Using Genetics Data in a Greenhouse Biology Classroom

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This curriculum unit is recommended for:
Biology, Greenhouse Biology, 9th and 10th grades

Keywords: Biology, Data, Analysis, Data Analysis, Greenhouse, Genetics, Scientific Teaching, strategies, Mendel

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis:

The brain is a wonder to many scientists around the world with its complex, yet simple ways to store and retrieve information. For much of a high school student's career, they cram information into their brain, dump it all out on a test and never retrieve it again. But what if there were a way to design our lessons so that we not only worked with the natural complexity of the brain but found a way to successfully teach our most difficult topics to lower level students? Genetics is a topic that is covered with students in middle school science and in high school biology. The fascination with the human genome and DNA's ability to provide information about body structure and family history is often difficult for students to understand. This curriculum unit will be a framework for providing students with data and information that builds on how they learn and how they need to digest information. The information in this unit will not only benefit the students, but will give teachers a guideline from which to teach and help students discover the miracle of genetics.

I plan to teach this unit during the coming year to 80 students in 10th grade Biology I.

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Adora Reid

Introduction

Before reading this unit, think back to your own learning experiences in school. What were they like? It is easy to become a teacher and get in the habit of teaching students based on the methods that helped you learn. Whether on the college, high school, or middle school level, learning always occurs in a particular way for different people. The strategies that worked for you in school may not work for your students. This is an important thing to note. As a young learner, there are many strategies that we are given to help us to memorize or take in information for a short period of time. Unless that information was repeated or practiced, as soon as we left the grade, we lost the information and over the years, all of the information that we thought we absorbed either is never retrieved again or is hidden deep in our memory. The current set up of school classrooms today are very test driven. At every twist and turn, students have to be tested on their knowledge so that teachers and administrators can track the short-term progress of students and the effectiveness of the educator in the classroom. What happens when students encounter a difficult concept and the test scores indicate that the students are not mastering the concept? How can you, as an educator, adjust your instruction? By designing curriculum units that focus explicitly on putting the science back in teaching in any subject; by using the very data that often scares students, teachers can find a way to influence their students learning on any difficult topic by challenging them to learn the way their brain works.

Rationale

I chose to complete this curriculum unit on Genetics because I wanted to investigate and implement research based methods of learning and I wanted to incorporate data as a way to teach difficult concepts. Often times, we teachers use a wide variety of strategies, but we still find our students struggling. For this unit, the topic of genetics will be taught and used to demonstrate how students can be challenged to use their natural inclination for learning in order to master difficult topics. During a CTI (Charlotte Teachers Institute) Seminar, we learned how to incorporate data into our classroom instruction. In addition, I was able to retrieve other resources about research based practices on how the brain works

Background

In 2014, South Mecklenburg High School, which is located on the southern border of Charlotte, NC was ranked #7 among US News and Reports best high schools in North Carolina. With over 3,000 students, nearly half the school (49%) are classified as economically disadvantaged (CMS, 2015). The demographics consists of 46% white, 27% black, 26% Hispanic, in addition to other racial groups which represent a smaller sector of the campus. In my Greenhouse Biology classroom, the level of academic, social, and cultural differences are obvious and can often hinder student learning. Depending upon the period, there may be five students out of 20 who are classified as ELL (English Language Learners), ten may be poor readers according to their EOG (End of Grade) and EOC (End of Course) scores, and the remaining may be middle to high achievers. Although, the diversity can, at times, add an element of interest to the class due to the differing perspectives, the diversity also presents severe learning challenges.

Greenhouse Biology is classified as an elective course and does not count toward the student's official credit record. Each block is packed with between 20-30 students that were flagged as needing extra assistance based on

their reading scores from 8th grade reading EOG. This is a class full of able bodied 10th graders that have been reduced to the watered down version of a higher level thinking Biology course because they scored a one or two on a reading test they took 2 years ago prior to in high school. Many of them came from places where science learning occurred through lecture and was teacher centered. Based on the newest understanding about how people learn, by authors such as Benedict Carey and Hermann Ebbinghaus, these students received a disservice. It is only through accepting the work that has been completed on the brain and learning that we can truly understand how to reach a population of students that has been classified as low-achieving and who received poor instruction of difficult concepts.

In this curriculum unit background, teachers can apply how all humans learn and attempt to apply the way we learn to the way educators and schools should tailor their curriculum. If educators are able to teach toward success that is student driven, we may be able to see greater results on standardized tests, as well as close the achievement gaps through valid and reliable in-class assessments. Curriculum units should be based on research-supported strategies that maximize student success. Therefore educators will teach other educators how we learn so that they can teach to students how to learn.

Content Objectives

For this unit, since it is primarily to be used to help teachers facilitate units that increase learning, I will use the NC Educator Evaluation System (NCEES) to assess the goals that need to be met. In order for teachers to understand how to inspire learning and to witness student growth on any objective in the classroom, teacher needs to experiment with research-based methods and assess their productivity. This unit is designed to reach all educators while eventually extending to meet the academic needs and success of any student.

In addition to using the NCEES, I will also be using the North Carolina Essential Standards (NCES) to build this unit. For detailed information related to the content objectives, please see Appendix 1 at the end of the unit for details on each for each standard to be assessed.

Content Background

All children, from birth, are ready to learn. Our neural networks begin the process of learning early so that strong connections can be built into their wiring system (Carey, 2014). Each behavior becomes part of our memories -- the place from where we naturally draw when we assess a learned task. Learning in the later stages of life tends to be more difficult because, as the brain ages, the body cannot extend its neural network as easily. Once connections have been established, we must find ways to organize information within the limited space that is available. With all of the information that we have on the brain, educators face the difficulty of understanding what it means to really learn. Is learning rote memorization? It is academic regurgitation? Or is learning built into those moments when we draw from the pool of our long term memory to integrate information?

Our genetics plays a role in who were are as learners, but we have to dig deep into our DNA (deoxyribonucleic acid) in order to find the truth about how information is organized and to find the role this organization plays throughout our lives. How do we observe these changes? How do we formulate the concepts about our genetic make-up through everyday interactions that we have with one another? Students need to understand that just as the brain is hardwired to control many functions in our bodies, deep within our cells, the nucleus takes it position as the manager of the cell using the DNA message to determine may of the traits we exhibit. Behind all of DNA's mystery is this hidden information that is used before cell division and sexual reproduction to make copies of each chromosome and to make a wide array of different types of organisms. Genetics can be a broad topic for biology students. However, the focus of this unit is on DNA, heredity, and basic inheritance patterns. DNA is in every cell in the human body. Heredity is the study of how traits are passed from parent to offspring. Scientists like Gregor Mendel, the Father of Genetics, made great contributions through his pea plant experiments. Students are responsible for understanding how

diseases are inherited, inheritance patterns, as well as the processes that are used to discover the likelihood of certain traits appearing in future generations.

Genetics in high school biology targets several components, all of which cannot be explored in a single unit. The following topics are the focus of most genetics lessons in the 10th grade in North Carolina:

1. DNA Structure and Function
2. Cellular Reproduction (Mitosis and Meiosis)
3. Mendelian Genetics
4. Heredity (Inheritance Patterns)

DNA structure and function lessons will require students to understand that DNA is a double helix which stores genetic information for organisms. This information can be used to for growth, reproduction, and repair. Scientists now know that in addition to its ability to perform complex tasks, DNA's structure relates directly to its function. Cellular reproduction is the next step in the genetic world since replication occurs for the purpose of passing on the genetic material to each new cell. Whether for sex (gametes) or body (somatic) cell reproduction, DNA is a critical piece in an organism's survival, without DNA there are no instructions for life and therefore there would be no life at all. Heredity is another area of the genetics of an organism that can be defined by inheritance patterns. The traits that are coded for in the genes of an organisms DNA helps determine the phenotypes (physical features) and genotypes (genetic make-up) of each organism whether human or insect. Mutations represent mistakes in the DNA sequences and in the chromosomes of an organism that results in variations in a population as well as huge health issues for the organisms. While not all mutation are bad, the mutations that cause damaging alterations in an organisms can lead to physical mishaps or even apoptosis (cell death). Advancements in DNA technology have allowed humans to develop sophisticated ways to determine the paternity of children as well as passing on life saving methods of predicting and preventing genetic disorders before a child is born. The wide scope of genetics can be fascinating and overwhelming for a high school (especially a middle school) student but finding ways to make students successful on difficult unit will prove beneficial when students begin self-regulating and managing their own learning.

