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***Statement of Purpose***

 Evolution has been known for its controversial subjects in relation to religious views. When teachers and students encounter the topic of Evolution many emotions emerge. These emotions, if not dealt with, create division among students and create negative attitudes that lead to a lack of participation. The topic of evolution is not just about the content provided, but it is also about open discussion and examination. The evolution curriculum in schools desperately needs to recognize that this is not just a scientific issue, but a social one as well and should be treated as such. This unit recognizes the relevant need for a direction of change in teaching this unit and will provide the skills needed to make it happen by incorporating exercises focusing on building inner confidence in ones rationale and conversing intensely with peers.

Students at the highschool level have formed many belief systems about all subjects concerning their education by the time they reach senior year. The implication of emotional intelligence\*, into this curricula, will help guide and build on the students skills in order to recognize their own emotions and that of others. The concept of “emotional intelligence” has been extensively popularized in the corporate and in the higher education world as many individuals, such as CEO’s and college administrators, profess the potential ability of emotional intelligence to predict various markers of success. Research has shown that the development of emotional intelligence was correlated with greater individual performance, often above and beyond that associated with one's level of general intelligence. Since the controversy surrounding evolution is public and political, the combination of both strong academic rationale and societal need for understanding one another will not only enhance this topic, but students will have the ability to constructively deal with other not related controversial issues.

This design incorporates the 5-E learning model which has shown to have a strong linkage to constructivist theories, such as, tapping in to prior knowledge and building upon what they know to apply in the future ¹(Chairelott , 2006). This model is also highly adaptable and can be modified easily and expanded over a period of time if needed. The educator acts as a facilitator or guide to encourage students to draw their own conclusions and help to further extend and connect the activity. By implicating emotional intelligence strategies, such as the development of language use, democratic approaches, and facilitated discussion throughout the unit, will not only prepare teachers for possible conflict, but it will also help students to be aware of their emotions and views throughout each subunit.

\* Emotional Intelligence:

¹ Chairelott ,L (2006). Curriculum in context: Designing curriculum for teaching and learning in context. Wadsworth:Belmont,CA

***Teacher’s 5-E Planning Guide Lesson 1***

**Unit**: Evolution **Subunit:** Natural Selection **Lesson Title:** Historical Development of Evolution in a Courtroom Setting **Grade Level:** 11

**Grade Level Indicators:**

* Describe historical scientific developments that occurred in evolutionary thought (e.g., Lamarck and Darwin, Mendelian Genetics and modern synthesis)
* Explain that natural selection provides the following mechanism for evolution, variation in inherited characteristics exist within every species. These characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring are more likely to survive and reproduce. Therefore, the proportion of individuals that have advantageous characteristics will increase.
* Use historical examples to explain how new ideas are limited by the context in which they are conceived. These ideas are often rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., biological evolution, germ theory, biotechnology, discovering germs).
* Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.

**Learner Outcomes/Evidence of Learning:** What will the students be able to do or know as a result of this experience (use measurable action verbs).

**The students will...**

* **[Bloom's Application/Analysis]:** Know that organisms do not obtain advantageous traits by change of habit, inner desires, and or by use or disuse of traits.
* **[Bloom's Application/Analysis]:** Know that acquired characteristics are not passed on to progeny.

* **[Bloom's Synthesis]:** Identify that mutation is a random process and not directed toward the advantage of the individual.
* **[Bloom's Evaluation]:** Be able to explain that evolution proceeds by the process of variation, genetically random processes, and selection that of which are an environmentally driven non-random process.

**Essential Vocabulary:**

* Jean Baptiste Lamarck
* Alfred Russel Wallace

* Charles Darwin
* Natural Selection
* Mutation
* Genetic Variation

**Closure: What is the summary of the big/ideas or main concepts your students will know or be able to do as a result of this lesson?**

* 1. Students will be able to compare the theories of Lamarck, Wallace, and Darwin by interpreting and examining evidence leading up to their individual conclusions.
	2. Students will be able to explain the main concepts of natural selection including the roles of variation, mutation, and environmental changes.
	3. Students will be thoroughly competent to give details why Lamarck and Wallace’s theories were incorrect based upon the evidence Darwin discovered and current biology research.
	4. Students will be able to examine and discuss other historical scientific theories, hypotheses, and draw conclusions based upon learned information.
	5. Students will be able to respectfully conduct a question / answer setting along with role playing in a mock court room setting.

**Materials:**

1) Folders (for construction of portfolio) Includes exhibits of evidence and opening and closing statements.

