Course: Biology **Unit #2:** *Genetics & Heredity*	**Year of Implementation:** 2026-2027

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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
https://www.state.nj.us/education/cccs/2020/

- **Unit Standards:** *(keep each of the following headings in place)*
  - ***Content Standards***
    - **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.
    - **HS-LS1-2**: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
    - **HS-LS1-3**: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
    - **HS-LS1-4:** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
    - **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.
    - **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.
    - **HS-LS3-3:** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
    - **HS-ETS1-3:** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

- ***21st Century Life & Career Standards***
  https://www.nj.gov/education/standards/clicks/Docs/2020NJSLS-CLKS.pdf

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
- 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society
- 9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information.
- 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources
- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions
- 9.4.12.IML.8: Evaluate media sources for point of view, bias, and motivations
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

English Companion Standards
https://www.nj.gov/education/standards/ela/Docs/2016NJSLS-ELA_Companion9-10.pdf

- NJSLSA.R1. Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
- NJSLSA.R2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
- NJSLSA.R3. Analyze how and why individuals, events, and ideas develop and interact over the course of a text
- NJSLSA.R7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
- NJSLSA.R8 Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence
- NJSLSA.R9. Analyze and reflect on how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

- NJSLSA.R10. Read and comprehend complex literary and informational texts independently and proficiently with scaffolding as needed.

Interdisciplinary Content Standards

  - RST.11-12.1: Cite specific textual evidence from genetic texts, studies, or articles.
  - RST.11-12.3: Follow precise multistep processes (e.g., how genetic traits are passed).
  - RST.11-12.9: Synthesize information from multiple sources about genetics (e.g., bioethics, gene editing).
  - WHST.11-12.1: Write arguments using evidence (e.g., CRISPR, GMOs).
  - WHST.11-12.2: Write informative texts to explain complex genetic ideas (e.g., inheritance, gene therapy).
  - WHST.11-12.7: Conduct short research projects on modern genetics topics (e.g., human genome, personalized medicine)
  - S-CP.1–5: Understand and apply probability rules (e.g., Punnett squares, pedigree analysis).
  - S-ID.1–4: Analyze data distributions (e.g., gene frequency, inheritance patterns).
  - HS-BIO.9-12.4.1: Apply understanding of genetics to biotechnology techniques.
  - HS-HS.9-12.1.1: Evaluate how genetic disorders affect individuals and healthcare decisions.
  - ENV.9-12.2.1: Understand genetic engineering applications in agriculture and conservation
  - 6.3.12.CivicsPR.4: Research and evaluate proposed solutions or policies for genetic technologies.
  - 6.1.12.HistoryCC.16.a: Examine historical decisions about science and technology (e.g., eugenics, cloning).

- ***NJ Statutes:*** NJ State law mandates the inclusion of the following topics in lesson design and instruction as aligned to elementary and secondary curriculum.

  Amistad Law: N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

  Holocaust Law: N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction

shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

Diversity and Inclusion (N.J.S.A. 18A:35-4.36a) A board of education shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards.

Asian American and Pacific Islanders (AAPI) P.L.2021, c.410 Ensures that the contributions, history, and heritage of Asian Americans and Pacific Islanders (AAPI) are included in the New Jersey Student Learning Standards (NJSLS) for Social Studies in kindergarten through Grade 12 (P.L.2021, c.416)

For additional information, see

NJ Amistad Curriculum: ***https://www.nj.gov/education/amistad/about/***

Diversity and Inclusion: ***https://www.nj.gov/education/standards/dei/index.shtml***

- *(Sample Activities/ Lessons):* ***https://www.nj.gov/education/standards/dei/samples/index.shtml***

Asian American and Pacific Islanders:

- ***Asian American and Pacific Islander Heritage and History in the U.S.***
  A Teacher's Guide from EDSITEment offering a collection of lessons and resources for K-12 social studies, literature and arts classrooms that center around the experiences, achievements and perspectives of Asian Americans and Pacific Islanders across U.S. history.