<u>Teaching Strategies: Scientific Teaching and Using Data</u>

The only way to truly ensure that you are creating an engaging unit for your students is by putting the science back into teaching. Scientific teaching (Handelsman et al, 2007) –as it is called – requires careful planning and strategic thought to have a profound impact on the classroom. It is not meant to improve teaching except to provide a way to use scientific research to help students improve upon the topics that they learn in school. This method of teaching requires that the teachers build teachable units that keep the students actively engaged, that includes a wide array of activities that affect different backgrounds and that allow for time to reflect on the content that is learned. Any teacher can use scientific teaching. The term scientific does not limit a teacher to a certain content area.

Each unit will be intentional and should to put the focus back on learning; therefore each lesson can be constructed via backwards planning. Backwards planning begins with the end in mind. What is it that the students need to be able to do at the end of the lesson? What are our objectives that must be accomplished? How do I know that the students learned the material? Every activity, video, lecture, game, etc. needs to be tailored toward that goals of the lesson. The 5E instructional model (Bybee et al, 2006) will also be used to build the science lessons to zero in on difficult topics and helps students learn by application rather than memorization of vocabulary words. The data will provide the application and other activities will be added support.

1. **Engagement**: This portion should be an eye opener, a warm-up, or some sort of activity that gets the brain going and that gives the students insight into what they will be learning.
2. **Exploration**: This portion allows the students to wrestle with the topic. Students should be given material that complements the engagement part of the lesson and allows the students to natural draw conclusions and participate in the lesson. Exploration is heavily based on activities.

3. **Explanation**: During the explanation, students try to use their reasoning skills to discuss or reflect on what happened during the activity.
4. **Elaboration**: For those students that need an extra boost, this is a great time to differentiate (focus on meeting the needs of the whole class) and challenge the thoughts of the students through a new activity or mini lesson.
5. **Evaluation**: Teachers find ways to assess the knowledge that has been acquired by each students through quizzes, tests, and projects.

Data Analysis Assignments

Data is an important part of this unit, therefore, it is essential that each analysis assignment is used and that the literacy strategies that are suggested are used to help the students to feel comfortable with the data and the difficult concepts. It is best to force them to annotate and to utilize all of the necessary tools that we learned during our seminar. All data analysis sheets were created by the writer of this unit, Adora Reid. For permission to make changes to the document, please email reid_1409@yahoo.com.

Unit Topics for Lessons

The sections listed below will be taught over an estimated 6 days including a post assessment. View suggested timeline below.

Day 1	Review DNA and Pre Assessment of Objectives and Content *I can identify DNA as the heritable material*
Day 2	Introduction to Genetics Contributions to Genetics Dominant, Recessive, Genotype, Phenotype, Homozygous, Heterozygous *I can explain scientist's contributions to the current study of Genetics.*
Day 3	Punnett Squares Offspring Ratios (Genotypic and Phenotypic Ratios) *I can interpret Punnett Squares to determine phenotypic and genotypic ratios.*
Day 4	Patterns of Inheritance Co-Dominance Incomplete Dominance Polygenic Traits (skin, hair, eye color) *I can recognize a variety of intermediate patterns of inheritance.*
Day 5	Karyotypes (gender, chromosomal abnormalities) Pedigrees (genotypes, type of inheritance) *I can interpret karyotypes and pedigrees to identify inheritance factors for particular individuals.*
Day 6	Post Assessment on Genetics

Questions to Consider before Lesson Development

The following questions are to be used as a part of the backwards planning model so that with each lesson, you, as the instructor, can know where the lesson should be going and assist students in reaching that goal.

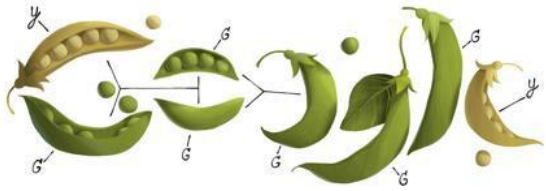
1. What should students know or be able to do as a result of this lesson?
2. Why is it (that learning) important?
3. How do you know who (if anyone) does not already have that knowledge?
4. What will success look like? How will you measure it for each student?
5. What activities and resources will lead to success for all students?
6. What will you do if students (all or some) do not achieve success?

Teacher Notes + Daily Lesson Plan

Teacher:		**Semester __**	**Subject/Course: Biology**
	Topic:	**Genetics (DNA Review/PreAssess)**	**Grade level: 9-12**
	Desired Results/Assessment evidence		
	I can assess my own knowledge of content objectives ***I can*** *identify the parts of DNA as the genetic material* ***I can*** *explain scientist's contributions to the current study of Genetics.* ***I can*** *locate and identify the genotypes and phenotypes of an organism* ***I can*** *analyze and calculate ratios from a Punnett square model* ***I can*** *describe the importance of genotypes and phenotypes*		
	NC Essential Standards: **Biology 3.2** **Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.** Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance).		
	21st Century Skills Observing, Identifying, Predicting, Organizing Data, Communicating, Measuring.		
	Essential Question (s): **What contributions have scientists made to the field of genetics?** **How do we know that DNA is the genetic material?**		

	Learning Plan
	Legend: GP=Guided Practice; IP=Independent Practice; INM=Introduce New Material; EQ=Essential question; bmo=by means of; PH=Prentice Hall textbook;
Engage: (Warm-up)	**Day 1** Teacher can begin the class with a short warm-up using the 3-2-1 strategy. Give each students a sticky note as they enter the classroom. On the board, have the assignment posted: **Warm-up: DO NOW (on sticky note)** 1. **Use only 3 words to describe DNA** 2. **Describe 2 ways that DNA is useful to every organism** 3. **List 1 thing that you wish you knew about DNA** After 5-7 minutes, when students are finished direct students to place responses in a central location in the room (on a door, on the whiteboard, on a window). Use notes as a way to assess prior knowledge and to dispel misconceptions
Explore Explain	***Pre-Assessment (See*** Appendix II***):*** Students will complete a pre-assessment to determine their knowledge and confidence in unit objectives. The teacher will distribute the sheet: Unit Content Objectives and allow the student's time to rate their current understanding of vocabulary words and objectives. (This pre-assessment in available with the lesson and must be given at the end of the unit) Teacher must explain to students that they are to rate themselves on scale of 1-5 on the vocabulary portion and they must use the rubric on the objective side (read the statements) Teacher will load up the video What is DNA and how does it work? From Stated Clearly channel on YouTube. Teacher can create their own follow-up questions or use the ones below. Teacher will allow student to interview a partner using the following questions for 1: 30 seconds each (total 3 minutes). **Interview Questions:** a. **Describe DNA** b. **Explain how DNA works**
Evaluate	Teacher will then proceed with the lesson after the interviews. Ask at least two groups to share their findings. After groups share with the class, distribute the article, *Dealing with DNA* (Appendix II). Direct the students to look at the figures first for 60 seconds. Then, instruct the students to write in the margins the most important information from each figure. After students have annotated next to each figure, model how to read each selection and answering the reflection questions with the class. Instruct students to record their responses to the questions in complete sentences in their interactive notebooks. After modeling for the students once, allow the students to complete the rest of the reading alone. **Modification: For ELL students, pair them with a student that speaks English. Instruct the native English speaker student to read the passages and show the ELL student what to record for the team.**

