uBEATS Teacher's Guide:

Biotechnology

(Grades 11-12)

This teacher guide is a supplementary text to support the use of the uBEATS "Biotechnology" module for grades 11-12.

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

- Summarize how a gene constructs a protein using RNA as an intermediary.
- Explain how polymerase chain reaction (PCR) is used in DNA research.
- List products that come from recombinant DNA.

Introduction

Sickle-cell anemia is a genetic disease that causes red blood cells to form incorrectly in a sickle shape resulting in a lower-than-normal blood oxygen level. This causes individuals who have this disorder to have episodes of extreme pain and often early death. Biotechnology and genetic engineering practices have shown promise in not just treating but one day curing genetic disorders such as sickle-cell anemia.

Prior Knowledge

Before beginning this module, the student should understand the Next Generation Science Standards (NGSS) featuring Three-Dimensional Learning.

Core Idea ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World A Framework for K-12 Education

- Modern civilization depends on major technological systems, including those related to agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.
- Widespread adoption of technological innovations often depends on market forces or other societal demands, but it may also be subject to evaluation by scientists and engineers and to eventual government regulation. New technologies can have deep impacts on society and the environment, including some that were not anticipated or that may build up over time to a level that requires attention or mitigation. Analysis of costs, environmental impacts, and risks, as well as of expected benefits, is a critical aspect of decisions about technology use.

Science and Engineering Practices **NGSS**

- Constructing explanations and designing solutions

Crosscutting Concepts **NGSS**

- Influence of Science, Engineering, and Technology on Society and the Natural World

Key Terms/Vocabulary

Genetic engineering, biotechnology, gene, protein, RNA, transcription, ribosomes, amino acids, RNA polymerase, exons, introns, spliceosome, protein synthesis, nucleus, cytoplasm, translation, codon, polypeptide, polymerase chain reaction, DNA template, primer, polymerase enzyme, nucleotide building blocks (dNTPs), thermal cycler, amplification, denaturation, annealing, elongation, polymorphism, recombinant DNA, restriction enzymes, bacterial plasmids, vectors, complementary DNA, point mutation.

Science Standards

Nebraska's College and Career Ready Standards for Science 2017

Nebraska Science Standards

Inheritance and Variation of Traits: SC.HSP.9.4.F

- Construct an explanation based on evidence for the role of biotechnology in the research and understanding of biological systems.
- Emphasis is on the evolution of genomes, how biotechnology allows researchers to study the sequence, expression, and function of genes, and the practical applications of biotechnology.

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 review the steps of protein synthesis, see the uBEATS module DNA & Proteins.
- Encourage students to check current events for the latest news involving biotechnology.
- As student misconceptions become apparent, the teacher may need to reinforce these important concepts:
    - DNA molecules are storage units for genetic information, but they do not directly make proteins. The DNA must be transcribed into RNA, which is able to leave the nucleus and move through the cytoplasm to the ribosomes where translation takes place.
    - When the RNA polymerase first builds a strand of RNA from the DNA, the new strand contains some non-coding regions. These non-coding portions (introns) are removed by a spliceosome, and the remaining coding portions (exons) are pieced back together to finish the messenger RNA (mRNA).
    - After the completed mRNA moves into the cytoplasm of the cell, the process of translation reads the information 3 nitrogen bases at a time (codon) by binding with a molecule of transfer RNA (tRNA) which is bound to a specific amino acid.
    - Additional amino acids are added in the sequence prescribed by the mRNA until a polypeptide chain is produced.
    - Polymerase chain reaction (PCR) is a laboratory technique for amplifying a small sample of DNA for commercial or research purposes.
    - PCR assists early diagnosis of viruses and bacteria. It can be used for early detection and treatment of cancer.
    - Recombinant DNA technology has many uses in health and diet, agriculture, environmental studies, pharmacy, gene therapy, and medicine.

Enrichment

- For information about Healthcare Career Opportunities, see the UNMC Health Career Book.
- To make connections in your community, contact local universities, agriculture organizations, local hospitals, healthcare clinics, nurses, doctors.
- For a lab activity, see Bacteria Transformation.