Transfer Goal: Students will be able to independently use their learning and understanding of genetics to make informed decisions and advocate for responsible use of genetic science to improve health, address societal challenges, and promote ethical scientific

advancements.

As aligned with LRHSD Long Term Learning Goal(s): https://www.lrhsd.org/academics/curriculum

1. design, critique, and carry out experiments in order to investigate scientific questions and/or propose solutions
2. collect, interpret, and analyze data in order to solve a defined problem
3. apply mathematics to express relationships efficiently and accurately
4. draw evidence-based conclusions from data in order to make informed decisions;
5. construct, interpret, and refine models (scientific and mathematical) to explain the physical and natural world
6. effectively communicate scientific ideas and evidence-based arguments to an appropriate audience through written and oral means
7. evaluate the validity of arguments that rely on scientific reasoning presented in the popular press and informational sources

Enduring Understandings Students will understand that. . .	*Essential Questions*
EU 1 ● the flow of genetic information from DNA to RNA to proteins (central dogma) determines the structure and function of all living organisms. Mutations in DNA can alter this flow, potentially changing protein structure and function, which can lead to variation in traits, influence evolution, or cause genetic disorders. *EU 2* ● cell division (Mitosis and Meiosis) is essential for the growth, maintenance, and reproduction of organisms. *EU 3* ● traits are inherited through the predictable patterns of gene transmission. EU 4	● How does the flow of genetic information from DNA to proteins explain inherited traits and the variation observed among individuals in a population? ● How can science make our lives better while balancing ethics, legal and social issues?

• Genes and inheritance patterns can be studied using advancements made in genetic science which provides powerful tools in the fields of medicine, agriculture, and forensics. These advancements also raise important ethical, legal, and social questions.	
<u>Knowledge</u> *Students will know . . .* *EU 1* • special structures within cells are also responsible for specific cellular functions. (LS1.A) (CCC6) • all cells contain genetic information, in the form of DNA (LS1.A) • some primitive forms of life (i.e.viruses) use RNA as their genetic material (LS1.A) • the instructions for forming species' characteristics are carried in the DNA. (LS3.A) • genes are specific regions within the extremely large DNA molecules that form the chromosomes.(LS1.A) • each chromosome consists of a single very long DNA molecule (LS3.A) • DNA molecules contain four different kinds of building blocks, called nucleotides (LS3.A) • the sequence of nucleotides spells out the information in a gene (LS3.A) (CCC6) • DNA controls the expression of proteins by being transcribed into a "messenger" RNA (LS3.A) • in effect, proteins build an organism's identifiable traits (LS3.A)	*<u>Skills</u>* *Students will be able to. . .* *EU 1* • construct or interpret models of the structure of DNA (SEP5) (CCC4) • compare viruses that use RNA to organisms that use DNA as genetic material. (SEP2) • construct or interpret models that show how DNA is organized into chromosomes and genes. (SEP2) (CCC4) • model the process of DNA replication (SEP5) (CCC4) • model the process of transcription and translation. (SEP2) (CCC4) • identify how a change in the DNA sequence can result in a different protein product. (SEP4) (CCC2) • analyze how specific mutations can lead to diseases such as cancer.(SEP4) (CCC2)

● genes contain the instructions that code for the formation of molecules called proteins, which carry out most of the work of cells to perform the essential functions of life (LS1.A) ● all cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.(LS3.A) ● proteins provide structural components, serve as signaling devices, regulate cell activities, and determine the performance of cells through their enzymatic actions (LS1.A) (CCC4) ● 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 (LS3.A) ● systems of specialized cells within organisms help them perform the essential functions of life, which involve chemical reactions that take place between different types of molecules, such as water, proteins, carbohydrates, lipids, and nucleic acids (LS1.C) (CCC4) *EU 2* ● to maintain all of these processes and functions, organisms require materials and energy from their environment; nearly all energy that sustains life ultimately comes from the sun (LS1.A) (CCC5) ● organisms grow and reproduce, transferring their genetic information to their offspring. (LS1.B) ● while individual organisms carry the same genetic information over their lifetime, mutation and the transfer	*EU 2* ● use a model to illustrate the stages of mitosis in normal and cancerous cells.(SEP2) (CCC4) ● compare the frequency of mitotic phases in normal vs. cancer cell samples.(SEP4, SEP6, SEP7) ● explain how disruption of cell cycle regulation can result in tumor formation.(SEP6) ● model meiosis and identify where genetic variation arises (e.g., crossing over). (SEP2) (CCC4) ● simulate inheritance of traits using a meiosis-based activity.(SEP2) (CCC4)