**References/Resources:**

* <http://www.genevaschools.org/standards>
* <http://www.ohiorc.org> - Ohio Resource Center
* <http://www.sciencenetlinks.com> - AAAS Science Netlinks
* <http://ims.ode.state.oh.us/ode/ims> - Ohio Department of Education Model Curricula

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|  **“5-E” Phase****Student Performance Indicators** | Planned Activities/Events  | Guiding Questions | Questions Students May Ask | **Materials/Safety/Notes** |
| Engage Day 1 Time: 5-10min* Tap prior knowledge
* Focus learner’s thinking
* Spark interest in the topic
 | Introduction of the “mock” courtroom activity. Introduce the time line of events: 1) Introduction of Topic 2,) Assignment of Defense (Darwin) and Plaintiff groups (Lamarck), 3) Group work to collect evidence for their case including preparing witnesses, 4) Present case to Judge and cross examine opposing side witnesses. Roles will then be assigned by group peers. Bring forth a portfolio; this will include the notes, evidence, and reasons for the case that will be used and graded. | 1) What are the main roles in a courtroom?2) Who would be the Plaintiff and Defense? Why?3) Who would the expert witnesses presented by the Defense? Plaintiff? Why would they be of importance? | 1) What does Plaintiff mean?2) What are the credible materials that can be used to find evidence?3) Who decides which argument is more compelling?4) How will everyone in the group participate if there are limited roles?5) What are the limitations in court? 6) Do we have to be accurate in courtroom laws?7) When is the portfolio due? | Make clear that this is not about accuracy in a court of law. Students must focus on collecting evidence to prove their case.A list of roles with descriptions is needed along with topic and credible sources to collect evidence and possible expert witnesses. |
| Explore~HANDS-ON! Time: 30min* Provide learners with common, concrete, experiences with skills and concepts
* Observe and listen to students
* Ask probing question
* Act as a consultant
 | Once groups are assigned students will select roles. Students will talk about the evidence needed to prove their case. Teacher will go around to each group as ask questions about their evidence and how each role will address their own questions versus possible questions from the opposing side. Consult on evidence found and possible holes in their ideas and be prepared to have arguments supporting their statements. | 1) What evidence does your group have to support your case?2) What is the refutable evidence which can draw reasonable doubt about certain evidence?3) Why did you choose a particular expert witness over another?4) What physical evidence are you going to present? Why?5) How are you going anticipate what the opposing side is going to present? | 1) Are we allowed to use current research or do we have to be in Darwin era?2) Can we research the other side’s person and use their research against them?3) Can we dress up as character and have a certain personality? | Students need to be reminded that this is a courtroom setting and certain disruptive behavior will decrease their grade substantially or cause for removal from court. Dress must be professional and appropriate.Instruct students on organizing their questions in an appropriate order.  |
| Explain~MINDS-ON! Day 2 Time: 40 min* Encourage students to explain concepts in their own words
* Ask for justification
* Use students’ previous experiences as the basis for explaining concepts
* Clarify and correct misconceptions
 | Students will begin the “mock” court. Explain that the Plaintiff will go first then Defense and present their case. The opposing side may cross examine each witness.  The Judge (teacher) is also allowed to guide students in case of not clear questioning and answering and possible misconceptions.Allow students to present their explanations for their case and allow a few minutes for re-grouping if needed.Remind the students to take notes in their portfolio including questions for the opposing side.  | 1) Are you certain that the evidence presented is accurate?2) Does anyone want to regroup and alter presenting questions?3) What are the credentials of your witnesses?4) Have all the witnesses been sworn in? | 1) Are we allowed to object?2) Is the judge going to determine unfair questioning?3) What if the witness does not know an answer to the question? Will our grade go down?4) How to we present something as evidence?5) Are we allowed to have our questions and answers written down aka scripted? | Leave some time for questions about procedure in the courtroom such as objecting, presenting of evidence, badgering of witness, and over questioning.The Judge has no limitations and can interrupt and stop questioning at any time. |
| **Extend-HANDS-ON! Day 2-3**   Time: 25 min* Apply same concepts and skills in a new context resulting in deeper and broader understanding
* Encourage the students to apply the concepts/skills to new situations via new activities
 | Students will reflect on the “mock” court experience the day before. The teacher will ask questions about other possible cases between historical figures. Ask about what topics would be appropriate and what questions could be asked in the courtroom. Ask students about what evidence will support each case and what would be the most irrefutable evidence that will win the case. Ask students to compare the “mock” case with the new case and ask them is any of the expert witnesses would be appropriate for the new case.  | 1) How do you think yesterdays “mock” court went?2) Were you surprised at the outcome? Why?3) What are some other historical figures that you can compare their cases with?4) What evidence and witnesses would be appropriate in the new case? Why?5) What do you think the outcome will be? Why? | 1) Can we compare historical figures even if they did not live in the same time period?2) Wouldn’t be unfair if one person had better technology advances than the other? Or does it not count? | Guide the students through the previous day and have them insert the new people and evidence. Let them come to their own conclusions and expand upon their answers. |
| **Evaluate**  Time: 15 min* Observe the students as they apply new concepts and skills
* Assess, formally and/or informally, student progress toward achieving the learner outcomes (knowledge and/or skills)
* Allow students to assess their own learning and group-process skills
 | Evaluation of students will occur during the “mock” court presentations. The teacher will take notes based upon what is presented and misconceptions still present. Evaluation will also occur the day following the “mock” court by observing their answers when asked about future cases.Give time for students to update or correct portfolios.Have the students turn in their notes and evidence along with reasons how they came to their conclusions the last day of lesson. | 1) Are you certain that the evidence presented is accurate? E-32) What are some other historical figures that you can compare their cases with? E-43) What evidence and witnesses would be appropriate in the new case? Why?E-44) What do you think the outcome will be? Why?E-4 | 1) What happens if the evidence changes over time?2) What are the misconceptions again?3) Can we add to our portfolio about what we learned today? | The portfolio needs to be accurate and misconception free. If there are still misconceptions apparent make a note to remind the students before starting next lesson. Look for organization and explanation of roles and their understanding of the outcome. |

