3D Printing in Evolution

Subject Area(s): **Biology**

Associated Unit: Evolution & Classification

Lesson Title: Trends in hominid evolution

Header

Image 1

Facial features of human evolution

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Grade Level 9th

Lesson # 1 of 1

Time Required: 150 minutes (50 min x 3)

Summary:

Students will be introduced to processes which will help them identify basic trends in hominid evolution from early ancestors six million years ago to modern humans, including brain size, jaw size, language, and manufacture of tools. This lesson will allow students to recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented. Students will use 3D printing to increase their spatial awareness with complex and challenging content that requires understanding of these visual concepts. They will learn to make connections for themselves while engaging in consist reflective exercises to help them with their designs.

Engineering Connection

Students will be using a software called "EASE 3D". The EASE 3D application implements the engineering design model as a way of guiding students through the creation of 3D printed artifacts (in this case, skulls). Of particular importance in the engineering design process is the opportunity students have to test different models and translate different representations of a particular science concept. This process allows students to understand the advantages and disadvantages of particular representations and to select optimal representations for particular purposes.

Engineering Category = Engineering design process

Keywords
3D Printing, adaptations, natural selection, hominid, evolution, fossils, comparative anatomy, survival, ancestors, species.

Educational Standards (List 2-4)
State STEM Standard

Standard 15

SC.912.L.15.1 Explain how the scientific theory of evolution is supported by the fossil record, comparative anatomy, comparative embryology, biogeography, molecular biology, and observed evolutionary change.

ITEEA Standard

Design (Grades K - 12)

NGSS Standard

HS-LS4-1

Students who demonstrate understanding can:
Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

Pre-Requisite Knowledge
No prerequisites necessary

Learning Objectives
After this lesson, students should be able to:

- Identify examples of and basic trends in hominid evolution from early ancestors to modern humans
- Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.
- Identify evidence and/or explain how the scientific theory of evolution is supported by the fossil record, comparative anatomy, comparative embryology, biogeography, molecular biology, and observable evolutionary change.
- Refer to the development of language or the manufacturing of tools and relate this development to changes in the skull or brain size.

Introduction / Motivation (5E – Engage)

- Opening discussion – Prepare different scenarios for students to discuss in pairs to relate the concept of structural adaptations with need/advantage. For example: Give students different roles of people trying to buy a car –

  "Michelle is a 36 year old mother of 4 boys. She is a stay at home mom who's daily activities surround driving her boys to various activities such as soccer practice, karate classes, piano lessons, etc. She also owns a 3 year old German Shepard dog. Michelle is looking into buying a new car. What car should she get and why?"

  "Alberto is a 23 year old single guy who just graduated from college. He is looking for a full time job as a biology teacher but needs to get a new car first. What car should he get and why?"

- Video – "Tree of Life" [https://www.youtube.com/watch?v=H6IrUUDboZo]

  Engage students in whole group discussion as to what were some "Aha moments in the video"

Lesson Background & Concepts for Teachers (5E – Explain)

- PowerPoint lecture on Structural Adaptations with note taking strategy (e.g. Cornell Note Taking) [See attachments]

Vocabulary / Definitions

Word	Definition
Adaptation	Evolution of a structural, internal or behavioral feature to better suit the organism for survival
Natural Selection	Survival of the fittest – organism with the most favorable genes will survive and pass them on
Divergent Evolution	Development of more than one species from a common ancestor
Convergent Evolution	Development of a common characteristic by more than one unrelated species due to living in similar environments
Mimicry	The close external resemblance of an animal or plant (or part of one) to another animal, plant, or inanimate object.
Camouflage	Is an adaptation that helps an organism blend in with its surroundings
Warning coloration	Is a conspicuous coloring that warns a predator that an animal is unpalatable or poisonous.
Mechanical defenses	Are physical additions that keep the organism from being eaten.
Migration	Is the relatively long-distance movement of individuals, usually on a seasonal basis, because of climate, local availability of food, the season of the year or for mating reasons.
Hibernation	Allows animals to survive in harsh climates where others would perish via going into a state of inactivity and metabolic depression

Associated Activities (5E – Explore)

- **2D Paired Discussion and Sketch**
  - Students will be paired up using specific methods of grouping
  - Groups/Pairs will be given a description of the type of hominid they are working on:

1. Australopithecus Afarensis

   She was found in1974 by Donald Johanson while searching for artifacts in Africa. She was only acout 3 feet and 7 inches tall. And weighed about 66 pounds. She had a mix of human and ape features. Her arms were longer than humans today but her hands and feet were simliar to modern humans. From this information scientists have inferred that Lucy lived about 3 to 4 million years ago. Lucy's remains also tell us that hominids could not talk.

