Unit Title: Molecular Genetics	**Content Area:** Biology	**Grade Level:** 9-12

Unit Summary: Students will be able to apply their knowledge of DNA structure and function to model the process of DNA replication and Protein Synthesis and identify patterns in the processes. They will also use information gathered to make predictions about how changes in the either process can lead to changes such as mutations.
Cross Cutting Concepts: Cause and Effects, Patterns, Systems and System Models, Structure and Function
Science and Engineering Practices: Analyzing and Interpreting Data, Obtaining, Evaluating, and Communicating Information, Developing and Using Models, Constructing Explanations and Designing Solutions, Engaging in argument from evidence

Unit Essential Questions:	**Unit Enduring Understandings:**
• What are the effects of changes in DNA? • How do we go from gene to protein?	• The relationship between structure and function in respect to DNA. • Changes in DNA lead to mutations and genetic disorders.

Possible Student Misconceptions: Students might think that mRNA is transcribed from DNA and then processed into tRNA and/or rRNA. Students might have difficulty visualizing the connections between genes, DNA and proteins.

NJCCCS: 5.3.12.D.1, 5.3.12.D.2, 5.3.12.D.3, 5.3.12.E.1,5.1.12.A.3, 5.1.12.B.1, 5.1.12.B.4, 5.1.12.C.1,5.1.12.D.1, 5.1.12.D.2

NGSS Performance Expectations: *Students who demonstrate understanding can…*

- 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-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 function of the organism.
- 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.

Primary CCSS ELA/Literacy Connections:	**Primary CCSS Mathematics Connections:**
3.1.12.A.1, 3.1.12.A.2, 3.1.12.E.3, 3.1.12.H.8, CCSS.ELA-Literacy.RST.9-10.3, CCSS.ELA-Literacy.RST.9-10.1, CCSS.ELA-Literacy.RST.9-10.4 CCSS.ELA-Literacy.RST.11-12.1, CCSS.ELA-Literacy.RST.11-12.2, CCSS.ELA-Literacy.RST.11-12.3, CCSS.ELA-Literacy.RST.11-12.4, CCSS.ELA-Literacy.RST.11-12.7, CCSS.ELA-Literacy.RST.11-12.8	4.4.12 A.1., 4.4.12 B.1, 4.4.12 B.3. CCSS.Math.Content.HSS.CP.A.2, CCSS.Math.Content.HSS.CP.A.4, CCSS.Math.Content.HSS.MD.A.3

Lesson Pace & Sequence

Lesson Title/Number: Introduction to DNA structure and synthesis	**Learning Objective(s):** Analyze how the structure of DNA is related to its function by engaging in group based lab station rotation activity.	**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Why is DNA called the genetic code?				Structure and Function: The way an object is shaped or structured determines many of its properties and functions
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	KWL: 3 column chart on board and notebook outlining student answers to the question: What do you KNOW and WANT to know about DNA?				

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Discussion/Presentation Introduction to DNA structure and function: Students aim to summarize the relationship between DNA, describe the overall structure of the DNA molecule individually.	• Chapter 12 Miller & Levine	Developing and Using Models Constructing Explanations and Designing Solutions Engaging in argument from evidence	LS3.A: Inheritance of Traits	Cause and Effect: Mechanism and Prediction: events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships and the mechanisms by which they are mediated, is a major activity of science engineering. Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Lab Station Rotation in small groups : Station 1: EXPERIMENT LEADING UP TO DNA DISCOVERY Using the experiments of Griffith, Avery or Hershey and Chase as an example, develop a flow chart or concept map that shows how the scientist used scientific processes. Be sure to identify each process. Include the following terms in your flow chart: Hypothesis, Procedure, and Conclusion for each experiment STATION 2: DNA INTERACTIVE WEBSITE Using the smart board, explore the following website: www.dnai.com. Explore the website, watch the video and			LS1.A: Structure and Function	

	answer the following questions: 1.) What was Rosalind Franklin's contribution to the discovery of DNA? 2.) What did Linus Pauling first believe DNA looked like? Why was he wrong? 3.) Who were Watson and Crick and how did they win the Nobel Prize? 4.) Describe how DNA is tightly packed up to fit in the nucleus of a cell. (chromatin video) 5.) Complete the base pairing interactive portion. Call me over when you think you have accurately paired the bases. STATION 3: CREATING A K'NEX MODEL OF DNA A. Using the instruction on the table create a small DNA model with the K'Nex pieces on the table. Once your model is complete, answer the following questions. 1.) What is the difference between major and minor grooves? Draw and explain.				

