AP Summer Homework 2018

Your summer work will cover four chapters in your textbook, **Principles of Life**, and all of **Your Inner Fish** by Neil Shubin. Each one has a series of questions to guide your progress.

Chapter 1 Principles of Life Unit Map **Due the week of June 25, submitted by shared Google doc.**

This chapter serves to introduce you to the overall themes of AP Biology. AP Biology is organized around four Big Ideas.

1. Big Idea 1: The process of evolution drives the diversity and unity of life.
2. Big Idea 2: Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
3. Big Idea 3: Living systems store, retrieve, transmit and respond to information essential to life processes.
4. Big Idea 4: Biological systems interact, and these systems and their interactions possess complex properties.

As you answer the questions, I am looking for you to begin putting ideas together. I do not expect you to have a complete understanding of the concepts. We will revisit each idea at least once during the year. I am looking for thought, not "right" answers.






1. Examine all of the pictures. They are all types of ecosystems. How can you classify the biotic (living) and abiotic (factors)? How does the flow of energy and macromolecules compare between the systems? What features do these systems share and how are they different.
2. What are the lines of evidence that support life had a single origin?
3. Justify the statement that life cannot ignore the laws of physics and chemistry.
4. Create a timeline of major events in evolution.
5. How has genomic changed our understanding of evolution? What gives this technology unique power?
6. Read https://www.nytimes.com/2018/05/04/science/first-animal-genes-evolution.html?rref=collection%2Fissuecollection%2Ftodays-new-york-times&action=click&contentCollection=todayspaper&region=rank&module=package&version=highlights&contentPlacement=9&pgtype=collection Based upon your reading of the article, explain the idea that "Life's unity allows discoveries in biology to be generalized." p 5
7. Examination of the biological universe reveals high degrees of organization into systems starting at the macromolecule level through complex ecosystems. This degree of organization exists in seeming conflict to the Second Law of Thermodynamics which states in a closed system, entropy (disorder) always increases. Comment about the different ways energy is transformed and moved through systems to maintain the order.
8. What kinds of information can be learned by examining genomes of diverse species?
9. How can you reconcile the fact that all cells in a multicellular organism have the same genomes but can have vastly different appearances and functions?
10. What is the concept of natural selection? How does it result in evolution?
11. How would you explain the scientific meaning of the word theory to a person who has not taken a science class?
12. What are the characteristics and processes of scientific studies?

Chapter 2 - The Chemistry and Energy of Life Unit Map

Due the week of July 23, submitted by shared Google doc.

This chapter reviews the fundamental chemistry essential to biology. It then moves on to a review of the macromolecules in biology and the energy of chemical reactions. Read and take notes on the chapter. Answer the following questions as your proceed. Some answers may require outside research.

1. Diagram the basic structure of an atom. What particles compose an atom? What charges and mass do they each have?
2. What is an element? What kind of information about an element can be gleaned from a periodic table?
3. Which elements are most abundant in living organisms?
4. What is an isotope? Research some ways isotopes are used in science.
5. How many electrons can be found in each electron shell??
6. What is the octet rule?
7. Complete Checkpoint 2.1 on p 20

8. Describe the properties of covalent bonds. Electronegativity is the measure of how easily an atom can attract electrons towards itself. How does the electronegativity of different elements impact the the properties of covalent bonds?
9. How does the unequal sharing of electrons result in the properties of water? What are those properties?
10. Why do hydrogen bonds form as a result of unequal electron sharing? Under what conditions to hydrogen bonds form? Why are they so important to the chemistry of life?
11. How does the equal or unequal distribution of electrons account for how different molecules interact with each other in cells? What kinds of distributions do we observed in hydrophilic molecules as opposed to hydrophobic molecules? Complete the Apply the Concept on page 24.
12. Explain the nature of ionic bonds. How do they differ from covalent bonds?
13. On page 22, there is a chart of five different types of bonds. Which are intermolecular and which are intramolecular? How does the different energy found in their bonds correspond with their various functions in building macromolecules and in determining the interactions between molecules.
14. Page 25 has a list of functional groups. They are all polar molecules. How might this applicable to their many functions? We will be revisiting this structures through the year.
15. Complete checkpoint 2.2 on page 26.
16. What are the functions of carbohydrates? How do these functions vary between the monomers and the polymers?
17. How are the monomers (monosaccharides) connected to make the polymers (disaccharides and polysaccharides)?
18. Lipids are composed of the same elements as carbohydrates but in different ratios. How does this difference impact the properties of lipids in contrast to carbohydrates?
19. What are the functions of lipids?
20. What is the structural impact of a saturated fatty acid vs an unsaturated fatty acid?
21. How does a phospholipid compare with a regular lipid? What does it mean to be amphipathic? How does being amphipathic allow for the function of a phospholipid?
22. What is a chemical reaction and what conditions are necessary for it to occur?
23. What is the biochemical definition of energy?
24. What is potential energy and what forms of potential energy exist in biological systems?
25. What is kinetic energy and what forms of kinetic energy exist in biological systems?
26. What is metabolism? Explain it including definitions of anabolism and catabolism?
27. The first and second laws of thermodynamics are essential to understanding the how and why chemical reactions occur. What are the first and second laws of thermodynamics.
28. Define entropy
29. Complete the Checkpoint Concept 2.5, p 34.
30. What did the Miller Urey Experiment suggest about the early origins of life?

