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

Unit Summary: In this unit students will explore and engage in Genetics. It will begin with a brief history outlining Mendel's work and principles which will set the foundation for questioning and exploration of how geneticist use the principle of probability to make sense of genetic crosses and/or outcomes. Students should be able to use information to extend knowledge and experiences and develop a clear understanding of inheritance patterns and the events of Meiosis.
Crosscutting Concepts: Cause and Effect, Patterns, Systems and System Models
Science and Engineering Practices: Analyze and Interpret Data, Developing and Using Models, Engaging in Argument Evidence, Using Mathematical and Computational Thinking, Constructing Explanations and Designing Solutions, Planning and Carrying Out Investigations, Obtaining, Evaluating and Communicating Information.

Unit Essential Questions:	**Unit Enduring Understandings:**
• How is genetic information passed through generations? • How can we predict the genetic outcome of an organism based on their parent's genotypes and/or phenotypes?	• There are predictable patterns of inheritance, and the variation that exists within a species is related to its mode of reproduction. • Traits are expressed by the genetic code of genes.

Possible Student Misconceptions: Students might think it is impossible for two tall pea plants to produce short pea plants. Students may misinterpret probable genotypic and phenotypic ratios as actual numbers of offspring. Students might try to apply the ideas of simple dominance to other types of gene expression. Students might confuse mitosis and meiosis.

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.
- 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.
- 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.

3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

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 Genetics/1	**Learning Objective(s):** Investigate and classify the traits of fellow classmates in order to gain knowledge of Genetic vocabulary and classification. Describe the principle of dominance and what happens during the segregation of alleles by actively engaging in class discussion and completion of Thinking Visually.	**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?	What comes to mind when you think of the word INHERTANCE?	• Chapter 11 section 11.1		LS3.A: Inheritance of Traits	Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them
Explore: What hands-on/minds-on common experience(s) will you provide for students?	Inquiry Activity pg. 262: Are traits inherited? Students will observe and make a list of different forms of traits among class mates		Analyze and Interpret Data	LS3.B: Variation of Traits	Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Create class data chart of students' results on board. Ask students to analyze data. Lead class discussion of results and review answers to Think About It questions. Infer whether traits are inherited and the method of inheritance.				
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Discussion regarding Mendel's work and general principles of heredity with visuals provided. Students will aim to (through presentation or text provided by teacher): Describe how Mendel studied inheritance in peas. Summarize Mendel's conclusion about inheritance. Explain the principle of dominance. Describe what happens during segregation				
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Completion of Thinking Visually: Using Diagrams pg. 266. Use a diagram to explain Mendel's principles of dominance and segregation. Your diagram should show how the alleles segregate during gamete formation		Developing and Using Models		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.

Extend: How will students deepen their conceptual understanding through use in new context?	Cite evidence from text to explain: Why were true breeding plants important for Mendel's experiment?		Engaging in Argument from Evidence		

Lesson Pace & Sequence

Lesson Title/Number: Probability and Punnett Squares/ 2		**Learning Objective(s):** Analyze how geneticist use the principles of probability and Punnett squares to make sense of genetic crosses/outcomes by participating in class discussion, activity and review of genetic concepts.			**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? ***Engage: How will you capture students' interest and get students' minds focused on the concept/topic?***	If you flip a coin 3 times in a row, what is the probability you will end up with heads every time	• Chapter 11 Section 11.2	Using Mathematical and Computational Thinking		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?	Quick Lab Pg. 268 How are dimples inherited? Use the last 4 digit of a various random telephone numbers to determine probability of inheritance of dimples using Punnett Square. 2 digits represent father genotype and 2 digits represent mother genotype. Even digits represent recessive trait of no dimples (d). Determine class average of percent children with dimples.		Analyzing and Interpreting Data, Using Mathematical and Computational Thinking		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.

