Unit 06: Heredity of Genetic Material

Content Area: **Science**
Course(s):
Time Period: **Marking Period 3**
Length: **6-8 Weeks**
Status: **Published**

Summary

Introduction:

The focus of this unit is on the inheritance of genetic information. The unit will begin with the history of the experiments that lead to the discovery of DNA as the genetic material of the cell. Students will then learn how these experiments relate to the discovery of the structure of DNA and its role in storing, interpreting, and transmitting the genetic information of the living organism. The unit will also examine the relationship between DNA, genes, and chromosomes. Students will learn the history of genetics as science in relation to Mendel's laws of inheritance. Students will evaluate the inheritance of traits that show Mendelian and non-Mendelian patterns of inheritance. To relate the unit to climate change, students will evaluate how the environment influences the phenotype of an organism in addition to its genes.

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Standards

MA.S-ID	Interpreting Categorical and Quantitative Data
9.1.12.CFR	Civic Financial Responsibility
	Brainstorming can create new, innovative ideas.
MA.S-ID.A	Summarize, represent, and interpret data on a single count or measurement variable
LA.RL.9-10.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferentially, including determining where the text leaves matters uncertain.
9.4.2.CI.1	Demonstrate openness to new ideas and perspectives (e.g., 1.1.2.CR1a, 2.1.2.EH.1,

	6.1.2.CivicsCM.2).
MA.S-ID.A.2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
9.4.2.CI.2	Demonstrate originality and inventiveness in work (e.g., 1.3A.2CR1a).
9.4.2.CT	Critical Thinking and Problem-solving
9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
	Career planning requires purposeful planning based on research, self-knowledge, and informed choices.
	Critical thinkers must first identify a problem then develop a plan to address it to effectively solve the problem.
9.4.2.CT.2	Identify possible approaches and resources to execute a plan (e.g., 1.2.2.CR1b, 8.2.2.ED.3).
9.4.2.CT.3	Use a variety of types of thinking to solve problems (e.g., inductive, deductive).
	Individuals should practice safe behaviors when using the Internet.
	Digital communities allow for social interactions that can result in positive or negative outcomes.
9.4.2.DC.6	Identify respectful and responsible ways to communicate in digital environments.
9.4.2.GCA	Global and Cultural Awareness
	Individuals from different cultures may have different points of view and experiences.
9.4.2.GCA.1	Articulate the role of culture in everyday life by describing one’s own culture and comparing it to the cultures of other individuals (e.g., 1.5.2.C2a, 7.1.NL.IPERS.5, 7.1.NL.IPERS.6).
9.4.2.IML	Information and Media Literacy
9.4.2.IML.1	Identify a simple search term to find information in a search engine or digital resource.
	Digital tools can be used to display data in various ways.
9.4.2.IML.2	Represent data in a visual format to tell a story about the data (e.g., 2.MD.D.10).
9.4.2.IML.3	Use a variety of sources including multimedia sources to find information about topics such as climate change, with guidance and support from adults (e.g., 6.3.2.GeoGI.2, 6.1.2.HistorySE.3, W.2.6, 1-LSI-2).
	Information is shared or conveyed in a variety of formats and sources.
LA.W.9-10.1.A	Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
9.4.2.TL.2	Create a document using a word processing application.
9.4.2.TL.3	Enter information into a spreadsheet and sort the information.
MA.A-REI.A	Understand solving equations as a process of reasoning and explain the reasoning
	Collaboration can simplify the work an individual has to do and sometimes produce a better product.
MA.A-REI.B	Solve equations and inequalities in one variable
LA.W.9-10.2.E	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
LA.W.9-10.2.F	Provide a concluding paragraph or section that supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

MA.A-REI.D	Represent and solve equations and inequalities graphically
	Comprehension and Collaboration
LA.SL.9-10.2	Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, qualitatively, orally) evaluating the credibility and accuracy of each source.
LA.SL.9-10.4	Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
LA.L.9-10	Language
	Obtaining, Evaluating, and Communicating Information
HS-LS1	From Molecules to Organisms: Structures and Processes
HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
LS1.A	Structure and Function
	Planning and Carrying Out Investigations
LS1.C	Organization for Matter and Energy Flow in Organisms
HS-LS3	Heredity: Inheritance and Variation of Traits
HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
LS1.A	Structure and Function
LS3.A	Inheritance of Traits
HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
LS3.B	Variation of Traits
HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
LS3.B	Variation of Traits
HS-LS4	Biological Evolution: Unity and Diversity
HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
LS4.A	Evidence of Common Ancestry and Diversity
HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Essential Questions/ Enduring Understanding

Essential Questions:

How did experiments throughout history result in the discovery of DNA as the genetic material of all organisms?

