Unit 05: DNA & Genetic Inheritance

Content Area: **Science**
Course(s):
Time Period: **Marking Period 3**
Length: **9-10 weeks**
Status: **Published**

Summary

The focus of this unit is DNA and the mechanisms by which genetic traits are inherited. The concepts of DNA, proteins, chromosomes, and genes will be studied. The structure, function, and replication of DNA will be examined. Molecular genetics, specifically the synthesis of proteins from DNA, as well as the regulation of genes and mutations, will be explored. Mendel's principles of inheritance as well as complex patterns of general and human inheritance will be investigated.

Revised July 2021

CS.9-12.8.1.12.AP.3	Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
CS.9-12.8.1.12.AP.5	Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
LA.W.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
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.
LA.W.9-10.1.E	Provide a concluding paragraph or section that supports the argument presented.
LA.W.9-10.2	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
LA.W.9-10.2.A	Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
LA.W.9-10.2.B	Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
LA.W.9-10.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.W.9-10.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation (MLA or APA Style Manuals).
LA.W.9-10.9	Draw evidence from literary or nonfiction informational texts to support analysis, reflection, and research.

LA.9-10.W.9-10.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence. 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.
MA.S-IC.B	Make inferences and justify conclusions from sample surveys, experiments, and observational studies
MA.S-ID.C.9	Distinguish between correlation and causation.
MA.S-MD	Using Probability to Make Decisions
MA.S-MD.A	Calculate expected values and use them to solve problems
MA.S-MD.B	Use probability to evaluate outcomes of decisions
CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP1.1	Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to

	search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP8.1	Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP11.1	Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.
CRP.K-12.CRP12.1	Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.
SCI.HS.LS1.A	Structure and Function
SCI.HS.LS3.A	Inheritance of Traits
SCI.HS.LS3.B	Variation of Traits
SCI.HS.LS3.B	Variation of Traits
SCI.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.
SCI.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.
SCI.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.
SCI.HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Assessment does not include Hardy-Weinberg calculations. Ask questions that arise from examining models or a theory to clarify relationships. Systems of specialized cells within organisms help them perform the essential functions of life. Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Emphasis is on using data to support arguments for the way variation occurs. Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process. All cells contain genetic information in the form of DNA molecules. Genes are regions in

the DNA that contain the instructions that code for the formation of proteins.

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 depends on both genetic and environmental factors.

Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

Cause and Effect

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 depends on both genetic and environmental factors.

Engaging in Argument from Evidence

Complex programs are developed, tested, and analyzed by teams drawing on the members' diverse strengths using a variety of resources, libraries, and tools.

Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.

Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.

Scale, Proportion, and Quantity

Cause and Effect

Structure and Function

Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

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.

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.

Asking Questions and Defining Problems

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.

Essential Questions / Enduring Understandings

Essential Questions:

What led to the discovery of DNA as the genetic material of all organisms?

How are DNA strands formed?

How and why is DNA used in forensic science?

How are prokaryotic and eukaryotic chromosomes formed?

What is the significance of enzymes in DNA replication?

What is the goal of semiconservative DNA replication and how does the process differ in prokaryotic vs. eukaryotic cells?

How do the specific functions of the various types of RNA lead to the formation of proteins?

What is the relationship between a gene and a protein?

How are genes regulated in prokaryotic and eukaryotic cells?

What are the effects of the various types of DNA mutations which occur in somatic cells vs. gametes?

How is probability used to determine the chances of inheriting certain traits?

How are Punnett squares used to predict inheritance?

How is biological sex determined?

How does meiosis produce genetic recombination and lead to variation in traits?

What is the significance of gene linkage and polyploidy?

How are dominant and recessive genetic disorders/diseases inherited and their patterns studied?

How can human karyotypes and fetal testing be used to determine chromosomal abnormalities and disorders?

Enduring Understandings:

DNA plays a significant role, purpose, and function in organisms.

DNA is converted into a functional product through the Central Dogma of biology.

Gregor Mendel contributed greatly to the field of genetics.

Dominant/recessive and complex patterns of inheritance can be used to predict possible traits in offspring.

The environment influences the phenotype and genotype of an organism.

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 what DNA is and which scientists and their experiments led to its discovery as the genetic material.

Students will know the basic structure of DNA.

Students will know how and why DNA is used in forensic science.

Students will know the important roles of various enzymes involved in DNA replication.

Students will know what happens during the process of semiconservative replication.

Students will know the different types of RNA and their specific roles in protein synthesis.

Students will know how DNA mutations differ between and affect somatic cells and gametes.

Students will know who Gregor Mendel was and what and how he contributed to the field of genetics.

Students will know how the process of meiosis produces genetic recombination.

Students will know why polyploidy is important to the field of agriculture.

Students will know how biological sex of offspring is determined.

Students will know how the environment can influence the phenotype and genotype of an organism.

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

Students will know how and why human karyotypes and fetal testing are used to determine chromosomal abnormalities and diseases/disorders.

Students will be skilled at comparing and contrasting between prokaryotic and eukaryotic chromosomes.

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

Students will be skilled at describing the Central Dogma.

Students will be skilled at explaining what happens during the processes of gene transcription and translation.

