STUDY GUIDE - *Ch. 22.3 - Evolution is supported by an overwhelming amount of scientific evidence.* **NAME:** _____

- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share* answers *with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfecting your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed-out, sideways, or upside-down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and start building your memory. Try to write answers out in your own words, when possible, and try to purposefully and accurately use all new terminology introduced.*

1. What are **four types of evidence that elucidate (make clear) the occurrence of evolution**?

   1. 3.

   2. 4.

2. First, read over the observational study (discovery science) outlined in **Figure 22.13** that supported the hypothesis that **changes in a food source** (in this case through the introduction of a new species of fruit tree) **can result in evolution by means of natural selection** (in this case in the beak length of the soapberry bugs).

   a. Second, data from additional studies showed that when soapberry bug eggs from a population that fed on balloon vine fruits were reared on golden rain tree fruits (or vice versa), the beak lengths of the adult insects were most similar to those in the population from which the eggs were initially obtained. **Why** is this the case?

   *(Check your answer to 2.a. by going to the Ch.22 **Figure Questions** for **Figure 22.13** in Appendix A of your textbook)*

   b. Now that, after studying Ch.22 Sections 1 and 2, you understand how **natural selection can result in changes in the average phenotype of a population in a region** (evolution involving a change in the frequency of alleles or the genetic make up of a population)**, that natural selection acts on each individual's phenotype, and that natural selection leads to the evolution of adaptations spreading through a population over generations**, describe, step by step, how the average beak length shrank in the population of soapberry bugs feeding the last several decades on golden rain tree fruit. *You **must** use the following statements or terms as part of your explanatory paragraph: allelic variation in genes, adaptation, selection for, heritable variation in a character, differential reproductive success, higher biological fitness.*

3. First read the section of your text on **The Evolution of Drug-Resistant Bacteria.** Thereafter, Review **Figure 22.14.**

   a. How does the antibiotic methicillin kill bacteria?

   b. What is different in the bacteria that are biologically able to avoid death even in the presence of methicillin?

   c. Explain **the evolution of Drug Resistance in bacteria** in terms of **natural selection**.

   c. What does it mean when a bacterial strain has become **multi-drug resistant**?

   d. *Think* - Some drugs being developed specifically target and kill only S. aureus; others slow the growth of MRSA, but do not kill it. Based on how natural selection works and on the fact that bacterial species can exchange genes, explain why each of these strategies might be effective.

      Reason why Strategy #1 - killing only *S. Aureus* - **could be effective =**

      Reason why Strategy #2 - slowing the growth of methicillin-resistant *S. Aureus* (MRSA) - **could be effective =**

   (Check your answer to 2.a. by going to the Ch.22 ***Figure Questions*** *for* ***Figure 22.14*** *in Appendix A of your textbook)*

4. a. Watch the following video on the subject of **antibiotic resistance**, a global health threat = https://www.biointeractive.org/classroom-resources/superbugs-resist-antibiotics-can-evolve-11-days

   b. **Natural selection is NOT a creative mechanism**. Given this statement, do antibiotics cause a bacteria to *become* resistant? *Explain your response*.

   (*Check your answers to #4.b. by going to the* ***Ch.22.3 Concept Check Question #1*** *answers in Appendix A)*

   c. How does the **generation time** *(the average interval of time between the birth of an individual and the birth of its offspring once it has reached reproductive maturity)* **influence the rate of evolution of a population**?

5. One type of evidence for evolution is the existence of homologies between organisms of different species. What does the term **homology** refer to?

6. a. **Anatomical homologies** *(homologies seen in the structure of the body)* and **embryological homologies** *(structural homologies seen during embryological development)* include homologous structures. What are **Homologous Structures**?

   b. Describe an example of an **anatomical homology visible during the adult stage of development** that lends evidence to evolution.

   c. Describe an example of an **anatomical homology visible during the embryological stage of development** that lends evidence to evolution.

   d. **Evolutionarily-related organisms contain homologous structures because those organisms inherited the ability to construct these structures from a shared common ancestor.** Because of the influence of natural selection, **do homologous structures have to have the same use or function today**? Explain.

7. One type of homology found in the bodies of organisms is referred to as a **vestigial structure**. **Vestigial structures too are evidence of shared common ancestry just as homologous structures are!**

   a. What is a **vestigial structure**?

   b. Describe an example of a vestigial homologous structure found in nature.

   c. **How is the vestigial structure** you described in 6.d. above **evidence for evolution from a common ancestor**?

