EDUCATION
GEORGIA AQUARIUM

Lesson Plan
7 PUNNETT SQUARE PARENTS

Essential Questions:

1. How does genetic information impact an offspring's traits?
2. How does asexual reproduction differ from sexual reproduction in regards to an offspring's genes?

GSE Standards:

- **S7L3**: Obtain, evaluate, and communicate information to explain how organisms reproduce either sexually or asexually and transfer genetic information to determine the traits of their offspring.
- **S7L3.b**: Develop and use a model to describe how asexual reproduction can result in offspring with identical genetic information while sexual reproduction results in genetic variation.

NGSS Standards:

- **MS-LS3-2**: Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Materials:

- Quarters or dice
- Drawing supplies
- Blank paper
- Punnett square worksheets
- Parent trait worksheet

Vocabulary:

- Phenotype
- Genotype
- Alleles
- Asexual reproduction
- Sexual reproduction
- Punnett square

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Background:

- Living organisms can reproduce either through asexual reproduction or sexual reproduction.
- **Asexual reproduction** is the process by which new offspring is produced, specifically from a single parent, which results in an exact copy of the parent.
- Because the offspring is an exact copy of the parent, there is not as much genetic diversity in organisms that reproduce asexually.
- Asexual reproduction is more common in plants, although some animals such as sea stars can reproduce through fragmentation.
- Some shark species, and even Komodo dragons, can reproduce asexually through fragmentation or parthenogenesis.
    - Parthenogenesis is the production of an embryo without any genetic contribution from a male gamete.
- **Sexual Reproduction** is the process by which new offspring is created through the fusion of both the male and female gametes. Because the offspring receives genetic information from both parents, they are not an exact copy, but will share some traits.
- For plants, they require pollination by insects or wind to transfer the pollen to the stigma of a flower.
- Punnett squares are a useful tool in predicting what percentage chance offspring have to inherit certain traits through a genetic cross between two individuals.
- Please note: Not all traits can be easily predicted by a simple cross. Many genes are determined by multiple factors. For this activity, explain to students that our genetic code can be complicated, but they'll be making a simple model.
- To create a Punnett square, the parents' alleles are written on the top and sides of the square, a capital letter represents dominant traits, and a lowercase letter represents the recessive traits.
- Inside the squares, one allele is taken from each parent to create a new combination. The four squares each represent one possibility of the offspring's genes.

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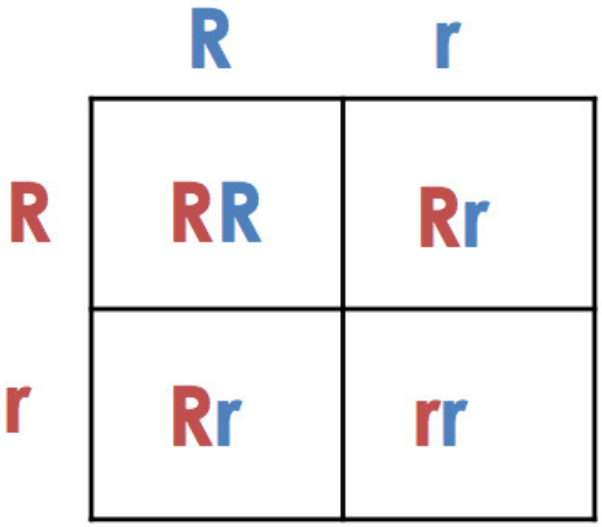
Background:



- **Alleles**: Alleles are versions of DNA sequences at a specific section of the chromosome. The offspring inherits two alleles, one from each parent.
- **Dominant Genes**: Dominant genes are expressed if present, even if it is the only one.
- **Recessive Genes**: Recessive genes are only expressed if both alleles are recessive.
- Dominant genes will mask or hide the recessive genes when present together.
- **Genotype**: Genotype refers to the genetic make-up or code of an organism. Typically represented by two letters, such as Tt or RR, depending on the trait and if the genes are dominant or recessive.
- **Phenotype**: Phenotypes are the physical and observable characteristics of an organism. Red hair or brown eyes are examples of a phenotype.
- **Heterozygous**: If an organism has both a dominant and recessive gene, they are considered heterozygous.
- Homozygous: If an organism has two of the same genes, they are considered homozygous.

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Lesson Structure:

1. Introduce Punnett squares to students, explaining how they can be used to predict an offspring's genotype and phenotype for a specific trait. Highlight the difference between a phenotype and genotype. Make sure to demonstrate how to fill in a Punnett square and calculate the percentages.
2. Pass out the worksheets and a quarter or die to each student.
3. To create their fish species, students will flip a quarter or roll a die to determine each parent fish's allele. Heads/even number is a dominant allele; tails/odd number is a recessive allele. They will flip their quarter a total of four times per feature, filling in the results along the sides of the Punnett square.
4. Once the parent genotypes are recorded, students will complete the Punnett square and calculate the percentages and phenotype of each trait. (See examples below)
5. After completing the Punnett squares, students will draw their fish family, representing both parents and at least two offspring.

