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The Use of Argumentation in Socio-Scientific Issues: Enhancing Evolutionary Biology Instruction

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APPROVED BY:

Advisor	Date
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Abstract:

With the adoption of the Next Generation Science Standards (NGSS), further emphasis in science education is being placed on preparing students to become more informed voters regarding social, ethical, economic and political topics that affect contemporary society. Parallel to this shift is a stronger emphasis on integrating evolutionary theory as a unifying concept in the biological sciences. Given that evolution is one of the aforementioned topics commonly discussed and debated about in social and political arenas, ensuring that instruction provides students from all backgrounds a comprehensive understanding of its principals is becoming increasingly important in contemporary science education. Chapter II of this project functions as a review of contemporary literature that will be utilized to help determine the best methodology for enhancing instruction and comprehension of prominent Socio-Scientific Issues (SSI) like evolution. Literature suggests that using argumentation to engage students in socially controversial scientific content may enhance comprehension and retention of material. More specifically, since evolution is a SSI that is often perceived by some to challenge individuals' religious and ethical beliefs, engaging students in the content is often difficult using traditional methods that do not allow alternative, non-scientific ideologies to be incorporated. Therefore, it is suggested that the incorporation of a data driven, formal argumentation that allows students the option to argue either for or against evolution may serve to increase the level of engagement of the student body as a whole in evolutionary content. Chapter III of this project is a unit planned designed to incorporate data driven SSI argumentation into an evolutionary context. Through the use of five case studies, students will be introduced to the raw data that is used by evolutionary biologists to support evolutionary theory. Using these activities, students will collaboratively analyze the data, and be asked to decide individually whether to use it to support

evolutionary theory or creationism. Subsequently, the formal argumentation piece is designed to engage all students in active argumentation using debate questions related to each case study.

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Chapter I: Introduction

More than ever before, scientific literacy is becoming a growing necessity for members of society and as a result a prominent aim in science curriculum. Curriculum for scientific literacy should aim for preparing future generations to understand scientific issues while enhancing their comprehension of the nature and practice of science. In turn, this will allow citizens to use science to aid in their personal decision making and discussions which will directly impact society (Roberts & Gott, 2010). The Nature of Science (NOS) is defined by Crowther, Lederman, and Lederman (2005) as:

> "• That science is a way of knowing, and there are values and beliefs inherent to the development of scientific knowledge;
>
> • That the philosophy, history, sociology, and psychology of science affect science teaching and learning;
>
> • That science is a human endeavor and that people of all ages, races, sexes, and nationalities engage in this enterprise; and
>
> • That science is based upon evidence—not logic or faith ."

The aforementioned components defined by Crowther et al. (2005), and implemented by the NSTA, are reflected in the Next Generation Science Standards (NGSS). The philosophy behind these standards suggest that as educators, we are responsible for not only providing an academic education, but an education that prepares students to later become voters informed on ethical, economic and political topics that affect contemporary society.

As a discipline, science is heavily rooted in data collection, analysis and the discovery of patterns that ultimately provide empirically supported arguments surrounding the meaning of those patterns, or in many cases the lack there of. These actions fall under the broad category of the nature of science. Experiments rooted in the nature of science and designed using a uniform scientific method have been used for hundreds of years to explain natural phenomena. Much of the societal advancements made since the onset of the industrial revolution can be attributed to the work done using the evidenced based arguments tied to the NOS. For this reason the United States, to remain at the forefront as a technological and academic leader of the modern world, must ensure its citizens are well versed in science. Consequently, shifts are being made in the generalized standards necessary for secondary education, which are integrated into the Next Generation Science Standards (NGSS) that will have a long reaching impact on how science is taught to students in the classroom.

In addition to an emphasis on NOS sifts, NGSS has made major shifts in content organization. This has resulted in four core shifts in biological curriculum. Standards will now focused on: 1) Biological organization: from molecules to organisms, 2) Ecological Interdependence, 3) heredity and gene expression and 4) evolution by means of natural selection (Bybee, 2013). Therefore, there will be an ever greater emphasis on these core topics in the curriculum and students will have to develop a more integrated understanding of these concepts and how they are conceptually intertwined. A ten year study conducted by Werth (2013)provides empirical evidence to support this shift in curricular emphasis. Worth and his instructional colleagues were able to frame their entire introductory undergraduate biology courses behind the notion of evolution, and effectively integrating evolution concepts in every aspect of their curriculum. This resulted in significant shifts in not only student understanding

and acceptance of evolution theory, but more notably their comprehension of the other three core concepts set forth by the NGSS. Therefore, it seems, in order for biology teachers to more effectively teach the whole of their content, need to restructure their instruction of evolution away from a standalone unit, and place more emphasis towards true comprehension and acceptance of it conceptually for the purpose of it acting as the unifying concept of biology.

This Project will function in helping students construct a more integrated view of biology from its molecular/chemical basis to its complex ecological hierarchy. However, in order for evolution to be utilized effectively in this manner it must be both understood and generally accepted by students. This creates a challenge and therefore requires a restructuring of content in a way that fosters this relationship. Implementing structured argumentation could function in improving student understanding and acceptance of evolutionary biology and integration of its concepts into other facets of biology as well.

Significance of Project:

A well informed public is necessary for making political and economic decisions that can shape the future of our society. With the onset of the scientific revolution, citizens are required to make decisions on a daily basis that can have lasting effects on future generations. Unfortunately, a general lack of understanding surrounding the nature of science acts as a significant road block to the proper utilization of much of the scientific knowledge that is necessary for informed decision making regarding SSI. Some major socio-scientific issues that have future implications on our society include but are not limited to, evolution, genetic engineering/biotechnology and human induced climate change. These noteworthy socio-

scientific issues will be at the forefront of political and economic decision making for years to come and will require informed ethical and economic decision making. Thus providing students with the knowledge base to make educationally weighted decisions during Election Day is essential. For this to occur this project will function in the following ways:

1) Advance students comprehension of the scientific process as a whole though instruction of how the nature of science is used in socio-scientific issues.
2) Provide students a knowledge base that will enable them to draw connections between evolution and the 3 other core shifts described by NGSS: Molecular basis of life, Genetics and Ecological interdependency.
3) Increase students ability to use empirical data to autonomously draw their conclusions about controversial Socio-scientific issues (Not just evolution)

Overview of the Following Chapters

Chapter II assesses the literature surrounding the use of argumentation in socio-scientific issues. It is meant to delve further into the topic of how argumentation can best be utilized as an effective tool with the function of increasing student engagement in socially controversial topics that they might otherwise resist. All too often, socio-scientific issues are approached in a way that does not ask students to question or make informed decisions for themselves. Instead they are approached as topics that need to be addressed in a very teacher centered methodology without considering how this practice affects students' perception or willingness to learn about the material. In many cases this can lead to students resisting learning material that threatens their prior beliefs, since they are less likely to engage themselves in the material. Research

suggests that actually allowing students to argue for a non-scientifically accepted ideology that counters scientific theory may actually increase engagement in SSI. Therefore, in an evolutionary context, allowing students to argue for creationism/intelligent design may be effective in increasing their exposure to material as well as foster more critical thinking in the controversy itself.

Chapter III is a curriculum based project designed to implement the research that was discussed and analyzed in chapter II. One of the most prominent socio-scientific issues in contemporary biology is that surrounding evolutionary theory. This project is deigned to be a comprehensive unit plan with the goal of enhancing student understanding of biological evolution. Instruction will focus on implementing research based argumentation and decision making practices in order to advance student understanding of the NOS, thus aiding in their ability to successfully make informed decisions regarding SSI. The goal of this unit will be to increase student engagement in authentic and empirically based evolutionary content by having students critically analyze raw data without initial interpretation by the teacher. This will provide students the opportunity to make data driven decisions regarding SSI's.

Definition of Terms:

I. Nature of Science – As defined by Crowther, Lederman, and Lederman (2005) for the purposes of the National Science Teachers Association

II. Socio-Scientific Issue (SSI) – Socially relevant issues that are characterized by their scientifically informed nature as well as the high level of social controversy that surrounds them. Oftentimes SSI have an ethical component that fuels the controversy.

III. Biological Evolution – The Scientific Theory that is used to explain how species change over time

IV. Natural Selection – Mechanism of Evolution in which the changes in a populations environment act as selective pressures that give certain traits a reproductive advantage over others, only to be expressed more often in successive generations

Chapter II: Literature Review

Overview

The Next Generation Science Standards have emphasized the importance of improving the scientific literacy of students, necessitating students' ability to have a more accurate understanding of the scientific process. This will inevitably make them more well-rounded citizens and informed voters. Alongside this, the standards also emphasize the importance of comprehending the Nature of Science as a means to achieve this goal. Coupled with this shift is the restructuring of biological curriculum to demonstrate the interconnectedness of major core concepts of biology. Evolution, being one of these abovementioned core concepts, is essential to the comprehension of the intricacy of biological hierarchy. For this reason, enhancing student understanding of evolutionary concepts is essential for students to grasp biology content as a whole. This literature review functions in assessing the potential of implementing argumentation as a means to enhance student acquisition of evolutionary based content knowledge. Much of the literature reviewed suggests that argumentation has functioned to achieve this goal in other abstract biological content due to its ability to shift student reasoning from Emotive to Rational Formal Reasoning. However, given the culturally sensitive nature of the subject matter suggestions to the proper and implementation of argumentation must be taken into account when using this format of instruction.

Introduction:

More than ever before, scientific literacy is becoming a growing necessity for members of society and as a result a prominent aim in science curriculum. Curriculum for scientific

literacy should aim for preparing future generations to understand scientific issues while enhancing their comprehension of the nature and practice of science. In turn, this will allow citizens to use science to aid in their personal decision making and discussions which will directly impact society (Roberts & Gott, 2010). The nature of science is defined by Crowther, Lederman, and Lederman (2005) as:

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> • That science is based upon evidence—not logic or faith.

The aforementioned components defined by Crowther et al. (2005), and implemented by the NSTA, are reflected in the Next Generation Science Standards (NGSS). The philosophy behind these standards suggest that as educators, we are responsible for not only providing an academic education, but an education that prepares students to later become voters informed on ethical, economic and political topics that affect contemporary society.

In addition to and emphasis on NOS sifts, NGSS has also made major shifts in content organization. This has resulted in four core shifts in biological curriculum. Standards will now focused on 1) Biological organization: from molecules to organisms, 2) Ecological Interdependence, 3) heredity and gene expression and 4) evolution by means of natural selection (Bybee, 2013). Therefore, there will be an ever greater emphasis on these core topics in the curriculum and students will have to develop a more integrated understanding of these concepts and how they are conceptually intertwined.

Given these curricular shifts, this review functions in 1) discussing the importance of teaching evolution while analyzing literature based instructional practices that could enhance student comprehension of evolutionary theory though the Nature of Science as described by Crowther et al. (2005). This would aim to have students construct a more integrated view of biology from its molecular/chemical basis to its complex ecological hierarchy. However, in order for evolution to be utilized effectively in this manner it must be both understood and generally accepted by students. This creates a challenge and therefore requires a restructuring of content in a way that fosters this relationship. Implementing structured argumentation could function in improving student understanding and acceptance of evolutionary biology and integration of its concepts into other facets of biology as well.

Educational Significance of Teaching Evolution:

In a study conducted over ten years, Werth (2013) provides empirical evidence to support this shift in NGSS curriculum. Werth and his instructional colleagues were able to frame their entire introductory undergraduate biology courses behind the notion of evolution, and by doing so effectively integrated evolution concepts in every aspect of their curriculum. This methodology resulted in significant shifts in not only student understanding and acceptance of evolution theory, but more notably their comprehension of the other 3 core concepts set forth by the NGSS. Therefore, it seems, biology teachers in order to more effectively teach the whole of their content, need to restructure their instruction of evolution away from a standalone unit, and place more emphasis towards true comprehension and acceptance of it conceptually for the purpose of it acting as the unifying concept of biology.

Unfortunately, it seems that evolution is one of those topics that is highly misunderstood by a large majority of students (Werth, 2013). This has been seen firsthand in the classroom where students who, as freshman in high school, seem to have no notion of what evolution truly is, the empirical evidence supporting it or even its mechanisms. Misconceptions of evolution are not a solitary issue. They have resounding effects on issues that are influential on the progression of society. For instance Sadler (2005) identifies that evolutionary misconceptions may actually influence decision making on issues involving biotechnology and human impact on the environment.

Equally as misunderstood by students is that evolution is an idea rooted in a large body of evidence and is not rooted in logic. General understandings regarding the Nature of Science may perpetuate this misconception, more specifically student inability to use evidence based reasoning to formulate decisions instead of faith and logic. This shift in how students examine data requires developing a skill set in data interpretation and analysis. Šorgo et al. (2014) examined the conceptual connections between the nature of science and evolution. They found that the in depth comprehension of NOS is essential for the cognitive development of scientific and evidence based reasoning needed for evolution. Therefore, students' inability to examine evidence in a scientifically rational way only compounds their inability to grasp evolutionary concepts. This inability to comprehend and successfully utilize NOS to make rational data driven conclusions and connections could also be one of the primary causes of students' inability to conceptualize evolutionary. Thus the challenge for teachers is presented: we know we have to make these conceptual shifts described by Bybee (2013)and Werth (2013). However, science educators will undoubtedly run into crippling cultural and conceptual barriers while

implementing this philosophy; barriers which make then resistant to accepting scientific ways of thinking an analysis.

