

Flower Power- The Genetic Journey



What is a Desert tutorial



How are Deserts Formed tutorial



Virtual Habitat

ACTIVITY OVERVIEW

In preparation for their visit to the Desert Botanical Garden, students review the reproductive parts and processes of angiosperm plants. Referring to provided graphics, the class reviews the specific parts of flowers, seeds, and fruit and discusses how a flower becomes a fruit, how a fruit produces seeds, and how a seed germinates. The class next explores how parents (of plants and other living things) pass characteristics to their offspring. Students apply basic genetic principals by using a Punnett square to determine the genetic make-up of offspring given parents of various dominant and recessive genes. Finally, students consider how desert plants pass on genetic information through seeds, as they develop a hypothesis about how seeds survive the harsh desert environment and germinate when conditions are favorable.

To support the Inquiry in the Garden lesson plans, you may also use the tutorials and Virtual Habitat in DBG's Digital Desert. These interactive activities will prepare students for their investigations by teaching them about the characteristics of deserts and the Sonoran Desert habitat.

MATERIALS

(Note: All of the following materials are provided as downloadable documents and should be prepared for use on an overhead projector or smartboard.)

- Parts of a Flower
- Teacher's Guide to the Parts of a Flower
- How a Fruit Develops
- Structure of a Seed
- Creating a Punnett Square

LEARNING OBJECTIVES

Upon completion of this activity, students will be able to...

- List and describe the reproductive parts of a flower.
- Describe how a fruit develops from a pollinated flower.
- Draw, label, and explain the functions of the parts of a seed.
- Define the terms dominant and recessive in relation to genetics.
- Complete and analyze the results of a Punnett square.
- Calculate the probability of offspring having a particular trait.
- State a hypothesis about desert seeds and consider ways to test their hypothesis.



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BACKGROUND KNOWLEDGE

These are concepts that the educator should know and that can be found in the glossary.

| Cotyledons | Hypothesis | Qu |
|---------------|--------------------|-----|
| Dominant | Genes | Rec |
| Dormancy | Germinate | See |
| Embryo | Observation | Tra |
| Fertilization | Pollination | |

Question Recessive Seed coat Traits

ACTIVITY PROCEDURES

1. Introduction.

Explain to students that they will be visiting the Desert Botanical Garden where they will be studying reproduction and heredity in plants – specifically in desert plants. This lesson will help prepare them for that field trip. Through an inquiry discussion, review with students the name of our desert (the Sonoran Desert) and the characteristics of deserts in general (hot, dry, high evaporation, low rainfall, and extreme temperature fluctuations).

2. Review reproductive parts of plants.

Display *Parts of a Flower* on the overhead projector or smartboard. Review and discuss the graphic and ask for students to name the different structures. As students respond with the correct names, fill in the appropriate blanks. (If necessary, refer to the *Teacher's Guide to the Parts of a Flower*.)

3. How does the flower produce seeds?

Display How a Fruit Develops on the overhead projector or smartboard. Review and discuss the graphic pointing out the specific steps in fruit development:

- The flower is pollinated (review flower parts involved in pollination).
- The pollinated flower is fertilized by the pollen (fertilization).
- The flower's fertilized ovary typically swells and becomes the fruit.
- The fruit is the seed-bearing structure produced from the flower.
- The fruit contains from one to many seeds.

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4. How do seeds become new plants?

Display *Structure of a Seed* on the overhead projector or smartboard. Review and discuss the seed structures and their functions, and the process of germination as stated on the graphic and below:

- The seed coat is the protective outer layer that functions to protect the embryo from parasites, injury, and harsh conditions (such as weather or digestive enzymes).
- The cotyledons are the embryo's "leaves" and are the seedling's energy source until real, photosynthetic leaves develop.
- The embryo is the immature plant with all the information necessary to become the full grown plant.
- A seed germinates (begins to grow into a plant) by absorbing water which activates growth. The embryo gets so big that it bursts from the seed coat. The roots and then the cotyledons emerge. With the right conditions, the seedling grows into an adult plant.