from parent to offspring produce new combinations of genes. (LS1.A) ● before a cell divides, the DNA sequence of its chromosomes is replicated and each daughter cell receives a copy. (LS3.A) ● in sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division). (LS3.B) ● proteins provide structural components, serve as signaling devices, regulate cell activities, and determine the performance of cells through their enzymatic actions. (LS1.A) (CCC4) ● the essential functions of a cell involve chemical reactions between many types of molecules, including water, proteins, carbohydrates, lipids, and nucleic acids. (LS1.A) (CCC6) ● in sexual reproduction, variations in traits between parent and offspring arise from the particular set of chromosomes (and their respective multiple genes) inherited, with each parent contributing half of each chromosome pair. (LS3.B) ● although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. (LS3.B)	● explain how meiosis prevents chromosome duplication across generations (SEP6) ● model crossing over and explain how it increases genetic variation.(SEP2) (CCC4) ● compare the outcomes of mitosis and meiosis in terms of genetic variation and chromosome number.(SEP6, SEP7, SEP8)
EU 3 ● organisms grow and reproduce, transferring their genetic information to their offspring (LS1.A)	EU3 ● use Punnett squares to predict the probability of trait inheritance. (SEP4, SEP5)(CCC4)

● over generations natural selection can lead to changes in a species overall; hence, species evolve over time (LS1.A) (CCC7) ● while individual organisms carry the same genetic information over their lifetime, mutation and the transfer from parent to offspring produce new combinations of genes (LS1.A) (CCC7) ● variation among individuals of the same species can be explained by both genetic and environmental factors (LS3.B) ● more rarely, such variations result from mutations, which are changes in the information that genes carry (LS3.B) ● individuals within a species have similar but not identical genes (LS3.B) ● other parts of the DNA and external environmental factors can modify an individual's specific development, appearance, behavior, and likelihood of producing offspring. (LS3.B) ● the variation and distribution of traits observed depend on both genetic and environmental factors (LS3.B) ● environmental factors can also cause mutations in genes, and viable mutations are inherited. (LS3.B) ● environmental factors also affect expression of traits, and affect the probability of occurrences of traits in a population. (LS3.B)	● analyze pedigrees to determine inheritance patterns of genetic diseases. (SEP4)(CCC1) ● distinguish between genotype and phenotype, and explain how mutations may be inherited.(SEP4, SEP6) ● distinguish between genetic and environmental causes of variation.(SEP4, SEP6) ● analyze how environmental factors (e.g., radiation, chemicals) can lead to mutations.(SEP4)
EU4 ● advances in genetic technology—such as DNA sequencing, genetic engineering, and CRISPR—have	EU4 ● research and present real-world applications of genetic technologies (e.g., CRISPR, gene therapy). (SEP6)

led to breakthroughs in medicine (e.g., gene therapy), agriculture (e.g., genetically modified crops), and forensic science (e.g., DNA profiling). These tools allow scientists to diagnose diseases, enhance food security, and solve crimes with high accuracy. (LS3.B)	● evaluate ethical and social implications of genetic modification and DNA use. (SEP7)

Stage Two - Assessment

Performance Task:

Other Evidence:

