uBEATS Teacher's Guide:

RNA

(Grades 11-12)

This teacher guide is a supplementary text to support the use of the uBEATS "RNA" 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

- Identify the role of nucleotide base-pair sequences in the process of protein synthesis.
- Explain the process in which DNA is transcribed into mRNA.
- Discuss the role of snRNA
- Describe the functions of tRNA and rRNA in the process of translation.

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Introduction

What do humans, dogs, and trees all have in common?

They all follow the Central Dogma of Biology! Although all of these things may appear very different, they perform very similar tasks at the cellular level. In this module you will learn about RNA, an intermediate messenger molecule that converts your genetic code from your DNA into functional proteins in your cells that make you who you are. The flow of genetic material from DNA to RNA to proteins is known as the Central Dogma of Biology.

Like all living things, our bodies are made up of cells. Inside eukaryotic cells, there are specialized structures called organelles that carry out specific functions such as energy production, waste elimination, and information storage. In addition to organelles, protein macromolecules do the work in cells of maintaining the structure, function, and regulation of our bodies' tissues that are essential for our survival. So how are these proteins made, or synthesized? All the information that makes you who you are is found in your genome. The genetic material, the DNA, is found in the nucleus of your body's cells. From the nucleus, your DNA is transcribed or converted into another genetic form called RNA and moved to the cytoplasm or rough endoplasmic reticulum. Lastly, your RNA is translated into proteins that carry out a variety of tasks inside and outside of your cells.

Prior Knowledge

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

Core Idea LS3.A: Heredity: Inheritance and Variation of Traits A Framework for K-12 Science Education.

- ***By the end of grade 12.*** Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.

Science and Engineering Practices NGSS

- Asking questions and defining problems

Crosscutting Concepts NGSS

- Cause and effect

Key Terms/Vocabulary

Central Dogma of Biology, DNA, nucleic acid, nucleotide, monomer, polymer, nitrogenous base, phosphate group, sugar group, ribose, adenine, thymine, guanine, cytosine, uracil, complementary base pairing, helix, hydrogen bond, transcription, template, RNA, messenger RNA (mRNA), RNA polymerase, 5' cap, 3' poly-A tail, small nuclear RNA (snRNA), intron, exon, spliceosome, translation, transfer RNA (tRNA), ribosomal RNA (rRNA), cytosol, ribosome, endoplasmic reticulum, codon, amino acid, polypeptide, initiation, elongation, termination, protein.

Science Standards

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

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

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

Core Idea LS3.B: Variation of Traits A Framework for K-12 Science 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 argument 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.
- To review the steps of protein synthesis, see the uBEATS module DNA & Proteins.
- For a virtual lab activity, see NOVA's RNA VirtuaLab.
- The teacher may need to address student misconceptions by emphasizing these important concepts:
    - DNA molecules are storage units for genetic information, but they do not directly make proteins. The double-stranded DNA must be transcribed into a single-stranded 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 pre-mRNA from the DNA, the new strand must be modified before it leaves the nucleus. The transcript has directionality to be read from the 5' end toward the 3' end. A 5' cap is added to the beginning of the strand, and a 3' tail is added to the end.
- The strand also contains some non-coding regions. These non-coding portions (introns) are cut out by a spliceosome complex, made up of proteins and small nuclear RNA (snRNA). The remaining coding portions (exons) are spliced back together to finish the messenger RNA (mRNA).
- After the completed mRNA moves into the cytoplasm of the cell, it moves to the ribosome which is made up of ribosomal RNA (rRNA).
- The sequence of nucleotides on the mRNA is read three at a time as codons. Each 3-nucleotide codon codes for a specific amino acid. A transfer RNA (tRNA) delivers that specific amino acid to the ribosome during initiation.
- During elongation, additional amino acids are added in the sequence prescribed by the mRNA until a polypeptide chain is produced. The chain grows until termination, when a stop-codon instructs the ribosome to release the completed polypeptide.
- The polypeptide that was produced by translation folds into a functional protein.

Enrichment

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