***Teacher’s 5-E Planning Guide Lesson 2:***

 **Unit:** Evolution  **Subunit:** Natural Selection **Title:** Natural Selection: Darwin Video Simulation Game **Grade Level:** 11

**Grade Level Indicators:**

* Recognize that ecosystems change when significant climate changes occur or when one or more new species appear as a result of immigration or speciation.
* Explain that natural selection leads to organisms that are well suited for survival in particular environments. *(Evolution of Life)*
* Explain natural selection provides the following mechanisms for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. *(Evolution of Life)*
* Ecosystems can be reasonably stable over hundreds or thousands of years. *(Interdependence of Life)*

**Learner Outcomes/Evidence of Learning:** What will the students be able to do or know as a result of this experience (use measurable action verbs).

**The students will...**

* **[Bloom's Application/Analysis]:** Be able to integrate two distinct processes in evolution, the occurrence of new traits in a population and their effect on long-term survival.
* **[Bloom's Synthesis]:** Be able to clarify that the variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions, and a great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment. *(Evolution of Life)*
* **[Bloom's Evaluation]:** Be able to broaden their thinking about evolution by identifying the specifics of individuals with certain traits to how the traits in a whole population can change.
* **[Bloom's Evaluation]:** Be able to relieve possible misconceptions such as; environmental conditions are responsible for changes in traits, or that organisms develop new traits because they need them to survive, or that they overuse or under-use certain bodily organs or abilities (Lamarck).

**Essential Vocabulary:**

* Natural Selection
* Adaptation

* Mutation
* Population

**Closure: What is the summary of the big/ideas or main concepts your students will know or be able to do as a result of this lesson?**

* Students will have a firm understanding about how mutation can both advantageous and deadly.
* Students will be introduced to direct hands on simulation game which demonstrates the direct effect of mutation on a population and environmental changes.
* Students will be able to recognize and identify those changes that are advantageous to a species and recognize the fitness and survival adaptations needed to survive.
* Students will have the experience to access the video simulation, along with access to further educational activities on the Discovery. com website.

**Materials:**

* Access to a computer lab
* Copies of the worksheet provided

**References/Resources:**

* <http://www.genevaschools.org/standards>
* <http://www.ohiorc.org> - Ohio Resource Center
* <http://www.sciencenetlinks.com> - AAAS Science Netlinks
* <http://ims.ode.state.oh.us/ode/ims> - Ohio Department of Education Model Curricula
* <http://www.globalchange.umich.edu/globalchange1/current/lectures/selection/selection.html>