Using NOS Argumentation to Stimulate Data Driven Reasoning:

According to Roberts and Gott (2010), argumentation has a central role in the Nature of Science. Specifically scientists make claims and weigh empirically collected evidence to frame and defend arguments. In a study conducted by Khishfe (2014), the importance of integrating NOS and explicit argumentation was empirically demonstrated. Through explicit instruction of Argumentation, seventh grade students were noted to demonstrate significant growth in their content knowledge of NOS, argumentation skills and long term transfer of NOS knowledge to unfamiliar content. Thus, it can be concluded that even basic incorporation of argumentation into secondary classrooms can enhance student comprehension and analysis of complex biological content. Supporting this, Dawson and Venville (2013) discovered that after being immersed in argumentation, students were able to demonstrate significant growth in their conceptual comprehension of genetic concepts. This may have been the result of a shift from "Emotive Formal Reasoning" to "Rational Formal Reasoning" (Dawson & Venville, 2013, p. 376). Their findings are reaffirmed by Cross, Taasoobshirazi, Hendricks, & Hickey, (2008), who used a pretest/posttest model to measure the learning gains of students when engaged in argumentation, and suggested based on their results that argumentation actually functions to help solidify preexisting scientific concepts in addition to preventing misconceptions. This would allow students to analyze evidence for evolution using less emotion and more reason based on empirical data. This shift is a key cognitive shift for comprehensively understanding the intricacy of evolutionary concepts in biology. Thus, as suggested by Bybee (2013) and Werth

(2013), the answer to this impending problem facing secondary biology teachers regarding evolution may lie in the incorporation of argumentation as a means of effectively instructing evolutionary concepts. More specifically, using argumentation as a major aspect of instructing evolutionary content to adjust formal reasoning, much along the lines of the methodology that Dawson and his colleagues used for their genetics curriculum, may prove beneficial since the abstract nature of evolution as an academic discipline parallels the abstract nature of genetics.

There seems to be an ever increasing demand for introducing students to authentic "real world activities" in the science classroom that exposes students to a more authentic scientific situation (Roberts & Gott, 2010). This will in turn provide students the opportunity to gain experience analyzing data so they can draw meaningful and relevant conclusions from it. Argumentation provides an opportunity for curriculum to be focused on contextually relevant situated learning activities, while still giving students exposure to authentic data analysis. According to Roberts and Gott (2010) studies have shown that providing students with these types of learning activities aid in the transfer of knowledge surrounding the correct usage of data to relevant situations. The authors even go further to add that authentic data collection enhances the benefits from this type of learning. Studies have shown that students directly involved in data collection are more engaged and respond differently when analyzing data that they had a direct hand in collecting themselves (Roberts & Gott, 2010). This suggests that using secondary data, which is commonplace in the teaching of evolution may not be the most beneficial, especially when attempting to have students utilize secondary data to formulate meaningful perspectives for argumentation. Interestingly, these students also were noted to be more accepting of diverse perspectives concerning data when the data was collected first hand (Roberts & Gott, 2010). Thus, if students who initially reject evolutionary concepts are given the

opportunity to collect and interpret evidence for themselves, they may be more apt to consider evolutionary viewpoints than if the data is presented as counter to their beliefs by the teacher.

This idea of providing students with opportunities to firsthand view and analyze data autonomously is an important science process skill that falls within the realm of Nature of Science. Therefore, in order to be effective in rationalizing evolutionary concepts, argumentative pedagogy must be driven by analysis of empirically collected data. Consequently, teaching students to distinguish between scientific and nonscientific reasoning is crucial for understanding the scientific validity various arguments. This suggests that explicit instruction on NOS topics like evolution, coupled with explicit instruction on argumentation and reason, has the potential to enhance student's ability to properly distinguish evolution as science and creationism as non-science.

The Issues of Implementing Argument-Based Instruction:

Shortcomings of argument-based instruction that Khishfe (2014) discussed in their study involving the use of argumentation with 7th grade students were reaffirmed by Acar et al. (2010). Acar and his colleagues describe a major problem that could arise with restructuring curriculum around argumentation. They have found that students have had significant difficulties engaging in socio-scientific argumentation in a meaningful way, specifically when it comes to choosing a side in the argument. This may be due to the fact that students are either not confronted equally with both sides of the argument or that they have not been asked to examine data before making a decision. In fact, Cross, Taasoobshirazi, Hendricks, & Hickey (2008) suggest that eliciting students to form high quality, empirically supported statements in a socio-scientific argument is

essential for student learning in topics rooted in NOS. However this requires students to first choose which side of the argument they will argue for. This choice should be based on data and rooted in the Nature of Science. For this reason argumentation must allow students to make informed decisions given both sides of an argument. Research conducted by Gresch et al. (2013) suggests the importance of choosing a side while implementing argumentation. For students to be able to successfully use argumentation to enhance their learning, they must be able to effectively weigh the controversy and make a decision when presented unbiased evidence. Most notably, in order for students to learn affectively from argumentation, they must use evidence to decide which position is best before being asked to justify their stance in a formal argumentative setting. Thus choosing a side in an argument is a necessary prerequisite activity that should be incorporated before formal argumentation in a classroom.

Research has found that choosing sides in a controversial context is especially difficult when scientific theories contradict student's long held beliefs. Essentially, students are more apt to abandon rational formal reasoning for emotive formal reasoning in which their ability to reason falls back on emotion and personal bias instead of evidence. This is only accentuated when students are challenged with an argument that forces them to contradict their long held personal and religious beliefs, they often fall back on their intuitive conceptions and reasoning skills, thus removing their cognitive processes and logic away from scientifically derived reasoning. This often stems from students' inability to successfully link or make connections between data and their arguments (Acar et al., 2010). To combat this Acar et al. (2010) suggest that using a model of argumentation that considers student values and belief systems may enhance the argumentation process. This suggestion is consistent with the Self-determination theory described by Gresch et al. (2013). The self-determination theory states that motivation and

performance in decision making tasks are best supported in a learning environment that provides students with perceived competence, perceived autonomy and relatedness. Ultimately this means that designing argumentation within an autonomous learning environment that enables student choice, allows self-regulation and the ability to independently fulfill tasks should increase motivation and enhance performance.

This ideology, however, is not consistent with much of the thinking regarding evolutionary instruction in the public school setting. Commonplace in secondary education is the avoidance of discussing creationism during instructional time (Foster, 2012). Whether this is because teachers are hesitant to enter in a hot topic or simply because they do not feel "non-science" deserves a place in a science classroom, it tends to produce a learning atmosphere centered on the teacher teaching how natural selection works while attempting to convince students of the validity of the evidence without having them examine it next to its alternatives. Foster (2012) suggests that this "teacher as an expert" methodology is ineffective and argues that students need to be provided the opportunity to determine evolution's validity for themselves in order to more effectively evaluate each stance. In fact, the former of these two pedagogical practices could actually be more detrimental toward student acceptance of evolutionary concepts than the latter, since it may actually elevate creationism. Therefore, Foster (2012) suggests a modified form of the Socio-Cognitive Conflict model that challenges student's way of thinking but incorporates student analysis of both creationism and evolution, thus enabling them to initially weigh each on an equal playing field decreasing the threatening nature of the argument.

Ultimately this means that, at least for the sake of argumentation, encouraging scientific examination of both creationists and evolutionary prospective using a models that give equal consideration at the onset of an argument, while eliminating non-science throughout the

argumentation process though students' own data analysis may prove to me effective. This methodology is consistent with Foster (2012), who states that in order to increase the efficacy of argumentation in an evolutionary context, students need to have alternative positions to argue.

Conclusions:

Research and personal experience have clearly demonstrated that student consistently enter science classrooms with predetermined misconceptions regarding scientific issues. Cultural values and lack of exposure to the complex and abstract concepts surrounding scientific issues make teaching topics like evolution challenging to say the least. For this reason it is necessary to devise an effective means of restructuring biology coursework in order to centralize it around evolution as the unifying concept of biology, thus shifting student conceptions of biology away from a standalone theory. This would in turn function in helping students construct a more integrated view of biology from its molecular/chemical basis to its complex ecological hierarchy. However, in order for evolution to be utilized effectively in this manner it must be both understood and generally accepted by students. This creates a challenge and therefore requires a restructuring of content in a way that fosters this relationship. Implementing structured argumentation models and instructing effective decision making could function in improving student understanding and acceptance of evolutionary biology and integration of its concepts into other facets of biology as well.

Chapter III: Curriculum Project

Overview of Project Design:

The unit plan will consist of the following elements:

1. Evolutionary understandings survey (For Pre and Post Instruction)
    a. Will function as a base assessment of students general perceptions on evolutionary theory. Students will use a simple ranking system to indicate whether they agree or disagree with statements that pertain to evolutionary biology and the societal debate surrounding it.
2. Relevant standards from the following:
    a. Next Generation Science Standards
    b. NY State Living Environment Core Curriculum Standards
3. Topic Unit/lesson plans indicating daily objectives
    a. Topic #2 – Case Study/Data Driven Argumentation – Two contrasting ideologies Explaining the Diversity of life (~10 Instructional Days)
        i. Compare and contrast major Creationism and Evolution concepts
        ii. Decision making – Students autonomously decide and provide explanations for opposing viewpoints based on the available data provided
            - Sickle Cell Anemia – case Study
                i. Students will analyze the relationship between sickle cell and Malaria
            - Vestigial & homologous structures – case study
                i. Students will determine various if various anatomical structures are either vestigial and homologous structures
            - Transitional Fossils – case study
                i. Students will determine whether fossils exhibit traits of transitional forms.
            - Rock Pocket Mice – case study

i. Students will analyze the phenotypes of geographically isolated populations and their relationship with ancient environmental changes in the ecosystem.

- Human / Chimp Comparison – Case Study

i. Students will compare and contrast various genetic and anatomical characteristics of Chimpanzees and humans

iii. Formal debate – Have Students choose a side in the socio-scientific argument.

- Provide carefully structured and relevant debate questions

i. This will be done in and electronic debate format utilizing the comments function of " Docs"

ii. Each student will have to post an initial argument for each debate question either for or against evolution, providing a data driven explanation relavant to the question.

iii. Once each student has completed an original post, they utilize the comment tab make at least two responses to two separate classmates of the opposing view point in the form of an evidence based rebuttal.

4. Evolution Summative Assessment (Given pre and post instruction).
   a. This will act to assess the effectiveness of using argumentation to enhance content acquisition in SSI topics like evolution.

Skeletal Example of Lesson Plan:

Basic Lesson info:	Course: Living Environment / Unit: Evolution / Topic: #2
Objectives:	Students will formulate relevant questions regarding the
Standards:	NY State Core Curriculum: 3.1 f, 3.1 G & 3.1 H NGSS: HS-LS4-1, HS-LS4-3, & HS-LS4-4
Introductory activity:	Facts and Questions: Student Inquiry activity →Have students draw 3 observable facts from a graph depicting the number of African Americans and Caucasian Americans with Sickle Cell Anemia →Ask students to formulate 2 questions they have regarding the specific facts they listed (goal) Have students ask Why and or how Africans display the Sickle Cell Phenotype more frequently than Caucasian Americans
Body of Lesson:	Case study Data →provide students with 3 diagrams: 1) Global Map of greatest sickle cell incidence 2) Global Map of regions with might malaria transmission 3) Globin Genotypes and their effect on survival →Have students answer questions regarding the relationships and connections between the
Conclusion Activities:	Provide students with Explanations for the phenomenon, one based on Evolutionary principles, one based on Creationism Principles

Project Lesson Plans and Materials:

Case Study Driven Argumentation – Analyzing the Evidence for Evolution

Pre and Post Instruction Survey

This survey is completely voluntary and will not be used to determine your grade for this course in any way. The information from this survey will be used by Mr. Marchand to help determine how using argumentation in a classroom setting affects students to learn content associated with socially controversial issues. You will not be asked or forced to change your opinion regarding the topic. Please give your honest opinion on each of the questions in the survey. I thank you in advance for your participation.

Agree	Unsure/ Don't Know	Disagree	
			1. All species as they appear today were created by an intelligent designer.
			2. Species do not change or evolve or change over time; therefore, they have always remained in the same form as they appear today.
			3. Both the earth and life itself was created approximately 5000 years ago. The earth is not billions of years old.
			4. Humans as a species evolved from other species instead of being created individually
			5. Scientists believe that humans evolved from chimpanzees
			6. Scientists believe humans evolved from an extinct species that share traits of both modern humans and modern apes.
			7. Humans share common evolutionary ancestors with animals like chimpanzees
			8. There is reliable scientific evidence that supports evolution
			9. Many Biologists disagree about whether evolution occurs
			10. No one can be sure about whether evolution occurred since no one has ever seen it.
			11. There are fossils that show gradual change from one type of organism to another (ex. Fossils that show traits of both fish and amphibians). This provides evidence that major groups of organisms like amphibians evolved from other groups of organisms like fish.
			12. The fossil record provides evidence that evolution has occurred over hundreds of millions of years
			13. Species are still evolving today, because specific changes in environments "select" traits that help organisms adapt and better survive changing environments
			14. All living things can be traced back to one original "bacteria like" life form hundreds of millions of years ago.
			15. Evolution is a random process, because it often needs random changes/mutations in individuals DNA and random environmental changes in order to cause changes in populations and species.
			16. Evolution works toward the goal of creating perfectly formed and perfectly adapted organisms
			17. People who believe in evolution cannot be religious or believe in god.
			18. Evolution is only a Scientific Theory, Theories in science are just ideas and therefore cannot be considered fact.
			19. If evolution actually happens as scientists suggest it does, then there would be species that are half fish/half amphibian, half dinosaur/half bird, half human/half ape, and half whale/half land mammal. Only this would indicate that one thing can turn into another. Species that show these types of traits have never been found, and thus evolution cannot be true.
			20. Natural Selection always chooses the biggest, strongest and fastest animals to survive in a population
			21. Mutations in DNA are always bad, and therefore mutations cannot lead to beneficial evolutionary adaptations.
			22. There are more scientifically accepted theories, in addition to evolution, that explains how life on earth originated.
			23. Evolution can lead to small scale changes in populations over a few hundred or even a few thousand years.
			24. Large scale changes like the formation of a new species of organism cannot result from evolution.

Lesson # 1 Plan

Heath Marchand Date: 10/15/2014
Subject of Lesson: Debate Topic One Case Study: Sickle Cell Malaria Connection
Time Estimate: 42 minutes Grade Level: 9th Grade Living Env.