8. **Molecular homologies** are homologous structures found in the DNA and protein sequences of organisms.

   a. How is the **genetic code evidence for the shared ancestry of all organisms** on Earth?

b. Do **homologous genes between related species have to code for proteins and RNAs that perform the same function** today? Explain.

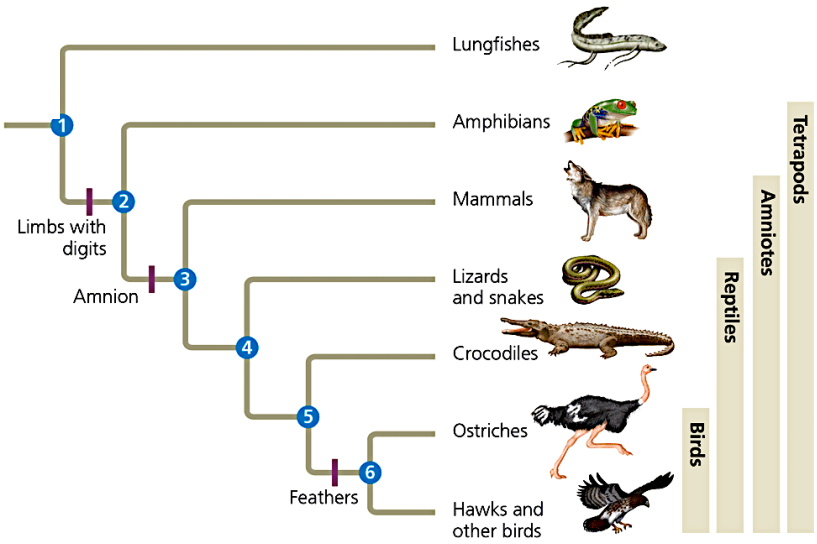
c. Describe an example of a **molecular homology** that lends evidence to evolution.

9. a. What is an **evolutionary tree**?

b. Review the evolutionary tree shown in **Figure 22.17**. What does a **branch point** in an evolutionary tree represent?

c. What is indicated by the **hatch marks** found immediately preceding a common ancestor in the tree?

d. *Think* - Based on this evolutionary tree, are crocodiles more closely related to lizards or birds? Explain. *(Remember, you will always be more closely related to the species you share a more recent common ancestor with)*



(Check your answer to 9.d. by going to the Ch.22 ***Figure Questions*** *for* ***Figure 22.17*** *in Appendix A of your textbook)*

e. A student in class, after analyzing the tree above, claims that amphibians like frogs are more closely related to lungfish than to ostriches based on their proximity within the tree. Is this student correct? Support or refute their claim, explaining your tree-thinking logic fully.

10. **BEWARE! Two structures and/or organisms may look similar, and so may look deceptively homologous, though the organisms may be LESS closely related than expected and may NOT have inherited that structure from their more distant common ancestor.** This can result from a process termed convergent evolution.

    a. What is **convergent evolution**?

    b. Convergent evolution might be summarized like this: ***Similar problem, similar solution*****.** Can you give an examples of convergent evolution?

    c. Why is your example given in 10.b. not an example of homologous structures?

11. **Convergent evolution leads to the formation of Analogous Structures** between organisms of different species. What are the **features of Analogous Structures**?

12. To review, let's see if you now understand fully the difference between homologous and analogous structures, and how evolutionary theory explains the appearance of both these structures. **These are must knows!** The AP Exam may try to test if you can identify homologous structures or test to make sure you don't confuse analogous structures for homologous ones in your explanations or any evolutionary tree you are asked to contruct

    In your answers below, practice using *proper biology language, i.e. descent with modification, common ancestor, convergent evolution, adaptation, natural selection, close / distant related species, etc...*

    How is it possible that a **homologous structure is inherited** by two distinct species of organisms **from the same common ancestor, but the structure today has two different functions** in these two organisms *(such as seen in the limb bone anatomy of tetrapods)?*

    How is it possible that **analogous structures arose in two distinct species** of organism **yet the ancestor these two organisms share in common did not share this structure** *(as seen in the excess skin between the fore and hind limbs of the Flying Squirrel in the Americas and the Sugar Glider in Australia)?*

    (*Check your answers to #12 by going to the **Ch.22.3 Concept Check Question #2** answers in Appendix A)*

13. Describe two ways do **fossils provide evidence for the theory of evolution?**

    1.