***Simulation Activity***

<http://science.discovery.com/interactives/literacy/darwin/darwin.html>

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| **“5-E” Phase****Student Performance Indicators** | Planned Activities/Events  | Guiding Questions | Questions Students May Ask | **Materials/Safety/Notes** |
| Engage Time: 5min* Tap prior knowledge
* Focus learner’s thinking
* Spark interest in the topic
 | a) Recap about what was learned in the previous lesson of the court case between Lamarck and Darwin.b) Focus on the main point of natural selection and adaptation.c) Have the students explain the process of natural selection and clear up misconceptions.d) Explain about the agenda of the day 1) Simulation Game 2) Group work including a reading and worksheet | What was the main point of the courtroom activity?Who won the case and why?Why is natural selection so important?What are the main mechanisms of natural selection? | Could you remind us of some of the examples of the day before?How can you witness natural selection?What is the best species to watch the act of natural selection? | None |
| Explore~HANDS-ON! Time:20min* Provide learners with common, concrete, experiences with skills and concepts
* Observe and listen to students
* Ask probing question
* Act as a consultant
 | a) Proceed to the computer lab and direct the students to the website. Have them read the instructions and the teacher should go around troubleshooting.b) Have the students run the simulation as many times as possible and take notes on which variations and adaptations survived over time. c) Teacher should go around and asses the students by listening to conversations and guiding them through the simulation.d) Explain that the students must do the simulation multiple times to see the favorable characteristics. | What are the kinds of adaptations that seem to be more suitable for your environment?Why do you have to introduce new mutations? Are they always beneficial?How is your species going to survive for a million years?What characteristics do you need to look for? | What if I am having technical problems?Is it even possible for a species to live for a million years?How accurate is this simulation? | 1) Students can also be in groups if there are limited amounts of computers.2) Make sure to watch that students are not using the internet for personal uses. Inform them there will be penalties.3) This is only a simulation example of natural selection and this is a hypothetical. |
| Explain~MINDS-ON! Time:10min* Encourage students to explain concepts in their own words
* Ask for justification
* Use students’ previous experiences as the basis for explaining concepts
* Clarify and correct misconceptions
 | a) After the simulation, gather back into the classroom and have the students take out their notes.b) Have a class discussion about the simulation. | What was the main reason for doing the simulation?What was the most interesting aspect of the simulation?What happened when you introduced a new mutation? Why was that so?What was the result of a predator entering the simulation?How many times did you use the life jacket in the simulation? What is the main reason for this life jacket?Who got results that they did not expect? What were you surprised? | How real is this simulation?Do predators affect natural selection more than the environment?What about camouflage? What is that role? | None |
| **Extend-HANDS-ON!**  Time:10min* Apply same concepts and skills in a new context resulting in deeper and broader understanding
* Encourage the students to apply the concepts/skills to new situations via new activities
 | a) Introduce the group activityb) Have the students break into groups of 3c) Have them work through the reading included with the worksheet and have them apply their simulation activity to the group work.d) Teacher goes around and assesses any questions and facilitate learning by monitoring conversations.e) Answers will vary since each simulation gives different outcomes. | What is the connection between the reading and the simulation?How are they similar/different?How does your experience with the simulation differ from your group peers?What are the examples in the simulation that connect with reading? Give specifics. | What if my experience with the simulation is very different from my group peers? Does that mean one is more right than the other?Is there only one answer for the worksheet questions? | 1) Make sure to tell the students that there are many answers because natural selection can affect any species at any time.2) Keep bringing the group work back to the simulation to make connections. |
| **Evaluate**  Time: * Observe the students as they apply new concepts and skills
* Assess, formally and/or informally, student progress toward achieving the learner outcomes (knowledge and/or skills)
* Allow students to assess their own learning and group-process skills
 | a) Assign a short writing exercise. Tell students to write one or two pages on a species. They can fictionalize the species; describe the species' advantages, and how it may have changed over millions of years to adapt to the environment. b) Instruct students to do the following: * Describe the species in the beginning.
* Explain how it changed from generation to generation.
* Describe in detail the variation in heritable characteristics; how some characteristics gave individuals an advantage over others, and how this affected reproduction and future populations.

c) Papers should show how the proportion of individuals that have advantageous characteristics would increase.d) Asses the students also in the 4-E section. | Think about the kinds of species that Darwin observed. How did they change due to natural selection?What other species have you learned about that have evolved? Beetles? Reptiles? Birds?When developing your species…what kind of environments is going to be appropriate in the beginning?What are your current ideas for a species? | What is I can’t draw very well can I print out pictures?Do we have to use a species based on what already exists? | 1) Students can be as creative as they wish. Have them also provide a drawing also of these changes. |

***Introductory Reading Handout***



### The Process of Natural Selection

Natural selection is a process that occurs over successive generations. The following is a summary of Darwin's line of reasoning for how it works (*see Figure 2*).

* + If all the offspring that organisms can produce were to survive and reproduce, they would soon overrun the earth.

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| Process of Natural Selection |
| *Figure 2: The Process of Natural Selection* |

* As a consequence, there is a "struggle" (metaphorically) to survive and reproduce, in which only a few individuals succeed in leaving progeny.
* Organisms show variation in characters that influence their success in this struggle for existence. Individuals within a population vary from one another in many traits. (Animal behavioralists making long-term studies of chimps or elephants soon recognize every individual by its size, coloration, and distinctive markings.)
* Offspring tend to resemble parents, including in characters that influence success in the struggle to survive and reproduce.
* Parents possessing certain traits that enable them to survive and reproduce will contribute disproportionately to the offspring that make up the next generation.
* To the extent that offspring resemble their parents, the population in the next generation will consist of a higher proportion of individuals that possess whatever adaptation enabled their parents to survive and reproduce.
* The well-known example of camouflage coloration in an insect makes for a very powerful, logical argument for adaptation by natural selection. Development of such coloration, which differs according to the insect's environment, requires variation. The variation must influence survival and reproduction (fitness), and it must be inherited.

