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Genetics: Our Past, Present and Future

A Middle Years Unit for Years 6–8

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INTRODUCTION TO THE UNIT

As a student, I always enjoyed looking at topics in depth and learning about how one field of study connects to another. As I developed this unit, I designed lessons that help students explore how the field of genetics relates to other disciplinary fields. Students are asked to examine not only the core ideas of genetics but also the cross-disciplinary relationships—how one field may influence the findings in another field of study. Without helping students to make these connections, I believe that learning becomes isolated and is more than likely forgotten by the students. While conducting the research for this unit, I learned so much about the field of genetics and all of the implications that genetics has in our everyday lives, from the food we eat, to the sports we watch and participate in, to the connections it has to our family and our sense of well-being. Understanding how genetics plays a role in our past, present and future helps us to better understand ourselves and those around us.

BACKGROUND TO THE UNIT

This unit focuses on the key concepts of form and function, expression, image, chance, order and cycles through the window of genetics. It provides students with

opportunities to learn the basic concepts of genetics that lead to understanding about heredity, DNA and genetic diseases. This unit contains three parallels. In the Core Curriculum parallel, students are introduced to classical genetics concepts, including the structure and function of DNA, Punnett squares and predicting heredity, and dominant and recessive genes. The Curriculum of Connections parallel uses the same concepts to connect genetics with forensics and crime fighting as well as history and the royal families of Europe. In the Curriculum of Practice parallel, students get to extract DNA from peas and also conduct in-depth research to understand the work and practices conducted by genetic scientists.

CONTENT FRAMEWORK

Principles

Genetics is the science of genes, heredity and the variation of organisms.

Heredity involves probability and predicting the likelihood of a certain genotype to occur.

Science as a discipline crosses over, affects and is affected by other disciplinary fields of study, including history, literature and mathematics.

Outward expression of a characteristic or trait depends on the individual's genes and specific genotype.

An individual's genes play a part in an individual's identity but do not control everything.

Skills

Answer questions through scientific investigations. Students should develop the ability to refine and refocus broad and ill-defined questions. An important aspect of this ability consists of students' ability to clarify questions and inquiries and direct them towards objects and phenomena that can be described, explained or predicted by scientific investigations. Students should develop the ability to identify their questions with scientific ideas, concepts and quantitative relationships that guide investigation.

Design and conduct a scientific investigation. Students should develop general abilities, such as systematic observation, making accurate measurements, and identifying and controlling variables. They should also develop the ability to clarify their ideas that are influencing and guiding the inquiry and to understand how those ideas compare with current scientific knowledge. Students can learn to formulate questions, design investigations, execute investigations, interpret data, use evidence to generate explanations, propose alternative explanations, and critique explanations and procedures.

Use appropriate tools and techniques to gather, analyse and interpret data. The use of tools and techniques, including mathematics, will be guided by the question asked and the investigations students design. The use of computers for the collec-

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Lesson 1.6: Genetics and European History

Time allocation: 2–3 class sessions

This lesson looks at the concepts of form and function, image, chance and expression through the scope of the royal family. Instead of focusing on the form and function of DNA, they examine how form and function can be destroyed due to image, chance and expression.

Students will examine the pedigree and make predictions about how hemophilia affected the royal families of Europe. The presence of hemophilia in the royal family of England spread throughout Europe as royals intermarried. This caused problems for the royal families in Europe and eventually lead to the Russian Revolution and Rasputin's rise in power.

Principles

Genetics is the science of genes, heredity and the variation of organisms.

Outward expression of a characteristic or trait depends on the individual's genes and specific genotype.

An individual's genes play a part in an individual's identity but do not control everything.

Skills

Questions that can be answered through scientific investigations.

Design and conduct a scientific investigation.

Use appropriate tools and techniques to gather, analyse and interpret data.

Develop descriptions, explanations, predictions and models using evidence.

Think critically and logically to make the relationships between evidence and explanations.

Standards

SD1 Every organism requires a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.

SD2 Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait. A human cell contains many thousands of different genes.

SD3 The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited, and others result from interactions with the environment.

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SD4 Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.

Guiding Questions

1. What are some genetic diseases?
2. How are genetic diseases passed on to offspring?
3. How can the study of genetic diseases help scientists find cures for genetic diseases?
4. What do genetic diseases and royal families have in common?
5. How have genetic diseases impacted societies today?

Key Terms

- Hemophilia
- Genetic diseases
- Pedigrees
- Sex-linked traits

Unit Sequence—Curriculum of Practice	*Teacher Reflections*
Teaching Strategies and Learning Experiences	
Introduction to Pedigree Charts A pedigree chart is a way to record all the known phenotypes for an organism and its ancestors. There are also used to track disease transmission. Pedigrees are also family trees that explain genetic history and can be used to find out the probability of a child having a disorder in a particular family. To provide an overview of the symbols that are used to read these charts, a PowerPoint presentation is recommended to guide students through how to read and interpret these charts. **Pedigree Chart Reading Lab Experience** Using the **Pedigree Studies Lab Experience** (Appendix 1F) set up file folders that contain the two lab experiences for students to complete. Students will randomly be placed in pairs based on your arrangements (readiness for the experience, style or interest).	I simply went to the Internet and typed in the phrase "Pedigree Chart PowerPoints" or "how to read a Pedigree Chart" and many sources were available for me to use.