Students will be skilled at reading a codon chart to create various lengths of polypeptides.

Students will be skilled at summarizing how polypeptides fold into proteins.

Students will be skilled at relating genes to proteins.

Students will be skilled at distinguishing how genes are regulated in prokaryotes and eukaryotes.

Students will be skilled at recognizing various types of mutations in DNA sequences.

Students will be skilled at applying Mendel's principles of inheritance.

Students will be skilled at utilizing Punnett squares to predict possible offspring with certain traits.

Students will be skilled at calculating probabilities of trait inheritance.

Students will be skilled at manipulating Punnett squares for complex patterns of inheritance.

Students will be skilled at analyzing and producing simple human pedigrees.

Students will be skilled at pointing out chromosomal abnormalities from human karyotypes.

Learning Plan

Unit Notes: Students will keep detailed notes in a specific notebook as the questions guiding the unit learning goals are answered through lectures and various activities.

CER Practice: Students will continue to practice making claims based on observations and inferences and providing the evidence and appropriate reasoning to support those claims.

Overview of DNA Highlights: Students will read a Newsela article and make their own notes in their notebook to highlight the things they already know, things they learned, and things they would like to learn more about when it comes to DNA.

Chargaff's Rule: Students will use real scientific data to find patterns and figure out which DNA bases pair together.

DIY 3D DNA Model: Students will create and present their own 3D model of a DNA strand using any household materials and media of their choice.

Prokaryotic vs. Eukaryotic DNA Replication: Students will compare and contrast the process of DNA replication in various types of prokaryotic and eukaryotic organisms using various forms of media and highlight the similarities and differences in their notebooks.

DNA Sequencing Lab: Students will determine paternity of a hypothetical child or the suspect of a hypothetical crime scene investigation using DNA sequencing techniques.

DNA vs. RNA: Students will compare and contrast DNA and RNA using various forms of media and highlight the similarities and differences in their notebooks.

Prokaryotic vs. Eukaryotic DNA Replication: Students will compare and contrast prokaryotic and eukaryotic DNA replication using various forms of media and highlight the similarities and differences in their notebooks.

DNA Replication Background and Practice: Students will use their own notes and various videos to review DNA replication and practice replicating hypothetical DNA strands.

Protein Synthesis in Eukaryotic Cells: Students will use their own notes and various videos to review the process of protein synthesis in eukaryotic cells and practice decoding hypothetical genes into polypeptides using a codon chart.

DNA Mutations: Students will use their own notes to review the types of DNA mutations and practice identifying various types of mutations in hypothetical DNA sequences. Students will then decode the mutated DNA sequences into polypeptides using a codon chart and compare the mutated polypeptide to the original unmutated polypeptide.

Calculating Probability: Students will review the basic mathematical rules of probability and practice calculating probabilities of random everyday events.

Monohybrid Punnett Squares Practice: Students will practice crossing one Mendelian trait at a time and predicting possible outcomes of offspring.

Dihybrid Punnett Squares Practice: Students will practice crossing two Mendelian traits at the same time and predicting possible outcomes of offspring.

Incomplete Dominance and Codominance Practice: Students will practice crossing one incompletely dominant or codominant trait at a time and predicting possible outcomes of offspring.

Multiple Alleles Practice: Students will practice crossing traits with multiple alleles and predicting possible outcomes of offspring.

Sex-Linked Traits Practice: Students will practice crossing sex-linked traits and predicting possible outcomes of offspring.

Human Pedigrees Practice: Students will practice reading and creating simple human pedigrees and predicting possible outcomes of offspring and genotypes of various family members.

Genetic Disease/Disorder Research Project: Working in groups of 3 or 4, students will choose from a list of autosomal and sex-linked dominant and recessive genetic diseases/disorders and research one to create an informative and educational slideshow presentation for their peers.

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 (*Overview of DNA; Chargaff's Rule; DIY 3D DNA Model; DNA Replication Background and Practice; Protein Synthesis in Eukaryotic Cells; DNA Mutations; Calculating Probability; Monohybrid and Dihybrid Cross Punnett squares; Incomplete Dominance and Codominance; Multiple Alleles; Sex-Linked Traits, Human Pedigrees*)

Group Tasks (*Genetic Disease/Disorder Research Project*)

Lab Experiments (*DNA Sequencing*)

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

Summative:

Formal Lab Report (DNA Sequencing)

Unit Test

Benchmark:

CP Biology Final Exam

Alternative Assessments:

Guided Formal Lab Report

Guided Genetic Disease/Disorder Research Project

Unit Study Guide/Guided Test

Materials

Textbook: *Biology* (Glencoe Science) by Alton Biggs

Unit Learning Goals Sheet

Technology: computers for student and teacher, SmartBoard projector

Teacher Slide Presentations

Amoeba Sisters Videos

Whiteboard + Accessories

Guided Notes/Worksheets

Study Guide

Lab Outline

Calculators

Colored pencils/markers

Integrated Accommodations and Modifications

See attached document.
https://docs.google.com/spreadsheets/d/1uDlwQcgdvbrOcLnMAKouOe1gQph5rWDWxM74UFeuACM/edit?usp=sharing