Teacher Notes + Daily Lesson Plan

Teacher:		**Semester __**	**Subject/Course: Biology**
	Topic:	**Genetics (Mendel)**	**Grade level: 9-12**
	Desired Results/Assessment evidence		
	I CAN identify the contributions that Gregor Mendel made to the field of Genetics *I CAN interpret data in a Punnett Square*		
	NC Essential Standards: **Biology 3.2** **Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.** Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance).		
	21st Century Skills Observing, Identifying, Predicting, Organizing Data, Communicating, Measuring.		
	Essential Question (s): **What contributions did scientists make to the field of Genetics?**		
	Learning Plan		
	Legend: GP=Guided Practice; IP=Independent Practice; INM=Introduce New Material; EQ=Essential question; bmo=by means of; PH=Prentice Hall textbook; APK=Assess Prior Knowledge		
Engage: (Warm-up) Explore	**<u>Day 2</u>** ***EQ:*** Teacher will distribute a short reading from the Washington Post titled, *Google Doodle Celebrates Gregor Mendel (https://www.washingtonpost.com/blogs/comic-riffs/post/gregor-mendel-new-google-doodle-celebrates-the-father-of-genetics/2011/07/20/gIQAL5sFPI_blog.html)* Teacher can project the image of his Google Doodle to draw the student's interests, in addition, to the following instructions.  **Warm-up: Do NOW** **1. Read the article. As you read, highlight at least 2 key points to remember about Gregor Mendel.** **2. Describe the type of plants pictured above. Explain how the plants relate to the article you read and the 2 key points you highlighted.** **3. Explain why Google may have chosen to create a Doodle for Mendel? (He is the Father of Genetics)**		

Explain	***INM***: Teacher should have students investigate the question: *Why do traits disappear?* Teacher can take comments from the class and write them on the board (Brainstorm) (This is a question that Mendel essentially wanted to explore through his pea plant experiments.) Show students the video from TedEd: How Mendel's Pea Plants Helped Us Understand Genetics: https://www.youtube.com/watch?v=Mehz7tCxjSE Have Students reflect alone in their notebooks by completing the following task after the video: Check for Understanding: 1. Explain why Mendel worked on Pea Plants. 2. Explain what Mendel discovered through his experiments on Pea Plants
Evaluate (Closing Activity)	***GP:*** Students will receive the reading selection: *Mendel's Pea Families (*Appendix II) to analyze. Students will be instructed that they will read the short passages and answer the reflection questions in their notebooks as before. On Day 2, direct the students to look at the figures first for 60 seconds. Then, instruct the students to write in the margins the most important information from each figure. After students have annotated next to each figure, model how to read each selection and answering the reflection questions with the class. Instruct students to record their responses to the questions in complete sentences in their interactive notebooks. After modeling for the students once, allow the students to complete the rest of the reading alone. **Modification: For ELL students, pair them with a student that speaks English. Instruct the high student to read the passages and show the ELL student what to record for the team.** Create an advertisement: Gregor Mendel is in need of a great deal of help with his research. Since he spends all his days in the garden with his plants, he has no time to seek the help that he needs. Create a short advertisement on behalf of Mendel to find an assistant. Include in your advertisement: 1. Identify who Gregor Mendel is. 2. Explain the work that he is completing with the pea plants. 3. Include pictures of Mendel and his garden (peas included) 4. Include a small section about his research so far (use information from the Data Analysis Assignment) 5. Include a payment (it cannot be more than 5 dollars per hour) 6. The advertisement must be neat, interesting, and legible.

Teacher Notes + Daily Lesson Plan

Teacher:	**Semester __**		**Subject/Course: Biology**
	Topic:	**Genetics (Punnett Squares)**	**Grade level: 9-12**

	Desired Results/Assessment evidence
	I CAN interpret a Punnett square *I CAN create a product that demonstrates my ability to read and interpret a Punnett square.* *I CAN calculate the ratios of Punnett squares*
	NC Essential Standards: **Biology 3.2** **Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.** Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance).
	21st Century Skills Observing, Identifying, Predicting, Organizing Data, Communicating, Measuring.
	Essential Question (s): **I can interpret Punnett Squares to determine phenotypic and genotypic ratios.**
	Learning Plan
	Legend: GP=Guided Practice; IP=Independent Practice; INM=Introduce New Material; EQ=Essential question; bmo=by means of; PH=Prentice Hall textbook;
	<u>Day 3</u>
Engage: (Warm-up)	Teacher can project a Punnett square problem on the screen. Instruct the students to create the Punnett square on their own paper and answer the related questions. (If may be best to use the same Punnett square problem from the Data Analysis Assignment from Day 2 to continue to reinforce the topic.)
Explore	Teacher will play the video: Monohybrids and Punnett Squares (Appendix II) by the Amoeba Sisters on YouTube. The Amoeba sisters have guides for all of their videos at www.amoebasisters.com. Teacher needs to create a key for the video and review each question with the class. Use this time as a moment to dispel misconceptions. Ask the students if they had difficult with a topic or example from the video. Review the topic with them before moving on.
Evaluate	***GP***: Punnett Square Practice- Students will complete a set of practice problems where they solve Punnett square scenarios with a partner. Teacher can chose to model on problem with the class and instruct them to work in teams (recommended). If students work in teams, assign roles. 1s read first, 2s write first and after each problem encourage them to swap roles. In addition, this would be a great time to teach the students how to read and interpret

	karyotypes before going into pedigrees.
Elaborate **(First day to do this)**	***IP:*** Students will receive the reading selection: *Analyzing Crazy Karyotypes (*Appendix II) to analyze. Students will be instructed that they will read the short passages and answer the reflection questions in their notebooks as before. On Day 3, direct the students to look at the figures first for ***30 seconds***. This is different from Day 1 and 2. Then, instruct the students to continue to write in the margins indicating the most important information from each figure. After students have annotated next to each figure, model how to read each selection and answering the reflection questions with the class. Instruct students to record their responses to the questions in complete sentences in their interactive notebooks. After modeling for the students once, allow the students to complete the rest of the reading alone. **Modification: For ELL students, pair them with a student that speaks English. Instruct the high student to read the passages and show the ELL student what to record for the team.**
Evaluate:	Teacher can review the data analysis assignment with the class and then ask three check for understanding questions below. 1. Explain how Punnett squares and karyotypes are used by scientists to understand inheritance patterns. 2. Describe one concept that is still difficult for you to grasp from the Data Analysis Assignment or the Video Guide. 3. Describe in one sentence on thing that you would like to know more about.

Teacher Notes + Daily Lesson Plan

Teacher:	**Semester __**	**Subject/Course: Biology**
Topic:	**Genetics (Interpreting Pedigrees)**	**Grade level: 9-12**

	Desired Results/Assessment evidence
	I CAN interpret a pedigree
	NC Essential Standards: **Biology 3.2** **Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.** Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance).
	21st Century Skills Observing, Identifying, Predicting, Organizing Data, Communicating, Measuring.
	Essential Question (s): **How can scientists determine inheritance patterns?**
	Learning Plan
	Legend: GP=Guided Practice; IP=Independent Practice; INM=Introduce New Material; EQ=Essential question; bmo=by means of; PH=Prentice Hall textbook;
Engage:	**Day 4** ***Begin the class with the short video on Pedigrees from Teacher's Pet on YouTube.*** **(See**

(Warm-up)	Appendix II for link) ***Project the following questions after the video. Allow the students 5-7 minutes to answer the questions.*** ***Warm-up: DO NOW*** ***1. Explain the importance of Pedigrees*** ***2. Explain why the key or legend for a pedigree will make reading it very easy.***
Explore	***GP:*** On Day 4, dive right into the Data Analysis Assignment. This may take students while to complete. Students will receive the reading selection: *Royal/Popular Pedigrees (*Appendix II) to analyze. Students will be instructed that they will read the short passages and answer the reflection questions in their notebooks as before. On Day 4, DO NOT direct the students to look at the figures first. Give them the Data Analysis Assignment and let them work. Instruct the students to write in the margins but on Day 4 let them use codes and symbols to reflect on the reading for example (star= important,?= questions, arrows= connection to something we already learned, etc). After students have annotated next to each figure, model how to read each selection and answering the reflection questions with the class. Instruct students to record their responses to the questions in complete sentences in their interactive notebooks. After modeling for the students once, allow the students to complete the rest of the reading alone. **Modification: For ELL students, pair them with a student that speaks English. Instruct the high student to read the passages and show the ELL student what to record for the team.**
Elaborate	Once the students have complete the Data Analysis Sheet, show them the second video, Meiosis form the Amoeba Sisters as a quick review on how chromosomes are passed from parent to offspring, through the process of Meiosis. **Create your own Pedigree (See** Appendix II): This activity is simple. The only materials needs is copy paper, colored pencils, markers, laptops (if needed), and science textbook (if information is available). Students can use laptops and approved sites to research information about the following genetic disorders: Hemophilia, Baldness, and Colorblindness. Direct students to research information about each disorder and to create a story about a fake family that is faced with one of the disorders. The students must include the following information for full credit: **1. A family pedigree (with a legend; include normal, carriers, and affected individuals)** 2. **A detailed storyline and explanation about the family and the disorder that is harming the family.** Recommended sites to use for research: https://www.genome.gov/**Stu**... www.pbslearningmedia.org/...**disorder**/inheritance-of-**genetic-disorders**/

Teacher Notes + Daily Lesson Plan

Teacher:	**Semester __**	**Subject/Course: Biology**
Topic:	**Genetics (Non Mendelian Genetics)**	**Grade level: 9-12**

Desired Results/Assessment evidence

I CAN recognize a variety of intermediate patterns of inheritance (codominance and incomplete dominance).