- Tests following end of large unit
- Quizzes (suggested for the following topics) DNA Structure and Function, cellular division, protein synthesis, probability and statistics (applying mathematics to concepts in genetics)
- Class Discussions - dialogues on “Why do we need new cells?”, “What is the role of cellular division?”, “What is the role of Meiosis?”, “How does the structure of DNA and/or proteins relate to function?”, “How is the information in DNA transcribed and translated to a protein and expressed as a trait?”, “How is the information in DNA transcribed and translated to a protein and expressed as a trait?”, “How do DNA, genes, and proteins translate into traits?”
- Lab Reports
- Evaluation of data and statistics
- Evaluation of data from prepared prompts
- Solving statistical problems such as punnett square crosses

Stage Three - Instruction

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.** *{place A, M and/or T along with the applicable EU number in parentheses after each statement} All knowledge and skills must be addressed in this section with a corresponding lesson/activity which teaches each concept. The following color codes are used to notate activities that correspond with interdisciplinary connections and 21st Century Life & Career Readiness, Life Literacies, and Key Skills (which involves Technology Literacy): Red = Interdisciplinary Connection; Purple = Career Readiness, Life Literacies, and Key Skills*

Unit Phenomenon: Some cancers run in families, while others seem to arise spontaneously. How can errors in cells lead to uncontrolled growth?

Unit Phenomenon Activities

1. Cancerous vs. Noncancerous Cells (EU2 A/M)
    a. Show students picture of cancerous vs. noncancerous cells Cancer Phenomena or microscope lab cancerous vs. noncancerous cells
    b. Individual - Compare & Contrast/Notice & Wonder
    c. Teacher Facilitated Class Discussion of Individual Results
2. Cell Cycle & Chromosome POGIL - Cell Cyle and Chromosome POGIL (EU1 A/M)
3. Cell Cycle Timing Article & Questions - Cycle Cycle Article & Qs (EU1 A)
4. Create or construct a model of DNA structure (EU1 A/M)
    a. K'Nex Kit DNA Structure & Replication - K'Nex Kit DNA Structure
        i. How could a change in the DNA structure affect cellular function?
    b. Revisit Phenomenon Notice & Wonder Results
        i. Think-Pair-Share
            1. What new information has been gained?
            2. What aspects still need to be investigated further?
5. Mitosis & Meiosis Bead Simulation - Mitosis Bead SIMULATION (EU2 A/M)
6. Probability Activity - Probability Lab (EU3 M)
7. Pedigree Activity Pedigree Activity.pdf (EU3 M)
8. Return to Phenomenon (EU1,2,3 M)

a. Small group discussions based on recent lessons:
    i. What new information has been gained or investigated and needs to be added?
    ii. What aspects of the initial results were inaccurate or incorrect and why?
b. Individual task: Revise to construct detailed final explanation of phenomenon.

Additional Unit 2 Activities:

1. Marbles vs. Yarn Activity - Marbles vs. Yarn Activity (EU1 A/M/T)
2. Bacteria Culture Lab - Example: Bacteria Culture Lab (EU2 A/M/T)
3. Genetic Disorder Project - For Example: Genetic Disorder Project Instructions (EU1,2,3 A/M/T)

Pacing Guide

Unit #	***Title of Unit***	***Approximate # of teaching days***
1	Ecosystems	60 days
2	Genetics	45 days
3	Evolution	30 days

Instructional Materials

- Microscope slides (cancerous and non-cancerous cells)
- K'Nex DNA Kit
- Mitosis vs. Meiosis Bead Simulation Supplies

Accommodations

Special Education: The curriculum will be modified as per the Individualized Education Plan (IEP). Students will be accommodated based on specific accommodations listed in the IEP.
Students with 504 Plans: Students will be accommodated based on specific accommodations listed in the 504 Plan.
English Language Learners: Students will be accommodated based on individual need and in consultation with the ELL teacher.
Students at Risk of School Failure: Students will be accommodated based on individual need and provided various structural supports through their school.
Gifted and Talented Students: Students will be challenged to enhance their knowledge and skills through acceleration and additional independent research on the subject matter.