CREATURE FEATURE:

A GENES AND MOLECULAR MACHINES LESSON

Target Audience:
Students, ages 11 - 13

STEM²D Topics:
Science, Technology, Mathematics, Design

STEM²D .org

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CREATURE FEATURE: A GENES AND MOLECULAR MACHINES LESSON is part of the STEM²D Student Activity Series. The content and layout were both developed by the Smithsonian Science Education Center as part of Johnson & Johnson's WiSTEM²D initiative (Women in Science, Technology, Engineering, Mathematics, Manufacturing, and Design), using a template provided by FHI 360 and JA Worldwide. This series includes a suite of interactive and fun, hands-on activities for girls (and boys), ages 5-18, globally.

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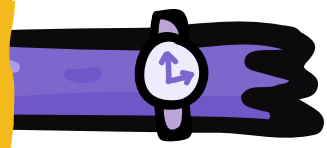
CREATURE FEATURE:
A GENES AND MOLECULAR MACHINES LESSON

Topics: Science, Technology, Mathematics, Design
Target Audience: Students, ages 11 - 13

ACTIVITY DESCRIPTION:

In this genetics activity, students will create their own creature from genetic traits that are determined by chance for physical characteristics such as fur length, eye color, horn and wing shapes, teeth, and height. Students will discover the difference between genotype and phenotype and dominant and recessive alleles for each trait, and then predict inheritance in an offspring of two parents. In addition to data collection, students will use interpersonal skills needed in STEM²D careers such as presenting ideas, organizing, and working as a collaborative team. This activity is adapted from the STCMS™ curriculum unit *Genes and Molecular Machines* by the Smithsonian Science Education Center.



ESTIMATED TIME:
This session typically takes **1 hour** to complete.

STUDENT DISCOVERIES:
Students will:

- Participate in a partner-based learning experience
- Learn how STEM²D – science, technology, engineering, mathematics, manufacturing, and design – subjects are used in the study of genetics
- Build important STEM²D skills such as problem-solving, engineering design, decision-making, and data collection
- Consider STEM²D concepts, including inherited genetic traits
- Become aware of how genetics influences many different fields, including medicine, agriculture, cell biology, physiology, and ecology
- Recognize that STEM²D offers diverse and exciting careers

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GETTING READY

Materials: *Suggested materials preparation prior to the activity with students*

- Activity Leader Checklist
- Tell My Story form
- For each pair of students:
  - 1 die
  - 1 Pair of scissors
  - Glue
  - Crayons or colored pencils
  - Student Sheet 5.2a Create a Creature, two pages, Mother and Father
  - Student Sheet 5.2b *Create a Creature Mat*
  - Student Sheet 5.2c
  - Creature Template, two copies
- Camera (optional)

ESTIMATED MATERIALS COST:

Activity leaders can expect to spend less than $10 on materials when completing this activity with 24 students in 12 groups of two, including printing the student sheets, and assuming that students have their own scissors, glue, and crayons or colored pencils.

Activity Leader Preparation

1. Read Spark WiSTEM²D. This is essential reading for all volunteers interested in working with youth, as it provides important background knowledge about STEM²D, strategies for engaging students, and tips for working with groups of students. Download at STEM2D.org.
2. Review the **Activity Leader Checklist** for details and specific steps for planning and preparing to implement this activity.
3. See the **STEM²D Student Activities Overview** for additional information.

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STEP-BY-STEP ACTIVITY:

CREATURE FEATURE: A GENES AND MOLECULAR MACHINES LESSON

Welcome and Introductions (15 minutes)

- Greet the students.
- Tell the students your name and your organization/company. Talk about your educational and career path. Use the Tell My Story form as a basis for your remarks. Be prepared to describe your job or a typical day, and provide information about your background, including:
    - Your education – focus on secondary and post-secondary classes and courses
    - Current work projects
    - Interests and hobbies
    - Why you love STEM²D, and how your work is connected
- Ask the students or any volunteers helping today to introduce themselves.
- Use Conversation Starters to learn more about the students and their interests.
- Discuss the opportunities that exists in the local community to support students as they develop their interests and personal experiences.
- Tell the students that your career is only one of the many careers available in STEM²D – science, technology, engineering, mathematics, manufacturing, and design.
- Explain that STEM²D careers are **high-demand**, **high-growth** ıand are predicted to remain in demand over the next 10 years.
- Some STEM²D careers do not require a college degree and offer young people exciting, high-paying opportunities. Stress the importance of gaining mathematics skills and engineering practices to succeed in any STEM²D career.

