*Inheritance and Natural Selection*

**Kristina Woods**

**Grade 7**

## Stage I

**Enduring Understandings**

- All life is based on the same genetic code
- Reproduction is essential to the continuation of a species
- The patterns of their inheritance can sometimes be described mathematically
- Multiple genetic and/or environmental factors often play a role in the expression of a trait

**Overarching Essential Questions**

- How do genetic variation and environmental factors contribute to the diversity of organisms?
- How does reproduction ensure the continuation of a species?

**Topical Essential Questions**

- Why is the study of patterns of inheritance important?
- How does the structure of DNA relate to its function?
- What is more advantageous: sexual or asexual reproduction?
- What role will the food, products and synthetic materials we consume play in future populations?
- How does nature always find a way to adapt?

**Massachusetts Department of Education Social Studies Curriculum Frameworks Learning Standards Addressed in This Unit:**

**Biology Standard 7:** Reproduction and Heredity - Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.
**Biology Standard 8:** Reproduction and Heredity - Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.
**Biology Standard 9:** Reproduction and Heredity - Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell).
**Biology Standard 10:** Evolution and Biodiversity - Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.

## Stage II

### *A. Evidence for Overarching Essential Questions:*

Overarching Essential Questions:

- How do genetic variation and environmental factors contribute to the diversity of organisms?
- How does reproduction ensure the continuation of a species?

**The following GRASPS assignment will give evidence of the overarching essential questions:***

**Goal** Students will be able to empathize with people who express sex-linked disorders and other genetic disorders. Additionally, they will apply the knowledge of genetic mutations and disorders to determine the impact on the individual and the families of those with genetic disorders.

**Role** Group of 3: doctor, mother, father
Group of 4: doctor, mother, father, sibling
Group of 5: doctor, mother, father, sibling, grandparent

**Audience** The audience will be the readers of the pamphlets and the class who will view the role playing

**Situation** As students begin to understand how inheritance patterns operate, they realize that sometimes something goes wrong. Alleles can be inherited that have a *deleterious* effect upon an offspring.

*Nondisjunction* - The failure of paired chromosomes or sister chromatids to separate and go to different cells during meiosis can (and does) occur also having negative effects on the offspring.

Confronted by their own feelings and beliefs, students must determine what to do in these situations. They get the chance to explore in a context that is non-threatening to themselves or others. It also allows them the opportunity to use ethical decision-making models.

All students are capable of understanding basic genetic inheritance patterns. They can take a step further into understanding what happens when mistakes occur, specifically the long-term consequences that can affect a family when confronted by the situation. The use of a decision-making model affords students the chance to explore and develop a decision that is "best" for them. This model can be used in many ways in their lives.

**Product, Performance, and Purpose** For their final examination, students design a human genetic condition pamphlet that they will present to the class and then may take to a doctor or pediatrician's office. The pamphlets will consist of information on types of inheritance, effects on the body, how the family is affected, what risks do other family members have of

passing the trait on populations (ancestral groups) in which this disease is most common, recent research or development, and other relevant information.

1.) Students are divided into groups of three, four or five and assigned roles
2.) Students develop presentations explaining disorders, inheritance pattern, expenses involved, and options. Each family member must participate, given his or her unique perspective to the family decision.
3.) Use of decision-making model as a class activity.
4.) Each group now evaluates another group's dilemma with the decision-making model.
5.) Class discussion as to why there are options to each situation and how diagnosis occurs using genetic counseling.

**Standards and Criteria for Success** Scoring guide

* Adapted from McCreight, S. (n.d.). *Genetic Disorder Role Play Activity.* University of Kansas Medical Center. Retrieved from http://www.kumc.edu/gec.

**Scoring Guide:**

| **Criteria** | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| • **Application:**<br>• Pamphlet of human genetic condition | Well-developed understanding of ideas and concepts | Reasonable understanding of ideas and concepts | Plausible understanding of ideas and concepts | Simplistic understanding of ideas and concepts |
| **Explanation:**<br>▪ Thoughtful answers to analysis questions | In-depth appreciation of concepts and application | Shows some understanding of concepts and application | Incomplete understanding of concepts and application | Inaccurate understanding of concepts and application |

| | | | | |
|---|---|---|---|---|
| **Accuracy of:**<br>• Chromosome disorder<br>• Effects on body<br>• Effects on family<br>• Risk factors for ancestral groups | Comprehension in all 4 areas | Comprehension in 3 of 4 areas | Comprehension in 2 of 4 areas | Comprehension in 1 of 4 areas |
| **Solution:**<br><br>Synthesis of genetic concepts, changing frequencies in genes in population and environmental responses | Meaningful synthesis of basic genetic concepts gene frequency in the population | Thoughtful synthesis of basic genetic concepts gene frequency in the population | Minimal abilities to synthesize of basic genetic concepts gene frequency in the population | Superficial synthesis of basic genetic concepts gene frequency in the population |

**Evidence for Topical Essential Questions**

(Grade 7)

| **Topical Questions** | **Evidence/Product** | **Facet of understanding** |
|---|---|---|
| How does nature always find a way? | Students will learn the five major types of mutations and experiment with them using an internet-bases program to visualize and internalize the ramifications of the different mutations. Students will learn that mutations are not always good or bad.<br><br>Additionally, students will learn that traits, which were once random DNA mutations, may allow for the survival or decline of an organism by analyzing an environmental disaster and its effects on populations. | Explanation<br>Perspective<br>Empathy<br>Explanation<br>Perspective<br>Self-Knowledge |