I. Objective(s)

- Identify the age demographics affected by both sickle cell anemia and malaria
- Identify which race of people has the highest incidence of sickle cell anemia
- Compare the number of people affected by malaria in tropical/ equatorial regions to those in non-tropical regions
- Compare the number of people affected by Sickle Cell anemia in tropical/ equatorial regions to those in non-tropical regions
- Describe how the different genetic Phenotypes (H^SH^S, H^NH^S & H^NH^N) affect the individual's ability to survive from malaria infection

II. Purpose or Rationale

- Each case study is a summary of empirically collected data, used by scientists to support the theory of evolution. Typically it is instructed in a way that "tells" students how the data is and should be interpreted. This can be problematic because it can cause students resistant to the idea of evolution to shut down when examining evolutionary data. Therefore this activity is meant to simply have students analyze the data themselves in order to draw their own conclusions and attempt to use it as evidence for their side of the argument, whether that be evolution or creationism. It forces students to become engaged with the material which is something that they may not do if not offered the opportunity to argue their viewpoint

- This particular case study is meant to have students observe and analyze the undeniable relationship between Sickle cell anemia and its protective function against malaria parasite's proliferation in the body. Students will analyze the facts of the case study and use them to argue for their particular Stance in the debate.

III. Essential Question

- Why is sickle cell anemia, a relatively deadly genetic disorder found mostly in tropical populations around the world?

IV. Task Analysis

- Students will have to understand the following prior to this lesson
  Vocabulary: Natural Selection, Environmental Selection Pressure/Agent, Microevolution, Macroevolution
  Concepts:
    - Mechanism of Natural Selection.
    - How natural Selection leads to microevolution
    - How numerous micro-evolutionary changes can lead to macro-evolutionary changes
    - How microevolution and macroevolution are represented on a Phylogenetic Tree

V. Standards

- NGSS:
    - HS-LS4 – 1
    - HS-LS4 – 2
    - HS-LS4 – 3
    - HS-LS4 – 4
    - HS-LS4 – 5

V. Lesson Procedures

Introduction (~ 10 minutes)

1) Ask students to take out last night's homework assignment entitled (Sickle Cell Anemia Introduction: Inquiry Homework)
2) This introduction should be a student driven activity, with the teacher acting only as a facilitator. Questions should be uniquely derived by the students in order to give them ownership of the material.
3) Ask Students to contribute the facts they wrote down about the sickle cell demographics diagram until the at the desired facts are mentioned:
   →Desired Fact: Sickle cell is more common in populations of African descent than those of Caucasian descent
   →Desired Fact: Sickle Cell anemia only severely affects Homozygous recessive individuals
4) Have students contribute their questions until they generated the following question(s)
   →Desired Question: Why do Africans inherit sickle cell anemia more than Caucasians?
   →Desired Question:

Body of the Lesson/Lesson Development (~ 25 minutes)

1) Discuss Debate Question #1 on page # 3 of Case Study #1
   → This will function to give the students a preview of what the data in the case study will be used for.
2) Have students read the short articles: "What is Malaria" & " What is Sickle Cell Anemia" on Pg #1 & #2 and ask them to use the articles to complete the questions in order to analyze the relationship between the two diseases
3) Inform students that they should be focusing on the connections between the 3 sickle cell phenotypes and their genotypes.
   →Specifically tell them to focus on:
   -which sickle phenotype causes mortality prior to reproductive age
   -which sickle phenotypes protect against the severe symptoms of malaria infection.
4) Once students finish the data based questions, discuss the correct answers to the data based questions with student input and discussion

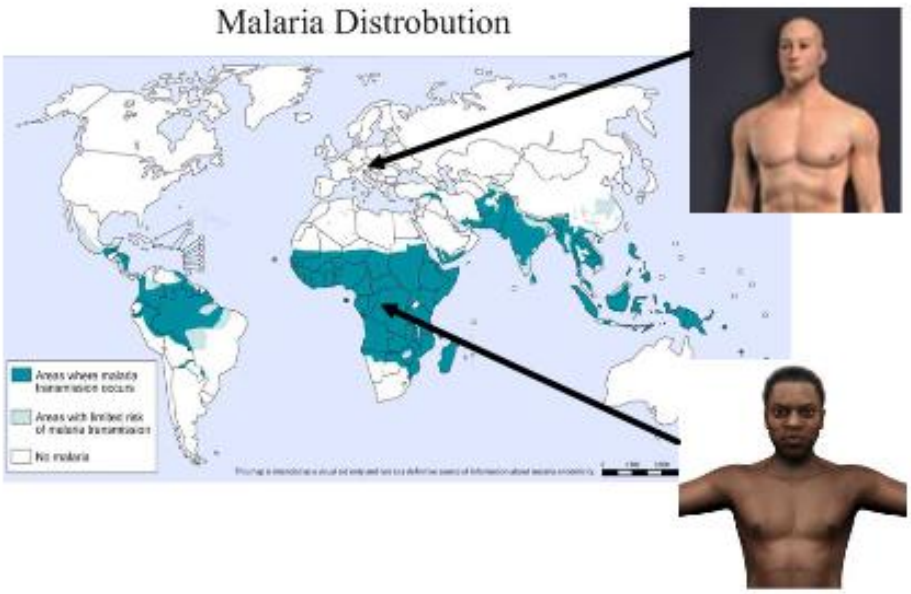
C. Closure/Concluding Activity (~7 minutes)

1) Ask students to begin working on their "choosing a side homework assignment" on page 3 of their case study.
   →Ask students to choose one of the two positions, and use that position to try to explain the protective function that sickle cell anemia has on malaria.
   →Students may not be able to come up with an explanation on their own since some of the connections require high order thinking skills. Tell them that if they feel that they are stuck they are allowed to use the internet to research how either creationists or evolutions would explain. However anticipate students to copy and paste others arguments, so it is important to reinforce the importance of constructing explanations in their own words explanations must.

Homework:

- Students need to Finish "Choosing a Side Homework" for Case Study #1 Prior to the Formal Debate.
- Tell Students that their explanations will be checked for a participation grade prior to the formal debate
- Allow students to come in during after school advisement to discuss their ideas. This added time may allow students to ask questions pertaining to either side of the argument, in order to better formulate their own position. Be sure the answers provided for these questions are as unbiased as possible.

Sickle Cell Anemia Introduction: Inquiry Homework.



Sickle Cell Anemia Statistical Demographics

Caucasian decent

Genotype	Phenotype	Percent of population
$H^N H^N$	Unaffected By Sickle Cell	0.01%
$H^N H^S$	Unaffected By Sickle Cell	
$H^S H^S$	Affected By Sickle Cell	

African

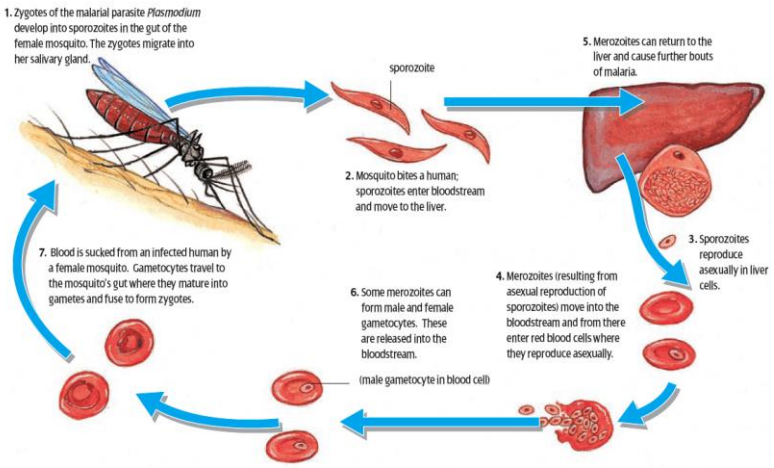
Genotype	Phenotype	Percent of population
$H^N H^N$	Unaffected By Sickle Cell	8%
$H^N H^S$	Unaffected By Sickle Cell	
$H^S H^S$	Affected By Sickle Cell	

→Using the diagram above, state three facts about the people who have high rates of Sickle Cell anemia.
→Once you have written your facts, ask one question that you have about the facts you wrote down.

Facts	Questions

Name_____ Case Study #1: Sickle Cell in African Populations

Malaria:

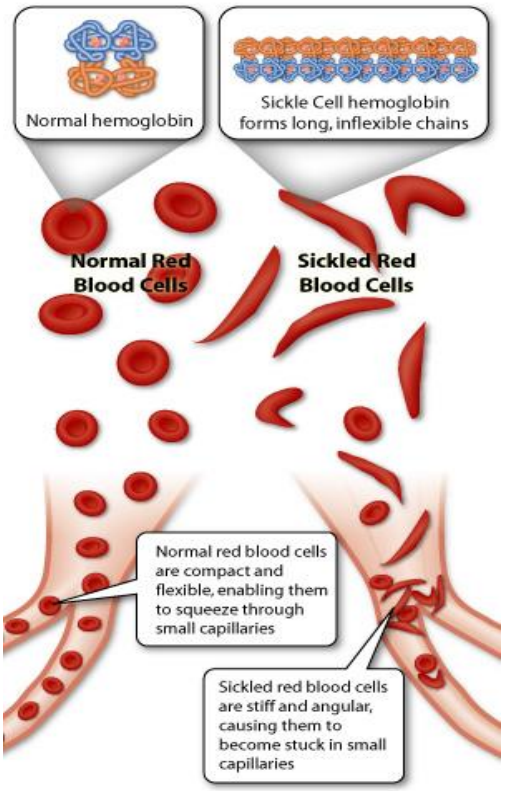


Malaria is a disease caused by a single celled parasite which is spread to humans by the female Anopheles mosquitoes. Malaria kills about 2 million people a year, making it one of the world's deadliest diseases. Forty percent of the world's population is at risk of contracting malaria. Most of the deaths caused by malaria are in Africa. Specifically most deaths are in children before the age of five. There are some areas where up to 40% of the children die of malaria when conditions are at their worst.

Inside the human host, the malaria parasite first invades the liver cells and then the red blood cells. Disease is caused when the parasite uses the red blood cells to reproduce. When the new parasites have matured inside the red blood cells, the cells burst, producing chills and a very high fever. The infected red blood cells and the burst blood cells can cause failure of the liver or the kidneys, hypoglycemia, or cerebral malaria which can include blocking the blood vessels carrying blood to the brain; these events may lead to death. Interestingly, not all people are not as negatively affected by malaria. In fact certain people with genetic hemoglobin disorders caused by mutations have been found to inhibit the complete reproductive cycle of the malaria parasites in red blood cells.

1) What race and age group is has the highest mortality as a result of malaria infection.
   a. Race _____
   b. Age Group _____
2) What percent of this group die? _____
3) Would malaria increase or decrease an individual's ability to survive and reproduce (their reproductive fitness).
4) →Explain:_____
   _____

Sickle Cell Anemia:



Sickle cell anemia affects millions of people throughout the world. It is particularly common among people whose ancestors come from sub-Saharan Africa. In the Unites States, sickle cell affects around 72,000 people, most of who are of African descent. The disease occurs in about 1 in every 500 African-American births. About 2 million Americans, or 1 in 12 African Americans, carry the sickle cell trait.

Sickle cell anemia is caused by a mutant form of the gene coding for the hemoglobin protein. Hemoglobin functions in binding oxygen within red blood cells, which then transport the oxygen to body tissues and release it to be used during cellular respiration. The sickle hemoglobin (in a person with the mutation) tends to clump together inside red blood cells after they release their oxygen. If the clumping is extensive, the red blood cell changes shape into an abnormal "sickle" shape (see diagram to right). These sickle red blood cells plug the blood vessels, thus blocking normal red blood cell passage through arteries which does not allow oxygen to get to the tissues.

Each person has two copies of the gene that determines whether that person has sickle cell disease. The genotype/phenotype options are:

- If both copies are "normal" alleles (H^NH^N), then only normal hemoglobin is produced. These individuals have no natural protection to malaria.
- If one of the two alleles is "mutated," ($H^N H^S$) then that person has a mixture of normal hemoglobin and sickle hemoglobin--a condition known as "sickle cell trait." These people have some sickled red blood cells, but do not have enough to cause death but interestingly are found to have a natural immunity to malaria.
- If both copies are the "defective" alleles (H^SH^S), only sickle hemoglobin is made and the person has sickle cell anemia. These people only have sickled red blood cells and are more likely to die before their teenage years, but also do not suffer from malaria. Thus having at least one H^s allele is known to provide natural protection to Malaria.

1) Identify the phenotypes of people with the following genotypes.
   (H^NH^N) →Do they die from Sickle Cell? _____
   →Do they die from Malaria? _____
   (H^NH^S) →Do they die from Sickle Cell? _____
   →Do they die from Malaria? _____
   (H^SH^S)→ →Do they die from Sickle Cell? _____
   →Do they die from Malaria? _____

2) Complete the Punnett square of two heterozygous individuals that have the sickle cell trait. Use this diagram to answer questions 3 & 4.

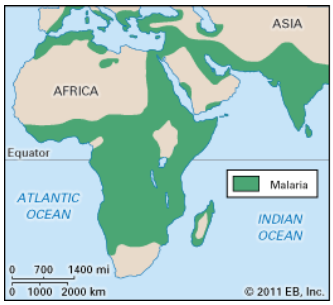
	H^N	H^s
H^N		
H^s		

3) Using a Pencil shade in the children in the box who would most likely not live to become an adult.

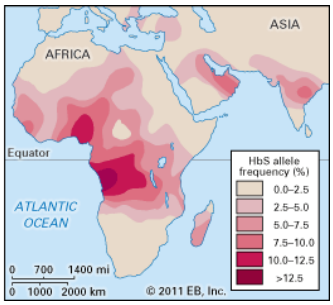
4) On average what percent of people would be born/die from sickle cell anemia
   a. Approximately 75 %
   b. Approximately 50 %
   c. Approximately 25 %
   d. Approximately 0 %

5) The diagrams show distrobution maps of those populations that have a high occurance of both Malaria and sickle cell anemia

Malaria distrobution



Sicke Cell Anemia Distrobution



How does the distribution of sickle cell anemia compare to that of malaria? Are they similar/different? Explain in detail.