CONVERSATION STARTERS: *CAREER PLANNING*

- When you consider your future, what are you most excited about?
- Do you see yourself working with others, for a large company, with your friends, for yourself? Why or why not?

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- What does the perfect work day look like to you? Are you outdoors? Are you working alone, or with others? Do you solve problems? Do you fix or build things?

CONVERSATION STARTERS: *LEARNING ACTIVITY*

- How many of you think that a child with blue eyes can have two parents with brown eyes? Why or why not?
- Imagine a new type of creature. What are some features or behaviors it might have?
- What are some things that are influenced by the genetic makeup of the imaginary creature?
- What are some things that are influenced by the environment of the imaginary creature?
- In the activity you are going to be doing, we have identified some traits that an imaginary creature might have. It's going to be up to you to determine what the creature actually looks like. Are you ready?

Instructions:

1. *Divide the class into pairs. You may want to consult the classroom teacher for the best partner combinations.*

2. *Review the genetic terminology with the students found in the box below.*

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Vocabulary:

genotype: *The genetic makeup of an organism*

phenotype: *The physical appearance; the traits expressed from an interaction of the genotype with the environment*

alleles: *The different forms a gene may have for a trait (during this activity we will use two alleles for each trait)*

homozygous: *The two alleles that make up the genotype are the same*

heterozygous: *The two alleles that make up the genotype are different*

dominant alleles: *The form of a gene that, when included in the genotype, is expressed in the phenotype*

recessive alleles: *The form of a gene that is only expressed in the phenotype when both alleles of the genotype are recessive*

3. *Give instructions for each pair of students to create their own creatures. Work through the first trait on Student Sheet 5.2a covering fur length with the students, as an example of how to record their data, and then answer any questions.*

    a. For each pair, determine which student will fill in the Mother and which student will fill in the Father form of Student Sheet 5.2a Create a Creature.

    b. Tell students that each allele will be determined by the roll of a die.

    c. Odd numbers will be dominant alleles.

    d. Even numbers will be recessive alleles.

    e. For each genetic trait, each partner rolls the die twice for their assigned parent to get two alleles.

    f. For each trait, ask students to use those alleles to determine the genotype, whether the alleles are homozygous recessive, heterozygous, or homozygous dominant, and finally the phenotype.

    g. Ask students to discuss the similarities between the parents for each trait.

    h. When the phenotype for each trait has been determined for both the Mother and Father, students should align the traits with the Creature Template (Student Sheet 5.2c). They should color and cut out the creature pieces and glue them to Student Sheet 5.2b: Create a Creature Mat.

    i. For the square labeled Baby on Student Sheet 5.2b, the students should discuss the possible genotype and phenotype of an offspring and draw what they think a baby creature from the two parents might look like.

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Example:

Trait	Dominant Allele	Recessive Allele	Allele 1	Allele 2	Genotype	Homozygous recessive, Heterozygous, Homozygous dominant	Phenotype
Fur length	Long (L)	Short (l)	L	L	LL	Homo-Dom	Long
Fur color	Green (G)	Blue (g)	g	g	gg	Homo-Rec	Blue
Eye color	Purple (P)	Blue (p)	P	p	Pp	Heterozygous	Purple
Horn shape	Curved (C)	Straight (c)	c	C	cC	Heterozygous	Curved

4. Let the students know how much time they have to complete their Creature Feature activity.

Visit the pairs as they work and ask guided questions to help the students think about their experience.

- ✓ *Are you rolling the die to find the genotype for the Mother or Father?*
- ✓ *Are you getting more dominant or recessive results on the two alleles?*
- ✓ *Are you getting more homozygous or heterozygous alleles?*
- ✓ *Can you explain the difference between genotype and phenotype?*

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✓ *What does your Mother or Father creature look like so far?*

✓ *Are there similarities between the Mother and Father?*

Reporting Results:

Have each pair show the Mother and Father creatures they have created from the genotypes they got by throwing the die, and share any traits they are pretty certain the baby will have based on the parent genotypes.

Remind the students genotypes influence is how physical traits are determined in real life. Genetic engineers and scientists go through a similar process when designing and creating new species of plants and animals.

Give positive feedback after each pair has presented, and encourage the other students to applaud their work.