2. Homo Habilis

   This group of hominids were dicovered by husband and wife, Louis and Mary Leakey. They were searching for evidence of early hominids in Africa when they came across bones scattered across artifats that looked like tools. That's why the Homo Habilis is known for making tools. They lived a little closer to our time, about 1.5 to 2 million years ago. Scientists believe that the Homo Habilis lived in groups which probably would have been easier to protect themselves and find food. The tools found were a huge clue. The ability to make tools helped them live longer that Lucy and her relatives.

3. Homo Erectus

   They were the first hominids out of Africa since researchers had discovered them near the Java island of the coast of Asia. They were very well- suited for travel. They were taller and skinnier than earlier hominids, soome even reached modern day human height. They were good walkers and runners because of their strong bones.

4. Homo Sapiens Neanderthalensis

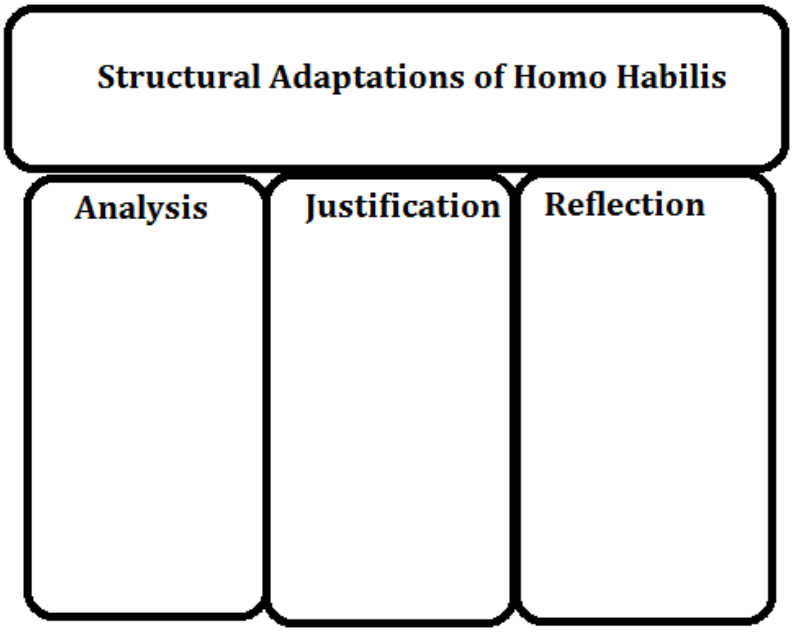
   Scientists called them "Neanderthal Man." They lived about 230,00 to 30,000 years ago. They were shorter and stockier than modern humans, but much stronger. They also became skilled toolmakers with their intelligence. The ability to make more advanced tools also increased their chance of survival. They lived and traveled in groups. They were actually the first hominids to hunt in groups. Scientists belive that the Neanderthal Man had a sense of community. When someone died they would be placed in burial mounds with tools and flowers. This was a sign that they had a sense of ritual.

5. Homo Sapiens Sapiens

   They were also known as "Doubly Wise Man." They lived about 150.000 years ago. They looked more like modern humans than any other honinids. Their bodies weren't as well

adapted to the cold as the Neanderthal Man but they probably survived because their ability to create better tools, clothing, and shelter.They were the most advanced toolmakers, who used sculpting and engraving. They were also the best hunters than the earlier hominids. They created bows and arrows as well. Through their art they have left their life story for scientists to study, but we definitly know that we adapted from these hominids.

- **3D Printing**
  - Students will use the "EASE 3D" application to 3D print their models.
  - Students will setup an 'Analysis-Justification-Reflection' (AJR) board with their partner



Analysis – Will include 2D printed screenshots of students' skull models

Justification – Will include the reasoning behind their choice of design

Reflection – Will include and changes they will make after other groups have circulated and given feedback

Link to "Unity" [Mock site for skull design]

https://dl.dropboxusercontent.com/u/101985018/AVC/Skull%20Editor/index.html

- **Group Carousel**

  Students will rotate for 10 minutes a time at each group's board and provide constructive feedback on 'post-it' notes – "3 positives/3 concerns"

- **Group Reflection**

  Students will be given time to consolidate comments and decide whether they would make changes or not – This will be recorded in the 'Reflection' piece of their board.

Lesson Closure

Assessment (5E – Evaluate)

Pre-Lesson Assessment
Pre-Test

Post-Introduction Assessment
Post-Test

Lesson Summary Assessment
Grading of AJR Board

Homework
Extension Activity

Lesson Extension Activities (5E – Extension)
Design a 2D model of what the "Future Homo Sapien" will look like with a brief 2 paragraph justification for your design.