_____

_____

_____

_____

Homework: Choosing a Side

Use the data presented in the case study to explain how/why sickle cell anemia is so common in populations of humans living in regions with a high incidence of malaria. Be sure to provide as detailed an explanation as possible to support your viewpoint since we will eventually be debating these topics.

→Disclaimer: This page will not be graded on what your viewpoint is, only on completion of one of the two options and for the level of thought put into it.

Viewpoint #1: Evolution was responsible for the increase of sickle cell anemia in African populations living in malaria stricken areas. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Viewpoint #2: Sickle Cell Anemia and malaria are both diseases that were created independently by a higher power or intelligent designer. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Picture References: Case Study #1

1. Retrieved from: http://learn.genetics.utah.edu/content/disorders/singlegene/sicklecell/ 7/14/14- Normal vs sickle erythrocytes
2. Retrieved from: http://www.britannica.com/EBchecked/media/160694/The-distribution-of-malaria-and-the-distribution-of-sickle-cell 7/14/14 - Geographic Distribution map of sickle cell and malaria.

Lesson # 2 Plan

Heath Marchand Date: 10/15/2014
Subject of Lesson: Case Study #2: Mystery of Missing Hind Limbs in Aquatic Mammals
Time Estimate: 42 minutes Grade Level: 9th Grade Living Env.

II. Objective(s)

- Students will identify the Structures missing in Aquatic Mammals as their hind limbs and hip bones.
- Students will inquire about "How?" and "Why?" hip Structures in aquatic Mammals are functionless/reduced in size
- Students will compare and contrast the size of left and right posterior structures in organisms with defective Pitx1 genes.
- Students will identify carious limbs of living vertebrate species as either analogous or homologous.
- Students will construct an argument explaining whether or not vestigial structures arose as a result of evolution.

II. Purpose or Rationale

- Each case study is a summary of empirically collected data, used by scientists to support the theory of evolution. Typically it is instructed in a way that "tells" students how the data is and should be interpreted. This can be problematic because it can cause students resistant to the idea of evolution to shut down when examining evolutionary data. Therefore this activity is meant to simply have students analyze the data themselves in order to draw their own conclusions and attempt to use it as evidence for their side of the argument, whether that be evolution or creationism. It forces students to become engaged with the material which is something that they may not do if not offered the opportunity to argue their viewpoint

- This particular case study is meant to have students observe and analyze the presence of vestigial structures in aquatic mammals. In addition the case study introduces students to a potential genetic trigger (Pitx1) that is currently being researched for its potential to explain the reduced hind limb development in whales, manatees, and snakes. Therefore this case study incorporates comparative anatomy, amongst extant and extinct species as well as one of the genetics mechanisms that is believed to have led to reduced hind limb development for the function of specialized locomotion.

III. Essential Question

- Why do whales, manatees and other aquatic mammals have small, underdeveloped, and functionless hip and hind limb bones?

IV. Task Analysis

- Students will have to understand the following prior to this lesson
  Vocabulary: Natural Selection, Environmental Selection Pressure/Agent, Microevolution, Macroevolution
  Concepts:
  - Mechanism of Natural Selection.
  - How natural Selection leads to microevolution
  - How numerous micro-evolutionary changes can lead to macro-evolutionary changes
  - How microevolution and macroevolution are represented on a Phylogenetic Tree

V. Standards

- NGSS:
  - HS-LS4 – 1
  - HS-LS4 – 2
  - HS-LS4 – 3
  - HS-LS4 – 4
  - HS-LS4 – 5

V. Lesson Procedures

Introduction (~ 15 minutes)

1) Ask students to take Case Study #2 packet, and open to the introduction inquiry activity
2) This introduction should be a student driven activity, with the teacher acting only as a facilitator. Questions should be uniquely derived by the students in order to give them ownership of the material.
3) Ask Students to observe the diagrams of the skeletons of extinct and extant aquatic mammals.
4) Ask them to list two or three facts comparing and contrasting the organisms in the diagram, as well as at least one question about the facts they listed
5) Collaboratively as a class ask students to share their facts until the at the desired facts are mentioned:
   →Desired Fact: All living whales and two extinct whale species have small, functionless hip structures
   →Desired Fact: One extinct aquatic mammal has fully developed hips and legs
   →Desired fact: Each Species looks similar in overall body structure (you may need to specifically ask them to compare the skeleton of Rodhocetus to the killer whale
6) Have students contribute their questions until they generated the following question(s)
   →Desired Question: Why do whales have functionless hip bones
   →Desired Question: Why do the skeleton of whales resemble those of ancient four legged creatures

Body of the Lesson/Lesson Development (~ 25 minutes)

1) Discuss Debate Question #2 on page # 4 of Case Study #2
   → This will function to give the students a preview of what the data in the case study will be used for.
2) Have students read the definition to the following vocabulary words: Vestigial, Analogous and Homologous Structures
3) Students will then use the definitions and diagrams to answer the questions in order to classify structures in the case study as either vestigial, homologous or analogous.
4) Inform students that they should be focusing on the similarities and differences in the arrangement, number and shape of bones of each structure
   →Specifically tell them to focus on:
   -comparing the number of digits and the number of Limb bones in each vertebrate species
   -Comparing the bone structure in the limbs of whales to that of fish fins.
5) Ask students to compare the Size of the posterior bone structures in whales and manatees to organisms like the stickleback and lab mutated mice with a mutated Pitx1 gene.
6) Once students finish the data based questions, discuss the correct answers to each of the data based questions with student input and discussion

C. Closure/Concluding Activity (~7 minutes)

1) Ask students to begin working on their "choosing a side homework assignment" on page 4 of their case study.
   →Ask students to choose one of the two positions, and use that position to try to explain the protective function that sickle cell anemia has on malaria.
   →Students may not be able to come up with an explanation on their own since some of the connections require high order thinking skills. Tell them that if they feel that they are stuck they are allowed to use the internet to research how either creationists or evolutions would explain. However anticipate students to copy and paste others arguments, so it is important to reinforce the importance of constructing explanations in their own words explanations must.

Homework:

- Students need to Finish "Choosing a Side Homework" for Case Study #2 Prior to the Formal Debate.
- Tell Students that their explanations will be checked for a participation grade prior to the formal debate

Name _____ Case Study #2: Mystery of Missing Hind Limbs in Aquatic Mammals

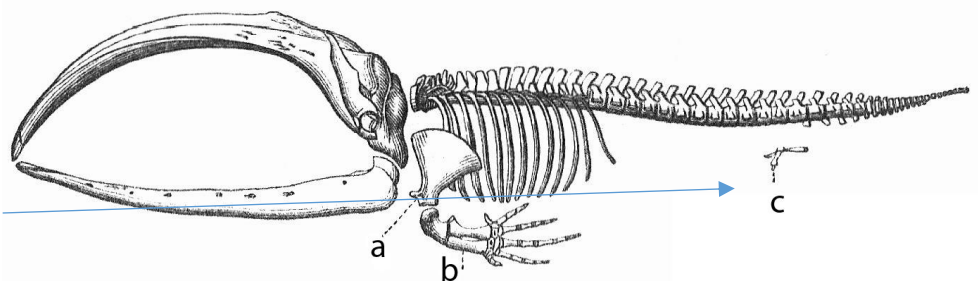
Introduction:

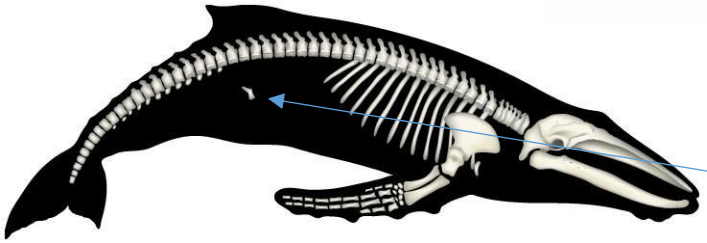
The diagrams below show the skeletal structure of various ocean dwelling organisms both alive and extinct.

Right Whale:

→Living species of whale

→ Possesses small functionless Hip bones





Humpback Whale:

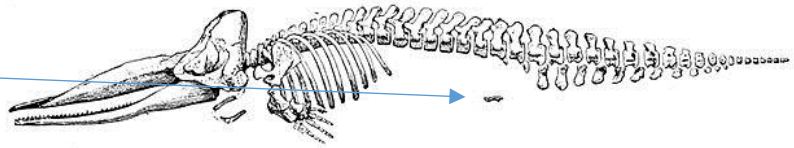
→Living species of whale

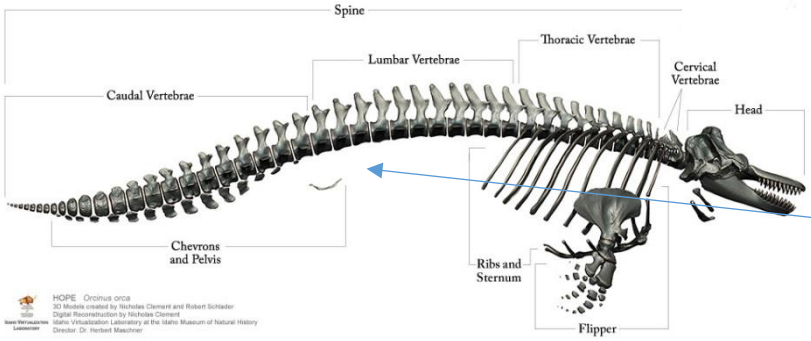
→Possesses small functionless Hip bones

Sperm Whale:

→Living species of whale

→Possesses small functionless Hip bones





Killer Whale:

→Living species of whale

→Possesses small functionless Hip bones

Dorudon:

→Extinct species of whale (fossil)

→Possesses small functionless Hip bones

Basilosaurous:

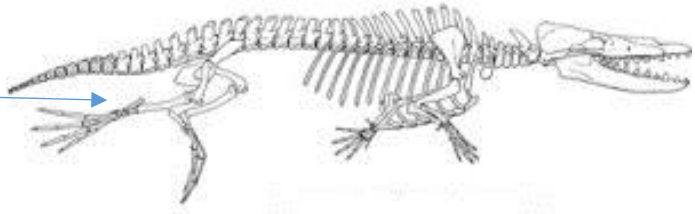
→Extinct species of whale (fossil)

→Possesses small seemingly functionless Hip ***AND*** hind leg bones

Rodhocetus:

→Extinct species aquatic vertebrate

→Has fully formed Hip bones and hind legs



Introduction Inquiry Activity:

→Using the diagram above, state three facts about the whale skeletons and fossil skeletons
→Once you have written your facts, ask one question that you have about the facts you wrote down

Facts	Questions

Vocabulary:

→**Vestigial structure** - A body part that is often reduced in size and no longer can perform a significant function in the organism. (ex. The tail bone of humans - a very small tail that has no function in humans.)

→**Homologous structures** – Body parts that are similar in their internal bone structure. Have very different functions and outward shapes. Homologous structures are shared traits of closely related organisms that originate (grow/develop) from the same tissue in the embryo. (ex: The limbs of all land vertebrates have the same general bone structure and develop from the same embryonic tissue).

→**Analogous structures** – Body parts that have developed to perform similar functions and have similar outward structures. However they are very different in their internal structure and embryonic origin. (ex: The wings of insects, birds and bats all are used for flying but structurally are very different).

1) Which species possess vestigial structures? (List)

- _____
- _____
- _____
- _____
- _____

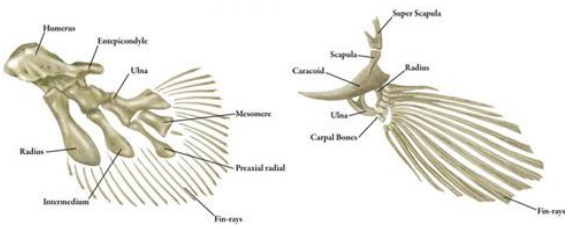
2) What is this vestigial structure? _____

3) Identify at least one other structure that all or most of these skeletons share in common

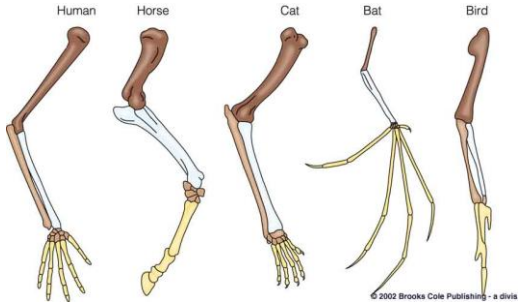
- _____

4) Do the internal forelimb bones of each organism look more like a fish fin or a land vertebrate? _____

Fish fin



Land vertebrate limbs



Would the limbs of a whale and a fish be considered analogous traits or homologous traits? _____

→Explain _____

_____

Would the limbs of a whale and a bat be considered analogous traits or homologous traits? _____

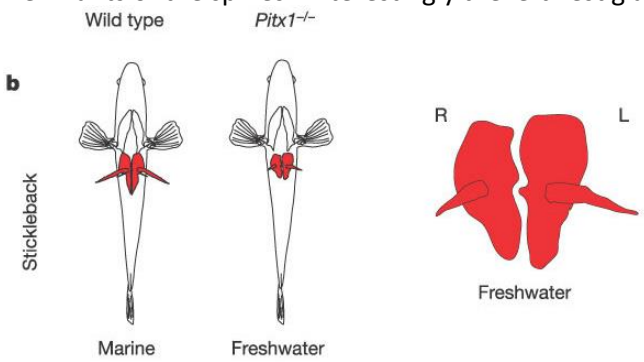
→Explain _____

_____

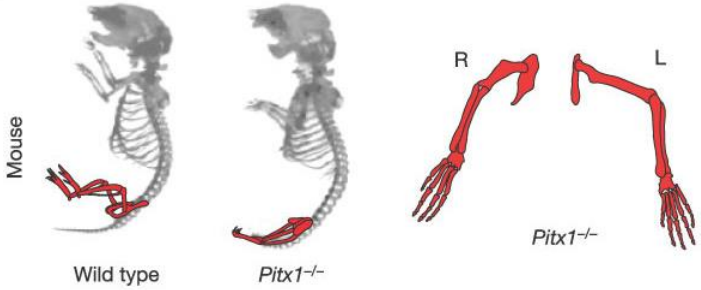
Genetic Triggers for vestigial hip bones and hind limbs:

A gene known as Pitx1 has been found to be responsible in the growth and development of vertebrate hind limbs and pelvic regions. Scientists have observed the following while performing studies on PitX1 and vertebrate hind limbs

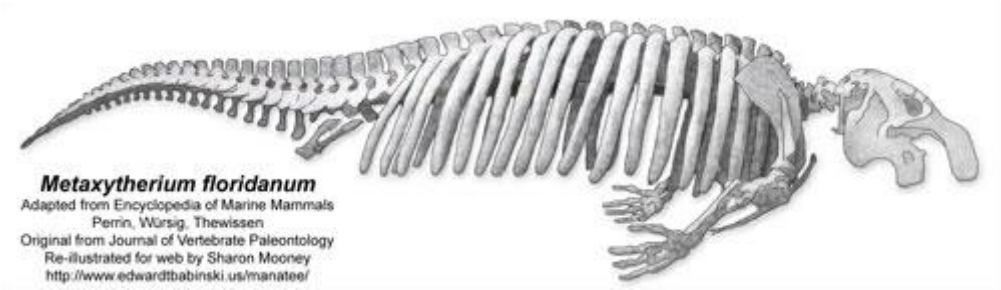
Stickleback fish: In natural freshwater lakes part of the PitX1 gene is completely missing. Fish with pelvic spines develop significantly smaller vestigial remnants of the spines. Interestingly the left vestigial pelvic spine is larger than the right spine.



