Genes, Chromosomes, and Inherited Characteristics

Lesson Overview
In this lesson, students will obtain information from various sources to explain the relationship of genes and chromosomes to inherited characteristics. Students will be introduced to the terminology of genetics and build the foundation for this unit of study. They will collaborate to develop an explanation in writing and then communicate their thinking both visually and through an oral presentation.

Alignment
Standard/Indicator Addressed
Standard 7.L.4 The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

7. L.4A.1 Obtain and communicate information about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics.

Science and Engineering Practices
7.S.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

7. S.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

Students should also ask questions and define problems; analyze and interpret data; use mathematical and computational thinking; plan and carry out investigations; develop, use, and refine models; and engage in scientific argument from evidence.

Crosscutting Concepts: Patterns, Structure and Function
ELA Inquiry Standards (as appropriate)

**Standard 3:** Construct knowledge, applying disciplinary concepts and tools, to build deeper understanding of the world through exploration, collaboration, and analysis.

3.1 Develop a plan of action by using appropriate discipline-specific strategies.

3.4 Organize and categorize important information, revise ideas, and report relevant findings.

**Standard 4:** Synthesize integrated information to share learning and/or take action.

ELA Communication

**Standard 1:** Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretations through collaborative conversations; build upon the ideas of others to clearly express one’s own views while respecting diverse perspectives.

1.2 Participate in discussions; ask probing questions and share evidence that supports and maintains the focus of the discussion.

1.5 Consider new ideas and diverse perspectives of others when forming opinions regarding a topic, text, or issue.

Content area literacy: Students should analyze data from a variety of sources, including informational text, argue based on evidence, obtain data from various sources, and evaluate and communicate evidence.

**Connections**

**Active Learning Strategies**

- KWL chart (see attached)
- Give Me Five
- Think, Ink, Pair Share (TIPS)
- Placemat (see attached)
- MTV (Making Thinking Visible)
- Exit Slip

**Computational Thinking:**

- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analyzing data
- Representing data through abstractions such as models and simulations
- The ability to communicate and work with others to achieve a common goal or solution

**Content Connections**

- Science
- English Language Arts
- Computational Thinking
Lesson Plan

Time Required – Two 60 minute class periods

Disciplinary Vocabulary – sex cell, egg, sperm, heredity, DNA, chromosome, gene, allele, genotype, phenotype, genetic trait, parent, offspring, inherited trait

Materials Needed:
- Post-it Notes
- Chart Paper or White Board Space to create KWL
- Video: 18 Things You Should Know About Genetics, https://www.youtube.com/watch?v=bVk0twJYL6Y&feature=youtu.be
- 11 x 17 paper for MTV
- Electronic Device for Reading Article and Doing Research
- FREE Post-it® Plus App if technology (iPhone or iPad) is available: https://itunes.apple.com/us/app/post-it-plus/id920127738
- 1 Copy of the student placemat for each group of four students

Formative Assessment Strategies: KWL, TIPS, Placemat, MTV and Exit Slips

Computational Thinking: This lesson addresses computational thinking by allowing students to use evidence, apply logic, and construct arguments for their proposed explanations, and evaluate and communicate the information scientifically.

Misconceptions:
According to Benchmarks, when asked to explain how physical traits are passed from parents to offspring, elementary-, middle-, and some high-school students express various misconceptions. For example, some students believe that traits are inherited from only one of the parents (e.g., the traits are inherited from the mother, because she gives birth or has most contact as children grow up; or the same-sex parent will be the determiner). Other students believe that certain characteristics are always inherited from the mother and others come from the father. Additionally, some students believe in a "blending of characteristics."

Early middle-school students explain inheritance only in observable features, but upper middle-school and high-school students have some understanding that characteristics are determined by a particular genetic entity that carries information to be translated by the cell. (Benchmarks for Science Literacy, p. 341.)

Some students may also think that because they look similar to an aunt or uncle that they received those traits from them.

Students often confuse terms used to identify genetic material: genes, alleles and chromosomes. (Boujemma et al., 2010; Shaw et al, 2008) This continues to be problematic as students reach high school.
An Interdisciplinary Exploration of Genetics and Probability within 7th grade Science and Mathematics
Lesson 1 Science