| | | |
|---|---|---|
| What role will the food, products and synthetic materials we consume play in future populations? | Students will learn that when genetic mutations and environmental changes have a major impact of the survival of organisms and their traits.<br><br>Students will simulate the idea that dominant genes can be eliminated quickly from a population by a new selective pressure while recessive genes decline slowly because they are hidden or masked.<br><br>This lesson will be conducted by students playing the toothpick fish game. They will experiment with genes and environment for a population of "toothpick" fish. They will learn about the relationships between many different aspects of fish life: genes, traits, variation, survival, and reproduction, however, specifically, they will model the way fish and other organisms live in nature. | Explanation<br>Interpretation<br>Self-Knowledge |
| How does the structure of DNA relate to its function? | Students learn that DNA's structure allows for transcription and translation, a point during which genetic mutations often occur. After watching videos and read about mutations and genetic variation, students will complete a webquest in which they will experience the process of mutating their name in the different processes.<br><br>Finally, students have the opportunity to extract DNA from strawberries and see DNA up-close and personal. This will provide them the opportunity to see the shape and embed the idea of the structure of DNA driving its function. Additionally, students will have the opportunity to use household items to extract DNA from food, and realize that this type of job is not just for people on "CSI." | Explanation<br>Application<br>Interpretation |

| | | |
|---|---|---|
| Why is it important to study patterns of inheritance? | Students will discuss their understandings of mutations and adaptations and share as a class. By discussing this, students will lead into the discussion and group assessment of a pedigree for the purpose of genetic counseling.<br><br>By looking at sex-linked or other genetic disorders, students will be able to empathize with the family and close friends of those with genetic disorders.<br><br>They will research different types of genetic disorders by conducting a webquest, they will collect information regarding the causes and ramifications of the disorder for the individual and family. The output will be an informational brochure or poster that can be used in a doctor's office for patient information. | Explanation<br>Interpretation<br>Self-Knowledge<br>Empathy |
| What is more advantageous: sexual or asexual reproduction? | By cooperating in groups and then collaborating with other expert groups regarding their view points on this question, students will debate their ideas and ask questions regarding why one may or may not be more important than another type of reproduction.<br>They will conduct a simultaneous roundtable discussion regarding their stance, where other members of the group will provide their understandings and support (or rebuttal) of the topic.<br><br>They will write a letter: "You are mitosis and you need to explain to your friend, meiosis, why you are more essential to life" or "You are meiosis, and you need to explain to your friend, mitosis, why you are more essential to life."<br><br>Finally, students will revisit their first answer to the essential question and re-assess their own stance.<br><br>Students will write an essay to answer the | Explanation<br>Interpretation<br>Self-Knowledge |

question. They will include their understanding of mitosis and meiosis, the ability for genetic diversity, the need for both processes in multi-cellular organisms for growth and repair.

Stage III

<table>
<tr><th colspan="3">Lesson overview</th></tr>
<tr><td>Week 1</td><td>3 days<br>Quis es pater (et mater) tuus?<br><br>• By introducing students to the terms inheritance, genetics, and trait, students will be able to identify their own inherited traits. Students will be able to explain how the traits of parents contribute to the makeup of their offspring.<br><br>• By experimenting generating a second generation using the offspring from day 1, students will practice predicting mathematically the probability of a given trait.<br><br>• By taking all the individual probabilities calculated on day 2, students will create a class data set to reveal a population’s patterns of inheritance.</td><td>2 days<br>The great debate – sex or no sex?<br>• By modeling the act of mutation, students will understand that all life is based on the same genetic code.<br><br>• Students will be able to describe how multiple genetic and/or environmental factors often play a role in the expression of a trait</td></tr>
<tr><td></td><td>3 Days<br>Sex and the Single Cell<br>• By working in cooperative groups, students will be able to explain the different aspects of meiosis and its role in heredity and variation<br><br>• Students will create word concept maps to aid in understanding the differences between mitosis and meiosis<br><br>• By working in cooperative groups, students will be able to explain the different aspects of meiosis and its role in heredity and variation and experience the other important</td><td>1 Day<br>Its a dog’s world<br>• Students will gain insight in selective breeding of dogs for desirable traits<br><br>2 Days<br>Toothpick Fish<br>• Students will be able to differentiate between a genetic disorder and an environmental problem<br><br>• Students will be able to explain the role genetic mutations on the appearance of the certain traits and its</td></tr>
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| | | |
|---|---|---|
| | activities meiosis affects.<br><br>• *Students will understand why meiosis is so important to species variation.*<br><br>• | *effects in the long-term for a population* |
| Week 3 | 1 Day<br>***Strawberry DNA***<br>*By experimenting with strawberries, students will extract DNA using household items and be able to visualize DNA while connecting how structure of DNA is related to function.*<br>The long, thick fibers of DNA store the information for the functioning of the chemistry of life. DNA is present in every cell of plants and animals. The DNA found in strawberry cells can be extracted using common, everyday materials. We will use an extraction buffer containing salt, to break up protein chains that bind around the nucleic acids, and dish soap to dissolve the lipid (fat) part of the strawberry cell wall and nuclear membrane.<br>With the assistance of a volunteer from Woods Hole (Marine Biological Labs), students will receive a background understanding of why DNA is important, how do scientists use it? (This volunteer works with microbes). | 4 Days<br>***GRASPS – All in the Family***<br>• By working in cooperative groups, students will develop an understanding of genetic disorders<br>• Students will be able to empathize with people who express sex-linked disorders and other genetic disorders. Additionally, they will apply the knowledge of genetic mutations and disorders to determine the impact on the individual and the families of those with genetic disorders. |

Inheritance Unit

**Subject – Life Science Grade - 7**

Lesson One – 3 days ***Quis es pater (et mater) tuus?***

**Instructional Content Objective**

By introducing students to the terms inheritance, genetics, and trait, students will be able to identify their own inherited traits. Students will be able to explain how the traits of parents contribute to the makeup of their offspring.

By experimenting generating a second generation using the offspring from the first day, students will practice predicting mathematically the probability of a given trait.