Laboratory mice: When scientists purposely delete the PitX1 gene of mice in a lab, the embryos developed abnormal, non-functional hind limbs. The left limb is larger than the right limb. In the diagram wild type is the the normal mouse and Pitx1 -/- are the mutated mice.



Manatees: Like whales and dolphins, manatees are mammals that have small, underdeveloped hind limbs and pelvises that do. Manatees also their entire lives in water like whales and dolphins. Close measurements of manatee hip bones shows that the left hip bones are slightly larger than the right hip bones.



Questions:

1) What do the mutated mouse, the freshwater stickleback and the manatee all have in common; both genetically and structurally? _____
_____
_____

2) What structural characteristic to the mouse, stickleback, and manatee all have in common with each of the skeletons on the first page?
_____
_____

3) What would you predict might cause the lack of functional hind limbs in whales given the information presented above?
_____
_____

→Could this be tested? _____ If so how? _____

Homework: Choosing a Side

Use the data presented in the case study to explain how/why vestigial hip structures exist in whales and manatees

→Disclaimer: This page will not be graded on what your viewpoint is, only on completion of one of the two options and for the level of thought put into it.

Viewpoint #1: Evolution was responsible for the decrease in size and loss of function of the hips in these species. Be sure to explain:

→How and why this could have happened?
→Any evidence that you feel supports your viewpoint

Viewpoint #2: Vestigial structures like the hips in whales and manatees were created by a higher power or intelligent designer. Be sure to explain:

→How and why this could have happened?
→Any evidence that you feel supports your viewpoint

Picture References: Case Study #2

1. Retrieved from: http://galleries.neaq.org/2011/08/its-bird-its-plane-its-whale.html - 8/20/14. - Right Whale
2. Retrieved from: http://www.nps.gov/glba/parknews/whale-skeleton-shelter-environmental-assessment-available-for-public-review.htm -8/20/14. humpback
3. Retrieved from: http://en.wikipedia.org/wiki/Sperm_whale -8/20/14. Sperm Whale
4. Retrieved from: http://www.ptmsc.org/boneatlas/ -8/20/14. Killer Whale
5. Retrieved from: http://palaeo.gly.bris.ac.uk/palaeofiles/whales/archaeoceti.htm -8/20/14. - Dorudon whale
6. Retrieved from: http://palaeo.gly.bris.ac.uk/palaeofiles/whales/archaeoceti.htm -8/20/14. - Basilosaurous whale
7. Retrieved from: http://palaeo.gly.bris.ac.uk/palaeofiles/whales/archaeoceti.htm -8/20/14. - Rodhocetus
8. Retrieved from: http://www.karencarr.com/portfolio-images/Marine-animals-and-fish/Modern/The-Teaching-Company/Lobe-finned-and-ray-finned-anatomy/511 -8/20/14. ray fin and lobe fin fish pectoral fin caparison
9. Retrieved from: http://itc.gsw.edu/faculty/bcarter/histgeol/paleo2/homol1.htm -8/20/14. Homologous forelimbs of vertebrates
10. Retrieved from: http://www.nature.com/nature/journal/v428/n6984/full/nature02415.html - 8/20/14. Stickleback Pelvic spine comparison in marine and freshwater species
11. Retrieved from: http://www.nature.com/nature/journal/v428/n6984/full/nature02415.html -8/20/14. Mouse hind limb diagram
12. Retrieved from: http://etb-whales.blogspot.com/2012/03/origin-of-sirenians.html -8/21/14. Manatee Skeleton
13. Retrieved from: http://www.deviantart.com/morelikethis/collections/47227260?view_mode=2 –8/21/14. Australian lung fish drawing
14. Retrieved from: http://etc.usf.edu/clipart/48000/48064/48064_lungfish_fin.htm -8/21/14. Australian Lung Fish fin diagram
15. Retrieved from: http://evolution.berkeley.edu/evolibrary/article/evodevo_02 -8/21/14. Salamander and axolotl comparison

Lesson # 3 Plan

Heath Marchand Date: 10/15/2014
Subject of Lesson: Case Study #3: Great Transformations & Transitional fossils
Time Estimate: 42 minutes Grade Level: 9th Grade Living Env.

III. Objective(s)

- Students will compare and contrast the anatomy of major taxonomic groups of organisms
- Using diagrams as data references, students will determine whether tiktaalik and archaeopteryx would be classified by definition as transitional species
- Students will determine whether an embryonic pigeon limb is more like that of a dinosaur, archaeopteryx or an adult pigeon.

II. Purpose or Rationale

- Each case study is a summary of empirically collected data, used by scientists to support the theory of evolution. Typically it is instructed in a way that "tells" students how the data is and should be interpreted. This can be problematic because it can cause students resistant to the idea of evolution to shut down when examining evolutionary data. Therefore this activity is meant to simply have students analyze the data themselves in order to draw their own conclusions and attempt to use it as evidence for their side of the argument, whether that be evolution or creationism. It forces students to become engaged with the material which is something that they may not do if not offered the opportunity to argue their viewpoint

- This particular case study is meant to have students observe and analyze two critical transitional fossils that exhibit characteristics of two major taxonomic groups of organisms. Specifically this case Study focuses on archaeopteryx as one of the transitional forms that existed during the evolution of theropod dinosaurs and modern birds. Similarly tiktaalik will be the focus on the transition between ancient fish and primitive amphibians. Lastly this case study incorporates combined analysis of anatomy, the fossil record and modern embryology.

III. Essential Question

- Do transitional species that exhibit a mixture of traits of two major taxa of organisms exist in the fossil record?

IV. Task Analysis

- Students will have to understand the following prior to this lesson
  Vocabulary: Natural Selection, Environmental Selection Pressure/Agent, Microevolution, Macroevolution
  Concepts:
    - Mechanism of Natural Selection.
    - How natural Selection leads to microevolution
    - How numerous micro-evolutionary changes can lead to macro-evolutionary changes
    - How microevolution and macroevolution are represented on a Phylogenetic Tree

V. Standards

- NGSS:
    - HS-LS4 – 1
    - HS-LS4 – 2
    - HS-LS4 – 3
    - HS-LS4 – 4
    - HS-LS4 – 5

V. Lesson Procedures

Introduction (~ 15 minutes)

1) Ask students to take Case Study #3 packet, and open to the Introduction – Identifying the Differences in Major classes of organisms
2) Ask Students to observe and list major differences in the anatomy of Fish and amphibians as well as between theropod dinosaurs and modern birds
3) As a class, collaboratively List the major differences on the smart board.
4) For fish and amphibians desired differences should be identified as:
   →fish have fins and amphibians have limbs
   →Fish limbs consist of many small bones and no digits whereas amphibians have a smaller number of larger longer bones with fingers at the end.
5) For dinosaurs and birds
   →Dinosaurs have a long tail birds have a very short tail
   →Dinosaurs had teeth, birds have a beak
   →dinosaurs had three fingered forelimbs, birds have fused fingered forelimbs

Body of the Lesson/Lesson Development (~ 25 minutes)

1) Discuss Debate Question #3 on page # 4 of Case Study #3
   → This will function to give the students a preview of what the data in the case study will be used for.
2) Have students turn to Part2: Transitional Forms and read the paragraph about transitional forms. Ask them to underline what transitional forms are defines as in the paragraph.
3) Ask Students to observe the anatomy diagrams of tiktaalik and archaeopteryx.
4) Using the definition of transitional forms to identify whether each would by definition be considered a transitional form and have them explain their answer.
5) Tiktaalik is by definition transitional because:
   →Has a fin with larger bones that and bones similar to digits, and thus has traits of both amphibians and fish
6) Archaeopteryx is by definition a transitional species because it shares traits with both dinosaurs and birds.
   →Archaeopteryx has a tail shorter than dinosaurs but longer than birds
   →Archaeopteryx has teeth like a dinosaur
   →Dinosaurs had three fingered forelimbs like dinosaurs, but the feathers of a bird.
6) Ask students to compare the size and number of "finger" in a velociraptor, archaeopteryx and adult pigeon in order to determine which two species look more similar.
7) Students will then compare the forelimb structure of a pigeon embryo to that of a velociraptor, archaeopteryx and adult pigeon in order to determine which organism the embryonic limb looks more similar to.
   →Students will hopefully be able to see that the third digit in the embryonic pigeon limb and the archaeopteryx limb are more similar in length then that of a velociraptor

C. Closure/Concluding Activity (~7 minutes)

1) Ask students to begin working on their "choosing a side homework assignment" on page 4 of their case study.
   →Ask students to choose one of the two positions, and use that position to try to explain the protective function that sickle cell anemia has on malaria.
   →Students may not be able to come up with an explanation on their own since some of the connections require high order thinking skills. Tell them that if they feel that they are stuck they are allowed to use the internet to research how either creationists or evolutions would explain. However anticipate students to copy and paste others arguments, so it is important to reinforce the importance of constructing explanations in their own words explanations must.

Homework:

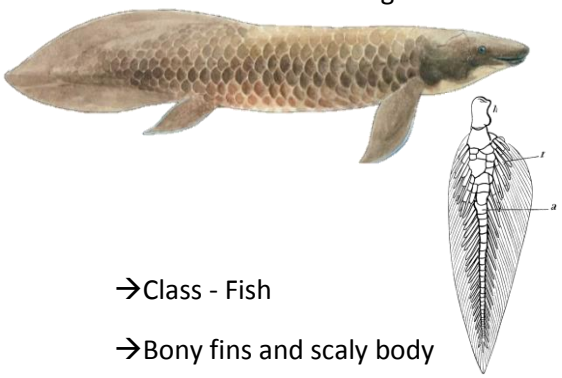
- Students need to Finish "Choosing a Side Homework" for Case Study #3 Prior to the Formal Debate.
- Tell Students that their explanations will be checked for a participation grade prior to the formal debate

Name _____ Case Study #3: Great Transformations & Transitional fossils

Part 1: Introduction –Identifying the Differences in Major classes of organisms

There are many living classes of organisms who in many ways look very different from other classes of organisms. For example most fish species have a distinct appearance that make them easily recognizable as fish. Similarly most amphibians are unique in their appearance.

Australian Lungfish

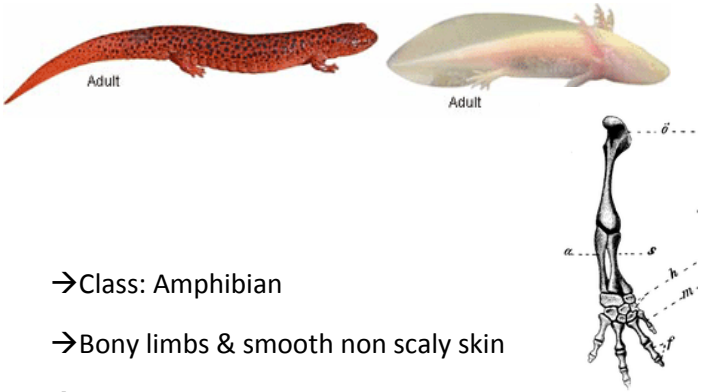


→Class - Fish

→Bony fins and scaly body

→Has both gills and a modified swim bladder used as a primitive lung for obtaining oxygen from the air.

