

Science

Unit/Timeframe: Biology Unit 6: Cell Division & Protein Synthesis / Up to 4 weeks	Grade Level: 9, 10, 11, 12
Content Standards	2017 MA Literacy Framework
<p><u>Standard #1: HS-LS1-1: DNA, Transcription and Translation (PARTIAL COVERAGE)</u> Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.</p> <p><u>State’s Clarification Statement:</u> Proteins that regulate and carry out essential functions of life include enzymes (which speed up chemical reactions), structural proteins (which provide structure and enable movement), and hormones and receptors (which send and receive signals). <i>Taught in a previous unit</i> The model should show the double-stranded structure of DNA, including genes as part of DNA’s transcribed strand, with complementary bases on the non-transcribed strand.</p> <p><u>State Assessment Boundary/ Possible Extension Topic for Honors:</u> Specific names of proteins or specific steps of transcription and translation are not expected in state assessment. Cell structures included in transcription and translation will be limited to nucleus, nuclear membrane, and ribosomes for state assessment.</p> <p><u>WPS Clarification Statement:</u> The major types of proteins were taught in a previous unit. The remaining sections of this standard encompass a lot of content: DNA structure (and therefore replication), transcription and translation. It is recommended that this unit be broken into two major parts - one that addresses DNA structure, replication, and cell division by mitosis, and another that addresses protein synthesis.</p> <p><u>Standard #2: HS-LS3-2: Genetic Variation (PARTIAL COVERAGE)</u> Make and defend a claim based on evidence that genetic variations (alleles) may result from (a) new genetic combinations via the processes of crossing over and random segregation of chromosomes during meiosis, (b) mutations that occur</p>	<p>RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.9-12.2 - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p>

<p>during replication, and/or (c) mutations caused by environmental factors. Recognize that mutations that occur in gametes can be passed to offspring.</p> <p><u>Clarification Statement:</u> Examples of evidence of genetic variation can include the work of McClintock in crossing over of maize chromosomes and the development of cancer due to DNA replication errors and UV ray exposure.</p> <p><u>State Assessment Boundary/Possible extension topic for Honors:</u> Specific phases of meiosis or identification of specific types of mutations are not expected in state assessment.</p> <p><u>WPS Clarification Statement:</u> Chromosomal level mutations, gene-environment interactions, and genetic variation in general will be taught in a later unit. Emphasis in this unit is on mutations at the nucleotide level and their effect on resulting proteins.</p> <p><u>Standard #3: HS-LS1-4: Cell Cycle and Mitosis</u> Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.</p> <p><u>State Assessment Boundary/ Possible Extension Topic for Honors:</u> Specific gene control mechanisms or specific details of each event (e.g., phases of mitosis) are not expected in state assessment.</p>	
Essential Questions	Skills/Knowledge
<p><u>Possible Phenomena:</u></p> <ul style="list-style-type: none"> ● The immortal cells of Henrietta Lacks <p><u>Essential Questions:</u></p> <ul style="list-style-type: none"> ● How is structure related to function at all biological levels of organization? ● How do organisms grow and develop? ● Why do cells divide? 	<p><u>Students should be able to:</u></p> <p><u>State Provided Objectives:</u></p> <ul style="list-style-type: none"> ● Create, analyze, and complete models and descriptions of the cell cycle, including interphase and cell division. Interphase should include DNA replication and cell growth. Cell division should include mitosis and cytokinesis. ● Construct an explanation of the importance of end products of mitosis, DNA replication, transcription, and translation.

- How do mutations occur and what are their effects?

- Create, analyze, and complete models and descriptions of protein synthesis (transcription and translation).
- Determine the complementary base pairs in a replicated section of DNA given the original DNA strand.
- Create, analyze, and modify models to show how mutations that occur in DNA may or may not result in a difference in a protein. Models may include the replication of DNA, the transcription of DNA to RNA, the translation of RNA to amino acids, and the production of amino acid chains (polypeptides). Models may show a nucleotide being removed from a DNA sequence, a nucleotide being added to a DNA sequence, or a nucleotide changing to another nucleotide.
- Use an mRNA codon table to determine and explain if a given mutation will result in a change to the to the resulting amino acid sequence/polypeptide/protein.

WPS Objectives:

- Explain how the structure of DNA allows it to perform its functions of storing, copying, and transmitting information
- Apply Chargaff's rule to make the compliment to a given DNA strand
- Explain the meaning of the term "antiparallel" as it applies to DNA
- Define DNA replication
- Describe when in the cell cycle DNA replication occurs and why it is necessary
- Explain why cells divide rather than grow continuously larger
- Explain why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms
- List the steps of the eukaryotic cell cycle in order
- Identify the major events in each phase of the cycle, and be able to create a diagram predicting how the cell will appear in its next phase
- Explain why it is only the DNA that needs to be carefully divided among the daughter cells, and not the organelles
- Construct and use a model of transcription and translation
- Differentiate between the terms "DNA" and "gene"
- Compare and contrast DNA and RNA

	<ul style="list-style-type: none"> ● List and describe the two major types of RNA and their roles in protein synthesis ● Transcribe a given DNA strand into mRNA ● Describe the relationship between DNA and proteins ● Explain why mRNA is necessary in order to carry out the instructions contained in DNA ● For a given DNA sequence or mRNA sequence, translate the information into an amino acid sequence using an amino acid chart ● Order the steps of transcription and translation ● Describe what happens to a polypeptide when translation is complete ● For a given scenario, predict the effect of a given mutation
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Common Resources	Common Assessments
Ted:Ed Immortal Cells of HeLa Agar Cube Lab & Data Table Learn Genetics Transcription and Translation	Agar Cube Lab

Vocabulary
Tier II: cell division, chromosome, chromatin, cell cycle, interphase, mitosis, chromatid, centriole, spindle, cytokinesis, prophase, metaphase, anaphase, telophase, base pairing rule, replication, DNA polymerase, RNA, mRNA, tRNA, transcription, polypeptide, translation, codon, anticodon, mutation, Tier III:

Additional Notes

Prior Knowledge:

In 8th grade students learned that chromosomes contain genes which code for proteins and therefore traits. Changes to genes may result in changes to proteins. The changes can be positive, negative or neutral. In 6th grade students learned that the nucleus regulates the activities of the cell.

Practice	Description	Example for this Unit
<i>Practice #2: Developing and Using Models</i>	A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models	Transcribe and translate a gene computer simulation on Learn Genetics website (see Common Resources)

	can be represented as diagrams, 3-D objects, mathematical representations, analogies or computer simulations	
<i>Practice #4: Analyzing and Interpreting Data</i>	Analyzing and interpreting data includes making sense of the data produced during investigations. Because patterns are not always obvious, this includes using a range of tools such as tables, graphs and other visualization techniques.	Agar Cube Lab (see Common Resources)
<i>Practice #5: Using Mathematics and Computational Thinking</i>	Mathematical and computational thinking involves using tools and mathematical concepts to address a scientific question.	Agar Cube Lab (see Common Resources)