Engage

- Create a K-W-L chart on a piece of chart paper or the class whiteboard. If using the class whiteboard, post it notes will need to be removed after each class period. They can easily be stored in stacks on a piece of copy paper labeled with the class period and the columns.
- Ask the question “What do you know about DNA, genetics, and heredity?”
- Have students write one thing they know about each word on a post it note.
- As students finish writing their thoughts about the words, have them place their responses in the K or “what I know” column of the chart.
- As responses are attached to the chart, the teacher should silently read student ideas and group similar responses together. After all post it notes have been added, the teacher should share out some of the common responses with the class.
- As students continue throughout the day, they will be adding the W and L pieces to the KWL chart. This can become an anchor chart for the unit. Students can continue to add questions and new learning throughout the unit. If technology is available, there is a free app called FREE Post-it® Plus that allows you to take pictures and organize the post it notes. This app can be downloaded from the App Store on an iPhone or iPad.
- Ask the question “How or where have you heard about genetics?”
- Use the Give Me Five strategy to randomly collect responses from 5 students. (Responses may include particular TV shows.)
- Inform students that today’s lesson is about relating key terms such as genes and chromosomes and inherited traits.

Explore

- After viewing the 18 Things You Should Know About Genetics video (3:28), https://www.youtube.com/watch?v=bVk0twjYL6Y&feature=youtu.be, have students take a minute to think about what they heard during the video.
- Using the Think, Ink, Pair, Share (TIPS) strategy, ask the students to think about the following Focus Question: “What is the relationship between genes and chromosomes and inherited characteristics?” and then have students ink your thoughts in your notebook. Then pair with someone in the class to share ideas with each other.”
- Engage students in a brief class discussion about their thoughts, what they have written, and what they have heard.
- Have students read the article “What Is a Gene?” (http://kidshealth.org/en/kids/what-is-gene.html) electronically. If electronic devices are not available, print the article from the website for student use.
- Students should STOP reading after the section on How do genes work?
- After reading the article, students will work in groups of four and use the Placemat strategy to answer the question “What is the relationship between the words- genes, chromosomes, and inherited characteristics?”
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- To use this strategy, a rectangular placemat is made by taking a large piece of paper and drawing either a circle or a diamond is drawn in the center. Around the circle or diamond are equal sections and each group member is assigned one section. The question to answer goes in the center of the circle or diamond and Give each team of four students a copy of student placemat.
- Print one placemat (attached) for each group of four students.
- Give each student 2 minutes to write a response. Each group member writes down his or her personal thoughts and ideas in his or her corresponding section on the placemat.
- After all the responses have been recorded, groups will dialogue (4-5 minutes) and come to a consensus on the answer they will place in the center of the placemat.

**Explain**

- In groups of 4, students should use the MTV (Making Thinking Visible) strategy to create a visual depicting their thinking on today’s topic. The visual can be a poster (on 11 X14 paper or poster board or bulletin board paper) or slide (using technology) and should represent the role that genes and chromosomes play in inherited characteristics.
- Caution students to mainly use pictures and as little words as possible. The goal is to have pictures and drawings with only a few words and then as a group be able to explain their thinking to the class. Be sure to give the students a set amount of time to create their MTV (20 to 25 minutes) and make sure that each student is participating in some way and that students are aware that they will be sharing with the class.
- While students are working on the MTV, students should make a list of questions that they want to know the answers to that came to mind during the video, reading the article, and making the MTV poster.
- Have each student write a question on a sticky note and place this in the W column (or “what I want to know”) of the KWL chart.
- Allow each group 5 minutes to communicate the information from their MTV poster or slide to the class.
- On a Post-it note, have each student write one thing they learned about the role of genes and chromosomes in the inheritance of characteristics or traits. This will be their Exit Slip and can be placed in the L column (or “what I learned”) of the KWL chart on their way out of class.

The article used in this lesson comes from the following source:
K-W-L and Variations

KWL is a strategy that models the active thinking students engage in before beginning a new unit of instruction or topic of study. It can be used prior to an inquiry investigation, learning activity, or reading an informational text selection. The KWL utilizes a graphic organizer to categorize the three activities students will do prior, during, and after lesson to inform them about their learning of the topic. Students will identify what they KNOW (K), WANT to know (W), and LEARNED (L).

How to implement the strategy:

1. Tell the students that they are going to use the KWL Strategy to help them identify what they know or think they know about a topic, what they want to know about it, and what they have learned.

2. Draw the K-W-L chart on the whiteboard or chart paper at the front of the class.

3. Ask students to share what they KNOW about the topic and record all their responses under the “K” on the K-W-L chart, even if some of the responses are incorrect.

Note: If opposing ideas or viewpoints are posed by the students, suggest identifying a question that the students can use to research or determine the answer to clear up any discrepancies that might exist between the ideas or viewpoints.

4. Provide students with an appropriate amount of time to identify as much knowledge as they have about the topic.

5. Tell the students they are not going to think about what questions they have about the topic that they WANT to know and have answered as they read (or conduct an investigation, research, etc.)

