INITIATIVE ON ISLAM AND MEDICINE
INSTILLING HIKMAH IN HEALTHCARE

Unit 2: What is the Origin of Humankind?

Evolution and God's Special Creation

Lesson 2: Day 1 - The Science of Evolution - Key Principles

Time Length: 45-50 min.

INSTRUCTIONAL OUTCOMES

Next Generation Science Standards (NGSS)

Life Sciences:

HS-LS3 Heredity: Inheritance and Variation of Traits: Understanding the role of DNA and genetics in evolution aligns with this standard.

HS-LS4 Biological Evolution: Unity and Diversity: This standard covers the understanding of natural selection, common ancestry, and biodiversity, all of which are key aspects of your lesson.

Science and Engineering Practices:

- Analyzing and Interpreting Data: Students will analyze data and information about the principles of evolution and how they are understood in different contexts.
- Engaging in Argument from Evidence: Discussing and evaluating different perspectives on evolution involves constructing arguments based on evidence.

Crosscutting Concepts:

- Patterns: Observing patterns in the natural world that can be explained by the theory of evolution.
- Cause and Effect: Understanding the mechanisms of evolution, like natural selection and genetic mutation.

Common Core State Standards (CCSS)

English Language Arts Standards for Literacy:

CCSS.ELA-Literacy.RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, making connections between the theory of evolution and various Islamic perspectives.

CCSS.ELA-Literacy.RST.11-12.2: Determine the central ideas or conclusions of a text; provide an accurate summary that distinguishes among fact, reasoned judgment based on research, and speculation.

English Language Arts Standards for Speaking and Listening:

CCSS.ELA-Literacy.SL.11-12.1: Initiate and participate effectively in a range of collaborative discussions on the topic of evolution and its various interpretations, integrating and evaluating multiple sources of information.

Content Learning Outcomes:

- Describe and explain the scientific account of Neo-Darwinian evolution.
- Describe, categorize, and evaluate various Muslim responses to Neo-Darwanism.
- Distinguish and evaluate the various kinds of conflicts (potential, apparent, and actual) between Islam and evolution

Materials:

- **Presentation Slides**
- **Triple-Entry Vocabulary Journal** (Student Responsibility)
- **Pre-historic Time**
- **Patterns of Pluralism and the Tree of Life Hypothesis** (Article/Research Study)
- Unit 2:Lesson 2 Assessment Questions – **Instructor's Version** and **Student's Version**

Instruction/Teacher Facilitation:

- In the previous lesson, we discussed the two big factors in the concept of evolution; the age of the earth (a time factor) and the origin of man from an Islamic perspective (theology-focused). We are going to build on that by looking at it from the perspective of science.
- **NOTE: Review the exit tickets from the last lesson and see what questions students still had and address them in this lesson.**
- **Most of this lesson will be a review and a helpful summary for the students *if* the chapters regarding evolution have already been covered in Biology class. Therefore, throughout this lesson, students can be asked to recall the information being presented and then fill in the gaps with the information within this lesson. IF the lessons of evolution have not been covered in Biology class, the teacher might need to go slowly and provide more detail.**

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- Let's now look at the common narrative of evolution and its key principles (within science/biology).

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- The concept of evolution was theorized by Charles Darwin, also known as the father of evolution. In general, on a voyage to South America, he went to the Galapagos Islands near Ecuador and studied finches primarily (among other things) and saw that there were many different types of finches, which were different based on which island he was on. Long story short, he came up with a few ideas to account for these differences and wrote his well-known work "The Origin of Species (by Means of Natural Selection)." Let's examine the key principles that he outlined.
- Historically speaking, Darwin was not the first to come up with the idea or concept of evolution. Many others had this idea before him.
  - What was unique about Darwin's presentation of this idea was that he came up with a process by which evolution takes place, a mechanism to try to explain the diversity of life seen on earth.
  - Using the process of induction, he was able to generalize and extrapolate a process for explaining evolution.
- This lesson will be focused on what we understand about evolution today, based on, and including, all the scientific advancements that we have had since then.
  - Therefore, there will be a few differences between Darwin's concept of evolution (at his time) and the modern conception of evolution.

