uBEATS Teacher's Guide:

Human Genetics

(Grades 9-10)

This teacher guide is a supplementary text to support the use of the uBEATS Human Genetics 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 three sources of genetic variation: new combinations through meiosis, viable errors occurring during replication, and mutations caused by environmental factors.
- Give examples of how diversity of traits affects survival, reproduction, and population dynamics.
- Differentiate between individual acclimation and population (species) adaption.

ubeats@unmc.edu

Introduction

Genetic variation is necessary for survival. How does genetic variation among organisms affect survival and reproduction? How does the environment influence populations of organisms over multiple generations?

Prior Knowledge

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

- ***By the end of grade 8.*** Genetic variations among individuals in a population give some individuals an advantage in surviving and reproducing in their environment. This is known as natural selection. It leads to the predominance of certain traits in a population and the suppression of others. In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring.

Core Idea LS4.C. A Framework for K-12 Science Education

- ***By the end of grade 8.*** Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. In separated populations with different conditions, the changes can be large enough that the populations, provided they remain separated (a process called reproductive isolation), evolve to become separate species.

Key Terms/Vocabulary

Genetic variation, diversity, survival, reproduction, environment, meiosis, replication, mutation, viable errors, random, nucleic acids, population dynamics, individual acclimation, population adaptation, natural selection, traits, UV radiation, vitamin D, predator, herbivore, PTC tasting gene, lactose, lactose tolerance, lactase, lactase persistence, cystic fibrosis, sickle cell gene, malaria, hemophilia, extinction.

Science Standards

Nebraska's College and Career Ready Standards for Science 2024 Nebraska Science Standards

- Biological Evolution: SC.HS.10.5.B, SC.HS.10.5.C, SC.HS.10.5.E

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

- **Core Idea** LS4.B: Natural Selection A Framework for K-12 Education
  - Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced and thus are more common in the population.
- **Core Idea** LS4.C: Adaptation A Framework for K-12 Education
  - Natural selection is the result of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.
  - Natural selection leads to adaptation—that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
  - Adaptation also means that the distribution of traits in a population can change when conditions change.
  - Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.
  - Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or too drastic, the opportunity for the species' evolution is lost.

- **Science and Engineering Practices NGSS**
  - Engaging in arguments from evidence
  - Obtaining, evaluation, 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 **private** conversation with their parents to discuss family characteristics, such as facial traits, height, family history of diseases, etc.
- The teacher may need to address student misconceptions by emphasizing these important concepts:
    - People are often confused about natural selection because they do not understand how the scientists use the term "adaptation." When someone speaks of "adapting to the environment" for greater chance of survival, students often form a mental image of an animal looking for a new food source or a human wearing more protective clothing. However, the new food source or the new clothing are not genetic traits that can be passed on to the next generation. Instead, we call such behaviors "acclimations" to the environment.
    - Adaptations allow organisms to inherit traits that increase chances for survival in a changing environment.
    - Species change over time as the percentage of certain adaptive traits in the population increase through generations.
    - The color of skin is an adaptation to the environment, but there are many factors involved in population survival. For example, the map provided in the module might suggest that Eskimos should have extremely light skin to allow absorption of more vitamin D, but diet and other factors are also involved in their survival.
    - Lactose is a natural sugar in the milk produced by mammals. Lactase is a digestive enzyme that allows mammal babies to use the lactose.
    - Sickle Cell anemia is a condition that interferes with life, but it is called a viable error because a person who is heterozygous for the trait actually has protection from another disease (malaria).

Enrichment

- For information about career opportunities, see UNMC's Careers in Healthcare.
- To make connections in your community, contact local hospitals, healthcare clinics, nurses, doctors.
- To read about the research regarding lactase persistence, see Genetics of Lactase Persistence and Lactose Intolerance.
- For classroom activities about natural selection, see NGSS Biology.