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| **Natural Selection** is the differential reproduction of genotypes. |

During the early and middle 20th Century, genetics became incorporated into evolution, allowing us to define natural selection this way:

### Natural Selection Requires...

For natural selection to occur, two requirements are essential:

1. There must be heritable variation for some trait. Examples: beak size, color pattern, thickness of skin, fleetness.

2. There must be differential survival and reproduction associated with the possession of that trait.

Unless both these requirements are met, adaptation by natural selection cannot occur.

Some examples:

* + If some plants grow taller than others and so are better able to avoid shading by others, they will produce more offspring. However, if the reason they grow tall is because of the soil in which their seeds happened to land, and not because they have the genes to grow tall, than no evolution will occur.
	+ If some individuals are fleeter than others because of differences in their genes, but the predator is so much faster that it does not matter, then no evolution will occur (e.g. if cheetahs ate snails).
	+ In addition, natural selection can only choose among existing varieties in a population. It might be very useful for polar bears to have white noses, and then they wouldn't have to cover their noses with their paws when they stalk their prey. The panda could have a much nicer thumb than the clumsy device that it does have.
	+ When we incorporate genetics into our story, it becomes more obvious why the generation of new variations is a chance process. Variants do not arise because they are needed. They arise by random processes governed by the laws of genetics. For today, the central point is the chance occurrence of variation, some of which is adaptive, and the weeding out by natural selection of the best adapted varieties.



***I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection.***
**- Charles Darwin, *The Origin of Species***

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Unit: Evolution

**Answer Using the Reading** Lesson: Natural Selection

1. How did observations in nature lead to the formulation of the theory of evolution?

2. What are the main points of Darwin's theory of evolution?

3. What are the main requirements for natural selection to occur? What did the simulation show about the process?

***Answer based upon the Simulation Activity***

###   1. Even though the “creatures” that "survived" the activity depended on their length of legs and neck and color, can you think of other environmental factors that could change the survival value of a species (both for the good or the bad)?

 2. What was the main factor contributing to the changing of the species?

3. What did you like the most about the simulation? What changes would you have made?

***Teachers Learning Guide Lesson 3***

**Unit**: Evolution **Subunit:** Natural & Sexual Selection **Lesson Title:** Natural Selection Lab Webquest **Grade Level:** 11

**Grade Level Indicators:**

* Recognize that ecosystems change when significant climate changes occur or when one or more new species appear as a result of immigration or speciation.
* Explain that natural selection leads to organisms that are well suited for survival in particular environments. *(Evolution of Life)*
* Explain natural selection provides the following mechanisms for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. *(Evolution of Life)*

**Learner Outcomes/Evidence of Learning:** What will the students be able to do or know as a result of this experience (use measurable action verbs).

**The students will...**

* **[Bloom's Application/Analysis]:** Be able to relieve possible misconceptions carried from previous lesson such as; environmental conditions are responsible for changes in traits, or that organisms develop new traits because they need them to survive, or that they overuse or under-use certain bodily organs or abilities (Lamarck).
* **[Bloom's Synthesis]:** Be able to broaden their thinking about evolution by identifying the specifics of individuals with certain traits.
* **[Bloom's Evaluation]:** Be able to integrate two distinct processes in evolution, the occurrence of new traits in a population and their effect on long-term survival.

**Essential Vocabulary:**

* Natural Selection
* Sexual Selection
* Genotype
* Adaptation

* Mutation
* Population

**Closure: What is the summary of the big/ideas or main concepts your students will know or be able to do as a result of this lesson?**

* Students will have a firm understanding about how mutation can both advantageous and deadly.
* Students will be introduced to connections currently being studied in the scientific community.
* Students will be able to recognize and identify those changes that are advantageous to a species.
* Students will have the experience to access the Webquest activity both at school and home.
* Students will be able to connect Natural Selection with a current experiment and further dispel misconceptions.

**Materials:**

* Access to a computer lab

***Webquest Activity***

[**http://personal.bgsu.edu/~awiles/webquest/**](http://personal.bgsu.edu/~awiles/webquest/)

**Note:** The following are the worksheets that would be included with this Webquest. It can be accessed directly from the website and/or instructor can pass them out before the Webquest activity.