Students will utilize Excel on Wednesday in order to create spreadsheet and graphs of the distribution.

**Enduring Understandings:**

- All life is based on the same genetic code
- Reproduction is essential to the continuation of life

**Overarching Essential Questions**

- How do genetic variation and environmental factors contribute to the diversity of organisms?
- How does reproduction ensure the continuation of a species?

**Topical Essential Questions**

- Why is the study of patterns of inheritance important?

**MA Curriculum Framework Standards**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard: 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

**1. P- Preparation Phase**

**Frontload key vocabulary terms**: **8-10 minutes**

Today's Critical Vocab Terms – Inheritance, genetics, heredity, and trait

**Focus, Arouse curiosity and the "need to know," work with - 5 minutes**

1. Ask the question: "You have probably noticed that different people have different traits, such as eye color, hair color, and ear lobes that do or do not attach directly to their head. Where do people get these different traits?" Students will answer this on paper, then round robin at their tables, determine a group answer, and report out with a table-wide answer.
2. Students will work in their cooperative groups (based on the table where they sit) to complete a VVWA for one of the critical vocabulary terms in order to create a poster to share with the class. Students will utilize roles in order to complete the task: recorder, materials manager, and coach. The coach student will provide the teacher with a written out version of the VVWA on notebook paper (and teacher will make copies for the class the next day). All students must contribute to the activity. When time is finished, students will hang up their posters, and then carousel around the room.

**2. A – Assistance and Association Phase**

After students have finished the preparatory activity, students will be given instructions the note sheet for inheritance vocabulary and a worksheet for the inherited traits lab activity.

1. Create a space to flip the coin into; this can be done creating a triangle with three textbooks corner to corner.
2. Determine which partner will toss for the female parent and which will toss for the male.

Remember, there are two genes for each trait.
3. Have the partner representing the male parent flip a coin into the well to determine the sex of the offspring. If the coin lands heads, the offspring is female. If it lands tails, the offspring is male. Record the sex of the offspring under observations.
4. For all of the coin, HEADS= DOMINANT and TAILS = RECESSIVE
5. Both partners flip the coins into the well at the same time. Note: the coins should be flipped **once for each trait.**
6. Continue to flip the coins for each trait listed in the table provided. After each flip, record the trait of your offspring by recording it in the data table.
7. Using the recorded traits, draw the FACIAL FEATURES of the offspring in the box provided.

**3. R – Reflection and Readiness for Application Phase**
**During the last seven minutes of class, students reprocess the information from the day by:**

1. Students will answer the reflection question in writing: How do two parents contribute to the makeup of their offspring?
2. Students will perform a standup and share of the answers they provided. Written reflections to be turned in to the teacher on the worksheet from today's class period.

**1. P – Preparation Phase**

**Frontload key vocabulary terms**: **8-10 minutes**

1. Today's Critical Vocabulary Terms – genes, trait, probability

**Focus, Arouse curiosity and the "need to know," work with - <u>5 minutes</u>**
Students will participate in an all class VVWA regarding probability.
Teacher will discuss the results from yesterday, and show them the numbers of DD, Dd, and dd and mention their amounts. Then ask: How do they relate? Do you see a *pattern?*

**2. A – Assistance and Association Phase**

After students have finished the preparatory activity, students will be given instructions to cross children and generate grandchildren, the second generation:
Using the recorded genotypes from yesterday, students will find a different partner and flip a coin to determine gender. Take the *genotype* for each trait from each partner and do a genetic cross using Punnett squares. After crossing all the traits, students will close their eyes and randomly choose a trait, circle it, and draw their grandchild. Does it look like the parents? Students will record their results on the chart paper on the wall.
Show and example using **face shape: R= dominant, round; r = recessive, square**
**Mom's Genotype: Rr Dad's Genotype: Rr**
**Punnett Square to calculate the probability of having a round face or a square face.**

| | R | r |
|---|---|---|
| R | RR | Rr |
| r | Rr | rr |

Round face probability: **3**/4 = 75%
Square face probability: **1**/4 = 25%
So, the **theoretical probability** is a **3:1** *ratio* of round face to square face offspring.

**3. R – Reflection and Readiness for Application Phase**

**During the last seven minutes of class, students reprocess the information from the day by:**
Students will answer the reflection question in writing: How can you use math to determine the likelihood of a trait?
Written reflections to be turned in to the teacher on the worksheet from today's class period.

**Subject – Life Science Grade - 7**

Lesson One – 3 days ***Quis es pater (et mater) tuus?***

**Instructional Content Objective**

By describing and modeling the act of mutation, students will understand that all life is based on the same genetic code. They will be able to describe how multiple genetic and/or environmental factors often play a role in the expression of a trait

**Enduring Understandings**

- All life is based on the same genetic code
- Reproduction is essential to the continuation of a species
- The patterns of their inheritance can sometimes be described mathematically
- Multiple genetic and/or environmental factors often play a role in the expression of a trait

**Overarching Essential Questions**

- How do genetic variation and environmental factors contribute to the diversity of organisms?
- How does reproduction ensure the continuation of a species?

**Topical Essential Questions**

- How does nature always find a way to adapt?
- Why is the study of patterns of inheritance important?
- How does the structure of DNA relate to its function?
- What is more advantageous: sexual or asexual reproduction?

**Facets of Understanding**

Explanation
Perspective
Empathy
Explanation
Perspective
Self-Knowledge

**MA Curriculum Framework Standards Addressed**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard: 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

**MA Standard 2.10:** Evolution and Biodiversity - Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.

**1. Preparation Phase –**

What is a mutation? Students will answer the question individually. One they have answered the question, they will compare with a partner. Then they will pair with the partners at the table behind them/in front of them. When that group has come to a consensus, they will report out to the class

**2. A – Assistance and Association Phase**

Students will take part in a webquest dealing with mutations. They will follow the guidelines on the handout, recording their responses on the worksheet provided. This will be reviewed as a class, pointing out the results and how they relate to changes in the organism's phenotype. One part of the activity deals with selective breeding.