5. Heredity in plants.

As mentioned previously, the embryo contains all the information necessary to become the adult plant. Ask students the following questions:

- How do plants (and other living things) pass on their characteristics to their offspring?
- How does a saguaro produce baby saguaros and not baby palo verde trees?
- How does a mesquite tree produce baby mesquites?
- <mark>– What is in a seed that</mark> determines what kind of plant it will become?

Entertain answers then conduct a class discussion about sexual reproduction in plants. Review the following key points about the processes involved in plant reproduction:

- Sexual reproduction occurs in plants when a flower is pollinated and fertilized.
- Once pollinated, flowers typically produce a fruit that contains from one to many seeds.
- In the right conditions, seeds will germinate and grow into a plant.

Following the review of those points make the following statement:

– The plant that a seed becomes is determined by the genes it inherits from its parents.

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6. Heredity in plants Q & A.

Continue the discussion on heredity using the following questions and answers as a guide:

- Question: What kinds of things are inherited from parent plants? (Answer: species identity, size, shape, color, flower color, etc.)
- Question: How about human parents? What are some things we inherit from human parents? (Answer: eye color, height, hair color, etc.)
- Question: What do we call these inherited characteristics? (Answer: traits)
- Questions: How are these "traits" inherited? What determines traits? (Answer: Traits are determined by genes, which are inherited from the parents. In sexual reproduction, half of an individual's genetic makeup (genes) comes from one parent and half from the other parent.)

7. Tongue curlers or not?

Explain that the lesson will get back around to discussing plants, but for now, as an example, the class will consider genetic traits in humans using a fun activity. As students now know, different genes determine different traits. One trait that is genetic (or carried in the genes) is the ability to curl one's tongue. Ask students to "curl" (or roll) their tongues. Have students that can curl their tongues raise their hands. Next have students that can't curl their tongues raise their hands. Were there more students that were tongue curlers or not tongue curlers? (It is most probable that there are more tongue curlers.) Ask students why there might be more of one group than another. Looking at the numbers in this class, what do students think the probability is of being a tongue curler in a given population? Review and discuss the following points with students:

- Genes determine the trait.
- There may be several possible expressions of a specific trait (e.g., tongue curler or not).
- Offspring inherit a gene pair one gene (hence one trait possibility) from each parent.
- The trait that is expressed by the offspring is called the dominant trait.

Considering the above points, which do students think is dominant, being a tongue curler or not?

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8. Dominant versus recessive.

Explain that the tongue curling gene is dominant over the non-curling gene. Usually in a population (as in the class) the majority of individuals express the **dominant** gene. The gene that is not dominant (in this case the non-curling gene) is called the **recessive** gene. Point out to students that even though recessive, the non-curling gene is still evident in our population. What does this say about the genetic make up of our population? (*Recessive traits are still in the gene pool.*)

9. Punnett squares.

Display *Creating a Punnett Square* on the overhead or smartboard explaining that a Punnett square can be used to determine the possible traits of an offspring given the genetic make-up of its two parents. Follow the directions on the overhead to walk students through the completion of first a cross of TT x tt parents. Review the discussion points. Next walk students through the cross of Tt x Tt parents.

10. Discuss Punnett squares and genetic traits.

Point out that Punnett squares and genetic variation will be further explored during the field trip to the Desert Botanical Garden. There, students will look at dominant and recessive traits in plants. They will also see a variety of possibilities of offspring in different situations.

11. Preparing for your investigation

As part of the field trip, students will be conducting several investigations. The rest of this lesson prepares students for one of those investigations. Specifically, students will be looking at the germination of selected seeds in the desert. In order to pass on genetic information, seeds need to germinate and grow into new plants.

Once again, display *Structure of a Seed* on the overhead projector or smartboard. Review the seed's structures and ask students the questions below discussing each in turn. Although the answers are provided, use inquiry to help guide students to come up with the answers themselves.

