Unit 4: Inheritance and Variation of Traits

CONTENT AREA: Biology	GRADES: 9-12	UNIT: 4 of 5
Pacing:		
Performance Expectations: NJSLS-S-HS-LS1-4, NJSLS-S-HS-LS3-1, NJSLS-S-HS-LS3-2, NJSLS-S-HS-LS3-3		
Evidence Statement(s): NJSLS-S-HS-LS1-4, NJSLS-S-HS-LS3-1, NJSLS-S-HS-LS3-2, NJSLS-S-HS-LS3-3		
Essential Question: How are the characteristics from one generation related to the previous generation?		
21st Century Skills: 9.2.8.B.3, 9.2.8.B.4 http://www.state.nj.us/education/cccs/2009/9.pdf		
Career Ready Practices: CRP4, CRP6, CRP7 http://www.state.nj.us/education/cccs/2014/career/CareerReadyPractices.pdf		
Technology:		

Technical Terms (Suggested)	Core Instructional Materials	Assessment Statement
Mitosis S Phase Gap 1 Gap 2 Karyokinesis Cytokinesis Stem cell Differentiation Differential gene expression Centromere *All terms should be taught in context rather than in isolation. These terms should be addressed after conceptual understanding.	NJSLS-S-HS-LS1-4 Microscopes Onion root tip slides Computers/chromebooks/IPads MItosis stage handouts Fruit fly karyotypes NJSLS-S-HS-LS3-1 NJSLS-S-HS-LS3-2 NJSLS-S-HS-LS3-3	
Modifications		

English Language Learners	Special Education	At Risk	Gifted & Talented
Scaffolding	Word walls	Teacher tutoring	Curriculum compacting
Word walls	Visual aides	Peer tutoring	Challenge assignments
Sentence/paragraph frames	Graphic organizers	Study guides	Enrichment activities
Bilingual dictionaries/translation	Multimedia	Graphic organizers	Tiered activities
Think alouds	Leveled readers	Extended time	Independent research/inquiry
Read alouds	Assistive technology	Parent communication	Collaborative team work
Highlight key vocabulary	Notes/summaries	Modified assignments	Higher level questioning
Annotation guides	Extended time	Counseling	Critical/Analytical thinking tasks
Think-pair-share	Answer masking		Self-directed activities
Visual aides	Answer eliminator		
Modeling	Highlighter		
Cognates	Color contrast		

5E Model

Performance Expectation: NJSLS-S-HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.	
Engage: Anticipatory Set	Begin lesson by showing a 5 minute video which introduces the student to the wonder and miracle of the cell division and cell cycle Mitosis dance video Students will also be shown a time lapse video showing human development from 0 to 14 years. After showing the videos, have a class discussion about what processes were observed. Do cells live forever? How do we grow from one cell to a complex organism?
Exploration: Student Inquiry	Group students into pairs. Students are given onion root tip slides or create your own wet mounts and an information sheet on the stages of mitosis. They will count the number of cells in each stage and relate it to the amount of time spent in each stage. An online mitosis activity could also be performed as an alternative or additional activity for districts with available technology. (microviewers and slides) Complete data table using google sheets and then calculate percentage of cells in each phase and time spent in each phase. https://docs.google.com/a/cliffsidepark.edu/spreadsheets/d/1U2mI9zsDbLFrCelaX1VFhgzOVJgAMtuklXrKY028om8/edit?usp=sharing Students will answer the following questions after they complete the above task: How are all the cells in the onion root tip similar to each other? What is the function of the new cells being created? How are the cells in the onion root tip similar to other cells in the onion plant? How are the cells in the onion roor tip different from other cells in the onion plant in structure and function? Group students into pairs: Students will be given 4 identical fruit fly karyotypes to cut out chromosomes. Students will be given a handout which discusses the parts of the cell cycle. Students will have to follow the chromosomes through each part of the cell cycle and stages of mitosis in terms of the number of sets (haploid vs diploid), condensation, and distribution. Students will complete a graph of time vs. the amount of chromosomes per cell for the cell cycle. Students will answer the following questions after they complete the above task: How do the number of chromosomes compare before and after the S phase? Why does the arrangement of chromosomes during metaphase make sense for what occurs to chromosomes during anaphase? Students will complete cell differentiation game.