What is the significance of the mechanisms by which DNA is replicated resulting in identical strands of DNA?

How do the processes of transcription and translation result in the formation of a functional protein and how can mutations result in changes to protein structure and function?

How can Punnett Squares be used to predict the probability of inheriting specific traits and diseases/disorders and demonstrate Mendel's Experiments and Laws of Inheritance?

How can crossing over affect the inheritance of linked genes?

Enduring Understandings:

The conversion of DNA into RNA and RNA into proteins constitutes the Central Dogma of biology.

The genetic code is universal.

Patterns of inheritance can be used to predict the possible genotypes and phenotypes of organisms.

The genotype and phenotype of an organism is influenced by its genes and its environment.

Objectives

Students will know Key Vocabulary: DNA, chromosome, DNA replication, semiconservative replication, central dogma, RNA, mRNA, rRNA, tRNA, protein synthesis, transcription, translation, codon, amino acid, polypeptide, protein, mutation, genetics, inheritance, probability, heredity, gene, allele, Punnett square, trait, dominant, recessive, homozygous, heterozygous, offspring, phenotype, genotype, fertilization, parent generation, genetic recombination, gene linkage, polyploidy, incomplete dominance, codominance, multiple alleles, polygenic traits, sex-linked traits, pedigree, genetic disorder/disease, nondisjunction, karyotype.

Students will know how experiments conducted by various scientists led to the discovery of DNA as the genetic material.

Students will know how the structure of DNA results in its function in living organisms.

Students will know the applications of DNA to technology.

Students will know the importance of specific enzymes in the process of DNA replication.

Students will know why the process of DNA replication is referred to as semiconservative replication.

Students will know how DNA replication is made more efficient in eukaryotic cells.

Students will know how different types of RNA have different functions in protein synthesis.

Students will know the mechanisms underlying the Central Dogma of protein synthesis.

Students will know how mutations in DNA can result in changes to protein structure and function.

Students will know how the experiments conducted by Gregor Mendel contributed to the Laws of Inheritance.

Students will know how polyploidy can be adapted in some organisms.

Students will know how the biological sex of offspring is determined.

Students will know how the phenotype and genotype of an organism are influenced by genes and the environment.

Students will know how dominant and recessive genetic diseases/disorders are inherited.

Students will be skilled at differentiating between prokaryotic and eukaryotic chromosomes.

Students will be skilled at differentiating DNA replication in prokaryotic cells and eukaryotic cells.

Students will be skilled at relating the processes of transcription and translation to the Central Dogma.

Students will be skilled at reading a codon chart to translate RNA segments into polypeptides.

Students will be skilled at identifying genetic mutations and their effect on protein synthesis.

Students will be skilled at applying the processes of transcription and translation to each level of protein structure.

Students will be skilled at explaining the mechanisms that regulate gene expression in prokaryotes and eukaryotes.

Students will be skilled at explaining how the results of Mendel's experiments show Mendels's laws of inheritance.

Students will be skilled at applying Mendelian and non-Mendelian patterns of inheritance to scenarios and problems.

Students will be skilled at utilizing Punnett squares to predict the probability of the inheritance of certain traits.

Students will be skilled at calculating probabilities of trait inheritance.

Students will be skilled at analyzing pedigrees for trends in inheritance.

Learning Plan

Unit Notes: Students will record detailed notes in a notebook that covers the learning goals of the unit.

DNA Discovery: Students will watch a video that demonstrates the various experiments that led to the discovery of DNA. While watching the video students will describe each experiment and summarize the conclusions and the importance of the discovery of DNA as the genetic material of the cell.

Chargaff's Rule CER: Students will analyze scientific data for trends in the number of each type of nucleotide between and among species. Students will make a claim about which nucleotides they believe pair together, which they will support with evidence from provided data.

DNA Replication Model: Students will create a model that shows each stage of DNA replication using any classroom materials and media of their choice. Students will label key structures and enzymes involved in DNA replication and include captions that summarize each stage of DNA replication.