What is a mutation? http://learn.genetics.utah.edu/archive/mutations/index.html

Mighty Mutation Maker: http://www.nature.ca/genome/04/0413_e.cfm - 010

Ask the students what adaptation means.

3. **R – Reflection and Readiness for Application Phase**

Students will turn to a neighbor and explain why they think mutations are important to the continuation of life.

**Subject – Life Science Grade - 7**

Lesson Two – ***The great debate – sex or no sex?*** - 3 days

**Instructional Content Objective**

By working in cooperative groups, students will be able to explain the different aspects of meiosis and its role in heredity and variation.

By working in cooperative groups, students will be able to explain the different aspects of meiosis and its role in heredity and variation and experience the other important activities meiosis affects.

**Enduring Understanding**

All life is based on the same genetic code

Reproduction is essential to the continuation of a species

The patterns of their inheritance can sometimes be described mathematically

Multiple genetic and/or environmental factors often play a role in the expression of a trait

**Topical Essential Questions**

What is more advantageous: sexual or asexual reproduction?
How does nature always find a way to adapt?
How does the structure of DNA relate to its function?

**Facet of Understanding**

Explanation
Perspective
Empathy
Explanation
Perspective
Self-Knowledge

**MA Curriculum Framework Standards Addressed**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard: 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

**Biology Standard 9:** Reproduction and Heredity - Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell).

**1. P – Preparation Phase**

**Frontload key vocabulary terms: 8-10 minutes**

Today's Critical Vocab Terms – Meiosis

**Focus, Arouse curiosity and the "need to know," work with - 5 minutes**

Students will brain dump everything they "remember" about inheritance from before vacation. (Partner A, Partner B)

**2. A – Assistance and Association Phase**

After students have finished the preparatory activity, student will read chapter 5 section 3 from the Holt text book (interactive text printout) and highlight the key terms and ideas in cooperative groups to which have been assigned (#1, 2, 3, or 4).

In their groups, students will read quietly their assigned section:

Group #1 - pages 76 + 79: sex cells, chromosomes, and sex-linked disorders; Group #2 - page 78: Meiosis and Mendel; Group #3 - page 75: How living things reproduce; Group #4 - pages 80 + 81: Genetic counseling and selective breeding

When finished reading, students in the group will share/summarize the section they read, in a round-robin format. The group may use the available laptop computer to view videos posted on the teacher's blog in order to visualize their assigned reading.

After everyone has shared, the group will come to a consensus as to the important information. On a piece of chart paper, students will create a concept-word map of the section they read. Homework is to read the whole chapter, and write a summary of just their own assigned pages

**3. R – Reflection and Readiness for Application Phase**

**During the last seven minutes of class**, **students reprocess the information from the day by:** Student will pair up with a student from another group. With that person, they will explain what they learned today about their own reading, for 1 minute. Then, for another minute, the second partner will share his/her reading. For one more minute, the first partner will get to ask questions of the other partner.

**1. P – Preparation Phase**

Review of yesterday's lesson on meiosis.
Brain dump partner A - mitosis and B – meiosis A2 – differences B2- similarities

**2. A – Assistance and Association Phase**

One Stay, Three Stray - One person from each group of four will stay with the post. The other three will rotate to the next group number and learn about that group's information. They will return to their own group and explain the information to their group mate who stayed. A different group member will stay; the rest will rotate one more group number. Repeat one more time. * In groups of 5, two stay, three stray

Group #1 - pages 76 + 79: sex cells, chromosomes, and sex-linked disorders; Group #2 - page 78: Meiosis and Mendel; Group #3 - page 75: How living things reproduce; Group #4 - pages 80 + 81: Genetic counseling and selective breeding.

Genetic disorders/sex-linked handout

**3. R – Reflection and Readiness for Application Phase**

**During the last seven minutes of class**, **students reprocess the information from the day by:** HW assignment/reflection: Letter to/from mitosis/meiosis as to why you are more essential to the continuation of life.

Assessment – Open-Response essay

**Subject – Life Science Grade – 7**

Lesson Three– *It's a Dog's World* 1 day

**<u>Instructional Content Objective</u>**

Students will gain insight in selective breeding of dogs for desirable traits.

Students will apply the concepts of heredity by experimenting with probability through breeding for traits.

**Enduring Understanding**

All life is based on the same genetic code
Reproduction is essential to the continuation of a species
The patterns of their inheritance can sometimes be described mathematically
How does reproduction ensure the continuation of a species?

**Overarching Essential Questions**

How do genetic variation and environmental factors contribute to the diversity of organisms?

**Topical Essential Questions**

Why is the study of patterns of inheritance important?

**MA Curriculum Standards**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard: 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

**MA Standard 2.9:** Reproduction and Heredity - Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell).

1. **P – Preparation Phase**

   Goldfish chapter starter from Holt Text book

2. **A – Application Phase**

Activity One: Activity Three: Selective Breeding: Dog Breeding
http://pbskids.org/dragonflytv/games/game_dogbreeding.html

1. Your goal is to breed a puppy with specific traits. In the first case, the goal is to create a puppy with brown fur.
2. Select a male dog by clicking on one of the cards on the right. Click the curved arrow to learn more about that dog.
3. Select a female dog by clicking on one of the cards the right. Click the curved arrow to learn more about that dog.
4. Once you have selected a male and female dog, the chances of producing different genetic traits are shown on the spinner. Different combinations of male and female dogs will produce different odds.
5. Clicking the breed button will start the spinner. The spinner will randomly stop at one of the four positions, which indicates the genetic trait for the puppy.
6. An image of the new puppy (and its traits) is in the "new puppy" window at the bottom. Compare the new puppy to the goal puppy. Some levels will require more than one round to breed a puppy with the right traits.