6. Give the students time to identify any questions they might have about the topic and have them share their questions and record all their responses under the “W” of the K-W-L Chart.

Note: The teacher can use the information from these two steps to determine what reading selection and/or learning activities are needed to support students in find out the information they need to answer their questions.

7. Engage students in a learning activity, such as reading appropriate text selection(s) or conducting a research or inquiry investigation, to locate the answers to their questions.

8. Rotate around the room as the students work individually or in groups to ensure students are on track and provide assistance as needed.

9. Provide an appropriate amount of time for the students to read the text selection and find the answers or complete the investigation to answer their questions.

10. Bring the class together as a whole and call the student attention to the K-W-L Chart.

11. Have the students review the questions they identified under “W” and share out what they LEARNED as a result of the learning activity.

12. Record their responses under the “L” column of the chart.

13. Return to the “K” column and have students review what they listed there.

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14. Have students identify any information that they now KNOW is inaccurate and draw a line through it.
15. Have students identify any information that was supported from the reading and place a check mark by it.
16. Return to the “W” chart to review all the questions that were listed.
17. Have students think of how they might proceed to answer any remaining questions that are still unanswered in the list.
18. Ask students to summarize their impressions of the K-W-L chart and how it assisted them in learning about the topic and have several students volunteer their impressions with their peers.

Variations:

- **K-W-L-S**: Students add a 4th column to their K-W-L chart for "S" which stands for "What I STILL need to know." This encourages students to think more deeply about what they know and identify new questions that they might have after engaging in a learning activity. Students recognize that more we know, the more questions we have and want to have answered. The “S” also encourages and supports the idea for students that they can take responsibility for their own learning and be independent, self-directed learners and find the answers to questions they have on their own.
- **K-W-L Plus**: Students extend and use the information from the K-W-L chart by organizing their new learning to make a semantic map or a graphic organizer that can be used as the basis for writing. Students organize key information in their charts by identifying labels for key categories and sorting and grouping facts or information from their reading under each. Student use the map or graphic organizer to write an essay or summary of what they have learned, pointing out connections and categories they have made as they learned about the topic.
- **K-W-H-L**: Students add a column labeled “H” for “HOW will I find the information.” This can support students in developing a plan for how they might find answers to their questions such as planning an investigation to collecting data or conducting a research study.
- **K-W-L-E**: Students add a column labeled “E” for “EVIDENCE for what they have learned.” This supports students in justifying what they say they have learned by offering evidence of that learning.

Additional Resources:

What Is a Gene?

The doorbell rings. Emma's dad calls out, "Emma, answer the door! I'm making dinner and my hands are full!"

Emma puts down her book, and heads to the door. As she opens it slowly, a burst of mostly familiar faces rush through the door. Aunts, uncles, and cousins she hasn't seen in years greet her enthusiastically.

Aunt Rita pulls Emma into a hug and says, "Well, look at you! You've grown! And you've got such beautiful red, curly hair! It runs in the family, you know. You look just like my grandmother!

Uncle Michael adds, "And, look, she's getting so tall! Just like her dad. Only 10 years old, and you look like a basketball player already!"

Emma's dad emerges from the kitchen to greet the guests. As he helps everyone get settled, Emma wonders, "Aunt Rita's grandmother? It runs in the family? What are they talking about?"

Genes (say: jeenz), that's what they're talking about. Genes play an important role in determining physical traits — how we look — and lots of other stuff about us. They carry information that makes you who you are and what you look like: curly or straight hair, long or short legs, even how you might smile or laugh. Many of these things are passed from one generation to the next in a family by genes.

What Is a Gene?

Each cell in the human body contains about 25,000 to 35,000 genes. Genes carry the information that determines your traits (say: trates), which are features or characteristics that are passed on to you — or inherited — from your parents.

For example, if both of your parents have green eyes, you might inherit the trait for green eyes from them. Or if your mom has freckles, you might have freckles too because you inherited the trait for freckles. Genes aren't just found in humans — all animals and plants have genes, too.

Where are these important genes? Well, they are so small you can't see them. Genes are found on tiny spaghetti-like structures called chromosomes (say: KRO-moh-somes). And chromosomes are found inside cells. Your body is made of billions of cells. Cells are the very small units that make up all living things. A cell is so tiny that you can only see it using a strong microscope.

Chromosomes come in matching sets of two (or pairs) and there are hundreds — sometimes thousands — of genes in just one chromosome. The chromosomes and genes are made of DNA, which is short for deoxyribonucleic (say: dee-ox-see-ri-bo-nyoo-CLAY-ik) acid.
Most cells have one nucleus (say: NOO-clee-us). The nucleus is a small egg-shaped structure inside the cell which acts like the brain of the cell. It tells every part of the cell what to do. But, how does the nucleus know so much? It contains our chromosomes and genes. As tiny as it is, the nucleus has more information in it than the biggest dictionary you’ve ever seen.