- Question: What activates germination? (Answer: water)
- Question: In the desert, are conditions always great for seeds to germinate? (Answer: no)
- Question: What would happen to a seed if there was just a little bit of rainfall and then no rain for weeks or months? (*Answer: The seed would sprout then die as there would be no water for the growing seedling.*)

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- Question: When (at what parts of the year) are there more reliable, consistent rains in the Sonoran Desert? (Answer: summer monsoons and winter rains)
- Question: Might it be beneficial for a seed to wait it out and be able to time its germination with reliable rains? *(Answer: yes)*
- Question: Does anyone know the word for something (like a seed) to "wait it out" or have a resting period? (*Answer: dormancy - Many desert seeds have a dormant stage during which they are resting and waiting for the right conditions.*)
- Question: How might a seed be able to do that? (Answer: By having some control over when it germinates.)
- Question: What do you observe on this diagram of a seed that might help it control germination? (Answer: the seed coat.)
- Question: How might a seed coat help control germination? (Answer: By being very durable, the seed coat could prevent water from easily getting in and activating germination. That way it would take more than one light rain to trigger germination.)
- Question: Would you expect a desert seed coat to be more durable than a seed coat from a less harsh environment? (*This answer is up to the students.*)
- Question: How could we test that? (This answer is up to the students.)

12. State a hypothesis about desert seeds.

Point out that at the Desert Botanical Garden, students will continue this investigation but with real seeds. Tell students that the Q and A they just went through was actually following the scientific method to prepare them for that investigation. In their answers, they actually just stated observations, came up with a question, and made a hypothesis about desert seeds. On the board, write the words Observation, Question, and Hypothesis leaving space beside each. Lead students to articulate the following:

Observations: Seeds need water to germinate. Desert rains are seasonal.

Question: How can desert seeds delay germination to the best conditions for growth (rainy seasons)?

Hypothesis: Desert seeds delay germination by having a hard outer seed coat.

Write these on the board and instruct each student to copy them down in their journals or on a piece of paper. Tell them to remember what they said about how they could test their hypothesis. Will the test they conduct at the Botanical Garden be what students suggested? Come on the field trip and find out!

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CREATING A PUNNETT SQUARE

Key Points:

- Each individual receives one type of the gene from each parent.
- For each trait, offspring receive a gene pair (one gene from each parent).
- The genetic makeup of the offspring is determined by which gene it gets from each parent.
- When representing genes, a capital letter is used for the dominant gene (T) and lower case letter used for the recessive gene (t).
- If the dominant gene (T) is present, the recessive (t) will not be expressed.

Instructions:

- Cross a dominant parent (TT = tongue curler) with a double recessive parent (tt = no curl).
- In the square, write the result of the pairing (the first pairing is done for you).
- State which trait is expressed.
- When all the squares are completed, calculate the probability that offspring born to TT x tt parents will be tongue curlers (to be stated as a ratio and percentage).
- On the next page repeat the process but with Tt parents (the next generation).



What is the probability that the offspring of TT x tt parents are tongue curlers? (How many out of four possibilities?):

How many offspring are not tongue curlers?

continued

7.



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continued

CREATING A PUNNETT SQUARE

Instructions:

• Cross a Tt parent with a Tt parent. Complete the Punnett square below then calculate the probability that offspring born to Tt x Tt parents will be tongue curlers (to be stated as a ratio and percentage).



What is the probability that the offspring of Tt x Tt parents are tongue curlers? (How many out of four possibilities?):

How many offspring are not tongue curlers?

/ 4 or ____: 4 = ____%

Continue making crossings with different pairings using your own Punnett squares.



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TEACHER'S GUIDE TO THE PARTS OF A FLOWER





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PARTS OF A FLOWER





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STRUCTURE OF A SEED





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HOW FRUIT DEVELOPS



Mature flower

The mature flower appears as a bright yellow open cone and is ready for pollination. For tomatoes, 3 to 5 flowers should be allowed to develop on a healthy truss.



Fertilized flower

Fertized flowers are denoted by the appearance of bruises on the anther cone left by bumble bees clamping onto and pollinating the flower.



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HOW FRUIT DEVELOPS



Fruit set

At fruit set, flower petals and anthers sensce (die) and fall away as a pea-sized green fruit appear at each termination of the flower truss. Typically it takes 45-50 more days from this point before fruit is ready to harvest.



