# Biology Unit 4 - DNA & Genetics

Content Area: **Science**
Course(s): **Biology**
Time Period: **MP3**
Length: **30 days**
Status: **Published**

## NJSLS - Science

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| 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-ETS1-1 | Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. |
| HS-ETS1-2 | Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. |
| HS-ETS1-4 | Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. |

## Science and Engineering Practices

### Constructing Explanations and Designing Solutions

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. (HS-LS1-1)

Design a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)

Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

### Developing and Using Models

Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4),(HS-LS1-5),(HS-LS1-7)

**Asking Questions and Defining Problems**

Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

**Analyzing and Interpreting 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. (HS-LS3-3)

**Engaging in Argument from Evidence**

Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)

**Using Mathematics and Computational Thinking**

Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

## Disciplinary Core Ideas

**LS1.A: Structure and Function**

Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

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. (HS-LS1-1)

**LS1.B: Growth and Development of Organisms**

In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed

of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

**LS3.A : Inheritance of Traits**

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. (HS-LS3-1)

**LS3.B: Variation of Traits**

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. (HS-LS3-2)

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. (HS-LS3-2),(HS-LS3-3)

**ETS1.A: Defining and Delimiting Engineering Problems**

Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)

Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

**ETS1.B: Developing Possible Solutions**

When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a

client about how a given design will meet his or her needs. (HS-ETS1-4)

**ETS1.C: Optimizing the Design Solution**

Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade offs) may be needed. (HS-ETS1-2)

## Crosscutting Concepts

**Systems and System Models**

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-4), (HS-ETS1-4)

**Structure and Function**

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. (HS-LS1- 1)

**Cause and Effect**

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS3-1), (HS-LS3-2)

**Scale, Proportion, and Quantity**

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). (HS-LS3-3)

**Science Science is a Human Endeavor**

Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3- 3)

Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

**Influence of Science, Engineering, and Technology on Society and the Natural World**

New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

## Rationale and Transfer Goals

Students analyze data to develop models to make sense of the relationship between DNA and chromosomes in the process of cellular division, which passes traits from one generation to the next. Students determine why individuals of the same species vary in how they look, function, and behave. Students develop conceptual models of the role of DNA in the unity of life on Earth and use statistical models to explain the importance of variation within populations for the survival and evolution of species. Ethical issues related to genetic modification of organisms and the nature of science are described. Students explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expressions. The crosscutting concepts of structure and function, patterns, and cause and effect are used as organizing concepts for the disciplinary core ideas. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Students must learn that systems of specialized cells within organisms help the organisms perform the essential functions of life. All cells contain genetic information in the form of DNA molecules. Genes are regions of DNA that contain the instructions that code (transcription and translation) for the formation of proteins, which carry out most of the work of cells. Students should conduct a detailed examination of the structure and function of DNA by building a model of DNA.

## Enduring Understandings

- All cells contain genetic information in the form of DNA molecules.
- 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.
- Environmental factors affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variations and distributions of traits observed depend on both genetic and environmental factors.

## Essential Questions

How is sickle cell anemia caused by a change in a single  nucleotide mutation? How can this mutation impact the body's response to malaria? https://thewonderofscience.com/phenomenon/2018/7/5/malaria-and-sickle-cell-anemia

What is the potential and what are the ethics of CRISPR?

https://thewonderofscience.com/phenomenon/2018/7/8/the-potential-and-ethics-of-crispr

## Content - What will students know?

- DNA structure
- DNA replication, transcription & translation
- Mitosis
- Meiosis
- Sexual reproduction & probability

## Skills - What will students be able to do?

- Demonstrate knowledge of the parts of a nucleotide and the many possible DNA sequences.
- Students will be able to transcribe and translate a protein sequence.
- Illustrate the stages of the cell cycle.
- Differentiate the process of meiosis from mitosis.
- Demonstrate how sexual reproduction leads to a wide variety of genetic variation in offspring.

## Activities - How will we teach the content and skills?

- Students will construct a strand of DNA, with alternating base-pairs.
- Protein synthesis simulation/lab activity.

- Students will complete a mitosis model as a lab activity or small group project.
- Students will compare and contrast the processes of mitosis & meiosis.
- Students will complete and analyze punnett squares for sex-linked traits.

## Evidence/Assessments - How will we know what students have learned?

- **Assessments can be reviewed for each course in this folder.**
- Chapter tests
- Biology Benchmark #3
- Lab assignments
- Small group projects
- DNA Transcription and Translation Simulation
- Modeling mitosis lab
- Sex-linked traits problems

## Spiraling for Mastery

| Content or Skill for this Unit | Spiral Focus from Previous Unit | Instructional Activity |
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| • 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.<br>• 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. | • MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.<br>• MS-LS3-1: Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and | • Students will label a diagram of the cell with the nucleus and its chromosomes as the focus.<br>• Analyze an exploded diagram of a gene segment with a DNA sequence.<br>• Compare and contrast sexual and asexual reproduction when describing the processes of mitosis and meiosis. |

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| • 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. | function of the organism.<br><br>• MS-LS3-2: Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. | |

## Key Resources

Structure and Function:  Stem Cell

DNA Transcription and Translation Simulation

Growth and Development

Modeling mitosis lab

Sex-linked traits problems

## 21st Century Life and Careers

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| 9.2.12.CAP.2 | Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs. |
| 9.2.12.CAP.3 | Investigate how continuing education contributes to one's career and personal growth. |
| 9.2.12.CAP.4 | Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment. |

## Career Readiness, Life Literacies, & Key Skills

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| 9.4.12.CT.3 | Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice). |
| 9.4.12.CT.4 | Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes. |
| 9.4.12.GCA.1 | Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3). |
| 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 (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources. |
| 9.4.12.IML.3 | Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8). |
| 9.4.12.IML.4 | Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4). |
| 9.4.12.IML.5 | Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2). |
| 9.4.12.IML.6 | Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5). |

## Interdisciplinary Connections

RL.CR.9–10.1. Cite a range of thorough textual evidence and make relevant connections to strongly support analysis of multiple aspects of what a literary text says explicitly and inferentially, as well as including determining where the text leaves matters uncertain.

RI.CR.9–10.1. cite a range and thorough textual evidence and make clear and relevant connections, to strongly support an analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text.

W.AW.9–10.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient textual and non-textual evidence.

W.IW.9–10.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

**Math**

**S.ID.A. Summarize, represent, and interpret data on a single count or measurement variable**

- Represent data with plots on the real number line (dot plots, histograms, and box plots).
- 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.
- Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages.
- Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

**Health/PE**

2.2.12.PF.1: Compare the short- and long-term benefits of physical activity and the impact on wellness associated with physical, mental, emotional fitness through one's lifetime

2.2.12.PF.4: Determine the role of genetics, age, nutrition, sleep, the environment, and exercise type on body composition and personal health (e.g., anabolic steroids, human growth hormones, stimulants)