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- Evolution has three key principles:

1. Deep time (needed for gradualism)
2. Common ancestry (or decent)
3. Mechanisms (natural selection)

➢ We will look at each one and elaborate on how it is defined in evolution.

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❖ Deep Time - The first of the principles of evolution:

➢ At the time of Darwin, the idea of the age of the earth was just that the earth is really old. No one had a precise measurement, but just knew it had to be old (especially coming from a religious era, knowing that all these Prophets came before them, the earth had to be a couple of thousand years old for sure) so they estimated about 6-10,000 years old (mostly based on biblical text calculations).

➢ The reason that the age of the earth is important is because an extremely long period(s) of time is required for the gradual changes that are seen in nature, according to the concept of evolution. Changes occur over time, but they are such small changes over a long time, so an extremely long time is needed to see major changes.

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➢ The estimate of the earth now is around 4.6 *billion* years old (so much older than originally thought). **[For a visual and more detailed explanation of how this is divided, view Prehistoric Timeline.]**

- Measurements are based on rock samples and isotope measurements within them. The decay of long-lived radioactive isotopes of elements that occur naturally in rocks and minerals is examined. Scientists then compare the present concentration of a radioactive isotope to its decay product in a rock sample, like measuring the amount of cake left in the oven to determine how long it has been baking.
- Scientists use radioactive isotopes to determine the age of the Earth through a process called radiometric dating. One commonly used method is uranium-lead dating, which relies on the radioactive decay of uranium isotopes into lead. Radiometric dating is a technique that has provided valuable insights into Earth's history, helping us understand its age, geological processes, and the timing of major events in our planet's past. It's a tool in the field of geology and has greatly contributed to our knowledge of Earth's evolution.
- It has been determined that, being such a robust and well-established technique, it has only a 1% error range. This 1% error means ±1. To put it into context, of a determined number of 10 million years, this could mean either 9 million years or 11 million years.

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➢ This leads to the question, is this information about the age of the earth qat'i or zanni?

- Give students an opportunity to answer the question to the class and give their reasons as to why they think it is either qat'i or zanni.
- It would be zanni still, due to that 1% error. Remember, Qat'i is only 100% certainty, no doubt whatsoever.

- ➢ For more information, read The Age of the Earth, by G. Brent Dalrymple.

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- ❖ Common Ancestry - second of the 3 key principles of evolution:
  - ➢ We are all familiar with the concept of a family tree. A family tree allows us to see how different members of that family are related or connected, who the ancestors are, who the descendants are, i.e. how generations are linked together.

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- ➢ Similarly, biology takes this same concept and applies it (instead of to individuals) to an entire species. The theory of evolution seeks to explain that all biological life is connected over a long period of time, which defines this concept of common ancestry.
- ➢ This is represented and examined through a Phylogenetic Tree of Life, which shows that all life came from the very same cell and continued to develop/adapt and branch off into different forms of life.
- ➢ Common ancestry is explained by the branching and diversification of lineages as populations adapted (primarily through natural selection).
- ➢ This is not only a way to explain the diversity of life (of all living things), but it also is a way of understanding the unity of life (core requirements that all living things have in common; cell structures and mechanisms, all have DNA which is constructed the same, basic elements that they are constructed from are the same/organic molecules etc).

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- ➢ An important distinction that needs to be made is between the origin of *life* versus the origin of *species*.
  - Origins of life - abiogenesis - refers to the very first life form (from which all life then originated)
  - Origins of species - evolution - how species evolve into other species.
    - It is interesting and important to note that Darwin never mentioned humans in his book when talking about the origin of species, he primarily focused on animals and insects. His book was called the “Origin of Species” ***not*** the “Origin of Life.”