This is a good time to take pictures of each pair with their Create a Creature Mat.

Student Reflection (10 minutes)

Have the students reflect on this activity by answering the following questions:

- What did you learn about genetics and physical traits?
- Was it fun? What made it fun?
- Who are you going to tell about today's activity? Why?
- What did you learn from creating the two parent creatures?
- What was your biggest challenge in determining two physical traits the baby might have?
- Would you consider a career in the field of genetics? Explain.

After a few minutes ask the students to share their thoughts.

Thank the students for participating.

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EXTENDED LEARNING

1. Determine what the possible genotypes and phenotypes of a baby could be from the two parents in the Creature Feature Activity.
2. Design new creature trait sheets for two parents and exchange with another pair of students. Repeat the throwing-the-die chance process in determining the phenotype and offspring.
3. Research careers in genetics and genetic engineering.

Vocabulary:

genotype: The entire genetic makeup of an individual organism; in organisms that reproduce sexually, the set of two alleles that contribute to determining the phenotype of an organism

phenotype: The observable physical traits exhibited by an individual organism, resulting from the interaction of its genotype with the environment

alleles: One of two or more alternative forms of a gene that are found at the same place on a chromosome

homozygous: When an organism has two of the same allele, whether dominant or recessive, in its genotype

heterozygous: When an organism has two alleles that are different in its genotype

dominant alleles: These show their effect if they are in the genotype; a dominant allele is a variation of a gene that will produce a certain phenotype, even in the presence of other alleles

recessive alleles: These show their effect only if they are homozygous (two of the same recessive alleles); a recessive allele produces its characteristic phenotype only when it is paired with an identical recessive allele

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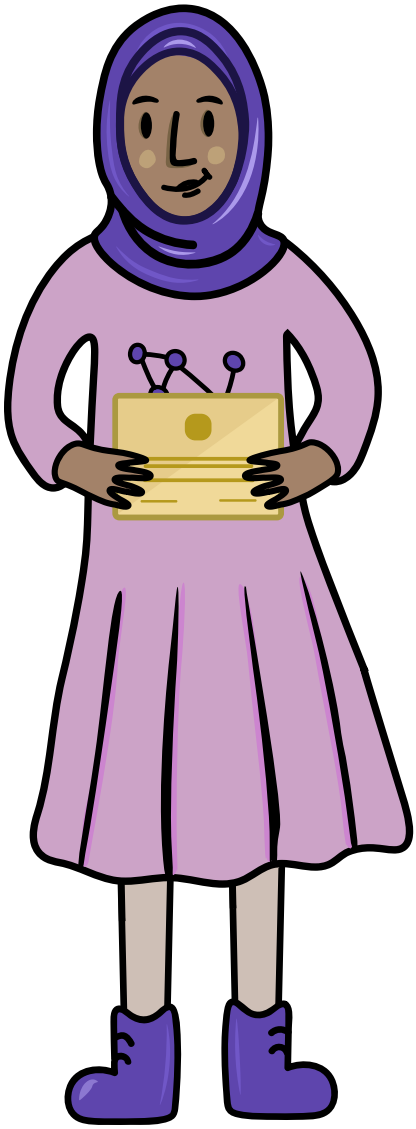
ACTIVITY LEADER REFLECTIONS

After the activity, take a few minutes to reflect on the following:

- What went well and what could be improved?
- What would you do differently next time?
- How comfortable did you feel leading the discussions?
- Do you have a better understanding of the STEM²D concepts?
- How useful was the information presented in the **Spark WiSTEM²D**?

RESOURCES AND REFERENCES

1. STCMS: Genes and Molecular Machines, 2017
2. Smithsonian Science Education Center



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ACTIVITY LEADER CHECKLIST:

DID YOU . . .

- ☐ Read Spark WiSTEM²D? This is essential reading for all volunteers interested in working with youth. It defines the STEM²D principles and philosophy and provides research-based strategies and tips for engaging and interacting with female students. Download at www.STEM2D.org.

