Lesson: Introduction to Genetic Traits

Subject Area(s)

Biology

Associated Unit

None

Lesson Title

Introduction to Genetic Traits

Image 1

ADA Description: Harry Potter portrait

Caption: Harry Potter (wizard born from wizard parents) and Hermione Granger (right, born from muggle parents).

Image file: muggles.jpg

Source/Rights: Copyright © 2010 Harry Potter Action Figures (http://www.harrypotter-actionfigures.com/).

Grade Level   10 (9-12)

Lesson #   __ of __

Lesson Dependency

None

Time Required

45 minutes

Summary

The complex subject of genetics is generally introduced by first observing and discussing how certain physical (or behavioral) characteristics occur in individuals from different generations of the same family. These inheritance traits are then explained by introducing the principles of Mendelian genetics and gene maps. This lesson introduces genetics and the inheritance principles from the perspective of the Harry Potter novels which have enjoyed a high degree of popularity among young students. The principles of dominant and recessive genes and the Punnett squares are introduced by referring to the characters present in the Harry Potter novels.

In the world of Harry Potter there are normal people, called muggles, and then there are the wizards, people with inherited magic powers. These powers are not acquired and usually a wizard is born from two wizard parents. However, sometimes it may happen that a wizard child is born from muggle parents as is the case with Harry's friend Hermione Granger. This "anomaly" or surprising event can be explained by genetics, more specifically recessive genes.

By using the analogy between genetics and the magic world of Harry Potter and capitalizing on the popularity of the character with young people, it is expected that students will develop some interest in exploring the role of genetics in trait inheritance and spark the curiosity on how the mechanisms of gene replication can determine physical and behavioral traits.

Engineering Connection
High-tech apparatus such as X-ray crystallography and fluorescent protein labeling and imaging are used to study the structure of genes. Chemical engineers interested in biomedical applications have contributed significantly in the field of biomolecular imaging.

Engineering Category = #1
Choose the category that best describes this lesson's amount/depth of engineering content:
1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords
Microscopy, molecular imaging, molecular transport phenomena, chemical engineering.

Educational Standards
Biology: Texas Essential Knowledge and Skills (112.34. Biology, Beginning with School Year 2010--2011)
 (c) (2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:
(D) Distinguish between scientific hypotheses and scientific theories;
 (c) (3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:
(F) Research and describe the history of biology and contributions of scientists.
 (c) (6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:
(D) recognize that gene expression is a regulated process;
(E) identify and illustrate changes in DNA and evaluate the significance of these changes;
 Math: None.

Pre-Requisite Knowledge
Basic understanding of proteins, amino acids, and their role in the activity of cells.

Learning Objectives
After this lesson, students should be able to:
- Infer if whether traits are inherited.

- Describe how Mendel studied inheritance in peas.

- Summarize Mendel's conclusion about inheritance.

- Explain the principle of dominance.
- Explain how geneticists use the principles of probability.
- Describe how geneticists use Punnett squares.

Introduction / Motivation

Begin the lesson with a short video clip from *Harry Potter and the Sorcerer's Stone* when Harry meets Hermione Granger at the Hogwarts School of Witchcraft and Wizardry. What are Harry Potter's parents? Are they wizards? Are Harry's magic powers inherited or acquired? Students should infer that Harry's traits (e.g., wizardry) are inherited directly from parents. What about Hermione's parents? Students should know that Hermione's parents are muggles with no magic powers. It seems that Hermione's parents are muggles (normal people with no magic powers or gifts) but she is a wizard. How is it possible that a wizard is born from muggle parents? Ask students to think about their families and if they have noticed traits that are present only in grandparents and grandchildren. Some genes are not expressed in every generation and certain traits that are present in parents may not necessarily be present in their children.

Inheritance, to most people, is property left to them by another person or relative that passed away. For biologists, there is another form of inheritance that is very important---the genes. Genes are used to pass a set of characteristics from parents to their children and by studying them people can understand how this inheritance is passed from generation to generation and what makes each species unique.

Genetics can now explain the mystery behind Hermione's inherited wizard powers by what is known as the Punnett squares method---a diagram that is used to predict and compare the genetic variations that can result from genetic crossing.

Lesson Background & Concepts for Teachers

Genetics an an important branch of biology that has witnessed a rapid development after the discovery of the DNA structure. However, the early studies of Gregor Mendel on ordinary garden peas have offered great insight into how traits (specific characteristics) can be passed on to the next generation and how the traits of each parent can be inherited by each offspring. These findings have allowed people to create new plant species with traits from both parents by cross-breeding.

