uBEATS Teacher's Guide:

Types of Genetic Mutations

(Grades 9-10)

This teacher guide is a supplementary text to support the use of the uBEATS "Types of Genetic Mutations" 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 role of pair-based sequences in the process of protein synthesis.
- Describe the mechanism and impact of the following DNA errors: substitution, insertion, deletion, duplication, frameshift mutation.
- Analyze and discuss the inheritance of a mutation caused by an environmental factor.

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Introduction

Why do individuals of the same species vary in how they look, function, and behave?

When you look at two different pictures of red blood cells, you might notice that one picture shows some of the cells in a “sickle” shape instead of consistently oval like the red blood cells in the other picture. And when you look at two different x-rays of lungs, you might see that one x-ray shows a cloudy appearance that does not show up in the accompanying picture. These differences are examples of protein changes due to genetic mutations—changes in the nucleotide sequences in an organism’s DNA. Some changes are beneficial, others harmful, and some neutral to the organism.

Prior Knowledge

Before beginning this module, the student should understand the Grade Band Endpoints for Core Idea LS3.B: Variation of Traits A Framework for K-12 Science Education.

- ***By the end of grade 8.*** In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

Key Terms/Vocabulary

Genes, DNA, nucleotide, base pairs, RNA, codon, amino acid, transcription, translation, protein synthesis, the Central Dogma of molecular biology, mutation, substitution, insertion, deletion, duplication, frameshift, somatic cells, gametes, mutagen.

Science Standards

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

- Heredity: Inheritance and Variation of Traits: SC.HS.9.4.B

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

Core Idea LS3.B: Variation of Traits A Framework for K-12 Education

- The information passed from parents to offspring is coded in the DNA molecules that form the chromosomes. In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.
- Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depend on both genetic and environmental factors.

Science and Engineering Practices NGSS

- Asking questions and defining problems
- Analyzing and interpreting data
- Engaging in arguments from evidence

Crosscutting Concepts NGSS

- Cause and effect
- Scale, proportion, and quantity

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.

- For a classroom activity, try Mutation Telephone.

- The teacher may need to address student misconceptions by emphasizing these important concepts:
    - Genetic mutations are random changes to the nucleotide sequences in DNA. As such, we often describe them as "errors" but we must avoid characterizing all mutations as "bad." Some are beneficial, some are harmful, some are neutral. Mutations drive evolution as species change.
    - DNA does not directly build proteins. First, the double-stranded DNA code must create a single-stranded mRNA code that can leave the nucleus and move to the ribosomes. There the mRNA can be translated into a chain of amino acids during the formation of proteins.
    - The term "Central Dogma" is not intended to be a religious belief in any way. The term refers to the importance of the flow of information within living systems, but scientifically it might be better described as a hypothesis. In the form of

a hypothesis, its description as “DNA makes RNA, and RNA makes protein” has been tested and shown to be over-simplified, as scientists continue to debate variations within that flow of molecular information.

- Environmental mutagens have the potential to cause changes in an organism’s genes, but exposure to the potential does not always cause a mutation.
- When a mutation does occur, it is not always passed on to the next generation. Changes in DNA of somatic (body) cells are not inherited by offspring. Only the changes carried by the DNA in gamete cells can be transmitted to future generations.

Enrichment

- For information about Healthcare Career Opportunities, see the UNMC Health Career Book.
- To make connections in your community, contact local hospitals, healthcare clinics, nurses, doctors.