows the 10% rule, how much energy gets transmitted to the tertiary consumers?

Study this age structure diagram that shows the human population for India.

11. What percent of the population is under 20? ________________

Complete this by hand and turn in on first day of school.
Calculating Rate of Change (slope)

12. Use the graph below to calculate the mean rate of population growth (individuals per hour) between hours 6 and 9. Give your answer to the nearest whole number. _____________

13. The graph shows the growth in cm of a pea plant over a period of 5 weeks. What was the average growth rate per day between week 1 and week 3? Give your answer to the nearest tenth. ____________

Some definitions. Use the internet to research the answers to the following questions:

14. Explain the difference between discrete variables and continuous variables. Give an example of each.

15. Explain the difference between quantitative and categorical variables. Give an example of each.

16. What is a null hypothesis? How is it different from an experimental hypothesis? (see http://psc.dss.ucdavis.edu/sommerb/sommerdemo/stat_inf/null.htm)
Types of Graphs


**Line Graph**

**Scatter Graph**

**Bar Graph**

Complete this by hand and turn in on first day of school.
Complete this by hand and turn in on first day of school.
Graphing is an important procedure used by scientists to display the data that is collected during a controlled experiment. **Line graphs** must be constructed correctly to accurately portray the data collected. Many times the wrong construction of a graph detracts from the acceptance of an individual’s hypothesis.

A graph contains five major parts:

- **Title**
- **The independent variable**
- **The dependent variable**
- **The scales for each variable/ Units**
- **A legend**

- **The Title**: depicts what the graph is about. It should be a concise statement placed above the graph.
- **The Independent Variable**: is the variable that can be controlled by the experimenter. It usually includes time (dates, minutes, hours, etc.), depth (feet, meters), and temperature (Celsius). This variable is placed on the X axis (horizontal axis).
- **The Dependent Variable**: is the variable that is directly affected by the independent variable. It is the result of what happens because of the independent variable. Example: How many oxygen bubbles are produced by a plant located five meters below the surface of the water? The oxygen bubbles are dependent on the depth of the water. This variable is placed on the Y-axis (vertical axis).
- **The Scales** for each Variable: In constructing a graph one needs to know where to plot the points representing the data. In order to do this a scale must be employed to include all the data points. This must also take up a conservative amount of space. It is not suggested to have a run on scale making the graph too hard to manage. The scales should start with 0 and climb based on intervals such as: multiples of 2, 5, 10, 20, 25, 50, or 100. The scale of numbers will be dictated by your data values.
- **The Legend**: is a short descriptive narrative concerning the graph’s data. It should be concise and placed under the graph.
- **The Mean** for a group of variables: To determine the mean for a group of variables, divide the sum of the variables by the total number of variables to get an average.
- **The Median** for a group of variables: To determine median or “middle” for an even number of values, put the values in ascending order and take the average of the two middle values. e.g. 2, 3, 4, 5, 9, 10 Add 4+5 (2 middle values) and divide by 2 to get 4.5
- **The Mode** for a group of variables: The mode for a group of values is the number that occurs most frequently. e.g. 2, 5, 8, 2, 6, 11 The number 2 is the mode because it occurred most often (twice)

We will quickly go over basic statistics for biology (mainly the four equations on the formula sheet in AP Biology) in the first week. If you are nervous about it, review the following videos and answer the optional, otherwise, just skip ahead to **the required problems** (Problems A-H).

1. Bozeman- [http://www.bozemanscience.com/standard-deviation](http://www.bozemanscience.com/standard-deviation) Be able to answer the following
   a. What is meant by normal distribution?
   b. What does standard deviation (SD) measure?
   c. Can 2 sets of data have the same mean but a different SD? Explain.
   d. 1 SD means ____ % of the population falls within this range; while 2 SD means ____ % falls in this range.
   e. Practice by pausing the video and calculate the SD from the 2nd set of data given BY HAND.