    2.

14. Analyze the phylogenic (evolutionary) tree in Figure 22.20. As you can see, a timeline is associated with this tree. Branches that extend until time 0 million years ago, represent **extant organisms** (species of organisms that are still alive today). Branches that end before extend into time 0 million years ago, represent **extinct organisms** (species of organisms that are no longer round anywhere in our biosphere).

    Use the diagram to determine which happened first during the evolution of cetaceans: changes in hind limb structure or the origin of tail flukes (the lobes on a whale's tail). **Explain by referencing the specific information the tree displays, including the common ancestors represented by the branch points as well as the associated the timeline.**

*(Check your answer to 14 by going to the Ch.22 **Figure Questions** for **Figure 22.20** in Appendix A of your textbook)*

15. a. What is **biogeography**?

    b. What was **Pangea**?

    c. How is **biogeography influenced by continental drift**?

16. Read through the **Scientific Skills Exercise: Making and Testing Predictions**

    Before you answer the questions, **review your slides for Ch.1 to refresh your memory on the Scientific Method and Experimental Design**. Then, complete this exercise.

    1. a.

    b. (Reminder: **Hypothesis** = is an explanatory statement that outlines **the effect of the independent variable *on the* dependent variable!** Remember, in experiments you may have two hypothesis: The **Null Hypothesis** states that the independent variable does not influence the dependent variable & the **Alternate Hypothesis** states that the independent variable does influence the dependent variable.)

    c. (Reminder: **Prediction** = an ***if...then*** statement based on the hypothesis that predicts how the dependent variable will change if you manipulate the independent variable in a particular stated way.)

    d. A quick note about **Control Groups** before you answer. Two types of Control Groups may exist in experiments. Each is useful for a different reason. **All controlled experiments on the AP Exam must include a Negative Control, but some may also include a Positive Control.** Watch the following videos before you continue in order better understand both types of Controls and to know how to design one of each if you are ever asked to do so.

- https://www.youtube.com/watch?v=7Qj-pubZDHg
- https://www.youtube.com/watch?v=ZHTqxczEY6Y

Negative Control Group = a group of subjects that does **not** receive the manipulated level of the independent variable; **the dependent variable data from this group is compared to the dependent variable data from the experimental group of subjects to see if there was a significant effect of the manipulated independent variable on the dependent variable in the experimental groups compared the Negative Control Group that did not experience any manipulation of the independent variable.** *The Negative Control Group's results allows scientists to eliminate alternative explanations for what causes changes in the dependent variable.*

Positive Control Group = *(not included in this guppy experiment)* a group of subjects that receives a **different** independent variable treatment *(from the independent variable being tested in the experiment)* for which their is an already known effect on the dependent variable. **Since we expect the dependent variable amongst the subjects in this Positive Control Group to respond in a very specific, already known, way, this group of subjects allows us to ensure that the experimental set up was effective and all the equipment used worked properly.** *If we didn't get the results expected after manipulated the subjects in a way already known to cause some specific effect on the dependent variable, then something must be interfering with the data being collected or the data being generated.* A researcher would need to revisit their experimental design set up to see if there is a flaw. Maybe there is an extraneous variables that is influencing the dependent variable in your Positive Control Group, maybe there is a problem with your subjects, the treatment, or the process of giving subjects a treatment etc.

e. (Reminder: **Experimental Group** = one or more treatment groups (groups of subjects) that receives a ***manipulated*** level - treatment - of the independent variable)

2.

3. *(Was the hypothesis supported?)*

4. a.

   b.

17. Fossils show that dinosaurs originated 200-250 million years ago. would you expect the geographic distribution of early dinosaur fossils to be broad (on many continents) or narrow (on one of a few continents only)? **Explain**

(*Check your answers to #17 by going to the **Ch.22.3 Concept Check Question #3** answers in Appendix A)*

18. Proceed to the TEST YOUR UNDERSTANDING section at the end of the chapter. **Study your chapter sections and all Ch.22 study guides first!** *Then, do your best to try to answer these from memory first in order to test how well you grasped the material before. If you are unsure, return to the relevant section of your chapter and restudy any pertinent material to refresh your memory. (Check some of your answers by going to the **Ch.22 Test Your Understanding** answers in Appendix A)*

1. _____ 2. _____ 3. _____ 4. _____ 5. _____