Course: Biology **Unit #3: DNA, Cell Reproduction, and Inheritance**	**Year of Implementation: 2019-2020**
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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/2016/science/HS-LS1.pdf
https://www.state.nj.us/education/cccs/2016/science/HS-LS2.pdf
https://www.state.nj.us/education/cccs/2016/science/HS-LS3.pdf
https://www.state.nj.us/education/cccs/2016/science/HS-LS4.pdf

Unit 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. [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.]

HS-LS1-4. 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.]

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

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. [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.]

HS-LS3-3. 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.]

21st Century Skills and Career Ready Practices

CRP2. Apply appropriate academic and technical skills. 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

CRP4. Communicate clearly and effectively and with reason. 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.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them. 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.

Career and Technical Education 9.3.12.AG-ANI.4 Apply principles of animal reproduction to achieve desired outcomes for performance, development and/or economic production.

Career and Technical Education 9.3.12.AG-ANI.6 Classify, evaluate and select animals based on anatomical and physiological characteristics.

Transfer Goal(s): Students will be able to independently use their learning to explain how different cells and organisms make proteins, reproduce, and then they will apply these concepts to predict the genetic make-up of the offspring with respect to the parent(s).	
Enduring Understandings Students will understand that. . . EU1 DNA is the universal genetic material that contains a blueprint for life. EU2 cellular division and cellular differentiation play a role in producing and maintaining complex organisms. EU3 there are predictable patterns of inheritance, and the variation that exists within a species is related to its mode of reproduction (asexual or sexual).	*Essential Questions* EU1 ● How does structure relate to function in living systems from the organism to the cellular level? ● How does the structure of DNA determine the structure and function of proteins? ● How does information flow from DNA to RNA to direct synthesis of proteins? ● How does the structure of DNA function in genetic inheritance? EU2 ● What changes do cells go through as they grow and develop? ● Why does mitosis alone not produce daughter cells? ● What would happen to reproducing organisms without meiosis? ● How does meiosis produce genetically varied gametes? EU3 ● How is genetic information passed through generations? ● How does DNA carry genetic information? ● How does the offspring differ between asexual and sexual reproductive strategies? [i.e. gamete formation,

	clone vs. non-cloning, diploid vs. haploid, viral reproductive methods, genetic mutations]
EU4 the concepts of statistics and probability can be applied to explain the variation and distribution of expressed traits in a population.	EU4 ● How can mathematics be used to express relationships efficiently and accurately? ● How can we use probability to predict traits?
Knowledge Students will know . . EU1 ● all cells contain genetic information in the form of DNA molecules. ● genes are regions in DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. EU2 ● cells divide through the process of mitosis, resulting in daughter cells that have the same genetic composition as the original cell. ● cell differentiation is regulated through the expression of different genes during the development of complex multicellular organisms. ● cells (singular and or multicellular organisms) may inherit genetic variations that may be caused by environmental factors. EU3 ● changes to DNA segments can alter the genetic code. ● changes to the DNA may be passed on to every cell that	*Skills* Students will be able to. . . EU1 ● construct an explanation based on evidence for how the structure of DNA determines the structures of proteins which carry out the essential functions of life through systems of specialized cells. HS-LS1-1 EU2 ● use a model to distinguish between the process of cellular growth (cell division) and development (differentiation). HS-LS1-4 ● describe modern applications of the regulation of cell differentiation and analyze the benefits and risks (e.g. stem cells, sex determination); propose a claim to defend the research benefits of genetic engineering. HS-LS3-2 ● describe how a disorder/mutation causes malfunctioning in a system, organ, and/or cell, as a result of disrupting normal protein synthesis. HS-LS3-1; HS-LS1-1 EU3 ● explain the value and potential applications of genome projects. HS-LS3-1 ● predict the potential impact on an organism (no impact, significant impact) given a change in a specific DNA

develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment. ● sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations in the offspring of any two parents. EU4 ● mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles. ● revisions of predictions and explanations are based on systematic observations, accurate measurements, and structured data/evidence.	code, and provide specific real world examples of conditions caused by mutations. HS-LS3-1 ● demonstrate through modeling how the sorting and recombination of genes during sexual reproduction has an effect on variation in offspring (meiosis, fertilization). HS-LS1-4 EU4 ● apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. HS-LS3-3, HS-LS4-3

Stage Two - Assessment

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
- Teacher-monitored Peer Tutoring
- 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.**

PHENOMENON: Show students the video The Inner Life of a Cell and discuss the importance of cells and discuss the question "Why do we need cells" - https://thewonderofscience.com/phenomenon/2018/7/8/the-inner-life-of-the-cell (A, M) (EU1)

- Discussion of the question, "Why do we need new cells?" to include: (A)
  - All cells in an organism contain the same genetic information and originate from a single zygote. (A)
  - Cells multiply and differentiate to form the many specialized cells, tissues, and organs that comprise a final organism. (A)
  - Replacement and repair of cells (A)
  - Construct any/all of the following: Simple Animal Cell, Simple Plant Cell, Simple Bacteria Cell – (purchased from Origami Organelles Website https://origamiorganelles.com/collections/organelles-cells) (A,M)

- Discussion of the question, "What is the role of cellular division?" (A)
  - Carolina Biological – Cell Assessment Questions: Mitosis (Item # 521370) (A)
  - Lab Activity: Carolina Biological – Cycling through Mitosis Lab (Item # 251003) (M,T)
  - Lab Activity: Arizona.edu – Online Onion Root Tip Virtual Lab - http://www.biology.arizona.edu/cell_bio/activities/cell_cycle/cell_cycle.html (A,T,M)

- Discussion of the question, "What is the role of Meiosis?" (A)
  - Fertilization and Sexual reproduction (A)
  - Mutations (inherited and caused by environmental factors) (A)
  - Review of Mitosis and Meiosis - https://origamiorganelles.com/products/mitosis-and-meiosis (A)

PHENOMENON– Show students the following and discuss variation in genes as it relates to humans and in other organisms. https://thewonderofscience.com/phenomenon/2018/5/13/why-do-humans-have-different-colored-skin - Why do humans have different skin color? (A, M) (EU1, EU2, EU3)

- Discussion on the question, “How does the structure of DNA determine the structure of proteins which carry out life’s essential functions?” to include: (A)
  - Chemistry of Nucleic Acid
    Nucleotides
    Nitrogenous Bases
  - Chemistry of Proteins

- Discussion: “How is the information in DNA transcribed and translated to a protein and expressed as a trait?”(A)
  - Protein Synthesis
  - Model Protein Synthesis through a student centered play (A, T, M)

PHENOMENON– Hemingway’s Polydactyl Cats - https://thewonderofscience.com/phenomenon/2018/7/5/hemingways-polydactyl-cats (A, M) (EU1, EU2, EU3)

- Discussion of the question, “How do DNA, genes, and proteins translate into traits?” to include: (A)
  - Identifying that hereditary information is contained in genes, located in the chromosomes of each cell, and each gene carries a single unit of information
  - Providing specific examples of how an inherited trait of an individual can be determined by one or many genes and a single gene can influence more than one trait
  - Understanding how new heritable characteristics can result from new combinations of existing genes in reproductive cells

- Observe and determine the probability of inheriting particular traits (M)
- Lab Activity: Chi Square and/or Probability Lab - Bean lab, Coin lab, Dice lab, M&M Lab (http://mabryonline.org/blogs/bowman/M&M.pdf -) lab that reviews concept of probability and statistics, applying mathematical concepts to genetics, students solve for chi square and apply rules of probability (there are many variations to these labs available online) (A, T, M)