2. Bozeman- [http://www.bozemanscience.com/standard-error](http://www.bozemanscience.com/standard-error) and Kevin Piers [Standard Deviation & Standard Error of Mean](https://www.youtube.com/watch?v=3UPYpOLeRJg)
   a. From Bozeman: Explain the significance of standard error among 2 different sets of data with different sample sizes that have the same Mean (in terms of precision).
   b. From Piers: What do SEM bars that have overlapping Means on a graph indicate?
   c. From Piers: Explain the significance if SEM bars overlap, but the Means do not overlap.
   d. From Piers: Explain the significance if there is no overlap between SEM bars.

3. *If additional review is needed*, one good site is [www.mathisfun.com](http://www.mathisfun.com).

Complete this by hand and turn in on first day of school.
Using the following data, answer the questions below and construct the appropriate type of graph by hand.

1. What is the dependent variable and why?

2. What is the independent variable and why?

3. What are the mean, median, and mode of all three columns of data?
   a. Depth: MEAN:_______ MEDIAN:_______ MODE:_______
   b. Bubble Plant A: MEAN:_______ MEDIAN:_______ MODE:_______
   c. Bubble Plant B: MEAN:_______ MEDIAN:_______ MODE:_______
   d. Title: ____________________________________________

Legend:

Complete this by hand and turn in on first day of school.
Problem B:

Diabetes is a disease affecting the insulin producing glands of the pancreas. If there is not enough insulin being produced by these cells, the amount of glucose in the blood will remain high. A blood glucose level above 140 for an extended period is not considered normal. This disease, if not brought under control can lead to severe complications and even death.

Use the data to answer the following questions below and the construct an appropriate graph **by hand** to show the data.

1. What is the dependent variable and why?

2. What is the independent variable and why?

3. Which if any individuals above (A or B) has diabetes? What data do you have to support your hypothesis?

4. Predict what would be the expected blood glucose level for person A and B if the time were extended to 6 hours after eating.

<table>
<thead>
<tr>
<th>Time after eating (hours)</th>
<th>Glucose (ml)/Liter of Blood Person A</th>
<th>Glucose (ml)/Liter of Blood Person B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>170</td>
<td>180</td>
</tr>
<tr>
<td>1</td>
<td>155</td>
<td>195</td>
</tr>
<tr>
<td>1.5</td>
<td>140</td>
<td>230</td>
</tr>
<tr>
<td>2</td>
<td>135</td>
<td>245</td>
</tr>
<tr>
<td>2.5</td>
<td>140</td>
<td>235</td>
</tr>
<tr>
<td>3</td>
<td>135</td>
<td>225</td>
</tr>
<tr>
<td>4</td>
<td>130</td>
<td>200</td>
</tr>
</tbody>
</table>

Title: _____________________________________________________________________

Legend:

Complete this by hand and turn in on first day of school.
The following experiment was designed to test whether different concentration gradients affect the rate of diffusion. In this experiment, four solutions (0% NaCl, 1% NaCl, 5% NaCl, and 10% NaCl) were tested under identical conditions. Fifteen milliliters (mL) of 0% NaCl were put into a bag formed of dialysis tubing that is permeable to Na+, Cl−, and water. The same was done for each NaCl solution. Each bag was submerged in a separate beaker containing 300 mL of distilled water. The concentration of NaCl in mg/L in the water outside each bag was measured at 40 second intervals. The results from the 5% bag are shown in the table below:

1. On the axes provided, graph by hand the data for the 5% NaCl solution.
2. Using the same set of axes, draw by hand and label 3 additional lines representing results that you would predict for the 0% NaCl, 1% NaCl, and 10% NaCl solutions. Explain your predictions. (If you need to review osmosis/diffusion!)