7. If the puppy does not have the desired genes, click the Continue button. The new puppy will be added to the Male or Female kennel on the side. The puppy is now available as a parent for the next round of breeding.
8. At higher levels of the game, the goal is to breed a puppy with more than one trait. Each spinner represents one genetic trait: fur color, coat length, and ear type.
9. Clicking the Breed button causes all three spinners to rotate. Remember, it may take more than one round to breed the puppy with all three desired genetic traits.

| Level # | # Tries |
|---|---|
| 1 | _____ |
| 2 | _____ |
| 3 | _____ |
| 4 | _____ |
| 5 | _____ |
| 6 | _____ |

Compare your results with a partner

**3. R – Reflective Phase**

How can selective breeding be used in other ways?

**Subject – Life Science Grade – 7**
Lesson four– *Toothpick Fish* 2 days

**Instructional Content Objective**
This lesson will be conducted by students playing the toothpick fish game. They will experiment with genes and environment for a population of "toothpick" fish. They will learn about the relationships between many different aspects of fish life: genes, traits, variation, survival, and reproduction, however, specifically, they will model the way fish and other organisms live in nature. Students will learn that when genetic mutations and environmental changes have a major impact of the survival of organisms and their traits. Students will simulate the idea that dominant genes can be eliminated quickly from a population by a new selective pressure while recessive genes decline slowly because they are hidden or masked.

**Enduring Understanding**
Reproduction is essential to the continuation of a species
Multiple genetic and/or environmental factors often play a role in the expression of a trait

**Overarching Essential Questions**
How do genetic variation and environmental factors contribute to the diversity of organisms?

**Topical Essential Questions**
How do genetic variation and environmental factors contribute to the diversity of organisms?
How does reproduction ensure the continuation of a species?
How does nature always find a way?

**Facets of Understanding**
Explanation

Interpretation
Self-Knowledge
Empathy
Self Knowledge

**MA Curriculum Standards**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard 2.10:** Evolution and Biodiversity - Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.

**1. P – Preparation Phase**

Hand out the student instructions and worksheet entitled "Toothpick Fish." Briefly review the reproductive cycle of the fish as shown on the first page of the instructions.

Hand out the gene pool containers (cups or plastic Petri dishes with covers) and colored toothpicks (pre-count 8 of each of the green, red, and yellow, for a total in each container of 24). Each toothpick's color represents the information carried by that gene, that is, green, red, or yellow skin. Drawing two toothpicks at random from the dish represents fusion of an egg and a sperm to form a new fish, with two copies of the skin color gene. **Remind students that each toothpick represents a gene and not a fish.**

**2. A – Application Phase**

**Materials (for each pair)**

1 "gene pool" container (e.g. a Petri dish), 8 green toothpicks, 8 red toothpicks, 8 yellow toothpicks

Go over the rules of fish skin color inheritance with the class (e.g. "the green gene is represented by the letter G and is dominant to all other color genes"). The rules of inheritance are listed in the table on the first page of the student handout. Have students work in pairs and fill out the table in question 2 and then answer questions 2a-2c on their worksheet. An overhead master that contains the rules of inheritance table and the question 2 table is included in this packet. To fill out the table, students should lay out before them on their desks the gene pairs that produce a green fish (GG, GR, GY), a red fish (RR), an orange fish (RY), and a yellow fish (YY). When they have the population's dominant/recessive gene pattern in hand, have them work through the instructions that follow.

In #3 and #4 of the instructions, students draw pairs of toothpicks and tally the resulting fish genotypes and colors in **Tables A and B**. You can compile the class results on an overhead transparency

- Why are there so many green fish?
- Why are there so few red, orange, and yellow fish?

In instruction #4, the environment comes into play. Yellow fish are poorly camouflaged and get eaten before they can spawn. Read from #4 out loud to the class **"If you have any yellow fish—fish in which both toothpicks are yellow—, set those toothpicks aside."** Emphasize that it is important to eliminate the yellow fish before continuing to draw future generations. Have

students move on to instructions #5 and #6 and draw two more generations of fish for a total of three generations. The genotypes and colors of fish offspring are tallied and recorded in **Tables A and B.** Students should not continue onto #7. After students have drawn three generations, discarding all resulting yellow fish, you can again tally the class results. The yellow gene is clearly not increasing the yellow fish's chance of surviving. Consider these questions:

• Have *all* the yellow genes disappeared? How long do you think it would take before they did?

• Has the population size changed? In what way? Would you expect this to occur in the wild?

• How does the population in the third generation compare to the population in the earlier generations?

Have students move on to #7 and draw a fourth generation of fish and record their data in **Tables A and B.** But this time, they do not remove the yellow fish because....
**"An environmental disaster occurs. Factory waste harmful to algae is dumped into the stream, killing much of the algae very rapidly. The remaining rocks and sand are good camouflage for the yellow, red, and orange fish. Now the green fish are easily spotted by predators and can't survive or reproduce."**

Instruction #8 tells students to set aside their green fish and record the remaining fish in **Table B** on the Fourth Generation Survivors line. Use the provided overhead**, "Table C. Fish surviving the pollution disaster: pooled data,"** to tally up the data from all the student pairs. Have students examine the data from the entire class and consider questions 8a-8c.

• Has the population changed compared to earlier generations? How?

• Have any genes disappeared entirely?

• Yellow genes are recessive to green; green genes are dominant to both red and yellow. Which color of genes disappeared faster when the environment was hostile to them? Why?

3. R – Reflection Phase
Real populations change much more slowly than these toothpick fish. Why?

1.