***Data worksheet:***

[**http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/4\_fish\_data.pdf**](http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/4_fish_data.pdf)

***Discussion Questions***

[**http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/4\_fish\_questions.pdf**](http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/4_fish_questions.pdf)

***Teacher’s 5-E Planning Guide Lesson 4***

**Unit:** Evolution **Subunit:** Natural Selection & Body Design **Title:** Experimental Inquiry of Body Design **Grade Level:** 11

**Grade Level Indicators:**

* **Evolutionary Theory:** Explain additional components of the evolutionary theory, including genetic drift, immigration, emigration and mutation.
* **Diversity and Interdependence of Life:** Explain how environmental factors can influence heredity or development of organisms. Relate diversity and adaptation to structures and functions of living organisms at various levels of organization.
* **Scientific Inquiry:** Formulate testable hypotheses. Develop and explain the appropriate procedures, controls and variables (dependent and independent) in scientific experimentation.
  2. Evaluate assumptions that have been used in reaching scientific conclusions.
  3. Design and carry out scientific inquiry (investigation), communicate and critique results through peer review.
  4. Explain why the methods of an investigation are based on the questions being asked.
  5. Summarize data and construct a reasonable argument based on those data and other known information.

**Learner Outcomes/Evidence of Learning:** What will the students be able to do or know as a result of this experience (use measurable action verbs).

**The students will...**

* **[Bloom's Application/Analysis]:** Propose reasonable hypotheses and design experiments to test effectively those hypotheses.
* **[Bloom's Synthesis]:** Provide a reasonable answer to the question posed in the title, based on the hypotheses proposed and the results of the experiments.
* **[Bloom's Evaluation]:** Acknowledge that natural selection favors a body design that is energy efficient.

**Essential Vocabulary:**

* Natural Selection
* Adaptation
* Extinction
* Fossils (especially involving whales)
* Cladogram
* Darwinism
* Mutation
* Evolutionary fitness
* Directional selection

**Closure/Concept:**

* What is the summary of the big/ideas or main concepts your students will know or be able to do as a result of this lesson?
* Use of critical thinking skills can help resolve questions about natural phenomena.
* Science attempts to answer questions by posing plausible hypotheses and testing them.

**Materials:**

FOR EACH TEAM (OF 2-4):

* Container that holds water (e.g., deep plastic tray or large plastic beaker)
* 1 latex or plastic glove
* 2 small zip-lock type plastic baggies
* 1 250 ml graduated beaker
* 1 Styrofoam cup (large enough to hold full plastic baggie)
* hot water (or way to safely heat water)/ cold water
* thermometer

**References/Resources:**

1) © 1999 ENSI (Evolution & the Nature of Science Institutes) [www.indiana.edu](http://www.indiana.edu)

2) National Geographic website for further information on other species body design.

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| “5-E” PhaseStudent Performance Indicators | Planned Activities/Events  | Guiding Questions | Questions Students May Ask | Materials/Safety/Notes |
| Engage Time: 5minTap prior knowledgeFocus learner’s thinkingSpark interest in the topic | a) Review about what Darwin discovered and evidence from the fossil record.b) Focus on the main point of natural selection and adaptation.c) Have the students explain the process of natural selection and clear up misconceptions.d) Explain about the agenda: 1) Experiment Design/ Open ended lab 2) Assign Groupse) Explain that Whales are going to be the species of investigation and interest. |  How important is your body design?What does body design decide in natural selection?What do you think these materials are going to tell you about body design in whales? What are the advantages to certain body designs in whales? |  What are we supposed to do in this lab?Do we have to figure this out for ourselves?What are some hints?Are there any limits to just physical design? Can we incorporate mutation and genes as a factor as well?What is an open-ended experiment? | Ask if any students are allergic to latex. If so then they can be observers and reporters. |
| Explore~HANDS-ON! Time:20minProvide learners with common, concrete, experiences with skills and conceptsObserve and listen to studentsAsk probing questionAct as a consultant | Have students write a hypothesis! a) Have students fill their balloons with hot water and have a small container filled with cold water.b) Have the students take the temperature of the water in the container before inserting one of the balloons. (start with the round water balloon) Record temp.c) Insert round balloon into cold water and wait for 3 min.d)Take temperature of container water and record temperature.e) Repeat step b-d with latex glove balloon. | What does a whale require for survival? Think about beneficial body design. Think about body design, what hypothesis can you come up with about the temperature of the “whale”?What is going to affect this mammal’s adaptability?What can the Styrofoam simulate? What is its purpose? |  What kinds of whales could these be?What is the Styrofoam for?Is this an accurate prediction of real world circumstances?What is the rate of heat transfer in mammals? |  None |
| Explain~MINDS-ON! Time:10minEncourage students to explain concepts in their own wordsAsk for justificationUse students’ previous experiences as the basis for explaining conceptsClarify and correct misconceptions |  a) Have students look at their data and their temperature differences.b) In their groups, they should discuss the purpose of the Styrofoam and how it either helped or not.c) Have them discuss why their hypothesis was right or wrong.d) Have each groups share their hypothesis and explain why they were right or wrong. (Have students decided their reporter in their group) | What was the main focus of this open-ended experiment?What was the most interesting aspect of this experiment?Who got results that they did not expect? What were you surprised?Does the initial temperature affect heat transfer?What adaptations or body design is beneficial to whales?What if the water was colder?Does whale migration and movement help survival based on your results? | How real is this experiment in comparison to other aquatic mammals?How can certain whales survive in colder climates than others?Is there more than one answer to this experiment?Can genes or certain alleles allow for a slower heat transfer or extra blubber?  | None |
| Extend Time:5minApply same concepts and skills in a new context resulting in deeper and broader understandingEncourage the students to apply the concepts/skills to new situations via new activities |  Take this lesson further by having students tap their prior knowledge of other species whose body design is extremely well adaptive to their environment.Example: Penguins, Sea Lions, Polar Bears, Hippos, etc. | What is the connection between marine mammals and terrestrial animals?How are they similar/different?What other mammals are similar to the whales? What is their body design like?What about those mammals that live in hot climates? How is their body type beneficial? | Do all mammals have adaptations concerning heat transfer? What don’t?Can genetics disrupt this heat transfer?  |  Show how you can apply this activity to any aquatic mammal.Ask about surface area and its possible affects on a mammal’s survival. |
| Evaluate Time: Observe the students as they apply new concepts and skillsAssess, formally and/or informally, student progress toward achieving the learner outcomes (knowledge and/or skills)Allow students to assess their own learning and group-process skills |  Give out the handout for them to complete.Given below. |  Think about YOUR experiment and not everyone else’s conclusions. What experiment could further this investigation?What else would you want to learn about certain body designs in a species?   |  Are there any limitations to this investigation?Are there any certain types of species that should be focused on? Or are better examples than others? |  None |