- ☐ Visit the implementation site and observe the young people? (optional) If visiting, take note of the following:
  - ☐ How does the site encourage orderly participation? For example, do the young people raise their hands when responding to questions or during discussions? How are interruptions handled? Do you see any potential problems with managing the class of young people?
  - ☐ What does the site do to make each student feel important and at ease?
  - ☐ How is the room arranged? Will you need to move desks or chairs for any part of your presentation?
  - ☐ How can you engage the site representative in your presentation?
- ☐ Meet with and finalize the logistics with the Site Representative?
  - ☐ Confirm the date, time, and location of the activity?
  - ☐ Confirm the number of students attending? Knowing this will help you decide how to group the students into teams, as well as the appropriate materials to purchase.
- ☐ Recruit additional volunteers, if needed?
- ☐ Prepare for the activity:
  - ☐ Read the entire activity text prior to implementation?
  - ☐ Customize the activity, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
  - ☐ Complete the Tell My Story Form, which will prepare you to talk about your educational and career path with the students?
  - ☐ If teams are needed for this activity, please ask the teacher in advance to organize the students into teams.
- ☐ Practice your presentation, including the hands-on, minds-on activity? Be sure to:
  - ☐ Do the activity; make sure you can explain the concepts to students, if needed, and that you know the correct answers.
- ☐ Obtain the required materials (see the Materials and Estimated Materials Costs sections) and, if asked for in the Getting Ready section, photocopy the Student Handouts and Materials Testing Sheets. In addition:
  - ☐ Organize the materials to ensure each team has everything listed in the Materials section—keep in mind some materials are shared among the teams.
- ☐ Prepare the space? Specifically:
  - ☐ Make sure tables and chairs are arranged to accommodate teams of students.
  - ☐ Bring a camera, if desired, to take photographs.
- ☐ Obtain and collect permission slips and photo release forms for conducting the activity if applicable?
- ☐ Have fun!

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“Tell My Story” Form

This form will help volunteers serving as activity leaders prepare to talk about their STEM²D interests, education, and career path.

ABOUT YOU

Name: _____

Job Title: _____

Company: _____

When/Why did you become interested in STEM²D? _____

_____

_____

What do you hope young people, especially girls, will get out of this activity? _____

_____

FUN FACT

Share a little about your background. Ideas:

- Share a memory from childhood where you first had your “spark” or “interest” in STEM.
- Detail your journey; highlight what you have tried, what you learned, steps to success, etc.
- Failures or set backs are also great to talk about—difficulties, and/or challenges and how you overcame them.

EDUCATION AND CAREER PATH

What classes/courses did you take in secondary school and in college that helped or interested you most? _____

How did you know you wanted to pursue a STEM²D career?

_____

What was your postsecondary path, including the institution you attended and your degree? *If you switched disciplines, make sure you explain why to the students.*

_____

What your current position entails. *Be sure to include how you use STEM²D on a typical work day.*

_____

_____

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Student's Name _____ Date _____ Class _____

Create a Creature (page 1 of 2)

Creature 1: Mother							
Trait	**Dominant Allele**	**Recessive Allele**	**Allele 1**	**Allele 2**	**Genotype**	**Homozygous Recessive, Heterozygous, Homozygous Dominant**	**Phenotype**
Fur Length	Long (L)	Short (l)					
Fur Color	Green (G)	Blue (g)					
Eye Color	Purple (P)	Blue (p)					
Horn Shape	Curved (C)	Straight (c)					
Wing Shape	Dragonfly (D)	Butterfly (d)					
Wing Color	Purple (R)	Red (r)					
Feet	Not webbed (W)	Webbed (w)					
Height	Tall (H)	Short (h)					
Teeth	Pointed (T)	Blunt (t)					

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Student's Name _____ Date _____ Class _____

Create a Creature (page 2 of 2)

Creature 1: Father							
Trait	**Dominant Allele**	**Recessive Allele**	**Allele 1**	**Allele 2**	**Genotype**	**Homozygous Recessive, Heterozygous, Homozygous Dominant**	**Phenotype**
Fur Length	Long (L)	Short (l)					
Fur Color	Green (G)	Blue (g)					
Eye Color	Purple (P)	Blue (p)					
Horn Shape	Curved (C)	Straight (c)					
Wing Shape	Dragonfly (D)	Butterfly (d)					
Wing Color	Purple (R)	Red (r)					
Feet	Not webbed (W)	Webbed (w)					
Height	Tall (H)	Short (h)					
Teeth	Pointed (T)	Blunt (t)					

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Student's Name _____ Date _____ Class _____