DNA vs. RNA Venn Diagram: Students will research the structure and function of both DNA and RNA using information from course notes, the textbook, and online resources. Students will use the information gathered to create a Venn Diagram comparing and contrasting DNA and RNA.

DNA Forensics WebQuest: Students will complete an online WebQuest for which they will visit various online resources to learn about how DNA can be used in forensics. Students will read about various types of DNA evidence collected from crime scenes, watch a video that summarizes gel electrophoresis, and summarize how DNA is used to solve cold cases. Students will use the information they gather from WebQuest to complete a CER Statement about who they predict committed a hypothetical crime.

DNA Replication Practice: Students will practice creating new DNA strands from provided template strands using their understanding of DNA replication.

Transcription and Translation Practice: Students will practice converting provided DNA sequences into

mRNA and polypeptide chains using a genetic code.

DNA Mutations Lab: Students will be provided with an original DNA sequence. They will flip a dice to determine how the original DNA strand will be changed and then identify the type of mutation caused by the change to the DNA sequence. Students will write a claim about if and how changing the DNA sequence changes the structure and function of the resulting polypeptide. They will support their claim with evidence from lab data and reasoning from their understanding of transcription, translation, and protein structure. A formal lab report can be written about this lab.

Calculating Probability Lab: Students will review the basic mathematical rules of probability. Then, students will use M&Ms to simulate the rules of probability. Students will calculate the probability of certain colored candies being in a bag of candies.

Monohybrid Punnett Squares Practice: Students will practice completing monohybrid cross Punnett squares that calculate the predicted genotypes and phenotypes of offspring for one trait.

Dihybrid Punnett Squares Practice: Students will practice completing dihybrid cross Punnett squares that calculate the predicted genotypes and phenotypes of offspring for two traits.

Incomplete Dominance and Codominance Practice: Students will practice completing Punnett squares that calculate the predicted genotypes and phenotypes of offspring for traits that show incomplete or codominance.

Multiple Alleles Practice: Students will practice completing Punnett squares that calculate the predicted genotypes and phenotypes of offspring for multiple allele traits.

Sex-Linked Traits Practice: Students will practice completing Punnett squares that calculate the predicted genotypes and phenotypes of offspring for sex-linked traits.

Human Pedigrees Practice: Students will practice predicting how traits are inherited by analyzing pedigrees and predicting possible outcomes of offspring and genotypes of various family members.

Genetics Design a Species Project: Students will work in groups to design a species that demonstrates principles of Mendelian and non- Mendelian inheritance. Students will choose five traits for which they will create different versions of the possible alleles. Students will draw their species, develop practice Punnett

square problems, and create a pedigree for the species.

Genetic Technology Debate: Students will work in groups to research one form of DNA technology (stem cells, cloning, forensics, gene therapy, genetically modified organisms). Students are for or against using the technology and will debate the opposing team. While watching the debates, students will take notes on the pros and cons of each technology and come to their conclusion about whether they are for or against the technology.

Assessment

Formative:

Do Now Questions

Exit Ticket Questions

Whole Class Discussion Participation

Small Group Discussion Participation

Think-Pair-Share Participation

Individual Student Questions/Responses

Independent Tasks (DNA Discovery, DNA Replication Practice, Transcription and Translation Practice, Monohybrid and Dihybrid Cross Punnett squares; Incomplete Dominance and Codominance; Multiple Alleles; Sex-Linked Traits, Human Pedigrees)

Group Tasks

Projects (Design a Species Project)

Lab Experiments (DNA Mutations Lab, Calculating Probability Lab)

Quizzes (DNA Replication; DNA vs. RNA; Protein Synthesis; Mendelian Genetics; Complex Patterns of Inheritance)

Summative:

Formal Lab Report (DNA Sequencing)

Unit Test

Benchmark:

Honors Biology Final Exam

Alternative Assessments:

Guided Formal Lab Report

Unit Study Guide/Guided Test

Genetic Technology Debate

Genetics Current Event

Materials

Textbook: Biology Concepts and Connections (Pearson Education) by Campell, Reece, Taylor, Simon, Dickey (2009)

Unit Learning Outline

Technology: computers for students and teacher, SmartBoard projector

Teacher Slide Presentations

Whiteboard + Accessories

Guided Notes/Worksheets

Lab Report Outline and Rubric

Personal Protective Equipment: safety glasses, gloves

Lab Equipment: beakers, water, dice, microscopes

Graphing paper, rulers, colored pencils/markers