***Worksheet Evaluation Post-Experiment***

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Group Member Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Answer the following questions based upon your own INDIVDUAL experiment/hypotheses.

**1. Was the experimental design reasonable? Why?**

**2. Was the execution of the experiment successful? How could you tell?**

**3. Analysis of experiment:**

- a. Did your conclusion support your hypothesis? What evidence supported your findings?

- b. Give a one sentence rationale of "Why don't whales have legs?"

- c. What was the probable intended purpose of the Styrofoam cup? Does thickness of foam matter in this case? Why?

- d. What is the corresponding function of such a cup in common use?

- e. What is the adaptive advantage of a sea lions legs or any other aquatic mammal?

***Evaluation Rubric***

**Note: This Rubric can also be applied to the Webquest and Simulation activity**

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| Lab Report: Experimental Inquiry of Body Design Teacher Name: Student Name:     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CATEGORY  | **4**  | **3**  | **2**  | **1**  |
| **Experimental Hypothesis**  | Hypothesized relationship between the variables and the predicted results is clear and reasonable based on what has been studied.  | Hypothesized relationship between the variables and the predicted results is reasonable based on general knowledge and observations.  | Hypothesized relationship between the variables and the predicted results has been stated, but appears to be based on flawed logic.  | No hypothesis has been stated.  |
| **Experimental Design**  | Experimental design is a well-constructed test of the stated hypothesis.  | Experimental design is adequate to test the hypothesis, but leaves some unanswered questions.  | Experimental design is relevant to the hypothesis, but is not a complete test.  | Experimental design is not relevant to the hypothesis.  |
| **Analysis**  | The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.  | The relationship between the variables is discussed and trends/patterns logically analyzed.  | The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.  | The relationship between the variables is not discussed.  |
| **Conclusion**  | Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment.  | Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment.  | Conclusion includes what was learned from the experiment.  | No conclusion was included in the report OR shows little effort and reflection.  |
| **Participation**  | Used time well in lab and focused attention on the experiment.  | Used time pretty well. Stayed focused on the experiment most of the time.  | Did the lab but did not appear very interested. Focus was lost on several occasions.  | Participation was minimal OR student was hostile about participating.  |

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***Teacher Professional Development***

<http://sites.google.com/site/evolutionteachinghs/home>

***Note to Teachers:*** This lesson plan can be applied at the end of every subunit, Example: Human evolution, Scientific findings, etc. Constant evaluation and communication of respect and understanding is not only used as an evaluation, it is also used to help students investigate further inquiry in controversial subjects.