	2.) Is your model right or left handed? 3.) Does your model have antiparallel strands? What is meant by antiparallel strands? B. Using the K'Nex pieces make a model of the base pairs and answer the following questions. 1.) What is the difference between pyrimidines and purines? Give the base pairs for each. STATION 4: WRITING & DECODING DNA 1.) Write 2 paragraphs describing the function of DNA. Include in your essay: a. What is the structure of DNA? b. Where is DNA located? Be specific. c. What does the genetic code represent? 2.) What are the 4 different combinations of base pairs? 3.) What is the DNA backbone made up of?				
Extend: How will students	Exit ticket: Based on the				

deepen their conceptual understanding through use in new context?	information gathered during the lab stations, why do you think DNA is referred to as the genetic code? Students write answers next to previous answers and compare previous knowledge to acquired knowledge				

Lesson Pace & Sequence

Lesson Title/Number: DNA Lab part 1		**Learning Objective(s):** Design and implement lab to answer the question: How can we extract DNA from cells?			**Lesson Duration:** 120 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	In what organelle is DNA located and why do you think it resides in that specific organelle?	• Chapter 12			Structure and Function: The way an object is shaped or structured determines many of its properties and functions
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Review concepts of cell, organelles and nucleus specifically.				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Design and predict the results for a lab that aims to answer the following question, "How can we extract DNA from cells?				
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Design and predict the results for a lab that aims to answer the following question, "How can we extract DNA from cells?			LS1.A: Structure and Function	
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Apply their knowledge of DNA structure and function to design and predict the outcome of the procedures put forth		Asking Questions and Defining Problems, Designing and Carrying out Investigations, Constructions Explanations and Designing Solutions		Cause and Effect: Mechanism and Prediction: events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships

					and the mechanisms by which they are mediated, is a major activity of science engineering.
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Implement procedures of Lab Design and complete Results				
Extend: How will students deepen their conceptual understanding through use in new context?	Derive a c conclusion based on information and results gathered through				

Lesson Pace & Sequence

Lesson Title/Number: DNA Lab part 2		**Learning Objective(s):** Carry out lab investigation, analyze results and reevaluate hypothesis			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Describe the structure of DNA and how it is able to fit into the nucleus of the cell?	• Chapter 12			Structure and Function: The way an object is shaped or structured determines many of its properties and functions
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students assemble into lab groups and review hypotheses				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Using materials provided students implement lab procedures and record data in lab journals		Designing and Carrying out Investigations, Analyzing and Interpreting Data, Constructions Explanations and Designing Solutions		

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Post Lab Questions: Were you able to visualize the DNA? Why or Why not? What were some things you could have done differently to improve your DNA yield. Why do you think this new method would result in better results?		Obtaining, Evaluating and Communicating Information	LS1.A: Structure and Function	Cause and Effect: Mechanism and Prediction: events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships and the mechanisms by which they are mediated, is a major activity of science engineering.
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Students will complete the lab investigation, accurately collect and analyze data and complete a comprehensive conclusion.		Analyze and Interpreting Data		
Extend: How will students deepen their conceptual understanding through use in new context?	Why was it important to use the saline solution before adding the detergent to the cell solution? What was the significance of treating the cell solution with ethanol? Do you think we could have substituted the ethanol for alcohol? Why or why not?		Obtaining, Evaluating and Communicating Information		

Lesson Pace & Sequence

Lesson Title/Number: DNA Replication		**Learning Objective(s):** All learners will be able to explain and model the process of DNA replication			**Lesson Duration:**
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	If each cell has one copy of DNA, where does the DNA in a new cell come from?				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	DNA Replication Paper Clip Activity or Modeling DNA Replication (in text)	• DNA Replication Paperclip Activity: http://www.tiemanbiology.com/uploads/6/3/2/3/6323843/dna_replication_paper_clip_activity.pdf	Developing and Using Models	LS1.A: Structure and Function	Structure and Function: The way an object is shaped or structured determines many of its properties and functions

Explain: How will you help students connect their exploration to the concept/topic under investigation?	DNA structure and replication video and class discussion: Have students write the following questions: "What is meant by the term complimentary? "What is the role of DNA Polymerase? How does the new strand of DNA differ from the original strand? etc. Use video and discussion to answer questions	• DNA Structure and Replication Video: https://www.youtube.com/watch?v=8kK2zwjRV0M	Obtaining, Evaluating and Communicating Information		Structure and Function: The way an object is shaped or structured determines many of its properties and functions
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Create a comic strip with visuals depicting DNA Replication for a 3rd grade class. Make sure to answer question: why is it important that DNA replicates, Why does DNA replicate in the manner that it does?		Obtaining, Evaluating and Communicating Information		

