uBEATS Teacher's Guide:

Evolution of Traits

(Grades 9-10)

This teacher guide is a supplementary text to support the use of the uBEATS "Evolution of Traits" module for grades 9-10.

To help students develop the knowledge necessary for an incredible future in health care, we created UNMC Building Excellence in Academics Through STEM (uBEATS), an online health science resource for Nebraska students.

UNMC uBEATS modules are short (15 minutes or less), interactive online health science modules to supplement curriculum taught in grades 6 – 12. These do not replace curriculum but are a supplement for teachers and students incorporating evidence-based information and UNMC expert guided material. Each module is chunked into sections with formative and summative assessments with immediate feedback provided.

Tips on how to utilize uBEATS modules:

- Internet access is required to view uBEATS modules.
- For those who have access to one-to-one technology, modules can be used in or outside of the classroom as a topic introduction, extension, or review.
- For classrooms without individual student devices modules can be used in whole group instruction. Formative assessment questions can use the teacher's preferred call and response method and summative assessment questions can be displayed on the board and answered individually by students or printed and distributed to students after viewing the module.

Objectives

- Identify the basics of phylogenetic tree interpretation and how they contribute to relatedness.
- Understand how amino acid sequences and genotypes lead to changes in phenotypic traits.
- Explain how genotypic evidence contributes to understanding common ancestry and biological evolution.

ubeats@unmc.edu

Introduction

What evidence shows that different species are related?

Have you ever wondered why chickens don't have teeth? We do share many similarities with chickens, including brain, eyes, lungs, heart, warm blood, bone structures, etc. Chickens are also different from us in several ways, including beak, feathers, wings, etc. Could humans be related to chickens? In this module we explore relatedness in terms of shared genes.

Prior Knowledge

Before beginning this module, the student should understand the Grade Band Endpoints for LS4.A. A Framework for K-12 Science Education.

- **By the end of grade 5.** Fossils provide evidence about the types of organisms (both visible and microscopic) that lived long ago and also about the nature of their environments. Fossils can be compared with one another and to living organisms according to their similarities and differences.
- **By the end of grade 8.** Fossils are mineral replacements, preserved remains, or traces of organisms that lived in the past. Thousands of layers of sedimentary rock not only provide evidence of the history of Earth itself but also of changes in organisms whose fossils remains have been found in those layers. The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. Because of the conditions necessary for their preservation, not all types of organisms that existed in the past have left fossils that can be retrieved. Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.

Key Terms/Vocabulary

Ancestry, relatedness, homology, phylogenetic tree, DNA, nucleotides, sequence, adenine, cytosine, thymine, genes, amino acids, proteins, enzymes, genotype, phenotype, environment, mutation, conserved genes, homology, divergent evolution, regulatory genes, Hox genes.

Science Standards

Nebraska's College and Career Ready Standards for Science 2017 Nebraska Science Standards

- Evidence of Common Ancestry and Diversity: SC.10.5.A

Next Generation Science Standards (NGSS) featuring Three-Dimensional Learning

Core Idea LS4.A: Evidence of Common Ancestry and Diversity A Framework for K-12 Science Education

- Genetic information, like the fossil record, also provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.

Science and Engineering Practices NGSS

- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts NGSS

- Patterns
- Cause and Effect

Extensions of the lesson

- To help students become more familiar with the Key Terms of this module, the teacher can use the vocabulary list for a classroom Word Wall, or integrate the vocabulary into classroom word games during review sessions.
- To help the students see personal relevance, suggest that they have a family conversation with their parents to discuss body segment comparisons of similarities and differences between humans and their pets (e.g. dog, cat, turtle, etc.).

- The teacher may need to address student misconceptions by emphasizing these important concepts:
    - Fossil remains and embryological development can provide evidence of relatedness, but genetic information in the form of amino acid sequences and DNA sequences can be compared across species as additional evidence for common ancestry.
    - Genes are inherited; therefore, if different species share some common genes they probably have a common ancestor.
    - Genetic information is coded by the sequential arrangement of four nucleotide bases: Adenine, Thymine, Guanine, and Cytosine.
    - The DNA code in the genotype gets transcribed by mRNA in order to carry the information out of the nucleus to the ribosomes of the cytoplasm, where the mRNA gets translated by the tRNA into chains of amino acids.
    - The chains of amino acids get folded into proteins, which do the work of the cell and produce the phenotypic appearance of the organism.
    - There are many kinds of regulatory genes that influence the transcription process. If a gene does not get transcribed, it does not get expressed in the phenotype.

- A special class of regulatory genes are called Hox genes. Hox genes determine segmentation and dictate what goes where from head to tail.
- Hox genes that are highly conserved among different species not only provide evidence of common ancestry, they can even be swapped out between species without changing the eventual phenotype.

Enrichment

- For information about Healthcare Career Opportunities, see the UNMC Health Career Book.
- To make connections in your community, contact local hospitals, healthcare clinics, zoo, nurses, doctors, veterinarians, county extension service, local farmers who raise livestock, etc.