I CAN recognize that some traits are controlled by more than one pair of genes and that this pattern of inheritance is identified by the presence of a wide range of phenotypes (skin, hair, and eye color).

NC Essential Standards:

Biology 3.2
Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.

Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance).

21st Century Skills
Observing, Identifying, Predicting, Organizing Data, Communicating, Measuring.

Essential Question (s):
How are other traits distributed in the population?

Learning Plan

Legend: GP=Guided Practice; IP=Independent Practice; INM=Introduce New Material; EQ=Essential question; bmo=by means of; PH=Prentice Hall textbook;

<u>Day 5</u>

Engage: (Warm-up)

Teacher can have students to create an inventory of their family and describe all of their members in four categories (height, eye color, hair types). Student can fill in the chart like the one below. Teachers must make sure that students included themselves in the inventory. Once students are complete, have them review the similarities in traits that they share with their family members. Ask student what they notice about height, hair type, and eye color. (Introduction to non-Mendelian inheritance) Remind student of Mendel's findings from Day 1, expand their knowledge to recognize other patterns.

Family Members	Tall/Short	Straight/Curly/Wavy	Brown/Blue/Other
Mom	Short	Curly	Brown
Dad	Tall	Straight	Brown
Me	Medium	Wavy	Blue

Explore

Explain Evaluate	Teacher can begin class again Incomplete Dominance, Codominance, Polygenic Traits, and Epistasis! (Amoeba Sisters). Have students define each term in their own words or list and example of each that may occur in real life. ***GP:*** Students will receive the reading selection: *Mendel, why is my hair so wavy (*Appendix II) to analyze. Students will be instructed that they will read the short passages and answer the reflection questions in their notebooks as before. On Day 5, students should be familiar enough with the process to know what to do. Simply remind them to look at the figures first for 60 seconds. Then, instruct the students to write in the margins the most important information from each figure. You can also add from Day 4 the code for annotating (star= important, ?= questions, arrows= connection to something we already learned, etc). After students have annotated next to each figure, model how to read each selection and answering the reflection questions with the class. Instruct students to record their responses to the questions in complete sentences in their interactive notebooks. After modeling for the students once, allow the students to complete the rest of the reading alone. **Modification: For ELL students, pair them with a student that speaks English. Instruct the high student to read the passages and show the ELL student what to record for the team.**

Teacher Notes + Daily Lesson Plan

Teacher: Adora Reid	**Semester 2**	**Subject/Course: Biology**	
	Topic:	**Genetics (Review and Post Assessment)**	**Grade level: 9-12**
	Desired Results/Assessment evidence		
	I can *identify the parts of DNA as the genetic material* ***I can*** *explain scientist's contributions to the current study of Genetics.* ***I can*** *locate and identify the genotypes and phenotypes of an organism* ***I can*** *analyze and calculate ratios from a Punnett square model* ***I can*** *describe the importance of genotypes and phenotypes*		
	NC Essential Standards: **Biology 3.2** **Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.** Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance).		
	21st Century Skills Observing, Identifying, Predicting, Organizing Data, Communicating, Measuring.		
	Essential Question (s): **What contributions did scientists make to the field of Genetics?** **How are other traits distributed in the population?**		

	How can scientists determine inheritance patterns? **I can interpret Punnett Squares to determine phenotypic and genotypic ratios.**
	Learning Plan
	Legend: GP=Guided Practice; IP=Independent Practice; INM=Introduce New Material; EQ=Essential question; bmo=by means of; PH=Prentice Hall textbook;
	<u>Day 6</u>
Engage: (Warm-up)	***POST-Assessment:*** Students will complete a POST-assessment to determine their knowledge and confidence in unit objectives. The teacher will distribute the sheet: Unit Content Objectives and allow the student's time to rate their current understanding of vocabulary words and objectives. (This pre-assessment in available with the lesson and must be given at the end of the unit) Teacher must explain to students that they are to rate themselves on scale of 1-5 on the vocabulary portion and they must use the rubric on the objective side (read the statements)
Explore/Explain	***KAHOOT REVIEW GAMES:*** Teacher will integrate technology into the lesson by incorporating a Kahoot Review Game. Search Kahoot games under ***<u>Genetics</u>*** on the "getkahoot.com" website. Be sure that your free account is created and that you are familiar with how to play before using this tool. If needed, you can create your own game using the images from the Data Analysis Assignments **(See** Appendix II) Kahoot is played by students using their electronic devices at "kahoot.it". If phones are not allowed in the school, the students can use laptops or any other electronic media to play. MODIFICATION: for students who do not have an electronic devices, you can have them answer on a separate sheet of paper or allow them to partner with a classmate. 1. Students must uses regular names to receive credit for participation 2. Students who earn the top number of points and pass with 80% accuracy can receive an incentive of their choice. (their favorite snack, homework pass, classroom helper for the day, etc)
Evaluate	Teacher will distribute an assessment based on the topics that are taught in the previous lessons. It is important to note that since an analysis of data was used to teach the concepts successful assessment of the unit will need to accurately reflect strategies used in the lessons. While multiple choice tests are a good tool, the use of data, charts, and other examples will best serve students in this assessment. This assessment will be teacher designed. An example is provided in the teacher resources section of the unit.

Annotated Bibliography

Bybee, R. et al. (2006) *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications, an executive summary.* Retrieved from http://www.bscs.org/sites/default/files/_legacy/BSCS_5E_Instructional_Model-Executive_Summary_0.pdf

Rodger Bybee and the staff at BSCS provide an executive summary of the 5E model and the measures of its effectiveness since implementation.

Carey, B. (2014). *How we learn: the surprising truth behind how the brain works*. Random House. New York, NY.

Benedict Carey's account of how we learn is an excellent culmination of old information and new research that gives each reader insight into the best practices for truly maximizing upon the natural ways of learning in the brain. The truth behind how the brain works uncovers mysteries and research that debunks previously practiced methods like rote memorization and studying in a quiet place. All of the ideas in the book help not only casual readers but educators to tap into the minds of their students to get them engaged and on the right side of learning.

NC Department of Public Instruction (2012). *NC Teacher Evaluation System*. Retrieved on June 18, 2015 from http://www.ncpublicschools.org/docs/effectiveness-model/ncees/instruments

The North Carolina Educator's Evaluation System is a tool used by the state to determine the effectiveness of each teacher. NCEES as it is called in short challenges teachers to reflect on their practice, to consider how to push students to the next level of learning and can be beneficial in ensure that educators are growing and improving in their own craft.

Handelsman, J, Miller, S, and Pfund, C. (2007) *Scientific teaching*. Macmillian.

Scientific Teaching is a highly recommended and scholarly text that encourages educators to put the science back into teaching. Many of the methods and strategies used in this book are based on solid research. The ideas help teachers to decide how to build a successful lesson and what components need to be taken into consideration before a lesson (even a unit) is created.

Image Credits

Figure 4.1 from Royal Pedigrees. Retrieved from http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/Q/Queen_Victoria.html

Map from Mendel, why is my hair so wavy? Retrieved from https://en.wikipedia.org/wiki/Human_skin_color#/media/File:Unlabeled_Renatto_Luschan_Skin_color_map.svg

Appendix I: Content Objectives

North Carolina Essential Standards (NCES) in Biology

Biology 3.2
Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.

Bio.3.2.2 Predict offspring ratios based on a variety of inheritance patterns (including dominance, co-dominance, incomplete dominance, multiple alleles, and sex-linked traits).

NCEES (North Carolina Educator Evaluation System)
Objective 1: Educators will make the content that they teach relevant, engaging, and achievable for all students and will create lessons and units that develop the whole learner (p.7, 2012).