Videos that will provide you with more understanding:
Guillotined Chemistry Electronegativity https://www.youtube.com/watch?v=ddG8zCTJF0U
Guillotined Chemistry Bonding: Polar vs Non Polar https://www.youtube.com/watch?v=Jk0kfZ8ZuYs&t=174s
Guillotined Chemistry Intermolecular Forces https://www.youtube.com/watch?v=-VQOtOCH_x4&t=6s
Guillotined Chemistry Hydrogen Bonding https://www.youtube.com/watch?v=6qXX7UfBJwA&t=2s
Bozeman Science Covalent and Ionic Bonds https://www.youtube.com/watch?v=7DjsD7Hcd9U&t=130s

Bozeman Science Carbohydrates https://www.youtube.com/watch?v=_zm_DyD6FJ0
Bozeman Science Lipids https://www.youtube.com/watch?v=VGHD9e3yRIU
Bozeman Science Metabolism and Thermodynamics
https://www.youtube.com/watch?v=JBmykor-2kU&t=381s

Chapter 3 - Nucleic Acids, Proteins and Enzymes Unit Map

Due the week of August 13 , submitted by shared Google doc.

In the prior chapter, we examined carbohydrates and lipids. In this chapter, we will focus on the other two macromolecules, nucleic acids and proteins. We will take a deeper look at enzymes as ***α***they are essential to facilitating the chemical reactions in cells.

1. Compare and contrast DNA and RNA. Include monomers, structures, functions, localization.
2. Thinking back to the prior chapter, what role does unequal distribution of electrons and hydrogen bond formation play in DNA structure? Based upon this understanding, explain why salt solutions can be used to denature DNA or RNA structure?
3. How can a bond as weak as a hydrogen bond be essential to the structure of a molecule like DNA?
4. We normally think of DNA as double stranded. Can RNA be double stranded ever? If so, what does that suggest about RNA function. Read http://exploringorigins.org/ribozymes.html and http://exploringorigins.org/nucleicacids.html in crafting your answer.
5. What would happen to DNA or RNA structure if nucleotides were not paired accurately?
6. The Central Dogma of Biology states information stored in DNA flows to information stored in RNA via transcription and is used to produce proteins by translation. DNA is maintained by replication. Explain why base pairing is central to all of these processes.
7. Why is replication essential to life?
8. What is the relationship between genes and the genome? What is the relationship between a gene and a protein?
9. What can DNA sequences reveal to us?
10. Complete Checkpoint Concept 3.1 on page 42.
11. Identify the the major functions of proteins.
12. Amino acids are the monomers of proteins. Sketch out a generic amino acid. Identify the ***α*** carbon. Which functional groups are present? What properties do they have? Which part of an amino acid confers its identity?
13. Look up the definition of a zwitterion. Why can an amino acid be classified as a zwitterion at neutral pH?
14. Based upon what properties are amino acids classified? How is the equal or unequal distribution of electrons around the atoms in the R groups related to these groupings?
15. What makes glycine, proline and cysteine unique?
16. What are the structural levels of protein?. Describe the characteristics of each level.
    a. What is the primary structure? How does it relate to gene sequences?
    b. Both the alpha helix and beta sheet are secondary structures. What is a secondary structure? What features are associated with the alpha helix as opposed to the beta sheet?
    c. What drives the formation of tertiary structure? What characteristics are associated with it?
    d. What is quaternary structure? Do all proteins possess it?