**Subject – Life Science Grade - 7**
Lesson 5 – *Strawberry DNA* 1 day

**Instructional Content Objective**
By experimenting with strawberries, students will extract DNA using household items and be able to visualize DNA while connecting how structure of DNA is related to function.
**Enduring Understandings:**
All life is based on the same genetic code
Reproduction is essential to the continuation of life
**Overarching Essential Questions**
How do genetic variation and environmental factors contribute to the diversity of organisms?
How does reproduction ensure the continuation of a species?
**Topical Essential Questions**
Why is the study of patterns of inheritance important?

How does the structure of DNA relate to its function?

**Facet of Understanding:**
Explanation
Application
Interpretation

**MA Curriculum Framework Standard**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard: 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

## 1. P – Preparation Phase

The long, thick fibers of DNA store the information for the functioning of the chemistry of life. DNA is present in every cell of plants and animals. The DNA found in strawberry cells can be extracted using common, everyday materials. We will use an extraction buffer containing salt, to break up protein chains that bind around the nucleic acids, and dish soap to dissolve the lipid (fat) part of the strawberry cell wall and nuclear membrane.
With the assistance of a volunteer from Woods Hole (Marine Biological Labs), students will receive a background understanding of why DNA is important, how do scientists use it? (This volunteer works with microbes).

Pre-lab questions: What do you think the DNA will look like? Where is DNA found?

## 2. A – Application Phase

**Materials**

- Heavy-duty Ziploc bag
- 1 strawberry
- Water
- Salt
- Detergent
- Meat tenderizer
- Filter
- Ice cold ethanol
- Clear test tube
- Glass stirring rod or plastic coffee stirrer

**Procedure**

1. Put the strawberry, an equal volume of water and a pinch of salt into the Ziploc bag. *Do a very good job of closing the bag!* Use your hand to mush the strawberry for about two minutes. You need to **completely** crush the strawberry.
2. When you're finished crushing, add 1 teaspoon of dish detergent. Let the mixture sit for 5 minutes.

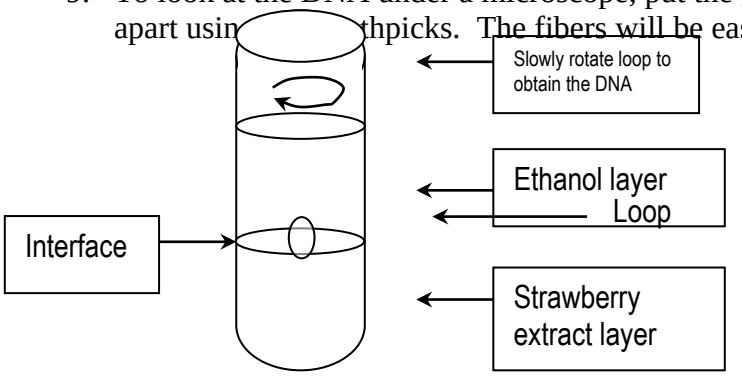
3. Strain the mixture through a coffee filter into a test tube. You should have 25 ml maximum.

4. Add a pinch of enzyme (meat tenderizer) and mix gently by inverting the tube.

5. Next, carefully pour an equal volume of ethanol into the test tube.

6. Watch for the development of several large air bubbles that have a white cloudy substance attached to them. The cloudy substance is DNA.

7. Take the coffee stirrer and spin and stir it like you're making cotton candy. If you tilt the test tube, you'll get more DNA.
8. Pull out the DNA. It will look like mucus or egg white. As it dries, it will look like a spider web. The fibers are millions of DNA strands.
9. To look at the DNA under a microscope, put the glob on a clean slide and gently stretch it apart using toothpicks. The fibers will be easier to see in the stretched apart area.




**Observations:**

Carefully sketch what you see under the microscope. Be sure to label the magnification (40x, 100x, 400x)

**Scanning Power** **Low Power** **High Power**

**3. R- Reflective Phase**

**Written relection – what was the best part of this lab? Provide at least two specific examples, and also mention how scientists can use DNA.**

Homework : Analysis questions and Thank you letter.

Analysis Questions:

1. It is important that you understand the steps in the extraction procedure and why each step was necessary. Each step in the procedure aided in isolating the DNA from other cellular materials. Match the procedure with its function:

**PROCEDURE** **FUNCTION**

A. Filter strawberry slurry through cheesecloth

B. Mush strawberry with salty/soapy solution

C. Initial smashing and grinding of strawberry

D. Addition of ethanol to filtered extract

___ To precipitate DNA from solution

___ Break open the cells

___ Separate components of the cell

___ Break up proteins and dissolve cell membranes

2. What did the DNA look like? Relate what you know about the chemical structure of DNA to what you observed today.

3. Explain what happened in the final step when you added ethanol to your strawberry extract. (Hint: DNA is soluble in water, but not in ethanol)

4. A person cannot see a single cotton thread 100 feet away, but if you wound thousands of threads together into a rope, it would be visible much further away. Is this statement analogous to our DNA extraction? Explain.

5. Why is it important for scientists to be able to remove DNA from an organism? List two reasons.

6. Is there DNA in your food? _____ How do you know?

Adapted from the Utah Protocol:

Genetic Science Learning Center (2010, March 13) How to Extract DNA from Anything Living.
*Learn.Genetics*. Retrieved March 13, 2010, from
http://learn.genetics.utah.edu/content/labs/extraction/howto/

**Subject – Life Science Grade - 7**

Lesson Six –*All in the Family* - 4 days

**Instructional Content Objective**

By working in cooperative groups, students will develop an understanding of genetic disorders and the effects on the individual and the family

**Enduring Understanding:**

All life is based on the same genetic code
Reproduction is essential to the continuation of a species
The patterns of their inheritance can sometimes be described mathematically
Multiple genetic and/or environmental factors often play a role in the expression of a trait

**Overarching Essential Questions**

How do genetic variation and environmental factors contribute to the diversity of organisms?