<table>
<thead>
<tr>
<th>Time (seconds)</th>
<th>NaCl (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>130</td>
</tr>
<tr>
<td>80</td>
<td>220</td>
</tr>
<tr>
<td>120</td>
<td>320</td>
</tr>
<tr>
<td>160</td>
<td>400</td>
</tr>
</tbody>
</table>

Complete this by hand and turn in on first day of school.
A species of insect has been accidentally introduced from Asia into the U.S. The success of this organism depends on its ability to find a suitable habitat. The larval stage is very sensitive to changes in temperature, humidity and light intensity. Exposed to situations outside the tolerance limits results in a high mortality (death) rate. Study the data table to the right.

1. What is the best range of temperature for the insect’s habitat? ______________________

2. What is the best range of humidity the insect’s habitat? ______________________

3. What is the best range of light intensity for the insect’s habitat? ______________________

*Bonus—where in the US is best for this invasive species to live? ______________________

On the graphs below, plot by hand line graphs for the effects of temperature and humidity on mortality rates.

Legend:
Problem E: Graph the following sample data set showing the number of leaf disks that rise in a solution over time as photosynthesis occurs.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Disks Floating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>20</td>
<td>18</td>
</tr>
</tbody>
</table>

Based on the graph and what you know about photosynthesis, what trends do you notice? Why might this be the case?

Problem F: Calculate the mean and standard deviation for the data set of annual monthly rainfall. Use the data to sketch the appropriate type of graph.

Mean =

Standard Deviation =

<table>
<thead>
<tr>
<th>Month</th>
<th>Rainfall (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>2.0</td>
</tr>
<tr>
<td>Feb</td>
<td>1.8</td>
</tr>
<tr>
<td>Mar</td>
<td>1.2</td>
</tr>
<tr>
<td>Apr</td>
<td>5.7</td>
</tr>
<tr>
<td>May</td>
<td>6.2</td>
</tr>
<tr>
<td>Jun</td>
<td>5.9</td>
</tr>
<tr>
<td>Jul</td>
<td>1.0</td>
</tr>
<tr>
<td>Aug</td>
<td>1.1</td>
</tr>
<tr>
<td>Sep</td>
<td>1.1</td>
</tr>
<tr>
<td>Oct</td>
<td>2.3</td>
</tr>
<tr>
<td>Nov</td>
<td>2.7</td>
</tr>
<tr>
<td>Dec</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Complete this by hand and turn in on first day of school.
Problem G: Below are 2 samples of data that were collected (*we will ignore Units & Graph Title for this one):
Sample A: 12, 13, 14, 15, 16, 17, 18
Sample B: 10, 15, 20

Calculate the mean for Sample A ________
Calculate the mean for Sample B ________

Are the calculated means sufficient in explaining the data? Why or why not? (*Be specific!)

Calculate:
Standard Deviation for Sample A __________
Standard Deviation for Sample B __________

**Explain** the significance of the results.

Calculate the Standard Error of Mean for Sample A _______
Calculate the SEM for Sample B _______

Graph your results, showing error bars for each.
Do the bars overlap?
Do the means overlap?

Explain whether or not there are ‘significant’ differences between the 2 populations.

Complete this by hand and turn in on first day of school.
Problem H: A student noticed that the ivy leaves growing on the shady side of a building were larger than ivy leaves growing on the sunny side of the same building. The student collected and measured the maximum width, in centimeters, of 30 leaves from each habitat. Use statistical analysis to determine if it’s likely that there is a significant difference in leaf size between the shady and sunny ivy plants with 95% confidence (±2 SE). Graph the data and indicate error bars.

Calculated Results (from collected data):

<table>
<thead>
<tr>
<th></th>
<th>Shady Leaves</th>
<th>Sunny Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>7.43</td>
<td>5.88</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>1.63</td>
<td>1.32</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td><strong>Standard Error</strong></td>
<td>0.30</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Graph the data and indicate error bars.

Determine if there is a significant difference between the two samples and justify your claim using evidence from your graph.

Complete this by hand and turn in on first day of school.