Lesson Pace & Sequence

Lesson Title/Number: Transcription/Translation		**Learning Objective(s):** Differentiate between transcription and translation through class discussion and card organization activity.			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: How does the molecular information in DNA result in traits we are able to see?				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Class discussion on answers to Do Now question. Address misconceptions				Cause and Effect: Mechanism and Prediction: events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships and the mechanisms by which they are mediated, is a major

					activity of science engineering.
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Card organization- in small groups, students will organize illustrations of transcription and translation in the order in which it makes the most sense and provide justification for sequence.		Analyzing and Interpreting Data		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Presentation/Discussion: From gene to protein: Students will aim to answer: Compare and Contrast DNA and RNA. What are the 3 main forms of RNA and their roles in protein synthesis? How does transcription occur? How does translation occur?	• Chapter 12 Section 12.2 to 12.3	Obtaining, Evaluating and Communicating Information	LS3.A: Inheritance of Traits	
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Re-organize the cards into the proper order. Provide explanations of steps in your own words.		Constructing Explanations and Designing Solutions		Structure and Function: The way an object is shaped or structured determines many of its properties and functions
Extend: How will students deepen their conceptual understanding through use in new context?	Exit ticket: Which process, transcription or translation, would cause greater change in a protein if a mistake were to happen? Explain using evidence from text		Engaging in Argument from Evidence		

Lesson Pace & Sequence

Lesson Title/Number: Gene to Protein	**Learning Objective(s):** Apply their understanding of “gene to protein” concepts in playing Bingo game.	**Lesson Duration:** 160 minutes

Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***
Elicit: How will you access students' prior knowledge?	Do Now: Explain transcription and translation in less than 10 words.				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Review concepts from last class of transcription/translation by voting on best short description and discussing why it is the best				
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Quick lab: How does a cell interpret DNA (in pairs) Students will be given a DNA sequence asked to transcribe and translate sequence. In both directions. Analyze and Conclude Questions: Why did steps 3 and 4 produce different polypeptide? Do cells usually decode nucleotides in one direction only or in either direction?	• Chapter 12 Section 12.3 pg. 303	Analyzing and Interpreting Data, Obtaining, Evaluating, and Communicating Information	LS3.A: Inheritance of Traits	
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Review Quick lab Procedures and Analyze and Conclude question by having students swap papers				Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them

Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Bingo game: Students will be given a Bingo sheet with various amino acid sequences. The teacher will provide a variety of DNA code on the board. Students will have to use Figure 12-17 pg. 303 to determine the amino acid sequence and see if it is on their board.	• Chapter 12 Section 12.3	Analyzing and Interpreting Data		
Extend: How will students deepen their conceptual understanding through use in new context?	Writing in Science/Creative Writing: An RNA molecule is looking for a job in a protein synthesis factory, and it asks you to write its resume. This RNA molecule is not yet specialized and could with some structural changes, function as with mRNA, tRNA or rRNA. The resume you create should reflect the qualifications needed for each type of RNA.		Obtaining, Evaluating and Communicating Information	LS3.A: Inheritance of Traits	

Lesson Pace & Sequence

Lesson Title/Number: Mutations/Genetic Disorders		**Learning Objective(s):** Discuss the different types of mutations and genetic disorder and apply their understandings by completing significance of mutations.			**Lesson Duration:** 80 minutes
Learning Cycle ***What lesson elements will support students' progress towards mastery of the learning objectives(s)?*** ****Elements do not have to be in conducted in sequence.***	***Learning Activities*** ***What specific learning experiences will support ALL students' progress towards mastery of the learning objective(s)?***	***Resources/Materials*** ***What curricular resources/materials are available to facilitate the implementation of the learning activities?***	***Science and Engineering Practices*** ***What specific practices do students need to use in order to progress towards mastery of the learning objective(s)?***	***Disciplinary Core Ideas*** ***What core ideas do students need to understand in order to progress towards mastery of the learning objective(s)?***	***Crosscutting Concepts*** ***What crosscutting concepts will enrich students' application of practices and their understanding of core ideas?***

Elicit: How will you access students' prior knowledge?	Sometimes mistakes happen during protein synthesis or DNA replication. What might be the effect of such changes?				
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Students will be given visuals depicting Chromosomal Mutations and scientific terms. They will be asked to match terms to visuals	• Figure 12-21 pg. 308	Obtaining, Evaluating and Communicating Information		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Presentation /Discussion: mutations and genetic disorders. Through discussion, and text determined by the teacher, students will aim to answer: What kinds of mutations can occur in organisms and what is the significance of these mutations? Have students correct any incorrect matches after presentation	• Chapter 12 Section 12.4 Mutations	Obtaining, Evaluating and Communicating Information	LS3.A: Inheritance of Traits	
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Significance of Mutations: Build Science Skills: Classifying: Have student groups generate 5 examples of gene mutations and 5 examples of chromosomal mutations. These examples should include DNA or gene sequences for both the normal and mutated sequences. Have groups exchange examples, and then classify mutations as being possible harmful, harmless or even helpful.	• Chapter 12 Section 12.4 Mutations	Analyzing and Interpreting Data	LS3.B: Variation of Traits	Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them

Extend: How will students deepen their conceptual understanding through use in new context?	Students will research a specific genetic mutation using 3 sources of evidence to answer the question: What change in DNA has caused the genetic disorder and what impact does the disorder have on individuals' lives? Teacher will discuss credible sources, provide rubric and outline for research paper.		Engaging in Argument from Evidence		