**Topical Essential Questions**

What is more advantageous: sexual or asexual reproduction?

**Facet of Understanding**

Explanation
Interpretation
Self-Knowledge

**MA Curriculum Framework Standard**

**MA Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Standard: 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

**Biology Standard 9:** Reproduction and Heredity - Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell).

See GRASPS

**Sample Lesson:**

***Title of Lesson:*** *Sex and the Single Cell*

***Brief Overview:***

The *Sex and the Single Cell* lesson is designed for students to be able to make connections between sexual and asexual reproduction. Specifically, students will focus on the role of meiosis in genetic diversity among all living things and within a given species and population.

***Essential Questions Addressed:***

***Overarching Essential Questions***

- How do genetic variation and environmental factors contribute to the diversity of organisms?
- How does reproduction ensure the continuation of a species?

***Topical Essential Questions***

- Why is the study of patterns of inheritance important?
- What is more advantageous: sexual or asexual reproduction?

***Background:***

Content: These activities may promote the development of certain mind-set proper to the field of science such as accuracy, reliability, and analytical rigor. This is an opportunity for students to reflect on the levels of hereditary organization: chromosomes, genes, alleles, and the expression of the information: homozygosis or heterozygosis genotypes, dominant and recessive alleles for traits, co-dominance, incomplete dominance, and mutations (Banet & Ayuso, 2003). These tasks should be successful in motivating students to overcome the commonly observed difficulties of students in the topic of biological evolution, which has yet to be mentioned in class. It is the "E word" (Desantis, 2009).

Misconceptions:

Students lack understanding of cell division's purpose, processes, and products, and struggle with distinguishing between mitosis and meiosis (Knipples et al., 2005). This may be

due to the difficulty understanding the concept of homologous chromosomes, sister chromatids, and alleles (Lewis & Wood-Robinson, 2000). Students hold the misconception that certain traits are inherited from only one parent. Additionally, students hold misapprehensions including that several living organisms such as sea mussels or geraniums lack cells, chromosomes, or genes, and they do not reproduce sexually with sex cells (gametes). Students believe only human gametes contain inheritance information, sex chromosomes, and genes and none of the other human With rapid developments in genetic screening with the human genome project, there has been increasing concern about the poor level of understanding of inheritance within the general population (Lewis & Wood-Robinson, 2000). The concern focuses on the extent to which consent to genetic screen is "informed" and that people are able to properly interpret the personal implications that result from the screening (Lewis & Wood-Robinson, 2000). These rapid developments require citizens to make informed decisions about genetic screening, stem cell research, genetically manipulated foods, antibiotic resistance, to name a few, and a sound understanding of fundamental concepts in genetics (Desantis, 2009; Duncan, Rogat, & Yarden, 2009).

In their study, Lewis and Wood-Robinson (2000) found there is confusion about the relationship between genes and genetic information. The results of this study indicate that the majority of students identified genes as the source of inherited information while few were understood that genes are specific locations on chromosomes (Lewis & Wood-Robinson, 2000). There was uncertainty about the relationship between genes and chromosomes, difficulties with the concept of 'cell," confusion about the terminology of cell division and its meaning, and difficulty distinguishing processes (Lewis & Wood-Robinson, 2000). This shows that students are not capable of making informed responses to genetic screening without significant support and counsel. The science education which these students received was neither a great framework nor a useful preparation for personal interactions with science in their adult lives for which it is possible to prepare (Lewis & Wood-Robinson, 2000). Chattopadhyay's 2005 study in India looked at high school students' knowledge and understanding of biology topics related to genetics and found students did not have an understanding of how the genetic information transforms during reproduction.

***Standards:***

**MA Biology 6-8 Standard: 2.7:** Recognize that every organism requires a set of instructions that specifies its traits. These instructions are stored in the organism's chromosomes. Heredity is the passage of these instructions from one generation to another.

**MA Biology 6-8 Standard 2.8**: Recognize that hereditary information is contained in genes located in the chromosomes of each cell. A human cell contains about 30,000 different genes on 23 different chromosomes.

**MA Biology 6-8 Standard 2.9:** Reproduction and Heredity - Compare sexual reproduction (offspring inherit half of their genes from each parent) with asexual reproduction (offspring is an identical copy of the parent's cell).

***Instructional and Content Objectives:***

- Students will be able to describe how multiple genetic and/or environmental factors often play a role in the expression of a trait
- Students will be able to explain how to differentiate between sex-linked disorder and an autosomal genetic disorders
- Students will be able to explain the different aspects of meiosis and its role in heredity and variation.
- Students will understand that all life is based on variations of the same genetic code by describing and modeling the act of mutation

***Framing of Learning****: (3 Science class periods, approximately 144 minutes)*

1. **Preparation Phase: (*day 1)***

Key vocabulary word: Meiosis, sexual reproduction

Students will view a video clip that recaps the idea of mitotic cellular division, and provides a comparison of mitosis to meiotic cellular division.

2. **Assistance Phase:**

After students have finished the preparatory activity, student will read chapter 5 section 3 from the Holt text book (interactive text printout) and highlight the key terms and ideas in cooperative groups to which have been assigned (#1, 2, 3, or 4).

1. In their groups, students will read quietly their assigned section:
    a. Group #1 - pages 76 + 79: sex cells, chromosomes, and sex-linked disorders
    b. Group #2 - page 78: Meiosis and Mendel
    c. Group #3 - page 75: How living things reproduce
    d. Group #4 - pages 80 + 81: Genetic counseling and selective breeding
2. When finished reading, students in the group will share/summarize the section they read, in a round-robin format.
3. After everyone has shared, the group will come to a consensus as to the important information.
4. On a piece of chart paper, students will create a concept-word map of the section they read (the teacher will model the concept word map first).
5. For homework, students will read the whole chapter, and write a summary of just their own assigned pages.