Salamanders



→Class: Amphibian

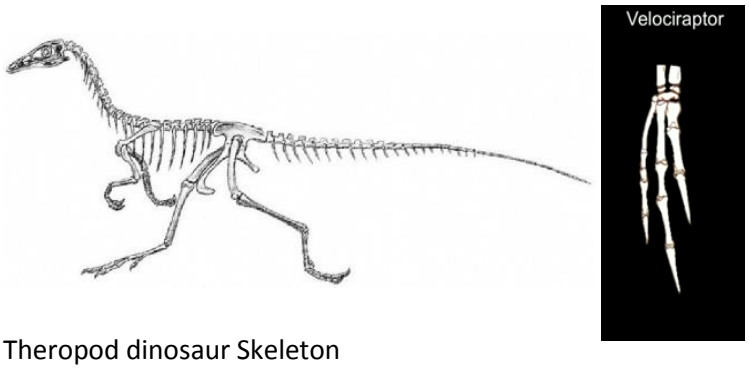
→Bony limbs & smooth non scaly skin

→Land forms have only lungs as adults for breathing air
→Aquatic forms and tad poles have gills for breathing in water

Questions:

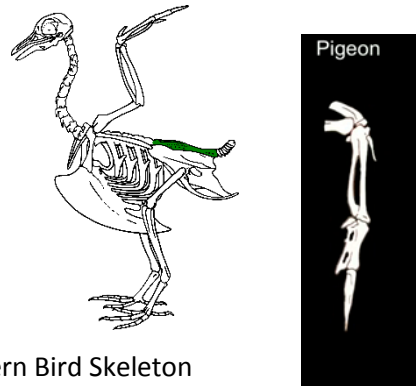
1) List two major differences between living lung fish and amphibians?
   - _____
   - _____

Similarly the fossils of many extinct classes of organisms look different from classes of organism living today. For example theropod dinosaurs in many ways look different from modern birds; each has their own distinct characteristics.



Theropod dinosaur Skeleton

→Skeleton Possesses long tail, three fingered forelimbs and teeth



Modern Bird Skeleton

→skeleton possesses toothless beak, vestigial tail and fused fingered forelimbs

Questions

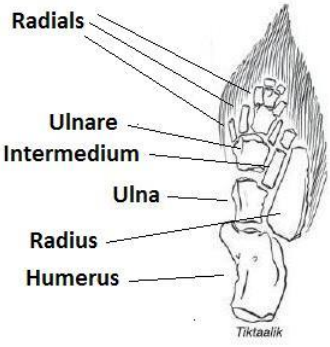
2) List two major differences between theropod dinosaurs and modern birds.
   - _____
   - _____

Part 2: Transitional fossils

Evolutionary Theory states that all organisms at one time shared common ancestors and that one class of organism change into new and different classes of organisms. However, in order for one major class of organism to evolve into a different class of organism there would have to be species that have some of the old group's characteristics and some of the new group's characteristics. Yet there are very few if any examples of these transitional organisms alive today. Therefore, since these transitional species appear to be extinct themselves, one must look in the fossil record for examples of these species. Fossils most often only preserve bone. However in some cases features like skin, soft tissue, organs and feathers leave impressions in rock as well. These impression fossils give us a better picture of not only the bones but of what the organism actually look like. The diagrams below show the fossils as well as reconstructed diagrams of two fossils found in ancient rock layers

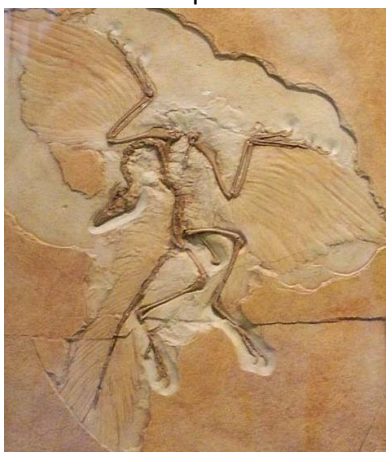
a. Tiktaalik

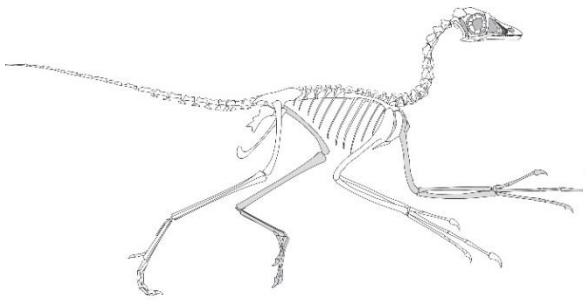
→ Skin impressions indicate scaly body like fish
→Bony fins that possess same basic bone structure in the forelimbs of amphibians



I. Archaeopteryx

→Fossil impressions preserved both insulating feathers and flight feathers
→Theropod dinosaur bone structure: Toothed jaws, three fingered forelimbs and long tail





Questions:

1) Would archaeopteryx by definition be considered a transitional form?_____
→Explain why?_____

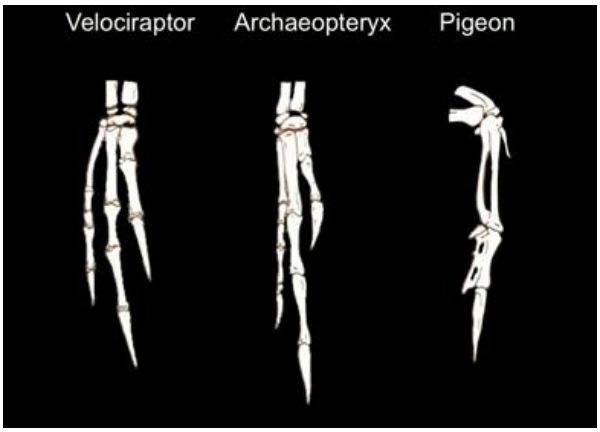
_____

2) Would tiktaalik by definition be considered a transitional form? _____
→Explain why? _____

_____

Part 3: Embryonic Development

There appears to be a large transitional jump between the bone structure of forelimbs in birds when compared to both archaeopteryx and Velociraptor. The diagram below compares the bone structure of the three species.



1) Which two forelimbs look more alike? _____

2) Which limb seems to be more bird like, a Velociraptor limb or a archaeopteryx limb (even if the similarities are small)? _____

   →Explain why you chose your answer. _____
   _____
   _____

Embryos can often be used to provide information about how body structures develop in modern species. The diagram below shows the forelimb of a pigeon chick still in the egg as an embryo.

3) During this stage of growth and development in the egg, does the pigeon forelimb look more like archaeopteryx forelimb or an adult pigeon forelimb. _____
   →Explain why you chose your answer _____
   _____
   _____

Homework: Choosing a Side

Use the data presented in the case study to explain how/why major groups of organisms originated on earth.

→Disclaimer: This page will not be graded on what your viewpoint is, only on completion of one of the two options and for the level of thought put into it.

Viewpoint #1: Evolution was responsible for the origin of the major groups of different organisms found both in the fossil record and alive today. In the past groups like amphibians evolved from ancient fish species, and birds evolved from certain dinosaur species. There fossils that show this transition between one form and another. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Viewpoint #2: Major species groups like dinosaurs, birds, fish and amphibians were all created by a higher power or intelligent designer. There are not fossil forms that show a transition between these groups. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Picture References: Case Study #3

1. Retrieved from: http://www.deviantart.com/morelikethis/collections/47227260?view_mode=2 – 9/3/14. Australian lung fish drawing
2. Retrieved from: http://etc.usf.edu/clipart/48000/48064/48064_lungfish_fin.htm -9/3/14. Australian Lung Fish fin diagram
3. Retrieved from: http://evolution.berkeley.edu/evolibrary/article/evodevo_02 -9/3/14. Salamander and axolotl comparison
4. Retrieved from: http://www.ck12.org/user:kay.teehan@polk-fl.net/book/7th-Grade-Life-Science%3A-Semester-1/r50/section/7.2/ -9/3 /14. salamander forelimb
5. Retrieved from: http://www.q-files.com/prehistoric/dinosaur-species/compsognathus/ -9/3/14. Theropod Dinosaur skeleton
6. Retrieved from: http://en.wikipedia.org/wiki/Synsacrum -9/3/14. Pigeon Skeleton
7. Retrieved from: http://www.history.com/news/from-fins-to-feet-ancient-fish-reveals-link -9/3/14. tiktaalik fossil
8. Retrieved from: http://www.evolutionnews.org/2008/07/tiktaalik_roseae_wheres_the_wr008921.html -9/4/14. tiktaalik limb comparison
9. Retrieved from: http://www.richannel.org/finding-tiktaalik -9/4/14. Tiktalik drawing
10. Retrieved from: http://www.bbc.com/news/science-environment-22695914 -9/4/14. Archaeopteryx fossil
11. Retrieved from: http://www.utexas.edu/news/2004/07/29/nr_geology/ - 9/4/14. Archaeopteryx Skeleton
12. Retrieved from: http://www.itsnature.org/rip/dinosaurs/archaeopteryx/ -9/4/14. Archaeopteryx drawing
13. Retrieved from: https://www.ted.com/talks/jack_horner_building_a_dinosaur_from_a_chicken#t-137473 – 9/4/14. Velociraptor, Archeopteryx, adult pigeon and embryonic pigeon limb comparison

Lesson # 4 Plan

Heath Marchand Date: 10/15/2014
Subject of Lesson: Case Study #4: Color Variations in Rock Pocket Mice
Time Estimate: 42 minutes Grade Level: 9th Grade Living Env.

IV. Objective(s)

- Students will identify the two contrasting color variations in Rock Pocket mice.
- Students will describe how predations acts as a significant limiting factor on the growth of the Rock Pocket Mice population
- Students describe the two contrasting environments in which the mice inhabit.
- Students will predict which variations of rock pocket mice will be favorable in each contrasting environment.
- Use the Data collected on rock pocket mice populations on tan and black environments to support or refute their predictions.

II. Purpose or Rationale

- Each case study is a summary of empirically collected data, used by scientists to support the theory of evolution. Typically it is instructed in a way that "tells" students how the data is and should be interpreted. This can be problematic because it can cause students resistant to the idea of evolution to shut down when examining evolutionary data. Therefore this activity is meant to simply have students analyze the data themselves in order to draw their own conclusions and attempt to use it as evidence for their side of the argument, whether that be evolution or creationism. It forces students to become engaged with the material which is something that they may not do if not offered the opportunity to argue their viewpoint

- This particular case study is meant to have students observe and analyze natural selection in a small rodent species in desert environments of the southwestern United States. It combines a combination of comparative anatomy, with ecological selection pressure analysis as well as and over of genetic comparison between. Interestingly this particular case shows that evolution although random is repeatable. In this case there were slightly different mutations in the MRC1 gene determining coat color in each of the different, isolated lava flows that show that variations can occur more than once and given strong enough selection, those variations can be selected for and perpetuated in multiple, reproductively isolated populations.

III. Essential Question

- Why are there two contrasting color variations of Rock pocket mice in the desert environments of the Southwest

IV. Task Analysis

- Students will have to understand the following prior to this lesson
  Vocabulary: Natural Selection, Environmental Selection Pressure/Agent, Microevolution, Macroevolution
  Concepts:
    - Mechanism of Natural Selection.
    - How natural Selection leads to microevolution
    - How numerous micro-evolutionary changes can lead to macro-evolutionary changes
    - How microevolution and macroevolution are represented on a Phylogenetic Tree

V. Standards

- NGSS:
    - HS-LS4 – 1
    - HS-LS4 – 2
    - HS-LS4 – 3
    - HS-LS4 – 4
    - HS-LS4 – 5

V. Lesson Procedures

Introduction (~ 15 minutes)
1) Ask students to take Case Study #4 packet, and open to Part 1: Predation in a Desert Environment 2) Students will work individually to identify and describe the following aspects about the described rock pocket mouse population: →Color Variations that exist →limiting factors on population growth (struggle for existence) →Significant changes/differences in the desert habitat of the mouse. 3) As a class, collaboratively identify and discuss each question to part 1 on the board. 4) Focusing discussion on →Predation as a limiting factor/selection pressure, the changes to certain regions of the desert as a result of volcanic activity and lastly different predictions about which mouse variant is more favorable.

Body of the Lesson/Lesson Development (~ 25 minutes)
1) Discuss Debate Question #4 on page # 4 of Case Study #4 → This will function to give the students a preview of what the data in the case study will be used for. 2) Have students read the paragraph about the MCR1 gene: →Ask them to focus on what trait the MRC1 Gene codes for, by underline this in the paragraph. → Also ask them to describe what happens to a mouse that has a coding change in this gene. 3) Have Students compare the phenotypes of mice living on lava flows throughout the Desert Southwest to those not living on lava flows. 4) Students should focus on describing the changes in the MRC1 gene across the various Lava Flows →Are they the same exact mutation? →Discuss what this means in terms of how many times this variation has occurred.

C. Closure/Concluding Activity (~7 minutes)
1) Ask students to begin working on their "choosing a side homework assignment" on page 4 of their case study. →Ask students to choose one of the two positions, and use that position to try to explain the protective function that sickle cell anemia has on malaria. →Students may not be able to come up with an explanation on their own since some of the connections require high order thinking skills. Tell them that if they feel that they are stuck they are allowed to use the internet to research how either creationists or evolutions would explain. However anticipate students to copy and paste others arguments, so it is important to reinforce the importance of constructing explanations in their own words explanations must.

Homework:

- Students need to Finish "Choosing a Side Homework" for Case Study #3 Prior to the Formal Debate.
- Tell Students that their explanations will be checked for a participation grade prior to the formal debate

Name _____ Case Study #4: Color Variations in Rock Pocket Mice

Part 1: Predation in a Desert Environment

→Rock pocket mice are a small desert species with populations found spread out all over the Sonoran Desert in the American southwest. There are two variations of rock pocket mice, black mice and tan mice.

→Around a thousand years ago volcanic activity caused lava flows in numerous isolated regions of the Sonoran desert in the American southwest. This has caused the primarily sandy colored desert to be spotted with black volcanic patches.

→There are a number of predator species that live in the region that feed on Rock pocket mice. Many of these predators like owls and hawks rely on their keen sense of eyesight to spot their prey.

→ When scientists collected mice from the desert they found that black mice were found only on the black rock environment and tan mice were found only on the tan sandy environments. The mice are adapted to their environments with camouflage that.