Unit Sequence—Curriculum of Practice	*Teacher Reflections*
Students will be asked to read through the background information on these two labs prior to start of these activities. As students work on these activities, rotate around the room, providing assistance and support. Ask questions that support your assurance that students understand how to read the chart, how to create a pedigree chart, and how to read and determine the genotypes of the families.	
Royal Families Activity Begin the lesson by reviewing what they know about pedigree charts showing the students a pedigree of the royal families of Europe. Teach them how to read the pedigree chart and discuss how sex-linked traits such as hemophilia are passed on to offspring. Use the information in Appendix 1G to discuss these traits. Introduce students to the case study from the National Center for Case Study Teaching. The case study is called *Hemophilia: "The Royal Disease"* written by Yelena Aronova-Tiuntseva and Clyde Freeman Herreid, from the University at Buffalo, State University of New York (www.sciencecases.org/hemo/hemo.asp). This case study uses the spread of hemophilia through successive generations of Europe's royal families through Queen Victoria's descendants to illustrate classical principles of genetics. Within this case study there are questions that guide student learning. Arrange students in groups of three so that each group has someone who can read the site, someone who can write down the responses to the questions that are posed, and someone who has the type of leadership skills to keep students managed during this process. Have the students read the case study about hemophilia (see Appendix 1G) and its impact on the royal families of Europe. After they complete the questions, work as a whole class to discuss the findings. The answers are available online, and a teacher can request access to the answers.	Students will need to understand what a pedigree is as well as understand basic information about sex-linked traits. The sex-link trait we will focus on is hemophilia, but make sure the students realise that there are several sex-linked traits. The case study that I recommend comes from National Center for Case Study Teaching in Science, whose purpose is to promote the development and dissemination of innovative materials and sound educational practices for case teaching in the sciences. The Center's website provides access to an award-winning library of case materials. Its work has been supported over the years by the National Science Foundation, The Pew Charitable Trusts, and the U.S. Department of Education (see Appendix 1G for hemophilia readings and the case study outline). **Guidelines for Using the Case Study Method** 1. Before you have students read through the case, prompt students to consider the impacts of genetic diseases on a society. Do they ever help to shape the way a society views people? Does the disease ever help to shape historical events? 2. Open the case by posing an interesting question to consider. Why would royal family be concerned about genetic diseases? Have students establish group rules to ensure cohesion in the group. Each group can come up with a list of rules and agree to sign it like a contract.

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APPENDIX 1F: PEDIGREE STUDIES LAB EXPERIENCE

Introduction

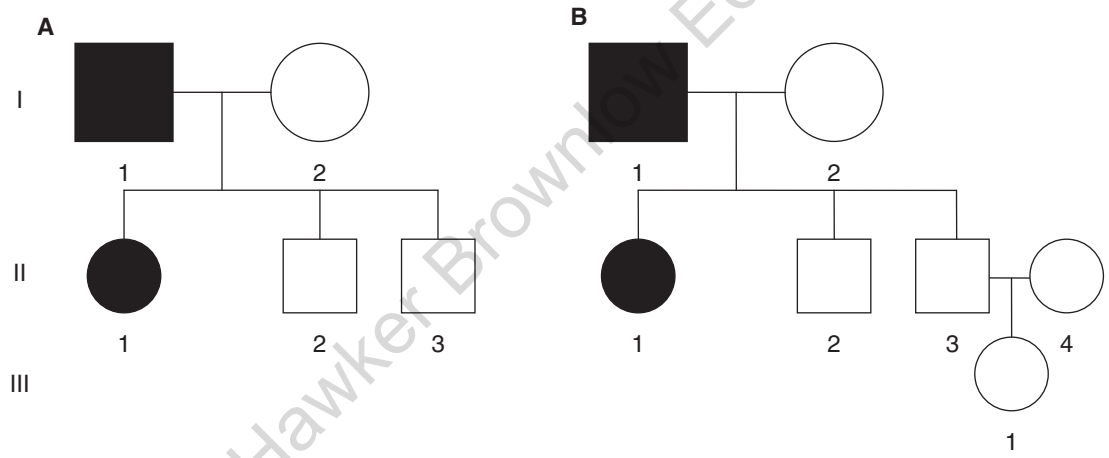
This should help you to understand how to read a pedigree chart. Pedigree charts show the phenotype of genetic traits and how they are expressed in a family from one generation to the next. The pedigree can help predict the genotype of each person for a certain trait.

Background Information

- In a pedigree chart, generations are represented by Roman numerals. Each person in each generation is numbered.
- Males are represented by a square and females by a circle.
- A horizontal line connecting a male and a female is called a marriage line.
- Vertical lines represent children.
- Children on the vertical line are always placed from left to right, with the child on the left being the oldest.

Let's Get Started

Examine Figures A and B found below. Answer the questions that follow concerning each figure.



1. What is the sex of the oldest child in Figure A? _____
2. What is the sex of the youngest child in Figure A? _____
3. Which person in Figure B is the daughter-in-law? _____
4. To whom is she married? _____
5. What is the sex of their child? _____

Determining Genotypes

If we look at a specific trait (earlobe shape), two general shapes of earlobes exist: the dominant, *free ear lobes* (E) and the recessive, *attached ear lobes* (e). Individuals on a pedigree chart who have unshaded symbols have at least one dominant gene and show the dominant trait.

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