References
The Future of Homo Sapiens The Future of Human Evolution. (n.d.). Retrieved July 29, 2016, from http://web4health.info/en/aux/homo-sapiens-future.html

Browse by Standards. (n.d.). Retrieved July 29, 2016, from https://www.teachengineering.org/standards/browse

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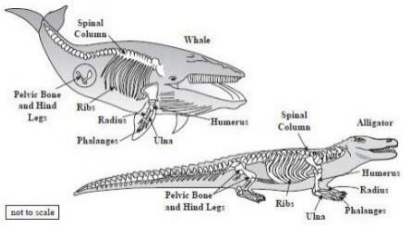
Classroom Testing Information

#1.

The scientific theory of evolution is supported by different types of evidence. The diagrams below show the skeletons of two different animal species. How does comparing the skeletons of these animals provide support for the scientific theory of evolution?



A. It provides information about the organisms' habitats.
B. It shows possible common ancestry between organisms.
C. It provides information to determine the organisms' ages.
D. It shows possible chromosomal similarities between organisms.

2. According to fossil records, the horses that lived 50 million years ago were much smaller, weaker and slower than modern horses. Which process is most likely responsible for the changes that have led to the increased size, strength, and speed in horses?

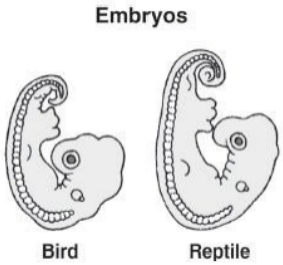
A. commensalism

B. inbreeding

C. migration

D. evolution by natural selection

3. The diagram illustrates an embryonic stage of two organisms.



Which of the following can be determined by observing the embryos shown in the diagram?

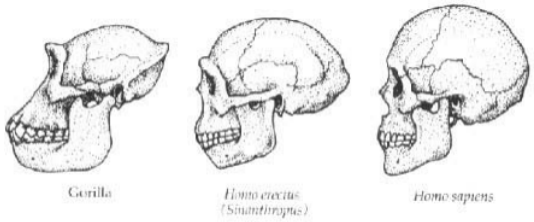
A. The organisms share a common ancestry.

B. The organisms belong to the same genus.

C. The organisms are native to the same geographic areas.

D. The organisms will grow into anatomically similar adults.

4. Scientists have found evidence that about 2.4 million years ago a gene regulating jaw muscles mutated and may have led to the more graceful human jaw we see today. The diagram below shows the skulls of 3 hominid species.



Which statement below most closely explains the link between jaw size and hominid evolution?

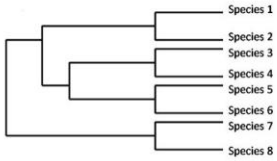
A. The jaws of hominids evolved to be smaller and less protruding over time.

B. The jaws of hominids evolved to be larger and more protruding over time.

C. There appears to be no change in the jaws of hominids over time.

D. The jaws of hominids changed over time due to a change in brain size.

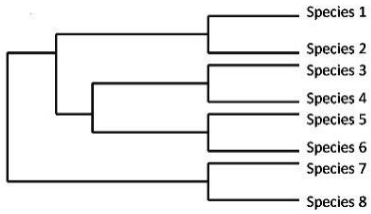
5. Scientists are studying the evolutionary history of a group of plants in the United States, and they developed an evolutionary tree, as shown below.



Which statement can be inferred from the evolutionary tree?

A. Species 1 is most closely related to Species 8.
B. Species 2 is most closely related to Species 3.
C. Species 3 is most closely related to Species 7.
D. Species 5 is most closely related to Species 6.

6. Scientists are studying the evolutionary history of a group of plants in the United States, and they developed an evolutionary tree, as shown below.



What information about the organisms best helps the scientists to determine the evolutionary relationships among them?

A. DNA sequences
B. Anatomical features
C. Habitat types
D. Reproductive Strategies

7. Over time, the climate of an island became drier, which resulted in changes to the populations of various island finch species. Finch populations with a certain beak shape thrived, while those not having that beak shape decreased. Which of the following describes a necessary condition for these changes in the finch populations to occur?

A. fewer mutations
B. limited food resources
C. limited beak variations
D. overproduction of offspring

8. Which of these would have the least effect on natural selection in a subspecies of giraffes that is geographically isolated from other subspecies of giraffes?

A. available niches
B. existing predators
C. chromosome number
D. available food resources

9. Which of the following best illustrates natural selection?

A. An organism with favorable genetic variations will tend to survive and breed successfully.
B. A population monopolizes all of the resources in its habitat, forcing other species to migrate.
C. A community whose members work together utilizing all existing resources and migratory routes.
D. The largest organisms in a species receive the only breeding opportunities.

10. A small portion of the population that is geographically isolated from the rest of the population runs the risk of decreased.

A. genetic drift
B. mutation rate
C. natural selection
D. genetic variation