Explanation: Concepts & Practices	In these lessons: Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): **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. (NJSLS-S-HS-LS1-4
Elaboration: Extension Activity	Students will research the arguments for and against stem-cell research. Review quotes from witnesses given to Congress in hearings on stem-cell research legislation. Explore questions such as: What diseases might be cured using stem-cell technology? What are some advantages and disadvantages to using adult stem cells vs. embryonic stem cells (Discussion specific stem cells can include: totipotent stem cells versus pluripotent stem cells versus unipotent stem cells;reserves include: placental stem cells, umbilical cord stem cells, hematopoietic stem cells, bone marrow and many others) Students will prepare a video or multimedia presentation on one aspect of their research. Barbara McClintock presents examples of the 4 C model of education; as a critical thinker, she was able to ascend to her status as a creator using collaboration and communication in her relationships both Beadle and Tatum, as well as moving forward with her own work studying jumping genes in corn. (http://www.dnaftb.org/32/bio.html) http://www.eurostemcell.org/files/Discover_SCs_Sept2011.pdf
Evaluation: Assessment	

5E Model	
Performance Expectation: NJSLS-S-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.	
Engage: Anticipatory Set	Show pictures or videos of generations of family members that seem to have all inherited a prominent trait, disease or mutation (chemical, physical and or behavioral - founders genetics). A population in Ireland missing a cell receptor and are immune to AIDS. Present examples of populations of tall or short populations around the world, a species of spiders that spins the same web every single time or bird songs. Do birds and spiders go to school to learn how to spin webs or build nests? Where did they get their behaviors from? Who do you look like? Do you look more like your mom or your dad. Does anyone in your family not look like anyone else in the family? How and why are you, you? Where do your traits come from and what percentage is from your father and mother? What is the evidence that DNA is responsible for the transmission of traits which are inherited and passed down to subsequent generations? Who was Gregor Mendel and why is he known as the father of genetics? Did Gregor Mendel "know" about "genes"? What exactly is a gene and DNA? What does it do?
Exploration: Student Inquiry	Punnett Squares: monohybrid, dihybrid, co-dominance, incomplete dominance, sex-linked traits,pedigree charts. Creating a punnett square https://www.youtube.com/watch?v=prkHKjfUmMs Practice punnett squares https://www.youtube.com/watch?v=9Bkc7SGVwqI Pass the gene please online activity Inventory of my traits http://www.glencoe.com/sites/common_assets/science/virtual_labs/E09/E09.html http://www.mhhe.com/biosci/genbio/virtual_labs/BL_05/BL_05.html Activity: Gummy Bear Genetics
Explanation: Concepts & Practices	In these lessons: Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Students will be able to use and demonstrate command of essential vocabulary associated with this unit but not limited to the following:

	● Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): How do you apply the laws of probability to Mendelian inheritance? Can you explain how inheritance patterns are often more complex than predicted by simple Mendelian genetics? How do linked genes tend to be inherited together because they are located near each other on the same chromosome? How do sex linked genes exhibit unique patterns of inheritance?
Elaboration: Extension Activity	**The Doctors New Genetic Tools**

5E Model
Performance Expectation: NJSLS-S-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. [

Engage: Anticipatory Set ***There are several different activities to introduce somewhat disparate topics. These can be spread over several days and coupled with Exploratory activities.**	To relate back to the previous lesson, and introduce new concepts, some discussion questions might be: ● Are bacterial daughter cells exact copies of each other? ● Why don't you look exactly like your parents? ● Can you relate gene expression to the differences between members of a population? -- Look around the classroom and notice the variety of skin and hair colors. What macromolecule determines hair color? ● Ask the students to think about the variety of hair colors in their own family. Do their siblings have a Intro to meiosis https://www.youtube.com/watch?v=ljT1WRI5nTs Original Phrase: The fat man sat on the cat. Altered Phrases: 1. The atm ans ato nth eca - deletion mutation 2. TThefatmansa ton the cat - insertion mutation 3. The fat mma nsa ton the cat - duplication mutation Student Reflection Questions: #1. Identify the change in the letter sequence that have been made in each of the altered phrase examples. #2. Do any of the altered phrases have the same meaning as the original phrase? #3. How many letters were changed (added, deleted, or duplicated) in each of the phrases? #4. How does this practice problem relate to DNA and our study of genetics? *The students will participate in a whole-class discussion to review the answers to these reflection questions. The responses to these reflections questions allow the teacher to gauge the level of student understanding which will guide the depth of details that can be*