Objective 2: Educators will not simply cover material, but will be facilitators of learning; helping students to discover the solutions to complex problems (p.7, 2012)

Objective 3: Educators demonstrate how to use 21st century skills such as critical thinking, problem solving, analyzing data or complex texts, and dissecting digital information (technology, communication) (p.7, 2012)

Appendix II: Teacher Resources

Essential Unit Vocabulary List for Teachers

The vocabulary list below is meant to be used as a reference for teachers to include in their classroom instruction. It is up to the teacher to decide how to address the vocabulary. Many of the definitions are listed in the Data Analysis Assignments.

Genetics- the study of heredity
Gregor Mendel- Father of Genetics
Heredity- study of the way in which traits are passed from parents to offspring
Traits- characteristics of a living thing; ex. skin color, hair color, eye color
Gene- unit of heredity that is located on a chromosome made of DNA
Hybrid/heterozygous- two different allele for a trait;
Pure/homozygous- contains two same alleles for a trait;
Allele- alternate forms of a gene. ex. for eye color:
Dominant- "stronger gene"; CAPITAL LETTER
Recessive- "weaker gene"; lower case letter
Genotype- genetic makeup; letters
Phenotype- physical appearance; what the organism looks like
Punnett square- a chart drawn to determine the probable results of a genetic cross
Fertilization- process in sexual reproduction in which male and female gametes (sperm& egg) join to form a zygote
Segregation- separation of alleles during gamete formation
Codominance- when two alleles blend and both phenotypes are evident (e.g., AB blood type),
Incomplete dominance- when the dominant trait does not completely mask the recessive trait (e.g., red x white flowers produces pink flowers).
Karyotypes- map of chromosomes
Pedigrees- a map of how genetic diseases are passed through families
Sex-linked traits- traits that are carried on the sex chromosomes
X-linked traits- traits connected to the X chromosome

Video Resources:
How Mendel helped us to Understand Genetics (Ted Education)
Link: https://www.youtube.com/watch?v=Mehz7tCxjSE

Monohybrids and the Punnett Square Guinea Pigs (Amoeba Sisters)
Link: https://www.youtube.com/watch?v=i-0rSv6oxSY

Incomplete Dominance, Codominance, Polygenic Traits, and Epistasis! (Amoeba Sisters)
Link: https://www.youtube.com/watch?v=YJHGfbW55l0

What is DNA and how does it work? (Review Video) (Stated Clearly)
Link: https://www.youtube.com/watch?v=zwibgNGe4aY

Pedigrees (Teacher's Pet)
Link: https://www.youtube.com/watch?v=YhRxoA_49m8
Meiosis (Review Video) (Amoeba Sisters)
Link: https://www.youtube.com/watch?v=toWK0fIyFlY

Materials List

This materials list is meant to assist you and make learning simple. Some materials are optional and can be used at the discretion of the instructor. Please adjust based on your needs and resources.

Creating an Advertisement for Mendel (Day 2)
-Copy paper
-Markers/Colored Pencils
-Glue
-Scissors (to cut pictures)
-Pictures of Mendel in his garden (Optional; students can draw here)
-**Mendel Pea Families (Data Analysis Assignment)**

Create your own Pedigree
-Laptops/Electronic Devices (Optional)
-Copy paper
-Markers/Colored Pencils
-Royal Pedigrees (Data Analysis Assignment)

Mendel's Pea Families

Essential Question: What contributions did scientists make to the field of genetics?

Directions: Analyze each diagram and then read the supporting information. Answer your questions in complete sentences in your Interactive Notebooks.

Gregor Mendel was an Austrian Monk who spent many days studying the **GENETICS** of pea plants. In other words, Mendel wanted to see how new peas received traits from their parents. As you know, **TRAITS** are characteristics of an organism that can be passed down from parent to offspring. Traits can be expressed as **ALLELES,** which are different forms of a trait (for example, eye color is a trait. Eyes can be brown or blue- the different colors are alleles). Mendel recorded the many alleles he found in his experiments and they are listed in Figure 1.1 to the right. These alleles are processed as proteins by the cells during mitosis to make the correct phenotype for the organism. **PHENOTYPES** are the <u>physical features</u> that you see as a result of the alleles in the genotype. **GENOTYPES** are the <u>written letters</u> that represent codes for phenotypes.

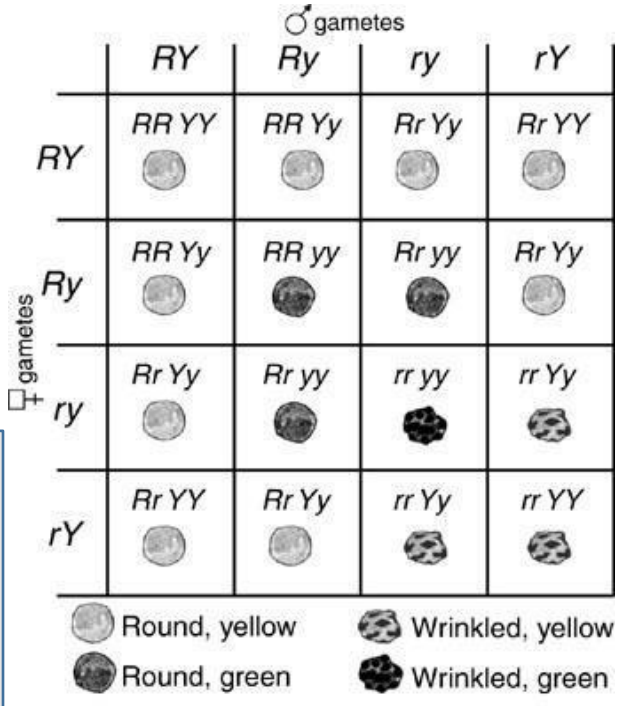


Figure 1.1: *A) Punnett square from Mendel's famous pea plant experiment shows the inheritance patterns of peas. B) Phenotypic ratio is 9:3:3:1. Image credit: South Mecklenburg, CMS*

Reflection Questions:

1. ***Identify at least three GENOTYPES of the pea plants.***
2. ***Identify at least two PHENOTYPES of the pea plants.***
3. ***Based on the figure, how many different combinations of genotypes were present in that pea population? Count them.***
4. ***Calculate the number of pea plants that inherited the phenotypes listed. (for example: find the number of round, yellow plants)***

The genotypes of the pea plants are a combination of the alleles received from the **GAMETES** of the mother and the father pea plant. Recall that during fertilization, offspring receive half of their genetic information from the mother's egg and the other half from the father's sperm. In plants, Mendel observed the same pattern. Therefore, the genotypes for the pea plants are RR, Rr, YY, Yy. The phenotypes are round, yellow, wrinkled, and green. Depending upon the kind of genotype received from each parent, the peas are going to all look different. Based on the Figure, there are 16 different combinations of alleles in the chart. The chart is called a **PUNNETT SQUARE**. By counting the number of combinations in the Punnett square, you can also determine the number of plants that exhibited each phenotype. There are 9 round, yellow plants, 3 round, green plants, 3 wrinkled, yellow plants, and 1

wrinkled and green plant. Often written as 9:3:3:1, these numbers are called **RATIOS** which Mendel discovered in his experiments.

Reflection Questions:

5. ***Predict what may happen if the Punnett square only contained four boxes instead of 16. How would the ratios change for the pea plants? What would be the chances of each child inheriting their parent's traits?***
6. ***Which of the traits from the figure would you consider to be dominant (strong) or recessive (weak)?***
7. ***Explain why the genotypes RR, rr, YY, yy would be connected to the root word: HOMO- and the other genotypes, Rr and Yy would be connected to the root word: HETERO- .***

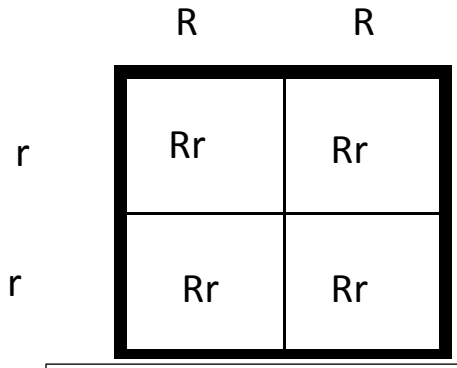


Figure 1.2 *Classic Punnett square*

If Mendel's Punnett Square only contained four boxes it would look like Figure 1.2. The ratios would increase drastically and the chances of each child inheriting their parents traits changes depending on the alleles that are available. Consider the setup in Figure 1.2 and examine how the ratios change.