Explain: How will you help students connect their exploration to the concept/topic under investigation?	Discussion/ Review of probability concepts and use of Punnett Squares with visuals embedded. Students will aim to Explain how geneticists use the principle of probability and describe how geneticist use Punnett Squares				
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Thinking Visually: Drawing Punnett Squares pg. 269		Constructing Explanations and Designing Solutions Developing and Using Models		
Evaluate: How will students demonstrate their mastery of the learning objective(s)?					

Lesson Pace & Sequence

Lesson Title/Number: Probability and Punnett Squares/ 3		**Learning Objective(s):** Assess understanding of Probability and Punnett Squares			**Lesson Duration:** 40 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?	What is the relationship between probability and Punnett Squares?	• Chapter 11 Section 11.2			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.
Engage: How will you capture students' interest and get students' minds focused on the concept/topic?	Class discussion of answers, address misconceptions				

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Complete and Review Sponge Bob Traits Graphic Organizer. Students will swap papers with a partner and will engage in peer assessment as a class	• SpongeBob Genetics Quiz: http://sciencespot.net/Media/gen_spbobgeneticsqz.pdf	Analyzing and Interpreting Data Using Mathematical and Computational Thinking		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?	Students will build on understanding of Punnett Squares of monohybrid cross to understand and practice Dihybrid crosses	• Dihybrid Cross Problem Set: www.biologycorner.com/worksheets/dihybrid_guinea_pigs.pdf			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.
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Students will evaluate understanding of Dihybrid crosses by completing Dihybrid Cross Worksheet	• Dihybrid Cross Worksheet: http://www.cbhs.k12.nf.ca/stephenwhalen/dihybridcross.pdf			

Lesson Pace & Sequence

Lesson Title/Number: Independent Assortment and Gene Expression/4		**Learning Objective(s):** Explain the principle of independent assortment by engaging in class lecture/discussion and apply understanding to problem solving activity. Extend knowledge to understanding and identifying other types of gene expression.			**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 all people with red hair have freckles? Why or Why not?	• Chapter 11 Section 11.3	Constructing 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.

Explore: What hands-on/minds-on common experience(s) will you provide for students?	Problem Solving: Producing True Breeding Seeds pg. 271. Designing a solution to a problem: of the 106 test plants, 31 have white flowers. Is there a way to develop seeds that produce only lavender flowers?		Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Constructing Explanations and Designing Solutions		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Have students share solutions and present plans from "Problem Solving Activity" with a peer or in groups				
Elaborate: How will students apply their learning and develop a more sophisticated understanding of the concept/topic?	Independent Assortment and Gene Expression Discussion/Review, Students will aim to: explain the principles of independent assortment, describe the inheritance patterns that exist aside from simple dominance, explain how Mendel's principles apply to all organisms.				
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Collect pictures for students to compare and analyze different types of gene expression. Have students choose 3 illustrations and cite evidence from text to explain why the illustration represents the chosen gene expression.		Engaging in Argument from Evidence		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?	Have students peer assess one another's plans based on new knowledge attained from lesson and/or text		Obtaining, Evaluating, and Communicating Information		
Lesson Pace & Sequence					
Lesson Title/Number: Meiosis/5		**Learning Objective(s):** Summarize the process of Meiosis and Compare it the process of Mitosis.			**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?	If each of your parents has 46 chromosomes, how many chromosomes do you have and how did you get them?	• Chapter 11 Section 11.4			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?	Provide students with cutout colored illustrations of Meiosis stages. Have student pairs put the stages in order based on what they believe to make sense		Analyzing and Interpreting Data		
Explain: How will you help students connect their exploration to the concept/topic under investigation?	Review phases of Meiosis (noting chromosome numbers) through lecture and/or discussion. Address misconceptions. Have students re-order stages based on new knowledge and check for correct order				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?	Provide an explanation for the initial order of the stages. What were some of your misconceptions?				
Evaluate: How will students demonstrate their mastery of the learning objective(s)?	Have students provide descriptions of the correct phases of Meiosis in their own word		Obtaining, Evaluating, and Communicating Information		

Extend: How will students deepen their conceptual understanding through use in new context?	Students will create a Venn Diagram to compare and contrast Meiosis and Mitosis				