Part 1 Questions

1. Are there variations in the rock pocket mouse population? _____
   ➔ If so what? _____

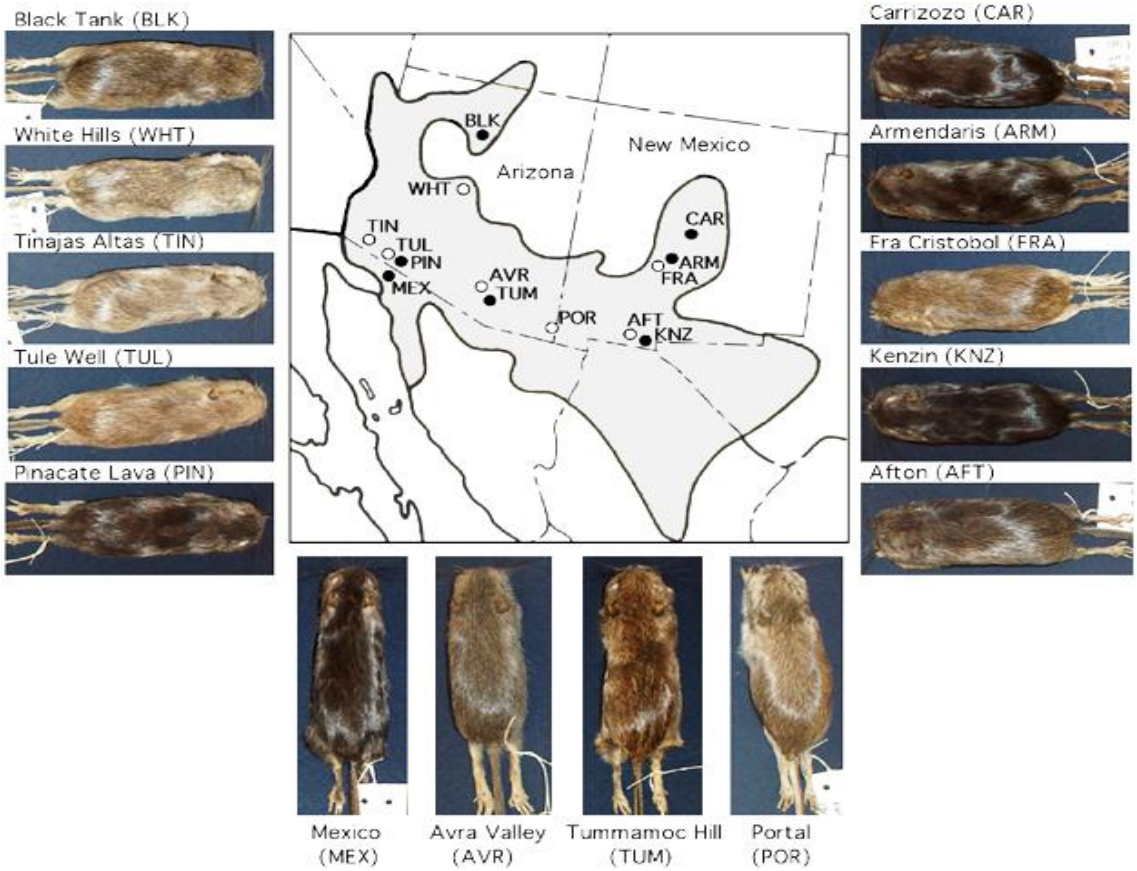
2. What is a major limiting factor in the environment that affects how the size of the rock pocket mice population?
   →_____
   → How would this limit the population? _____
   _____

3. Was there a significant environmental change in the environment where the rock pocket mice live?_____
   ➔ If so what? _____

4. Would certain variations in rock pocket mice be favorable over others? _____
   ➔ If so which describe which variations would be favorable for each environment?
   _____
   _____
   _____
   _____.

Part 2: Genetics of Rock Pocket Mice

Scientists have analyzed the DNA of numerous mice from each of the separate locations where you find black populations. In each of the black mice they found a difference of four Nucleotide base pairs (ACTG) in a gene called MCR1. When a mouse was born with these changes in its DNA it grew dark fur instead of light fur. When the DNA of these black mice were compared to other populations of black mice living on lava flows, hundreds of miles away it was found that the genetic mutations that caused the black fur in each population were different. Therefore, many of the black mouse populations' have different mutations black fur.



5. Describe what trait the MRC1 gene codes for in Rock Pocket Mice.

   _____
   _____
   _____

6. Looking at the diagram, what do you notice about the mice that are found on black lava flows compared to those mice found in areas without lava flows? _____

7. Are all the black mice the same color black? _____
   →What do you think might cause the black mice from each of the different lava flows to have slightly different shades of black fur? _____

   _____
   _____
   _____

8. Are these variations in rock pocket mice inheritable? _____
   →Explain why or why not_____
   _____

9. Given this data, do you think the black fur variation occurred once in the mouse population or would the black fur variation occurred numerous times? _____
   →Explain your answer _____
   _____
   _____
   _____

Homework: Choosing a Side

Use the data presented in the case study to explain how/why rock pocket mice have both tan and black fur that blends into their environment.

→Disclaimer: This page will not be graded on what your viewpoint is, only on completion of one of the two options and for the level of thought put into it.

Viewpoint #1: The black fur variation in rock pocket mice populations occurred many times as a result of separate occurrences of evolution by means of natural selection. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Viewpoint #2: The different black fur populations of rock pocket mice were each created independently by a higher power or intelligent designer at one time about 5,000 years ago. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Picture References: Case Study 4

1. Retrieved: http://museum2.utep.edu/archive/biology/DDmelanism.htm - 9/12/14. Black and Tan Rock pocket Mouse comparison
2. Retrieved: http://ibc.lynxeds.com/photo/harris039-hawk-parabuteo-unicinctus/bird-part-collection-raptors-desert-museum-tucson-az-bird- - 9/12/14. Harris Hawk
3. Retrieved: http://animalia-life.com/owl.html -9/12/14. Barn Owl
4. Retrieved: http://www.evolution-textbook.org/content/free/figures/ch18.html -9/12/14. Rock Pocket mice variations on volcanic and desert backgrounds.
5. Retrieved: http://en.wikipedia.org/wiki/San_Francisco_volcanic_field -9/12/14. Sonoran Lava Flow Satellite Image
6. Retrieved: http://www.nature.com/hdy/journal/v94/n2/fig_tab/6800600f1.html -9/12/14. Localized Rock Pocket mouse phenotypes map

Lesson # 5 Plan

Heath Marchand Date: 10/15/2014
Subject of Lesson: Case Study #5: Comparative Anatomy and Genetics of Chimpanzees and Humans
Time Estimate: 42 minutes Grade Level: 9th Grade Living Env.

V. Objective(s)

- Students will compare and contrast anatomical data on the skull morphology of living chimps, extinct hominids and modern humans
- Students will describe how the changes in the MYh16 gene affects size of the temporalis muscle of humans when compared to chimps..
- Students will explain why the temporalis muscle limits the size of the braincase in chimps but not in humans
- Students will explain the role of the PNKP gene in determining the size of the brains of both chimps and humans
- Students will compare the gene banding patterns of chimp chromosomes #2 & #24 with human chromosome #2

II. Purpose or Rationale

- Each case study is a summary of empirically collected data, used by scientists to support the theory of evolution. Typically it is instructed in a way that "tells" students how the data is and should be interpreted. This can be problematic because it can cause students resistant to the idea of evolution to shut down when examining evolutionary data. Therefore this activity is meant to simply have students analyze the data themselves in order to draw their own conclusions and attempt to use it as evidence for their side of the argument, whether that be evolution or creationism. It forces students to become engaged with the material which is something that they may not do if not offered the opportunity to argue their viewpoint

- This particular case study is meant to have students compare and contrast various anatomic and genetic characteristics of humans and chimpanzees. Most people know that we share 98 percent of our genetic code with chimpanzees. Genetic testing has shown how even slight changes in the genetic sequence can cause significant changes in anatomy and morphology when comparing chimps and humans. This case is meant to show students how some slight small changes in the genetic code, can have a significant changes in phenotype; thus making the evolutionary jump from ape to human not that unthinkable.

III. Essential Question

- How does genetics help explain the anatomical differences between chimps and humans?
- If chimps and humans share 98% of their DNA, why do we appear to be so different in many ways?

IV. Task Analysis

- Students will have to understand the following prior to this lesson
  Vocabulary: Natural Selection, Environmental Selection Pressure/Agent, Microevolution, Macroevolution
  Concepts:
  - Mechanism of Natural Selection.
  - How natural Selection leads to microevolution
  - How numerous micro-evolutionary changes can lead to macro-evolutionary changes
  - How microevolution and macroevolution are represented on a Phylogenetic Tree

V. Standards

- NGSS:
  - HS-LS4 – 1
  - HS-LS4 – 2
  - HS-LS4 – 3
  - HS-LS4 – 4
  - HS-LS4 – 5

V. Lesson Procedures

Introduction (~ 15 minutes)
5) Ask students to take Case Study #5 packet, and open to Part 1: The fossil record 6) Students will work individually to identify how skull size differences between extinct hominids and extant humans and chimps: →Students should be able to describe a general trend in which older hominids have smaller brain cases resembling those of apes and younger hominids have brain cases more similar to that of modern humans.

Body of the Lesson/Lesson Development (~ 25 minutes)
5) Discuss Debate Question #4 on page # 4 of Case Study #4 → This will function to give the students a preview of what the data in the case study will be used for. 1) Ask Students to read and answer the questions on the Genes MYH16 and PNKP and answer the questions that follow each paragraph. →Students should be able to explain how variations in the MYH16 gene cause humans to have a larger brain case →Students should be able to explain the role of PNKP in the regulation of brain size in Humans and chimps →The goal of this is to have students draw conclusions that lead them to understand that both mutations (variations that are not shared by chimps) are important for the development our large brain. 2) Ask students describe the similarities between the genes found on chimp Chromosomes #2 and #24 and human chromosome #2 → The goal for this part of the case study is to have students describe how and why humans and chimps have a different chromosome number, which is typically indicative of reduced genetic relatedness.

C. Closure/Concluding Activity (~7 minutes)
1) Ask students to begin working on their "choosing a side homework assignment" on page 4 of their case study. →Ask students to choose one of the two positions, and use that position to try to explain the protective function that sickle cell anemia has on malaria. →Students may not be able to come up with an explanation on their own since some of the connections require high order thinking skills. Tell them that if they feel that they are stuck they are allowed to use the internet to research how either creationists or evolutions would explain. However anticipate students to copy and paste others arguments, so it is important to reinforce the importance of constructing explanations in their own words explanations must.

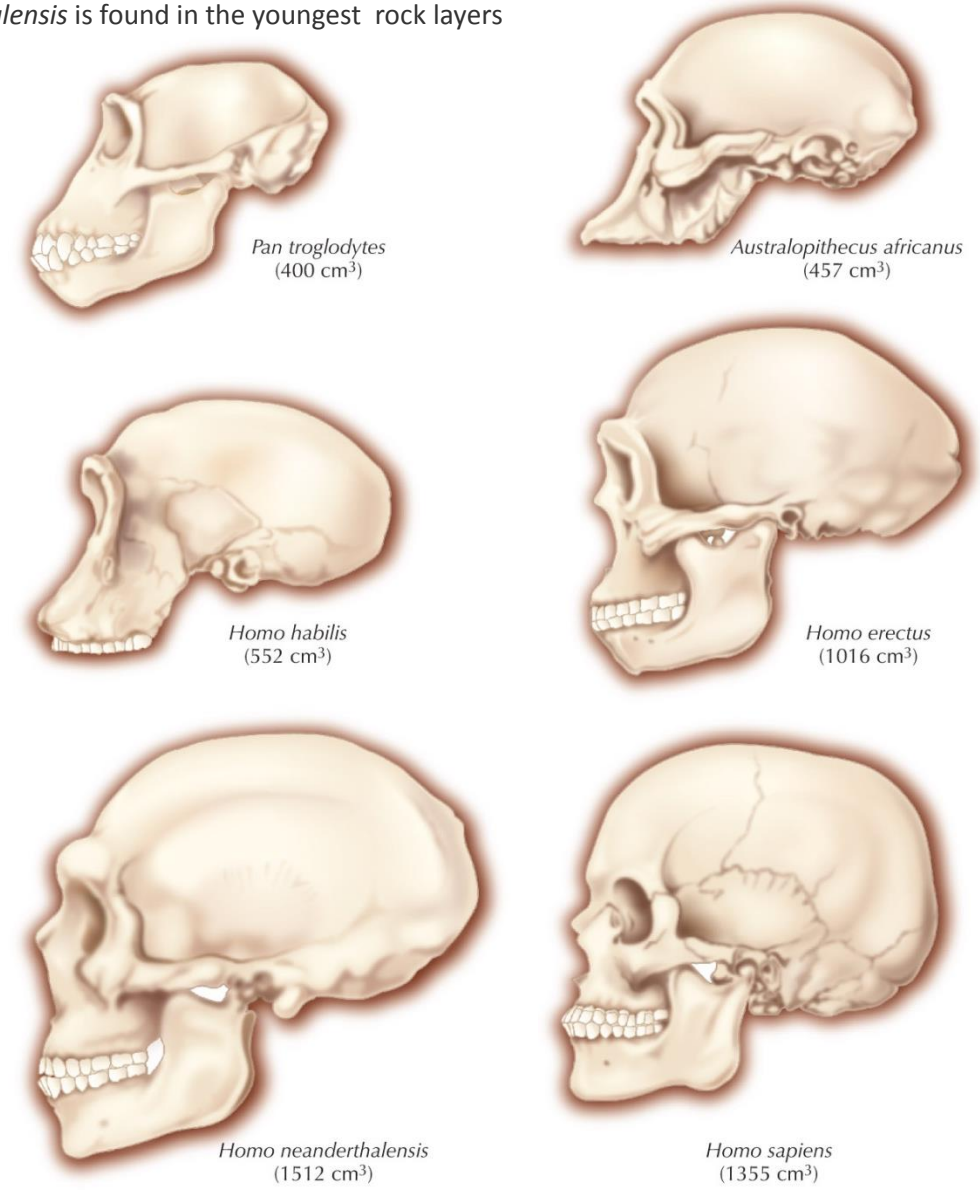
Homework:

- Students need to Finish "Choosing a Side Homework" for Case Study #3 Prior to the Formal Debate.
- Tell Students that their explanations will be checked for a participation grade prior to the formal debate

Name _____ Case Study #5: Comparative Anatomy and Genetics of Chimpanzees and Humans

Par 1: the Fossil Record.