When genotypes are the same letter they are considered **HOMOZYGOUS** because they are the same. In the case of the pea plants, the mother gave a capital "R" and the father also gave a capital R, creating the genotype RR. The same pattern can be followed for the other homozygous traits. Traits can also be dominant or recessive. **DOMINANT** genes like the allele "R" represent genes that are stronger while genes like the allele "r" are considered **RECESSIVE** because they are weaker. So, the genotypes RR and YY = HOMOZYGOUS DOMINANT and the genotypes rr and yy = HOMOZYGOUS RECESSIVE. Any genotypes with two different size letters are considered HETEROZYGOUS because it represents two different alleles, one dominant and one recessive.

Reflection Questions:

8. What do you think Mendel concluded from his experiments on pea plants?
9. Evaluate how Mendel's experiment with pea plants can help you to understand why you are not clones of your parents?
10. Explain how Mendel's contributions to genetics helps us to understand inheritance patterns in families today. Give specific examples from the reading and the figures to support your answer.

Analyzing Crazy Karyotypes

Essential Question: I can interpret a karyotype to determine inheritance patterns for individuals

Directions: Analyze each diagram and then read the supporting information. Answer your questions in complete sentences in your Interactive Notebooks.

Ever wondered what those 46 chromosomes in your cells look like? Do you ever wish that some scientist would just take a picture and show you what it looks like when all of the chromosomes are laid out on a piece of paper? Scientists figured out a way to map out the chromosomes so that they can be read and used to determine human disorders. These maps are called karyotypes. Karyotypes help scientists in many different fields. Normal human **KARYOTYPES** have 23 pairs (46 chromosomes). Each chromosome pair on a karyotype can be mapped out in the same way regardless of the number or the

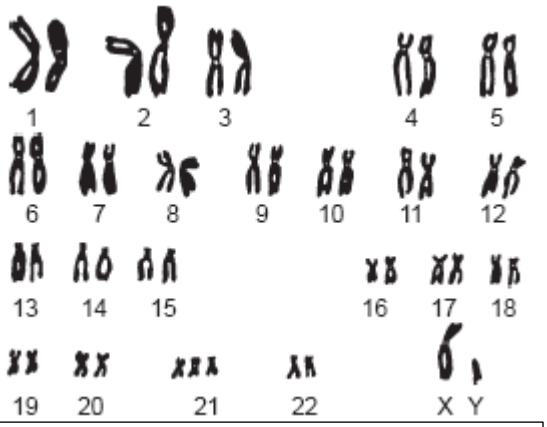


Figure 2.1: An human karyotype with 47 chromosomes which indicates that this individual may have an genetic disorder. *Image credit: South Mecklenburg High, CMS*

Reflection Questions:

1. How many pairs of chromosomes are present in Figure 2.1?
2. Look at the 21st pair of chromosomes. What do you notice about that set that may be different from the others?
3. How can karyotypes be used to help scientists in the medical field?
4. Using your knowledge of meiosis, predict how the extra chromosome may have appeared in this individual's karyotype.

In the karyotype, there are 22 pairs of homologous chromosomes; however, for the individual whose chromosomes were mapped in figure 2.1, there is a triplet group making the chromosome count 47 instead of the usual 46. **HOMOLOGOUS CHROMOSOMES** are usually the same size and contain similar pieces of information. Karyotypes can be used to determine whether abnormalities in the chromosome are harmful genetic diseases and can be used to study the division of cell information during meiosis. It is possible that 21st chromosome was duplicated during interphase of meiosis. This chromosome was then divided into the cells and passed on to the child.

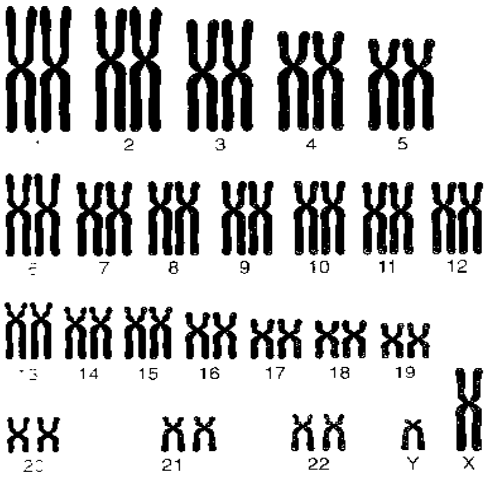


Image credit: South Mecklenburg High, CMS

Reflection Questions:

5. Analyze the karyotype to the right. What do you notice about the size of the chromosomes? Would you consider them to be homologous? Why or why not?
6. Examine the last set of chromosomes. These are used to determine the sex of the organism. Predict why these chromosomes may appear different.

Dealing with DNA

Essential Question: How do we know that DNA contains genetic information?

Directions: Analyze each diagram and then read the supporting information. Answer your questions in complete sentences in your Interactive Notebooks.

As you may remember from your previous lessons on DNA, it is an acronym that stands for **DEOXYRIBONUCLEIC ACID** (de-oxy-ry-bow-nu-clay-ic acid). **DNA** can code for traits in all organisms and is shaped like a double helix. Scientists James Watson, Francis Crick, and Rosalind Franklin are the most famous participants in the discovery of this special molecule. But, how did they know that the DNA was an important molecule that held information for all of life? In other experiments complete by Griffith, Avery, among other scientists, DNA was tested in bacteria cells to determine what happens when information is missing. Their findings were astounding and led to a greater understanding of the genetic code that we use today. In the double helix structure, there are four popular **NITROGEN BASES (A, C, T, G)** that make up the middle of the ladder, in addition to, the **DEOXYRIBOSE** and **PHOSPHATE** molecules. These pieces makes up a nucleotide which are the building blocks of DNA.

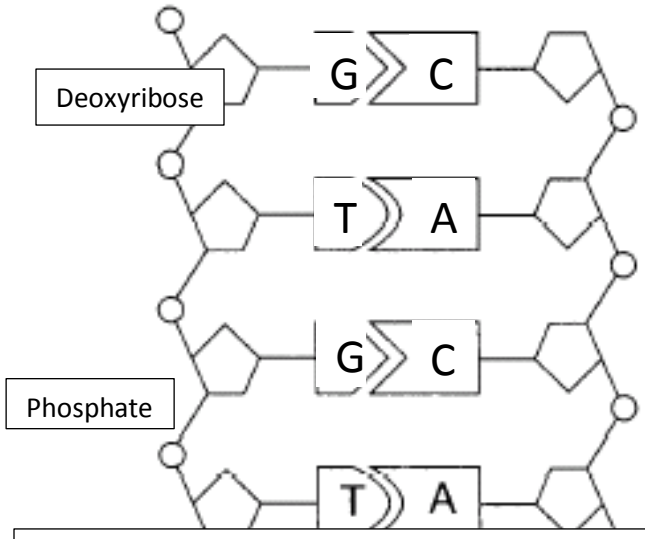


Figure 3.1: Ladder model of DNA. Image credit: South Mecklenburg High, CMS

Reflection Questions:

1. Examine the DNA molecule in Figure 2.1. Create rule that you can establish based on the paring of the nitrogen bases.
2. Describe one thing that you notice about the structure of the DNA molecule. Think about how things are positioned and organized.

In order to better understand the structure of the DNA molecule, a rule was established by Erwin Chargaff called Chargaff's rule. What does this rule say? It simply states that A (Adenine) is ALWAYS paired with T (Thymine). It also states that C (Cytosine) is ALWAYS paired with G (Guanine). Therefore, in simpler terms A=T and C=G. The structure of the DNA is also made up of important parts called nucleotides. Nucleotides consist of 3 main components: sugar (glucose), phosphate, and nitrogenous bases. The ladder model of DNA is helpful because it allows us to see the simple parts of DNA but is also shows how organized DNA can be.

Original Strand	**ATCGTA**	**TTACCG**	**GAACTA**
New Strand	**TAGCAT**	**AATGGC**	**CTTGAT**

Reflection Questions:

3. DNA must be copied in order to be moved into a new cell. Based on the original strands in the chart above, was the new strand copied properly? Using Chargaff's rule, explain why the new strand is correct.