	accomplished in today's lesson. If the students do not understand these simple review questions then the teacher needs to scaffold instruction to build student comprehension.
Exploration: Student Inquiry	Students will complete the Gene Mutations Practice Worksheet to reinforce their understanding of the five main types of genetic mutations. This worksheet uses simple letter "genes" to demonstrate deletion, insertion, duplication, inversion, and nondisjunction genetic mutations. By using simple A,B,C's students are able to conceptualize what is happening at the DNA level when a mutation has occurred. The students are encouraged to use their Genetic Mutations Lecture Notes and textbooks as resources to guide their progress through this activity. The students will pair-share their responses and provide a verbal explanation their rationale for identifying the specific genetic mutations for each example. After the pair-share, the teacher will ask for volunteer groups to share their answers and the class will be able to provide feedback that supports or questions the answers given by the volunteer groups. Gene Mutation Student Work - This sample demonstrates that the student is able to identify where the mutation has occurred but sometimes have a difficult time either determining the type of mutation or exactly which base pairs have been impacted.
Explanation: Concepts & Practices	<u>In these lessons:</u> Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. <u>Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas):</u> Topics to introduce I. What is Meiosis? II. What is Independent Assortment? III. What is Genetic Recombination? IV. What is a Mutation? V. How can DNA change due to A. Replication errors? B. Environmental exposure to mutagens, teratogens, and carcinogens? As an introduction to the genetic mutations, students will read the original phrase below and try to decode the three example phrases to identify the change that has been made to cause the error in the letter sequence. Meiosis activity http://www.indiana.edu/~ensiweb/lessons/gen.mm.html
Elaboration: Extension Activity	Meiosis: lab http://www.genetics-gsa.org/education/pdf/Durham%202015_Demonstrating%20Meiosis_Resource%20Justification%20and%20Instructor%20Guide.pdf The correlation between the mutations and application to the amino acid sequence is further clarified in the following website: http://learn.genetics.utah.edu/content/molecules/dnacodes/ Using a Chi Square test for data analysis: http://www2.lv.psu.edu/jxm57/irp/chisquar.html

Evaluation: Assessment	

5E Model	
Performance Expectation: NJSLS-S-HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	
Engage: Anticipatory Set	Population genetics https://www.youtube.com/watch?v=4YqOF-XNa9c
Exploration: Student Inquiry	Measuring string beans or mass of acorn to construct a bar graph bell curve. Peppered moth Chi Square M and M lab Darwin's Finches http://www.galapagos.org/wp-content/uploads/2012/04/Beak-of-the-Finch-Activity.pdf
Explanation: Concepts & Practices	In these lessons: Direct instruction Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities.

	Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. graphing/genetic drift/bottleneck http://programs.clarendoncollege.edu/programs/NatSci/Biology/Zoology/zoo%20online%20outlines/Lab%20population%20genetics%202%20-%20fall%2011.pdf Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ● 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. (NJSLS-S-HS-LS3-3) ● **Literacy activity**: Using two articles on connection between sickle cell anemia and malaria, develop PARCC like questions for analysis. ● Genetic Counseling
Elaboration: Extension Activity	The original statistical analysis of Gregor Mendel's work may be accessed at the following link: http://arxiv.org/pdf/1104.2975.pdf Model of Inheritance: Which Model of Inheritance Best Explains How a Specific Trait is Inherited in Fruit Flies? Sickle Cell gene distribution in a region may be correlated to malaria resistance in the context of analyzing pioneering work of Linus Pauling via analysis of the three following links: 1. https://www.sciencedaily.com/releases/2011/04/110428123931.htm 2. http://www.who.int/gho/malaria/epidemic/cases/en/ 3. http://www.nature.com/ncomms/journal/v1/n8/fig_tab/ncomms1104_F1.html
Evaluation: Assessment	

How are the characteristics from one generation related to the previous generation?

Students demonstrate understanding of the relationship of DNA and chromosomes in the processes of cellular division that pass traits from one generation to the next. Students can determine why individuals of the same species vary in how they look, function, and behave. Students develop conceptual models for 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 expression. Crosscutting concepts of structure and function, patterns, and cause and effect developed in this topic help students to generalize understanding of inheritance of traits to other applications in science (p. 2, Life Science Topics Storyline).