17. How do the properties of amino acids drive the formation of the three dimensional state of proteins? Look back to Chapter 2 on page 22. How do the different bond types impact structure? How do they explain how chemicals,heat, salt and pH changes can impact the three dimensional structure? Can a protein return to its functional state if denatured?
18. Explain the ways the functional protein structure can shift as a result of changes in the environment.
19. Complete Checkpoint Concept 3.2, p49.
20. Complete the Apply the Concept, p 49.
21. Explain why enzymes can be characterized as catalysts.
22. What is Gibbs Free Energy (G)? What is the difference between an exergonic reaction and an endergonic reaction? How does reaction coupling allow for energetically unfavorable reactions to occur?
23. Why don't reactions that are energetically favorable just spontaneously happen all the time?
24. What is the relationship between activation energy and transition states? Why does adding heat speed up reactions? What is the relationship between enzymes and activation energy? By what factor do enzymes speed up chemical reactions?
25. What makes enzyme catalyzed reactions specific? What kinds of bond interactions lead to the specific interaction between substrate and enzyme binding site? Do these interactions explain why the product of an enzymatic reaction is released at the end of a reaction?Why or why not?
26. Is the enzyme transformed in a reaction?
27. What kinds of tools do enzymes use to catalyze reactions?
28. Compare and contrast the lock and key model with the induced fit model of enzyme substrate interaction.
29. Explain the importance and types of non protein partners of enzymes.
30. How can the maximum enzymatic rate be used to measure enzyme efficiency?
31. Complete Checkpoint Concept 3.3, p 52.
32. What is a metabolic pathway? How can they be regulated? How are individual enzymatic reactions related to the pathway?
33. How is the idea of homeostasis relevant to the control of metabolic pathways?
34. Enzymes can be regulated. Compare and contrast irreversible inhibition, reversible inhibition, competitive inhibition, noncompetitive inhibition and uncompetitive inhibition.
35. How is allosteric regulation of enzymes different than regulation by inhibitors?
36. How does feedback inhibition regulate enzyme activity?
37. How do environmental factors impact enzyme functions and in what ways?
38. Complete the Apply the Concept, p 56.
39. Complete Checkpoint Concept 3.4, p 57

Videos that will provide you with more understanding:
Nucleic Acids https://www.youtube.com/watch?v=NNASRkIU5Fw or
https://www.youtube.com/watch?v=8kK2zwjRV0M
Proteins https://www.youtube.com/watch?v=2Jgb_DpaQhM&t=2s or
https://www.youtube.com/watch?v=H8WJ2KENlK0
Enzymes https://www.youtube.com/watch?v=ok9esggzN18

Chapter 4 - Cells: The Working Units of Life Unit Map

Due the week of August 27, submitted by shared Google doc.

This chapter investigates the basic structures of cells and how those structures allow for life functions to occur most efficiently.

1. What are the three statements of the Cell Theory?
2. What are the broad implications of the cell theory?
3. Cell size is limited as a result of surface area to volume ratio. Why is this limiting? Speculate why the size limitation for eukaryotes is approximately 10 times larger than for prokaryotes? In what ways do cells circumvent the limitations?
4. What features are studied microscopically vs chemically?
5. Complete Checkpoint Concept 4.1, p 63
6. What differentiates prokaryotes from eukaryotes?
7. What features are common amongst all cells? Why do these features need to be universal?
8. Which features are unique to prokaryotes? Which are unique to eukaryotes?
9. Create a chart of the functions and features of organelles. Identify if they are prokaryotic, eukaryotic or both.
10. Why do membrane bound compartments allow eukaryotes to be larger?
11. Complete the Apply the Concept on p 69.
12. Complete Checkpoint Concept 4.3, p 73.
13. What are the types, structures and functions of cytoskeletal elements?
14. How can cytoskeletal elements be employed to create motion?
15. Complete Checkpoint Concept 4.4 on p 76.
16. Complete the Investigation, p 77.
17. Extracellular structures have multiple functions. What are they? What is their role in formation of multicellular organisms?
18. Complete checkpoint 4.5, p 80.

Videos that will provide you with more understanding:
Cell Theory https://www.youtube.com/watch?v=4OpBylwH9DU
Characteristics of Prokaryotic and Eukaryotic Cells https://www.youtube.com/watch?v=1Z9pqST72is
Cell Size Limits https://www.youtube.com/watch?v=wuXSEOKNxN8

Your Inner Fish Reading Guide

Due the first day of school, submitted as a Google doc.

Chapter 1: Finding Your Inner Fish

1. What are the lines of evidence employed in learning our evolutionary history?
2. What are the essential for identifying good fossil sites?
3. What kinds of information can be obtained from fossils?