Royal Pedigrees

Essential Question: I can interpret karyotypes and pedigrees to identify inheritance factors for particular individuals.

Directions: Analyze each diagram and then read the supporting information. Answer your questions in complete sentences in your Interactive Notebooks.

Remember those popular commercials with the cute puppies running across the yard and finally in the end a huge bag of dog food would show up on the screen advertising the food brand Pedigree? What you may not have realized is that even the names of dog food could have significant meaning, for example, in the field of genetics, **PEDIGREES** are actually ways for scientists to trace **INHERITANCE** factors in families. There was once a famous British royal family that had a huge problem with Hemophilia which is a blood disorder that prevents the blood from clotting. Eventually males that were impacted by the disorder bled to death creating a devastating loss for the family. The hemophilia gene is linked to the X chromosomes and can only be passed onto boys from their mothers. No females are affected by Hemophilia. How do we know that? By using pedigrees.

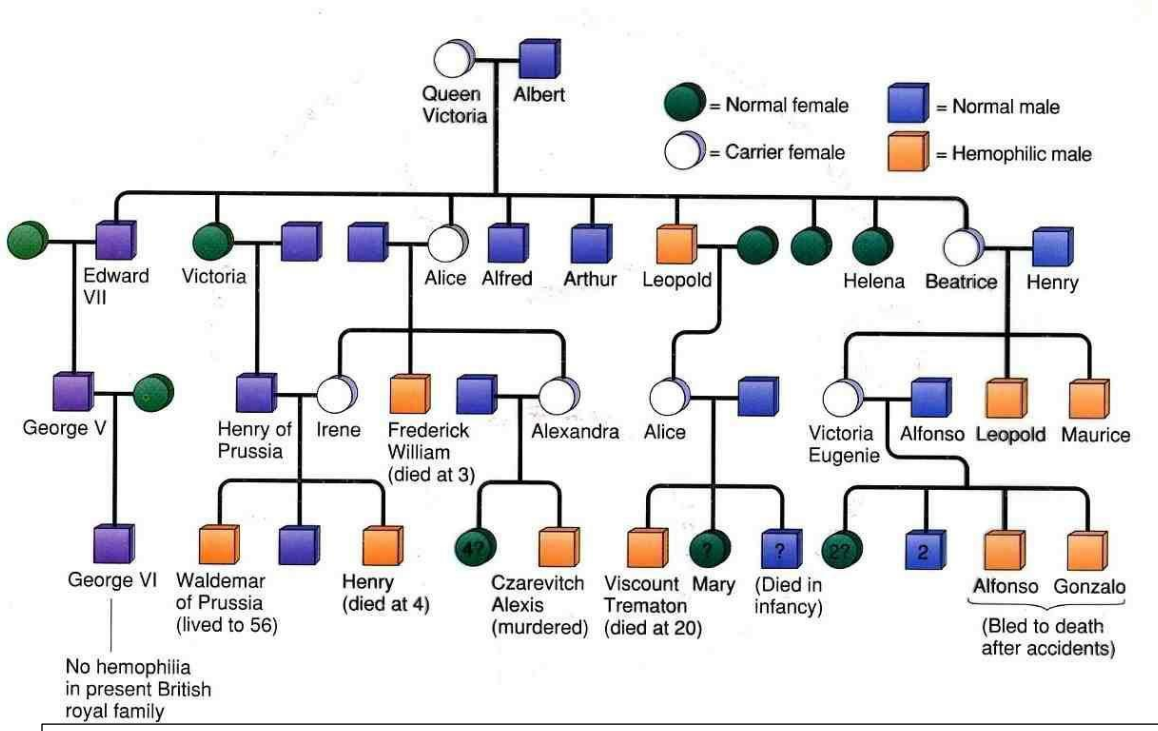


Figure 4.1: Royal Family of Queen Victoria. The pedigree shows the lineage of the royal family and the carriers, normal relatives, and hemophiliac members of the family. Image credit: http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/Q/Queen_Victoria.html

Reflection Questions:

1. Consider the pedigree above in Figure 4.1. Calculate the number of males in the Royal Family that acquired the hemophilia disease.
2. Identify the mothers that were carriers of the hemophilia genes but were not affected by the diseases. (Use their names for proper identification purposes).

Royal Pedigrees (Part 2)

Essential Question: I can interpret karyotypes and pedigrees to identify inheritance factors for particular individuals.

3. Examine the figure carefully and create a conclusion about why the hemophilia disease was so rampant in this family. In order for the disease to be passed down to each generation, where did it have to begin?
4. Calculate the number of normal males in the pedigree. What conclusion can you draw about all the males that were not affected by hemophilia?

According to the pedigree, it is clear that there were ten males that inherited the hemophilia. By color coding the pedigree, scientists find it easy to see how disease move from generation to generation. The mothers that carried the gene but were not affected were: Queen Victoria, Alice, Beatrice, Irene, Alexandra, Alice (F2 generation), and Victoria Eugenie. Theses females who were parents, grandparents, or great-grandparents to the hemophiliac boys exhibited no symptoms of the disease. The gene was simply passes down. In order for the disease to be passed down, it had to have been given by Queen Victoria, herself, and passed from daughter to daughter, and then from daughter to son. The only normal males equaled thirteen members who were outside males not of the royal bloodline, the other three normal makes were Edward VII, George V, and George VI all who bore children free from the disease.

Reflection Questions:

Referring to the figure to the right, you will find the lineage that lead to the royal family that we know today. Provide a brief explanation as to why George VI did not inherit hemophilia even though he came from the same royal bloodline.

5. Based on the portion of the pedigree, are the wives of the males in the British Royal family carries of the disease? Explain how you are confidence in your answer.
6. After analyzing the pedigree closely, explain why scientist would use this as a tool to trace genetic disease that may run in families. How can a tool like this be helpful to parents that may want to have children but are unsure of their health history?
7. Agree or Disagree: Insurance companies should have access to the full health history of a family. Explain your rationale.

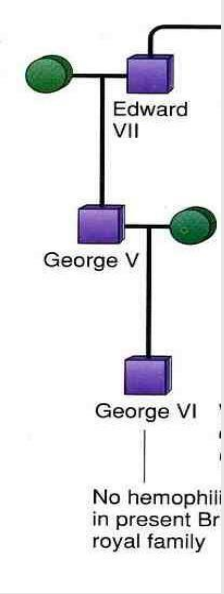


Figure 4.2: a snapshot of the current royal family pedigree. What is different?

Mendel, why is my hair so wavy?

Essential Question: I can recognize a variety of intermediate patterns of inheritance.

Directions: Analyze each diagram and then read the supporting information. Answer your questions in complete sentences in your Interactive Notebooks.

As it is with all great scientists Mendel had his fair share of difficulty in getting his work accepted by the scientific community. Yet, even in all of his utter brilliance, Mendel still was not able to foresee all of the possible patterns of inheritance that could take place in a family. There were so many questions left, for example, why do people have wavy hair and are there traits that are stronger than others? When people say, "you have your mom's eyes," can that be supported by genetics? So, what did Mendel miss? **CODOMINANCE** which is the genetic principal where two traits show in an organism and **INCOMPLETE DOMINANCE** which indicates when two traits blend and one is not dominant over the other.

Figure 5.1: Picture of three different hair types in humans. Image credit: https://en.wikipedia.org/wiki/Human_skin_color#/media/File:Unlabeled_Renatto_Luschan_Skin_color_map.svg

Reflection Questions:

1. Now that you have had a great deal of practice with Punnett squares, create a 4 box (simple) punnett square to determine the probability of producing children with curly, wavy, and straight hair. If the mother's genotype is SS for straight and the father's genotype is CC for curly hair.

   a. What is the probability of having children, with three different hair types?

   b. What is the probability of producing children with wavy hair?