Mendel's experiments consisted of cross-pollination of peas with different traits to obtain new species that inherit some specific traits from each parent. He used peas with seven different plant traits and studied how each trait was passed down from each parent to each offspring. He noticed that certain traits would not be present in the first generation offspring but it would appear in the some subsequent offspring generations while other traits were present in each subsequent generation. Mendel also noticed that the characters of each parent were not blending in the offspring but that all the offspring would have the character of only one parent.

The above findings have led Mendel to draw two major conclusions. The first is that the biological inheritance is determined by factors that are passed from one generation to another---these factors that determine traits are now called genes and were discovered in the early 1940s.

The second conclusion is what is now called the principle of dominance. The traits that Mendel studied were controlled by one gene that occurs in contrasting forms (e.g., the gene expressed in one form would result in peas with green seeds while expressed in a contrasting form would result in peas with yellow seeds). These different forms of a gene are called alleles and the principle of dominance states that some alleles are dominant while others are recessive.

Mendel also noticed the reappearance of traits determined by recessive alleles and concluded that the dominant and recessive alleles get separated or segregated. This segregation was observed to be completely random, therefore, probability principles can be applied to predict the end result of genetic crosses. The possible combinations that can result from a genetic cross can be determined and summarized in a diagram that is known as the Punnett square.
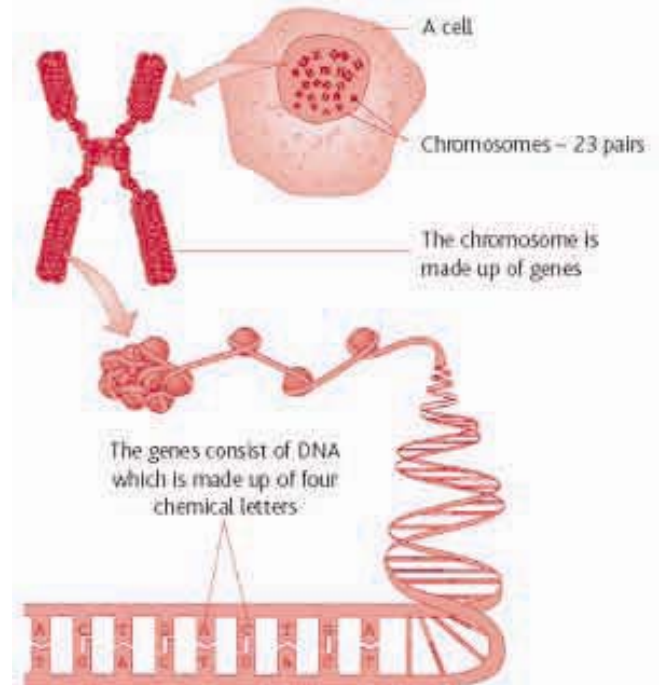
Figure 2

**ADA Description:** Cartoon showing the relation between genes, DNA, and chromosomes

Caption: Genes

Image file: gene.jpg

Source/Rights: Copyright © 2010 Macmillan Cancer Support 2010 (http://www.macmillan.org.uk/Home.aspx).

Vocabulary / Definitions

Word	Definition
Allele	Form of a gene, usually arising through mutation, that is responsible for hereditary variation.
Gene	A linear sequence of nucleotides along a segment of DNA that provides the coded instructions for synthesis of RNA, which, when translated into protein, leads to the expression of hereditary character.
Genetics	The science of heredity, dealing with resemblances and differences of related organisms resulting from the interaction of their genes and the environment.
Probability	The likelihood that a particular event will occur.
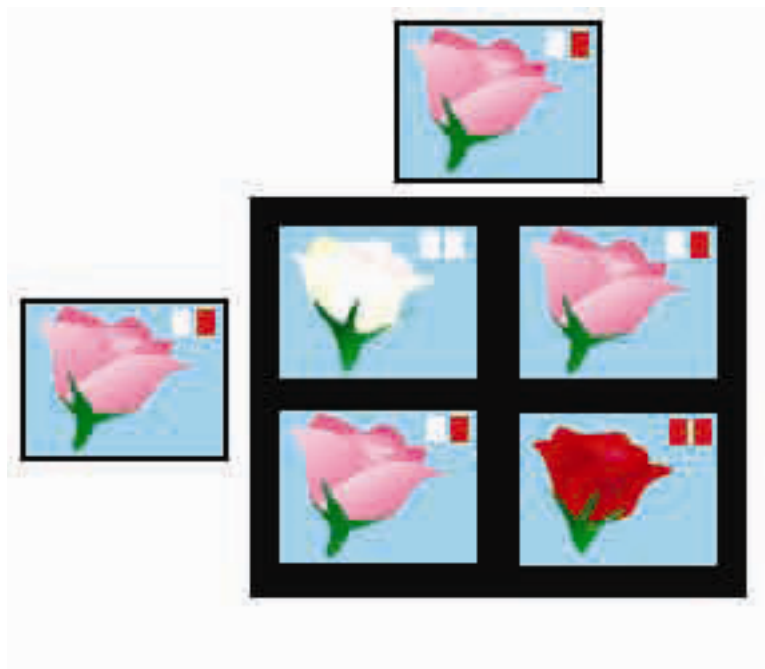
| Punnett square	Diagram that list all possible combinations that might result from a genetic cross.
Segregation	Separation of allelic genes during cell division (meiosis).
Trait	A specific characteristic that varies from one individual to another.