4. How can living organisms be used to make predictions about key evolutionary moments?
5. Explain how fossil features and DNA are employed.
6. Why are sedimentary rocks the most useful for identifying fossils?
7. What is the role of failure in discovery?
8. Why was Tiktaalik valuable?

Chapter 2: Getting a Grip

1. What was Owen's great observation and what made it significant?
2. How does Darwin's theory explain Owen's observation?
3. What is the value of lungfish anatomy in understanding evolution?
4. What was the purpose of the earliest limbs?
5. What made Tiktaalik ready for boot camp?
6. What selective pressure probably spurred Tiktaalik to evolve arm structures?

Chapter 3: Handy Genes

1. What makes a skin cell different from a neuron?
2. Recall the Central Dogma of Biology (if you cannot, look it up). How does it connect with the chapter?
3. How does comparative genetics/DNA help explain evolution?
4. What is the role of the zone of polarizing activity (ZPA)? What roles does diffusion play in its job?
5. How did the hedgehog gene in fruit flies explain the structural development of not just flies, but all limbed organisms? What is its function?
6. What did using the mouse Sonic Hedgehog protein in the skate reveal about evolution?

Chapter 4: Teeth Everywhere

1. What do teeth reveal about an organism?
2. What does Shubin's experience reveal about the nature of science and of learning? What role does failure play in it?
3. What was the fossil evidence for the transition from reptiles to mammal?
4. Why can diet be a described as a driving force for mammalian evolution?
5. What was the evolutionary impetus for hard internal structures?
6. What characteristic of teeth formation became a common motif?

Chapter 5: Getting Ahead

1. How can understanding how organisms develop segments lead to understanding of the factors that control development?
2. Explain the concept of a genetic address.
3. Speculate on the function of the Hox genes since different hox genes are active in different segments of developing organisms.
4. What is the relevance of the development of the notochord in worms? What does it reveal about vertebrate evolution?

Chapter 6: The Best-Laid (Body) Plans

1. Explain the role of the germ layer.
2. How does early embryonic development relate to final structures?

3. What does the universality of early development reveal about evolution?
4. Define the ectoderm, mesoderm and endoderm and identify the structures that originate in each.
5. How does the appearance of common features compare to the appearance of unique features in development?
6. What did Spemann learn about the potency of cells?
7. What did Mangold add to the understanding of how embryos develop? What is the Organizer?
8. What is the relationship of gene organization to body structure organization?
9. What is the homeobox sequence and what is a hox gene? What role did duplication of the hox genes play in evolution?
10. How can two genes interacting result in the body plan organization?

Chapter 7: Adventures in Bodybuilding

1. When did organisms with a body plan first occur?
2. What was notable about these organisms?
3. How do multicellular organisms connect their cells together?
4. What characteristics of collagen are valuable to building bone? What about hydroxyapatite?
5. What is the value of using the same materials in different ratios to make different body parts?
6. What features do cell to cell connections have in common with cell to cell communication?
7. Why is the formation of specialized cells an essential evolutionary leap?
8. What does the elaboration of collagen types in humans when compared to placoderms and sponges suggest about how evolution occurs?
9. How do choanoflagellates represent a bridge on the journey to multicellular organisms?
10. What kinds of selective pressures may have lead to multicellular organisms? How does Boraas's experiment highlight it?
11. What are the drawbacks to multicellularity and how does Boraas's experiment demonstrate it?

Chapter 8: Making Scents

1. Recall how an enzyme binds a substrate in the induced fit model. (Look it up or email me if you do not remember.) What does this model suggest might occur when a chemical that is perceived as an odor binds a chemical binding/sensing nerve? How might this binding event trigger a signal to be sent?
2. How does the representation of scent receptor genes reflect evolutionary history?
3. How did just a few scent receptor genes increase to the large multiples found in mammals?
4. What role do errors in replication (mutations) play in selection of which genes serve a function? What is the role of a neutral mutation in evolution?

Chapter 9: Vision

1. How ancient is the evolution of light reception?
2. What kind of pressure may have selected for color vision? Why was it advantageous?
3. Explain what a genetic switch is.

Chapter 10: Ears

1. What does the mammalian ear reveal about how mammals evolved from reptiles?

2. How do these structures demonstrate how embryonic development can be used to determine evolutionary relationships?

Chapter 11: The Meaning of It All

1. In your own words, explain the concept of descent with modification at a level that a middle school student would understand it.