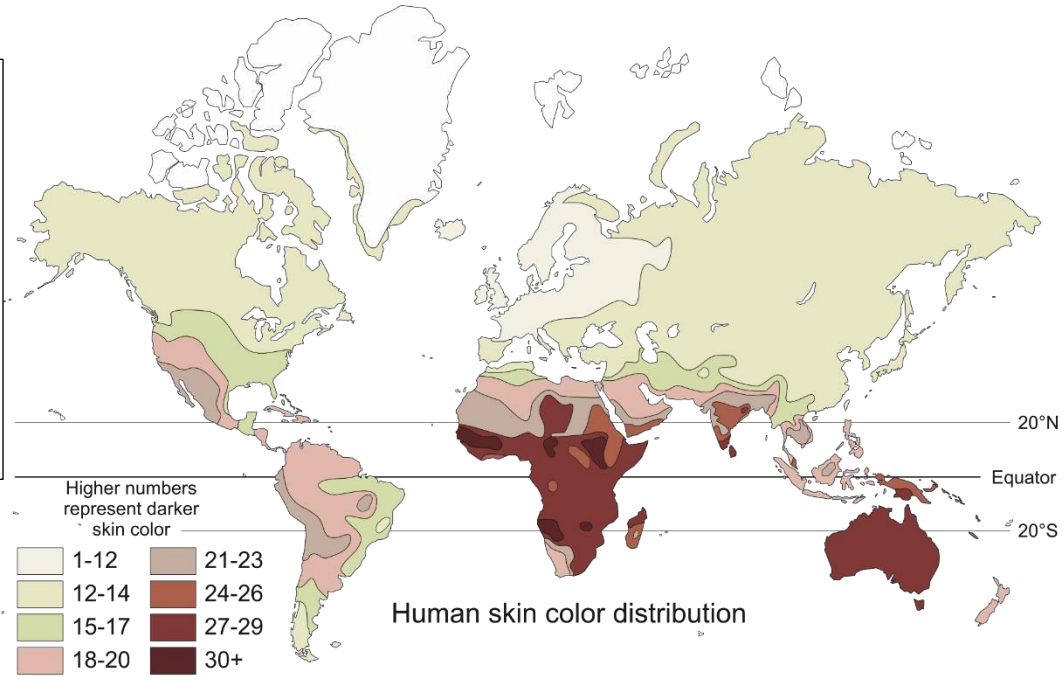
   c. Provide a clear explanation on how the mixing of the parent's genotypes produces wavy hair children.
2. Identify at least 2 other examples of codominance that can occur in nature.
3. Explain how the hair texture of humans and other organisms would be different if codominance did not occur. What would be the result of hair patterns?

When looking the genotypes of the parents in the example scenario, it is easier to create a punnett square to solve the problem. If the mother is SS for straight hair and the father is CC for straight hair, the family would have no chance of producing children with straight or curly hair; however, they would have a 100% chance of having children with wavy hair. If all the wavy hair children mated with wavy hair spouses, their chance of producing curly hair children would be 25%, straight hair= 25%, and wavy = 50%. The mixing of parent's genes produces wavy hair children because there is no dominant trait. The

traits blend. There are other examples of codominance in nature in snapdragons (flowers) and in eye color. If codominance did not exist, there would be a world full of people with curly and straight hair.

Figure 5.2: An example of Polygenic trait distribution around the globe.

*Image credit: http://anthro.palomar.edu/adapt/images/map_of_skin_color_*



Reflection Questions:

4. According to the map, identify the continent where the heaviest distribution of skin color is located. (heavy =30+)
5. Provide an explanation as to why color pigments are found in the locations that are shown on the map.
6. Propose a theory as to why there are so many different skin pigment on the planet and the genes that control. If you could write to Mendel, how would you explain the inconsistencies in his original theory and the new theory that you are proposing on skin color.

Based on the information in the map, the continent where the heaviest distribution of skin color is located in Africa. This may be, in part, because of the location below the equator in warmer regions as the lighter skin tones are mostly located above the equator in colder regions. If a new theory was to be proposed to Mendel, it would be the theory of **POLYGENIC TRAITS**. Poly= many, genic= relating to genes; therefore polygenic refers to the idea that there are traits that are controlled by more than one gene which can explain its wide distribution and variation in the world. This would be inconsistent with Mendel's ideas because of the clear pattern that was established. There are many other traits that are considered polygenic, such as, height and eye color.

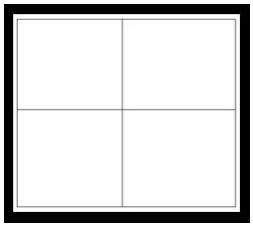
Punnett Practice

Essential Question: I can interpret Punnett Squares to determine phenotypic and genotypic ratios.

Complete these genetics problems according to the appropriate procedure. Use a separate sheet of paper if needed.

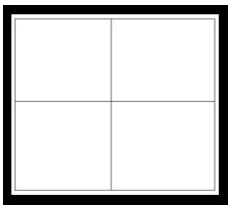
EASY

1. In pea plants, tall is dominant to short in terms of plant height. What are the possible genotypes and phenotypes if you cross 2 heterozygous tall pea plants?

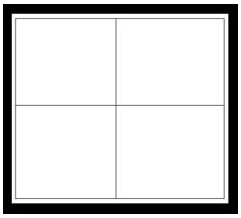


MEDIUM

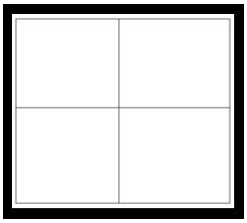
2. There are 3 possible phenotypes for carnations; Yellow, blue and Green. The gene for pedal color is incompletely dominant. Cross a Yellow carnation with a Green carnations.



3. In cats, fur color is co-dominant (Black, Grey, Brindle). Cross a Black cat with a brindled cat?

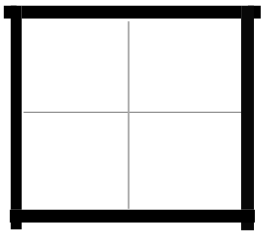


4. Robert is heterozygous for brown eyes (Bb). Sandy is homozygous recessive for blue eyes (bb). What will be the outcome for their family?



CHALLENGE QUESTION:

5. Baldness is a sex linked disorder. Your father is normal haired and your mother is heterozygous also for the trait. What is the chance that your little sister will have the trait for baldness?



Name: _____ Block:

Unit: Part 1: Genetics and Inheritance Patterns

Student Self -Assessment

Vocabulary

Directions: Rate your understanding of each word based upon the given scale below:

Part 2A: Mendel/Genetics		
Key Word	Before Instruction	After Instruction
Gregor Mendel		
DNA		
Genetics		
Heredity		
Heterozygous		
Homozygous		
Donlinant		
Recessive		
Chromosomes		
Allele		
Traits		
Gene		
Fenilization		
Meiosis		
Phenotype		
Genotype		
Punnett Square		

Part 2B: Inheritance Patterns		
Key Word	Before Instructlou	After Instruction
Codonlinance		
Incomplete Donlinance		
Polygenic Traits		
Sex-linked traits		
X-linked Traits		
Inhe1itance		
Pedigree		

0 = You've never heard of it 1 = You've heard of it 2 = You have an idea
3 = You can explain it somewhat 4 = You know exactly what it is

BACK

Unit: Part 2: Genetics and Inheritance Patterns
Student Self-Assessment

Learning Objectives

Dii·t'ctions: each objective must be included in your study guide (use the vocab. that applies to each)

You will evaluate your tmdersranding the day before the test

Lt'a rning Objt'ctivt's: :\"CES: Bio.3.2.2		I'm Stuck	I'm Getting It	Got It
Date	**Part lA: Genetics**			
	1. I coli ide11rijy the parrs of DNA as rile genetic material			
	2. I coli explain scie11rist's c01Jtriburio11s to the current study of Genetics.			
	3. I coli locate and identify the genof)pes and pl!e11of)pes of an orga11is111			
	4. I coli m1av=e a11d calculare raTios from a P111mett square 111odel			
	5. I coli describe the i111porra11ce of genof)pes and phenotypes			
	Part 2A: Inheritance Patterns			
	6. I coli recogni=e a mriety of intermediate pattems of inheritance.			
	7. I call inte1pret kar:l'of)pes and pedigrees to identify inheritance factors for particular indiYiduals.			

Appendix III: Student Reading List

1. Dealing with DNA (Review)
2. Mendel's Pea Families
3. Mendel, why is my hair so wavy? (Incomplete/Codominance)
4. Analyzing Karyotypes
5. Popular Pedigrees
6. Punnett Pedigrees
7. Pre/Post Assessment
8. Google Doodle on Gregor Mendel