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- ➢ On a phylogenetic tree of life, the organism or cell at the very bottom tip would depict the origin of life, and the rest of the tree depicts the origin of species. (picture from slides)

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- ➢ Evaluating if this information or principle is qat’i or zanni
  - Until now, there is no adequate explanation of the origin of life - abiogenesis (from a scientific perspective).
  - Evolutionary biologists have:
    - Methodological disagreements about these phylogenetic trees (where they should branch, which species to be included where or under which previous species etc). The branching patterns of phylogenetic trees often disagree even when they have been constructed using different portions of the *same* data. This phylogenetic discord (incongruence) can be

explained by real differences in evolutionary process or history but also may be due simply to random chance or sampling error.
- Questioned whether there is a single tree or multiple trees - to accommodate all the disagreements and interpretations of the data.
- Constantly revised placements of species in the light of new knowledge. Scientists can not go back in time and investigate or analyze extinct species, and then measure accurately, or do experiments in a lab. Scientists have to use inferences based on current traces and project them onto the past.

- As a result, what we get from this is that inferences and projections are constantly changing due to new information being deciphered.
- This would mean that the principle of common ancestry is very zanni in terms of its truth seen through the constant adjustments and disagreements.

➢ **For more information, look at the "Patterns of Pluralism and the Tree of Life Hypothesis."**

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❖ Mechanisms - the third key principle of evolution

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➢ There are 2 key mechanisms in evolution:
1. Random mutations
2. Natural selection

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➢ Random mutations - Random mutations are changes in the nucleotide sequence of DNA that occur without a pattern (i.e. randomly) and introduce new variations into a population.
- These genes are then combined or mixed on very probabilistic measures.
- After this combining/mixing of genes happens to produce offspring, we can not absolutely determine which gene came from which parent. (If we were calculating the projectile of a tossed ball, we would be quite accurate based on the speed, its angle, distance, etc. but this is not the case with genes. We can not say with certainty which genetic makeup will be passed on to the offspring.)
- Example: a coin toss, you can never say with absolute certainty that the coin will land on heads (or tails).
- We consider this "random" only because we have not figured out what the particular mechanism is that determines such information.

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➢ Natural Selection - natural selection is an organism's ability to survive in a specific environment, in other words, nature's ability to select the ones that are the most capable to survive in that environment. Because of their survival, they are able to grow long enough to reproduce, generally passing on that successful trait to their offspring.
- Famous examples

- A longer neck allows animals to reach the leaves in trees to eat, and those who can't reach it will have more competition with other organisms who also eat the lower food sources. Therefore, giraffes, the ones with the longer/longest necks survive, and then pass on that gene to their offspring which continue to survive due to the lack of competition and consistent food source.
- In a dark field, there are white mice and dark mice (black or brown). Because the white mice are easily seen on dark terrain, they become easy targets for predators, predatory birds to be specific. This results in the dark mice surviving longer and reproducing and passing on that dark color gene. The dark mice are selected by nature to survive in this environment.
- Note that if the terrain was light in color, the white mice would be selected for, and would survive, whereas the dark mice would be selected against and eaten much easier by predators. Therefore, a key aspect to remember is that the environment in which the organism lives plays a vital role in which organism survives.

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- In summary, what is evolution?
  - Evolution is characterized by 3 key principles:
    1. Deep time - the earth is really, really old (4.6 billion years)
    2. Common ancestry - all biological life is interconnected through a long, historical lineage like a family tree.
    3. Mechanisms -
       a. Random mutations
       b. Natural selection
  - Collectively, this is known as Neo-Darwinism.
    - Neo-Darwinism is defined as a theory of evolution that represents a synthesis of Charles Darwin's theory in terms of natural selection and adds modern population genetics.
    - The key difference to note is that Darwinism was based on phenotypic differences passed down for speciation, but Neo-Darwinism has been updated to include genetics to explain these differences and the understanding that variant genes are inherited and passed down.

Biological Connections:

- This lesson can be connected to the chapter on concepts of evolution and biodiversity of life in Biology classes (usually the 3rd or 4th Unit, according to most Biology textbooks.)
- These concepts can also be connected to the definition of mammals, due to the concept of haywaan-un-naatiq.
- This lesson can also be connected to cellular reproduction (mitosis and meiosis) and genetics (DNA and inheritance) in Biology classes, which includes genetic mutations (usually the 2nd unit, according to most Biology textbooks).