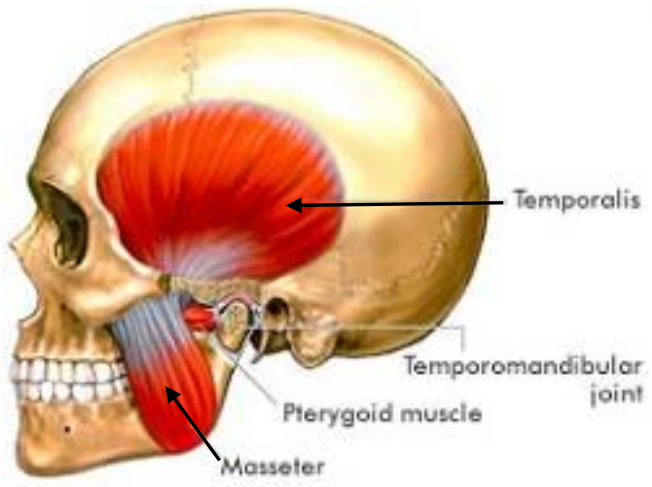
I. The skulls of extinct and living primates are shown below. The first skull shown is of Chimpanzees *(Pan troglodytes*) the last skill shown is of modern humans (*Homo sapiens*) the four species in between are fossil remains of extinct species. *Australopithecus africanus* is found in the oldest rock layers and *Homo neaderthalensis* is found in the youngest rock layers

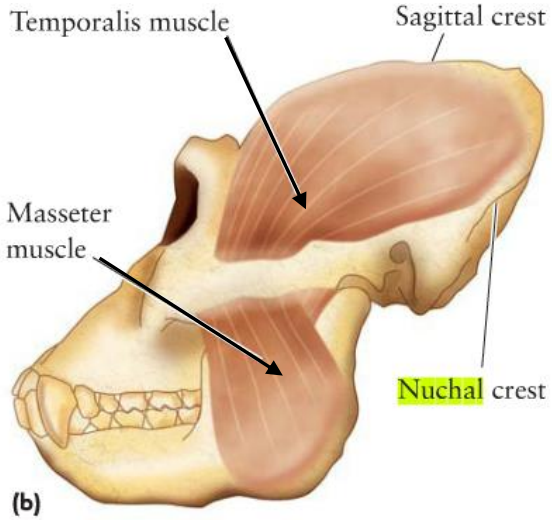


1) What is the major difference between he skulls of humans and chimps _____
   ➔ What does this mean about the brains of chimps and humans _____
2) Describe how the skull and brain sizes of each extinct species compares to both chimps and humans
   ➔ A. Africanus : compared to modern humans _____ compared to chimps _____
   ➔ H. habilis : compared to modern humans _____ compared to chimps _____
   ➔ H. erectus: compared to modern humans _____ compared to chimps _____
   ➔ H. neanderthalensis: compared to modern humans _____ compared to chimps _____

Part 2: Comparative Anatomy and Genetics of Chimps and Humans

II. The muscle group that controls the movement of the lower jaw for chewing consists of the masseter and temporalis muscles (see diagrams below). In chimps this muscle is so large is it attaches at the top of the skull and by the age of 5 these muscles are so large they actually stop the skull from growing any larger. Because chimps often eat hard chewy plant material, a strong jaw is beneficial. In humans the temporalis muscle only attaches to the side of the head, not all the way to the top like apes. This means that human skull s can continue grow well into the individuals 20's. Humans do not need as strong of jaws since we eat cooked food that is easier to chew, therefore large temporalis and masseter muscles.





All humans share a variation in the MYH16 gene that regulates the size of the temporalis muscle. In humans there is a deletion of two nucleotide bases in the MYH16 gene. This causes the human temporalis muscle to be much smaller When the MYH16 gene is analyzed in chimpanzees, it was found that chimps do not share this change, and instead have a normal copy of the gene. This is what allows their temporalis muscle to grow large.

1) What observable difference do you see in the masseter and temporalis muscle when comparing chimps to humans?

_____

_____

2) What is one way that chimps and humans differ genetically that explains the differences in their musculature?

_____

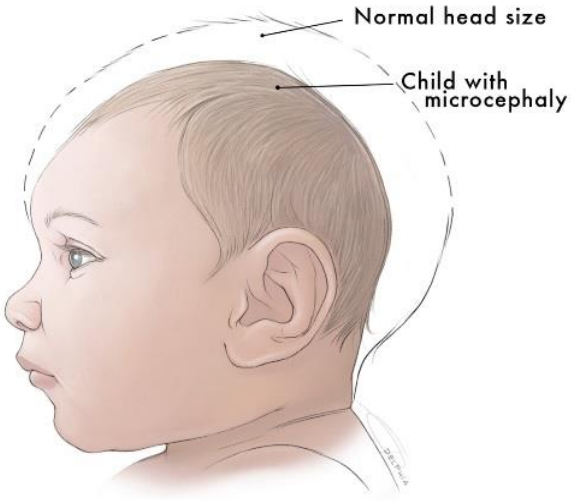
_____

3) Based on the information above, what would be the most likely explanation for the reason chimps have a much smaller Skull and brain?

_____

_____

III. PNKP is a gene responsible for brain growth in humans. A normal copy of PNKP in humans is in part responsible for the growth of our large complex brain. A known mutation in the PNKP of human's results in individuals with a genetic disorder called microcephaly. Because the PNKP gene is now "broken" the brain and skull of individuals with the genetic mutation grow much smaller and causes forms of mental retardation. When the DNA of chimps and humans were compared, chimp DNA was found to have a number of nucleotide base pair differences in their PNKP gene, and is in part responsible for their brain growing much smaller.



1) What is the PNKP Gene responsible for in humans and chimps? _____
2) How do the differences in the genetic code of both the PNKP gene and the MYH16 gene in humans explain why we have such a large complex brain?

_____

IV. Humans have 46 chromosomes, chimps have 48 chromosomes. The diagram below shows human Chromosome # 2 and chimp chromosomes #2 and #24. The diagram also shows the gene patterns on each chromosome.

1) How does the banding pattern of the "stacked" C24 & C2 chromosomes compare to the banding pattern of H2?
_____
_____
_____

2) What does this banding pattern say about the genes present on H#2 when compared to C#2 and C#24
_____
_____
_____

Homework: Choosing a Side

Use the data presented in the case study to explain the origins of chimpanzees and humans.

→Disclaimer: This page will not be graded on what your viewpoint is, only on completion of one of the two options and for the level of thought put into it.

Viewpoint #1: Humans chimps share are evolutionary cousins that evolved from an ancient ape-like common ancestor. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Viewpoint #2: Chimps and humans are completely unrelated species that were created independently from each other by a higher power or intelligent designer. They do not share a common ancestor and have not changed significantly since their creation. Be sure to explain:

- ➔ How and why this happened?
- ➔ What data supports your argument?

Picture References: Case Study #5

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Lesson Plan #6-10

Heath Marchand Date: 10/27/2014
Subject of Lesson: Formal Debate: Questions 1-5
Time Estimate: 5 - 42 minute lessons Grade Level: Freshman Living Env.

1) Objective(s)

- Students will construct evidence based arguments supporting or refuting the claim that is the best explanation for the protection that Sickle cell anemia has against sever Malaria infection.
- Students write three rebuttal arguments countering other students initial arguments

II. Purpose or Rationale

- Each case study is a summary of empirically collected data, used by scientists to support the theory of evolution. Typically it is instructed in a way that "tells" students how the data is and should be interpreted. This can be problematic because it can cause students resistant to the idea of evolution to shut down when examining evolutionary data. Therefore this activity is meant to simply have students analyze the data themselves in order to draw their own conclusions and attempt to use it as evidence for their side of the argument, whether that is evolution or creationism. It forces students to become engaged with the material which is something that they may not do if not offered the opportunity to argue their viewpoint

- Each of the debates will be a continuation of each of the five Case studies from which the debate questions were derived. Therefore, each debate will be similar in format. They will utilize google docs as an electronic debate forum for which all students will submit evidence based arguments for or against evolutionary theory.

III. Essential Question

- What is the best explanation for Sickle cell anemia providing a protection against Malaria?

IV. Task Analysis

- Students will have to understand the following prior to this lesson
  Vocabulary: Natural Selection, Environmental Selection Pressure/Agent, Microevolution, Macroevolution
  Concepts:
    - How Natural Selection favors any genetic variation that increases reproductive fitness.
    - How natural Selection leads to microevolution
    - How mutations can cause genetic disorders
    - What Sickle cell genotypes provide protection against malaria?

V. Standards

- NGSS:
    - HS-LS4 – 1
    - HS-LS4 – 2
    - HS-LS4 – 3
    - HS-LS4 – 4
    - HS-LS4 – 5

V. Lesson Procedures

A. Introduction (~ 10 minutes)

Steps
1) Ask students to open the common google document, Entitled – "Formal Debate: Evolution Vs Creationism 2) Discuss what students responsibilities are for the in class portion of the assignment and the at home portion of the debate are. o For class work students will work collaboratively in similar interest groups to construct a response answering the day's formal debate question. These responses should specifically discuss the connection between Sickle Cell anemia and malaria. o These initial posts will be used as the subject matter for further rebuttals and comments during the at home potion of the debate. 3) Assign Collaborative Groups of 2-3 to students on either side of the debate for the in class portion of the lesson

B. Body of the Lesson/Lesson Development (~ 20 minutes)

Steps
1) Allow students to discuss the first debate question with the objective of collaboratively formulating an argument for their side directly related to each specific debate topic. Groups will have to either create and argument for evolution or for creationism rooted in evidence that they feel supports their answer to the debate question. Initial posts should range between 5-10 sentences 2) Ask students to focus on the "how's" of the debate question, specifically how did this come about, using evidence to support their argument. 3) Once students finish their argument on a separate document they will copy it into the common debate document followed by their names.

C. Closure/Concluding Activity (~12 minutes)

Steps
1) Explain to students what the at home potion of the debate is: o Each student will be responsible for making at least two responses to other group's posts from the opposing side in the form of a rebuttal using comments in google docs. o To properly indicate which of your peer's posts you are commenting on students should be instructed to highlight the post they are commenting on before clicking on the comment button in the upper right hand corner. o Any additional comments on that particular post should be submitted within that comment stream. 2) Model for students how they will be utilizing the comments application of google docs to continue the debate during the at home portion of the debate. 3) Remaining time should be devoted to students practicing how to make comments using google docs since this will be their first time using in a debate type situation.

Homework:

- Rebuttal Comments, at least two should be made by each Student

Enrichment:

- Students who use a relevant outside source in one of their rebuttal arguments that pertains specifically to the sickle cell debate topic will be awarded an extra credit point on their topic quiz.

Formal Debate: Evolution vs Creationism

The theory of evolution states that species have changed over long periods of geologic time through the process of natural selection. The theory does not in any way make statements concerning the existence of God, it simply states that the life changed and diversified as a result of the accumulation of small changes over hundreds of millions of years. Therefore this debate is not meant to discuss whether or not god exists, instead it is meant to discuss the validity of the two conflicting ideas concerning the origin and diversity of life on earth.

Debate Description & Directions:

→The teacher will share this document with every student in the class so that everyone will have the ability to view and make comments on each of five debate questions. Students will graded on their active participation and ability to contribute well thought out posts and comments. Students will not be graded on their specific viewpoints. For each debate question students will:

1) Contribute a post in the column (evolution or creationism) that you are arguing for in your collaborative groups. In front of your post put your group member's names so that you can be given credit for your post.
2) Once you have typed your original post in the chart, you will be responsible for making at least two responses to other posts from the opposing side in the form of a rebuttal using comments in google docs. To properly indicate which of your peers posts you are commenting on please highlight the post before clicking on the comment button in the upper right hand corner. Any additional comments on that particular post should be submitted within that comment stream.

Debate Question # 1: What is the best explanation for the connection between Sickle cell anemia and Malaria?

→Provide reliable evidence/data that can be used to support your side of this argument

→When commenting, Identify and explain specific problems/ gaps with the opposing side's arguments

Evolution	Creationism

Debate Question # 2:

- Whales, manatees and other aquatic mammals have small vestigial hip bones that have no function.
- Lake Stickleback fish have vestigial pelvic spines that in some individuals are reduced in size while in others are almost completely absent.
- Snake embryos begin to develop legs, which then stop developing leaving only functionless leg bones in adults.
- Humans, like all vertebrates began to develop a long tail as embryos, this tail eventually shrinks during the later stages of development becoming a small functionless vestigial structure

What is the best explanation for seemingly functionless vestigial structures?

→Provide reliable evidence/data that can be used to support your side of this argument
→When commenting, Identify and explain specific problems/ gaps with the opposing side's arguments

Evolution	Creationism

Debate Question #3: What is the best explanation for the existence of fossils like Archaeopteryx and Tiktaalik. Can these be considered transitional fossils between major lineages of organisms?

→Provide reliable evidence/data that can be used to support your side of this argument

→When commenting, Identify and explain specific problems/ gaps with the opposing side's arguments

Evolution / Yes	Creationism / No

Debate Question # 4

What is the best explanation for the existence of tan rock pocket mice in tan desert environments and black rock pocket mice in black desert environments, despite the populations living in the same exact desert ecosystem?

→Provide reliable evidence/data that can be used to support your side of this argument
→When commenting, Identify and explain specific problems/ gaps with the opposing side's arguments

Evolution	Creationism

Debate Question #5: What is the best explanation for the genetic and anatomical (physical characteristics) similarities that humans and chimps share.

→Provide reliable evidence/data that can be used to support your side of this argument

→When commenting, Identify and explain specific problems/ gaps with the opposing side's arguments

Evolution	Creationism

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