#	STUDENT LEARNING OBJECTIVES	CORRESPONDING PEs and DCIs
1	**Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** *[Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]*	**NJSLS-S-HS-LS1-4**
2	Compare the products of meiosis and mitosis. *[Clarification Statement: Emphasis is on the replication and separation of DNA and cellular material, changes in chromosome number, number of cell divisions, and number of cells produced in a complete cycle. Assessment Boundary: Assessment does not include memorization of the steps of meiosis or mitosis.]*	LS1.A, LS3.A
3	Explain how the process of meiosis results in the passage of traits from parent to offspring, and how that results in increased genetic diversity necessary for evolution.	LS3.A
4	**Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** *[Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]*	**NJSLS-S-HS-LS3-1**
5	**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.** *[Clarification Statement: Emphasis is on the cause and effect relationships between DNA, the proteins it codes for, and the resulting traits observed in an organism.] [Assessment Boundary: 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.]*	**NJSLS-S-HS-LS1-1**
6	Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. *[Clarification Statement: Focus is on how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection.]* [*Assessment Boundary: Assessment does not include enzymes and factors involved or rote memorization of the steps of transcription and translation.*]	LS3.B
7	**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.** *[Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]*	**NJSLS-S-HS-LS3-2**

8	**Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** *[Clarification Statement: 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.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]*	**NJSLS-S-HS-LS3-3**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems (pp. 54-56, NRC, 2012)

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.

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

Developing and Using Models (pp. 56-59, NRC, 2012)

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

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

Analyzing and Interpreting Data (pp. 61-63, NRC, 2012)

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. (NJSLS-S-HS-LS3-3)

Engaging in Argument from Evidence (pp. 71-74, NRC, 2012)

Disciplinary Core Ideas

LS1.A: Structure and Function (pp. 143-145, NRC, 2012)

- 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. (secondary to NJSLS-S-HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by NJSLS-S-HS-LS1-1.)

LS1.B: Growth and Development of Organisms (pp. 145-147, NRC, 2012)

- 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. (NJSLS-S-HS-LS1-4)

LS3.A: Inheritance of Traits (pp. 158-159, NRC, 2012)

- 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

Crosscutting Concepts

Cause and Effect (pp. 87-89, NRC, 2012)

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

Scale, Proportion, and Quantity (pp. 89-91, NRC, 2012)

- 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). (NJSLS-S-HS-LS3-3)

Systems and System Models (pp. 91-94, NRC, 2012)

- 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. (NJSLS-S-HS-LS1-4)

Connections to Nature of Science

Science is a Human Endeavor (Appendix H)

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

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. ● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (NJSLS-S-HS-LS3-2)	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. (NJSLS-S-HS-LS3-1) **LS3.B: Variation of Traits** (pp. 160-161, NRC, 2012) ● 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. (NJSLS-S-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. (NJSLS-S-HS-LS3-2),(NJSLS-S-HS-LS3-3)	● Science and engineering are influenced by society and society is influenced by science and engineering. (NJSLS-S-HS-LS3-3)

Connections to other DCIs in this grade-band:
HS.LS2.A (NJSLS-S-HS-LS3-3); **HS.LS2.C** (NJSLS-S-HS-LS3-3); **HS.LS4.B** (NJSLS-S-HS-LS3-3); **HS.LS4.C** (NJSLS-S-HS-LS3-3)

Articulation of DCIs across grade-bands:
MS.LS1.A (NJSLS-S-HS-LS1-4); **MS.LS1.B** (NJSLS-S-HS-LS1-4); **MS.LS2.A** (NJSLS-S-HS-LS3-3); **MS.LS3.A** (NJSLS-S-HS-LS1-4),(NJSLS-S-HS-LS3-1),(NJSLS-S-HS-LS3-2); **MS.LS3.B** (NJSLS-S-HS-LS3-1),(NJSLS-S-HS-LS3-2),(NJSLS-S-HS-LS3-3); **MS.LS4.C** (NJSLS-S-HS-LS3-3)

Common Core State Standards Connections:
ELA/Literacy -

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. (NJSLS-S-HS-LS3-1),(NJSLS-S-HS-LS3-2)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (NJSLS-S-HS-LS3-1)
WHST.9-12.1	Write arguments focused on discipline-specific content. (NJSLS-S-HS-LS3-2)
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (NJSLS-S-HS-LS1-4)

Mathematics -

MP.2	Reason abstractly and quantitatively. (NJSLS-S-HS-LS3-2),(NJSLS-S-HS-LS3-3)
MP.4	Model with mathematics. (NJSLS-S-HS-LS1-4)
HSF-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. (NJSLS-S-HS-LS1-4)
HSF-BF.A.1	Write a function that describes a relationship between two quantities. (NJSLS-S-HS-LS1-4)