***3.Reflection and Readiness for Application Phase***

During the last seven minutes of class, students reprocess the information from the day by pairing up with a student from another group. With that person, they will explain what they learned today about their own reading, for 1 minute. Then, for another minute, the second partner will share his/her reading. For one more minute, the first partner will get to ask questions of the other partner.

***1. Preparation Phase: (day 2)***

1. Review of yesterday's lesson on meiosis (Brain dump partner A - mitosis and B – meiosis A2 – differences B2- similarities)

2. Students will share their summaries from the previous night with their group mates by following the protocol for a round robin. Each student will read his/her summary and then the group will provide feedback and ask questions. All students will take this time to make any additions or corrections to their own summary prior to handing it in to the teacher.

3. When all students in the group are finished, they will hand in the summaries.

***2. Assistance Phase:***

One Stay, Three Stray - One person from each group of four will stay with the poster

The other three group mates will rotate the next group (in a clockwise manner) and have someone from that group explain their poster and information. Students who are learning need to take notes on the graphic organizer in order to remember the information. Each time the students switch to a new group, a different group member will remain at their home table to present the poster and its information. At the end other activity, one (or two) person from each group will not have seen one poster in the classroom. It is the job of the rest of the group to go around in a round robin, each explaining one of the other groups' posters. This is yet another opportunity for a verbal summary of the information.

***3. Reflections and Readiness for Application:***

During the last seven minutes of class, students will reprocess the information from the day's lesson by answering the question in writing: *what is more advantageous: sexual or asexual reproduction?* Provide support for homework.

***1. Preparation Phase: (day 3)***

1. Social Skills T-Chart:

**How to politely disagree**

| **Looks Like** | **Sounds Like** |
|---|---|
| ▪ No crossed arms | - "I understand what you are saying, but…" |
| ▪ Nodding head | - "I agree with you about this, but I have a question about….?" |
| ▪ Closed mouth while listening | - "That's interesting, but don't forget…" |
| ▪ Eye contact | |

2. 4-Corner Value Statement:

*Asexual reproduction is the most valuable form of reproduction for the continuing of a species.*

1. Strongly Agree
2. Agree
3. Disagree
4. Strongly Disagree

***2. Assistance Phase:***

In each corner of the classroom, the numbers 1-4 are posted. Instruct students to go to the sign that applies to them. The have written their answer already, so make sure they bring it with them.

In the corner, students will work together to brainstorm reasons as to why they believe it is the most important form of reproduction. They may use the book, the internet (laptop computers available), and each other's "defense" from the previous night for resources. When they have compiled at least 5 strong examples of why they are correct, the group will create a poster "proving their point"

When all groups have finished compiling their list of support for their stance, opposing opinion groups will line up opposite each other. They will count off by 4's and pair up all the 1s, 2s, 3s, or 4s. Their job is to try to sway the others to their side, while trying not to fold and give into them.

They will begin in class as a sponge activity if they finish "early." Five minutes early is the most students are allowed to finish their discussion. Any longer than five minutes means they need help delving deeper into the argument.

***3. Reflections and Readiness for Application:***

During the last ten minutes of class, students will reflect on the lesson by discussing the two opposing arguments to the question. They will finish this for homework and hand in the next day. They will follow the Team 3 rubric/graphic organizer.

***Purpose:***

The purpose of this lesson is to educate students about the role of genetics in our everyday lives and the role of reproduction in the continuation of a trait and the diversity of species. Students often come to science class as wonder "why do I need to know this?" This is an opportunity for students to learn more about themselves and their own traits and it is also an opportunity for students to expand their understanding and ability to empathize with others with certain disorders.

***Assessment:***

Students will be informally assessed on their group presentations and formally assessed on their posters and summaries that they put together after their reading and brainstorming is complete. In order for it to be clear that the student understands the intended objectives, the following should be present in their conversations, summaries, posters, and reflections:

- -Substantial dialogue in the group explanation, summarizing, and explanations
- -Ability to present information to group members and other classmates clearly
- -Accurate information regarding the specific topics
- -Personal connections between students' lives and genetic disorders
- -Answer (and support) the question: *what is more advantageous: sexual or asexual reproduction?*
- -Written summary of both arguments about the issue.

***Special Considerations to Include All Learners:***

Students will be working in teacher created cooperative learning groups. They will work together and rely on one another for everyone to understand. This will address many behavior and attention issues. Students

In order to meet the needs of all students, they will be given the opportunity to show their learning in a variety of ways. When expert groups make their posters students will be advised to use words, drawings, and symbols, and they will follow a given format modeled for the class by the teacher. In addition, students will be encouraged to both use words and drawings in their summaries.

To support students with organizational challenges, a graphic organizer will be provided to organize the material presented by the other groups. The graphic organizer will be available to all students as they carousel the room and take notes, as its benefits would be valuable to all students.

The summaries that students write will be assessed based on the Lawrence School Team 3 Summary Grading Rubric/graphic organizer, developed and used by the ELA, social studies, and science teacher on the team.

### *Resources*


Allen, K., Berg, L., Christopher, B., Dushek, J., & Taylor, M. (2007). *Life Science*, Orlando: Holt, Rinehart & Winston.

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Chattopadhyay, A. (2005). Understanding of genetic information in higher secondary students in northeast India and the implications for genetics education. *Cell Biology Education,* 4, 97-104.

Desantis, L. (2009). Teaching evolution through inquiry-based lessons of uncontroversial science. *The American Biology Teacher,* 71 (2), 106-111.

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