Create a Creature Mat

Parent 1

Parent 2

Baby

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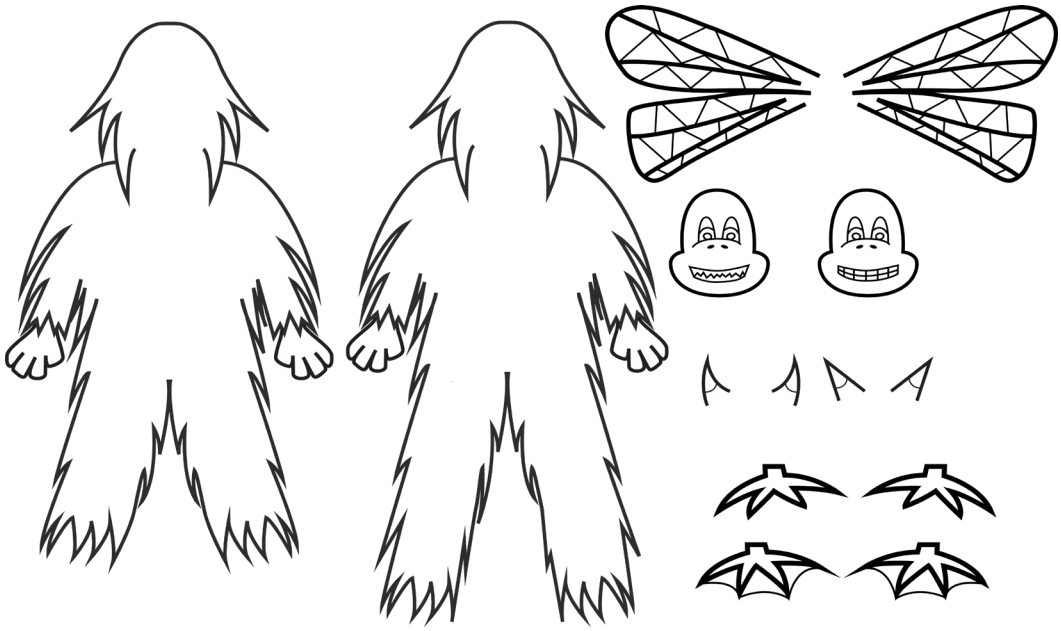
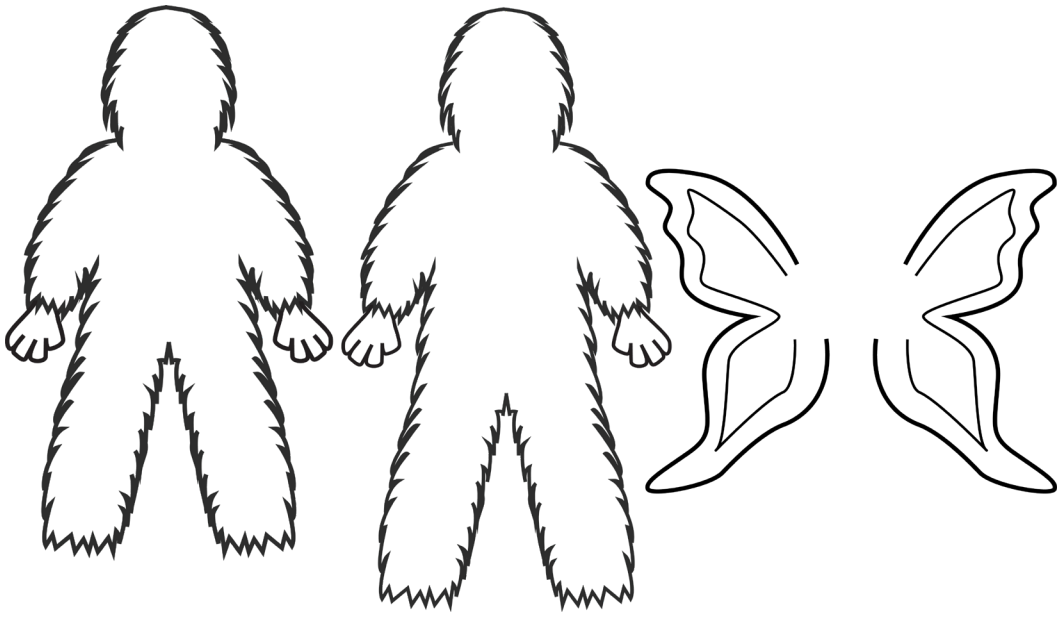
Student's Name _____ Date _____ Class _____

Creature Template





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