***Teacher’s 5-E Planning Guide Lesson 5:***

**Unit:** Evolution **Title:** Conflict Management and Resolutions **Grade Level:** 11

**Grade Level Indicators:**

* **Evolutionary Theory:** Explain additional components of the evolution theory, including genetic drift, immigration, emigration and mutation.
* **Diversity and Interdependence of Life:** Explain how environmental factors can influence heredity or development of organisms. Relate diversity and adaptation to structures and functions of living organisms at various levels of organization.

 **Learner Outcomes/Evidence of Learning:** What will the students be able to do or know as a result of this experience?

The students will...

* **[Bloom's Application/Analysis]:** Be able to reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.
* **[Bloom's Synthesis]:** Be able to explain and apply respectful information regarding evolutionary theory.
* **[Bloom's Evaluation]:** Be able to manage conflict of evolutionary theory through respect and acknowledgement of controversy.

 **Essential Vocabulary:**

* Natural Selection
* Controversy
* Adaptation
* Theory
* Evidence
* Cladogram
* Darwinism
* Mutation
* Evolutionary fitness
* Directional selection

**Closure/Concept:** What is the summary of the big/ideas or main concepts your students will know or be able to do as a result of this lesson?

* Use of critical thinking skills can help resolve questions about natural phenomena.
* Science attempts to answer questions by posing plausible hypotheses.
* Controversial subjects are essential and enrich the educational environment when emotional intelligence is applied.
* Respectful discussion results in successful collaboration and instills further research in related topics.

**Materials:**

 None

Discussion and reflection of the entire lesson only.

**References/Resources:**

 www.PBS.org/evolution

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| --- | --- | --- | --- | --- |
| “5-E” PhaseStudent Performance Indicators | Planned Activities/Events  | Guiding Questions | Questions Students May Ask | Materials/Safety/Notes |
| Engage Time: 5minTap prior knowledgeFocus learner’s thinkingSpark interest in the topic | a) Review about what Darwin discovered and evidence from the fossil record.b) Focus on the main point of natural selection and adaptation.c) Have the students explain the process of natural selection and clear up misconceptions.d) Explain about the agenda: 1) Discussion 1 2) Assign Groups 3) Discussion 2 4) Video and lecture |  What are the main points of evolution?What were the most interesting and difficult parts of this unit?What did you struggle with the most?What is the definition of a theory? |  How do you discuss evolution?Are people going to be mad about this? |  None |
| Explore Time:20minProvide learners with common, concrete, experiences with skills and conceptsObserve and listen to studentsAsk probing questionAct as a consultant |  **Discussion 1**1)Put the students into groups of 3 or 4.2) Explain the questions that need to be addressed.3) Express the need to be understanding when addressing questions. No opposing opinions.4) Encourage open discussion and opinions about certain aspects of the unit. | Have students ask these questions in their group;1) What was the most difficult to learn about?2) How does this conflict with your own beliefs?3) Did you talk to anyone about this topic? |  Are people going to be mean if I am open about my beliefs?What do I do if someone does not understand? |  Make sure to monitor discussion to keep students on track and not being disrespectful. |
| Explain~MINDS-ON! Time:5minEncourage students to explain concepts in their own wordsAsk for justificationUse students’ previous experiences as the basis for explaining conceptsClarify and correct misconceptions |  1) Have students explain and discuss with the whole class about the different opinions heard.2) Have them express the most interesting answers and how different people opinions are. |  Are your peers answers different that what you expected?What do you think about what others have said?Are your eyes opened to the importance of understanding others opinions?What is the main purpose of science and their discoveries? |  What if I don’t agree?What do you mean by the main purpose of science? | None |
| Extend Time:15minApply same concepts and skills in a new context resulting in deeper and broader understandingEncourage the students to apply the concepts/skills to new situations via new activities |  **Discussion 2**1) Gather students back into their original groups.2) Ask them about the different responses they can give to people about their opinions to evolutionary theory.3) Expand on some of the best ways to handle this conflict. |  What do you think is the right way to deal with this conflict?What can you say to resolve an argument?How would you handle a situation if you strongly disagreed with an opinion?What phrases can you say? |  What phrases are the best to resolve conflict?What if you cannot resolve or reduce controversy in a heated discussion? |  Go around and council groups on certain phrases. Introduce a scenario and ask how a student would resolve the conflict. |
| Evaluate Time: Observe the students as they apply new concepts and skillsAssess, formally and/or informally, student progress toward achieving the learner outcomes (knowledge and/or skills)Allow students to assess their own learning and group-process skills |  Have the students write an essay reflecting on the unit and expressing their beliefs and what might have changed throughout the unit. |   Think about what you have learned and how did it change or not change your opinions.Are you confident that you can approach conflict in a confident manner?Do you feel you have a strong grasp on what scientists have found? |   Can I write what I didn’t like about the unit? Will I get points off if I do?How open can we be on this unit? |  None |