Immature Fruit As a fruit enlarges, it remains light green in color and very firm (high turgor pressure). Fruit closest to the plant stem is the most mature, and thus largest in size.



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Related ADE Standards:

Reading Strand 1: Reading Process

| Concept | PERFORMANCE OBJECTIVE |
|----------------|---|
| C4: Vocabulary | PO 2: Use context to identify the intended meaning of unfamiliar words (e.g., definition, example, restatement, synonym, contrast). |
| | PO 3: Use context to identify the meaning of words with multiple meanings (e.g., definition, example, restatement, contrast). |

Reading Strand 3: Comprehending Informational Text

| Concept | PERFORMANCE OBJECTIVE |
|---------------------|---|
| C1: Expository Text | PO 8: Interpret graphic features (e.g., charts, maps, diagrams, illustrations, tables, timelines, graphs) of expository text. |
| C2: Functional Text | PO 1: Use information from text and text features to determine the sequence of activities needed to carry out a procedure. |

WRITING STRAND 3: WRITING APPLICATIONS

| Concept | PERFORMANCE OBJECTIVE |
|----------------|---|
| C2: Expository | PO 1: Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic. |

LANGUAGE ARTS STANDARD 3: LISTENING AND SPEAKING

| STANDARD | PERFORMANCE OBJECTIVE |
|---|---|
| Students effectively listen and speak in situations that serve different purposes and involve a variety of audiences. | LS-E3: Interpret and respond to questions and evaluate responses both as interviewer and interviewee. |

MATH STRAND 1: NUMBER AND OPERATIONS

| Concept | PERFORMANCE OBJECTIVE |
|--------------------------|---|
| C2: Numerical Operations | PO 3: Solve problems involving percent increase, percent decrease, and simple interest rates. |

MATH STRAND 2: DATA ANALYSIS, PROBABILITY, AND DISCRETE MATHEMATICS

| Concept | Performance Objective |
|-----------------|---|
| C2: Probability | PO 2: Interpret probabilities within a given context and compare the outcome of an experiment to predictions made prior to performing the experiment. |



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SCIENCE STRAND 1: INQUIRY PROCESS

| Concept | PERFORMANCE OBJECTIVE |
|---|--|
| C1: Observations, Questions, and Hypotheses | PO 1: Formulate questions based on observations that lead to the development of a hypothesis. |
| | PO 2: Use appropriate research information, not limited to a single source, to use in the development of a testable hypothesis. PO 3: Generate a hypothesis that can be tested. |

SCIENCE STRAND 4: LIFE SCIENCE

| Concept | PERFORMANCE OBJECTIVE |
|-------------------------------|--|
| C2: Reproduction and Heredity | PO 2: Explain the basic principles of heredity using the human examples of: |
| | • eye color |
| | • widow's peak |
| | • blood type |
| | PO 3: Distinguish between the nature of dominant and recessive traits in humans. |

SCIENCE STRAND 4: LIFE SCIENCE

| Concept | PERFORMANCE OBJECTIVE |
|---|---|
| C4: Diversity, Adaptation, and Behavior | PO 1: Explain how an organism's behavior allows it to survive in an environment. |
| | PO 2: Describe how an organism can maintain a stable internal environment while living in a constantly changing external environment. |
| | PO 3: Determine characteristics of organisms that could change over several generations. |
| | PO 5: Analyze the following behavioral cycles of organisms: |
| | dormancy (plants) |
| | PO 6: Describe the following factors that allow for the survival of living organisms: |
| | pollination |

WORKPLACE SKILLS STANDARD 1: STUDENTS USE PRINCIPLES OF EFFECTIVE ORAL, WRITTEN AND LISTENING COMMUNICATION SKILLS TO MAKE DECISIONS AND SOLVE WORKPLACE PROBLEMS.

| STANDARD | PERFORMANCE OBJECTIVE |
|---|--|
| 1WP-E4: Respond to oral and written presentations by formulating relevant feedback, expressing opinions, discerning the main idea and distinguishing fact from opinion. | PO 1: Summarize main ideas of an oral or written presentationPO 3: Formulate related questions in a presentationPO 4: Express opinions relating to the main idea in a presentation |