In humans, a cell nucleus contains 46 individual chromosomes or 23 pairs of chromosomes (chromosomes come in pairs, remember? 23 x 2 = 46). Half of these chromosomes come from one parent and half come from the other parent.

Under the microscope, we can see that chromosomes come in different lengths and striping patterns. When they are lined up by size and similar striping pattern, the first twenty two of the pairs these are called autosomes; the final pair of chromosomes are called sex chromosomes, X and Y. The sex chromosomes determine whether you’re a boy or a girl: females have two X chromosomes while males have one X and one Y.

But not every living thing has 46 chromosomes inside of its cells. For instance, a fruit fly cell only has four chromosomes!

How Do Genes Work?

Each gene has a special job to do. The DNA in a gene spells out specific instructions—much like in a cookbook recipe—for making proteins (say: PRO-teens) in the cell. Proteins are the building blocks for everything in your body. Bones and teeth, hair and earlobes, muscles and blood, are all made up of proteins. Those proteins help our bodies grow, work properly, and stay healthy. Scientists today estimate that each gene in the body may make as many as 10 different proteins. That’s more than 300,000 proteins!

Like chromosomes, genes also come in pairs. Each of your parents has two copies of each of their genes, and each parent passes along just one copy to make up the genes you have. Genes that are passed on to you determine many of your traits, such as your hair color and skin color.

Maybe Emma’s mother has one gene for brown hair and one for red hair, and she passed the red hair gene on to Emma. If her father has two genes for red hair, that could explain her red hair. Emma ended up with two genes for red hair, one from each of her parents.

You also can see genes at work if you think about all the many different breeds of dogs. They all have the genes that make them dogs instead of cats, fish, or people. But those same genes that make a dog a dog also make different dog traits. So some breeds are small and others are big. Some have long fur and others have short fur. Dalmatians have genes for white fur and black spots, and toy poodles have genes that make them small with curly fur. You get the idea!

Use this article with Lesson 5: Changes in Genes (Mutations)

When There Are Problems With Genes

Scientists are very busy studying genes. They want to know which proteins each gene makes and what those proteins do. They also want to know what illnesses are caused by genes that don't work right. Genes that have been changed are called mutations. Researchers think that mutations may be partly to blame for lung problems, cancer, and many other illnesses. Other illnesses and health problems happen when there are missing genes or extra parts of genes or chromosomes.

Some of these gene problems can be inherited from a parent. For example, take the gene that helps the body make hemoglobin (say: HEE-muh-glow-bin). Hemoglobin is an important protein needed for red blood cells to carry oxygen throughout the body. If parents pass on altered hemoglobin genes to their child, the child might only be able to make a type of hemoglobin that doesn't work properly. This can cause a condition known as anemia (say: uh-NEE-mee-uh), a condition in which a person has fewer healthy red blood cells. Sickle cell anemia is one kind of anemia that is passed on through genes from parents to children.

Cystic fibrosis (say: SIS-tick fi-BRO-sus), or CF, is another illness that some kids inherit. Parents with a changed CF gene can pass it on to their kids. People who have CF often have trouble breathing because their bodies make a lot of mucus (say: MYOO-kus) — the slimy stuff that comes out of your nose when you're sick — that gets stuck in the lungs. People with CF need treatment throughout their lives to keep their lungs as healthy as possible.

What Is Gene Therapy?

Gene therapy is a new kind of medicine — so new that scientists are still doing experiments to see if it works. It uses the technology of genetic engineering to treat a disease caused by a gene that has changed in some way. One method being tested is replacing sick genes with healthy ones. Gene therapy trials — where the research is tested on people — and other research may lead to new ways to treat or even prevent many diseases.

**Place mat**

Place mat is a strategy that promotes both individual and group thinking and reflection on issues, questions, or solving problems. (Bennett and Rolheiser 2001).

![Diagram of Place Mat Strategy]

**How to implement the strategy:**

1. Acting as the “place mat,” a piece of chart paper is divided up into pieces based on the number of group members, with a circle or square or diamond located in the center of the paper.

2. In groups of three to six, students individually consider the question posed and jot their thoughts in their own space before sharing their ideas with other group members.

3. Following this, students exchange their ideas and produce their group summary or consensus, which is then recorded in the space provided in the center of the paper.

**Additional Resources:**

What is the relationship between the words- genes, chromosomes, and inherited characteristics?