Figure 3

ADA Description: Cartoon showing Punnett squares and all possible gene color combinations.

Caption: Punnett squares

Image file: punnett.jpg

Source/Rights: Copyright © 2010 Purdue University (http://www.entm.purdue.edu/extensiongenomics/G AME/incompletedominance.html)
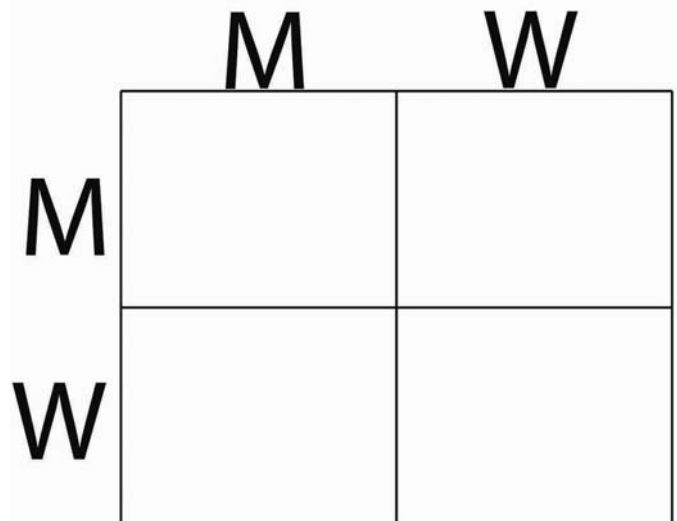
Associated Activities

Punnett square showing Hermione Grange's probability to inherit only wizard type of genes. The students are asked to complete a Punnett square to investigate all the possible combinations that can occur with two forms of the gene that determine if an individual is a muggle or a wizard. For simplicity let us call the gene form that determines muggle characteristics as M and the gene form that determines the wizard characteristics as W. Now, for an individual to be a wizard and possess magical abilities, he or she needs two have two W genes, WW, one inherited from the mother and the other one from the father. Ask students what genes the child will inherit if he or she is born from parents that are pure-blooded wizards (i.e. they both have WW genes)? In this case the child will also be a wizard because it inherits only WW genes. But when an individual carries MW genes then he or she is a muggle. However, when both parents are MW carriers there is a one in four chance that the inherit WW genes and therefore have magical powers as is the case with Hermione Grange.

The students should complete the Punnett square diagram and state the probability for WW genes to occur in the offspring from parents with MW genes.

Figure 4

ADA Description: Punnett squares for use in the associated activity

Caption: Punnett square to determine all possible combinations of genes. M is the muggle gene while W is the wizard gene.

Image file: psq.jpg

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Lesson Closure
Engage students in short discussion about the new concepts they were introduced during the lesson. How are the principles of probability used to predict the gene inheritance? How are the Punnett squares used? How can recessive alleles reappear in subsequent generations and how scientists have confirmed all of Mendel's findings? What was the engineering contribution to genetics?

Assessment

Post-Introduction Assessment
Questions/Answers: Ask the students if it is possible to loose the wizard gene. Also, ask them what are some of the characteristics that are passed down from generation to generation (e.g., physical or behavioral such as taste and talent).

Lesson Summary Assessment
Completed Worksheet: When the lesson has finished, the students should complete a short worksheet that will assess their knowledge of the concepts discussed during the lesson. The Introduction to Genetics Worksheet is attached to this lesson.

Lesson Extension Activities
None

Additional Multimedia Support
Harry Potter and the Sorcerer's Stone, © 2001 Warner Bros. Pictures

References
"*Texas Edition: Biology*" by K. Miller, J. Levine, 2004, Pearson Prentice Hall, New Jersey.

Attachments
Introduction to Genetics Worksheet

Other
None

Redirect URL
None

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Introduction to Genetics Worksheet

- What are traits (give few examples) and from whom they are inherited?

- What determines biological inheritance?

- What are dominant and recessive alleles?

- What happens to alleles during segregation?

- How are the Prunnett squares used?