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Evaluate:

1. Ensure that students understand how a parent's alleles impact an offspring's features by evaluating the phenotypes present in their drawings. Make sure that the percentages are accurately represented in the image.
2. Ask students to share examples of Punnett squares that showed completely heterozygous results, or completely homozygous results. Discuss what the most common results were during their creation stage.
3. Discuss with students how their results may have changed if the parents had completely identical alleles for all of the traits, such as plants that self pollinate or animals that reproduce asexually.

Extend:

1. To further explore Punnett squares, specifically dihybrid crosses, check out the 9th-12th grade lesson plan from Georgia Aquarium, "Genetic Hijinx".
2. Instead of using one of the templates below, have students create their own examples of phenotypes and genotypes for the parents, using those to create the offspring Punnett squares. These could include creatures such as sharks or even mythical creatures such as mermaids or sea monsters.
3. To learn more about genetics, split students into teams and host a class debate on GMOs or cloning.

Parent Traits
WORKSHEET

Directions:

For each trait, flip a quarter or roll a die to determine the parent's genotype. Remember, you'll need to flip twice to get both alleles! Heads/even is dominant, tails/odd is recessive.

MOTHER: FISH

Trait	Genotype	Phenotype
Stripes (S), Spots (s)		
Big scales (B), Small scales (b)		
Forked tail (T), Round tail (t)		
Wavy dorsal fin (D), Spikey dorsal fin (d)		
Pointy pectoral fin (P), Round pectoral fin (p)		
Red (R), Blue (r)		
Eyespot (E), No eyespot (e)		
Teeth (Y), No teeth (y)		

Parent Traits WORKSHEET

Directions:

For each trait, flip a quarter or roll a die to determine the parent's genotype. Remember, you'll need to flip twice to get both alleles! Heads/even is dominant, tails/odd is recessive.

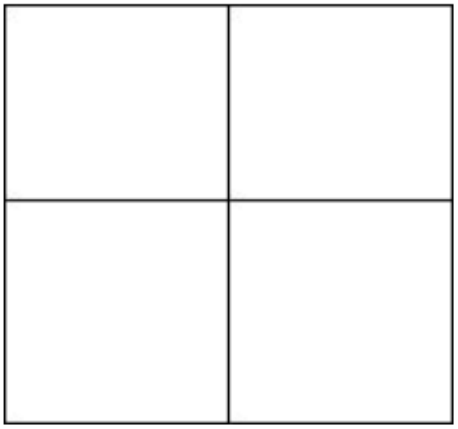
FATHER: FISH

Trait	Genotype	Phenotype
Stripes (S), Spots (s)		
Big scales (B), Small scales (b)		
Forked tail (T), Round tail (t)		
Wavy dorsal fin (D), Spikey dorsal fin (d)		
Pointy pectoral fin (P), Round pectoral fin (p)		
Red (R), Blue (r)		
Eyespot (E), No eyespot (e)		
Teeth (Y), No teeth (y)		

Punnett Square WORKSHEET

Directions:

Put your parents' alleles on each side of the Punnett square. Next, complete the Punnett square cross and calculate the percentage chance of the offspring's genotypes.



Trait: _____

Percentages: _____

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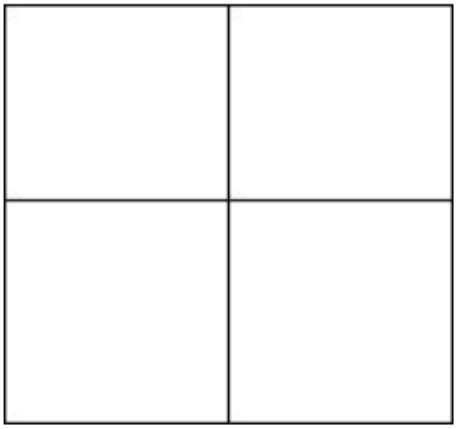

Trait: _____

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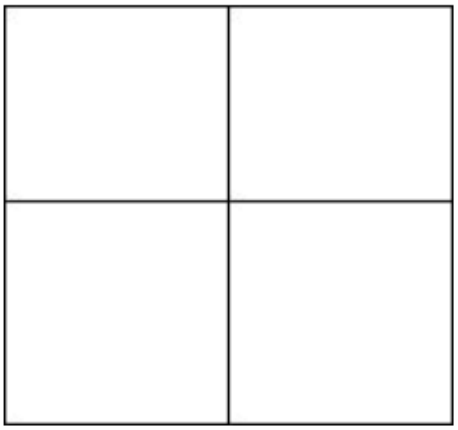

Trait: _____

Percentages: _____

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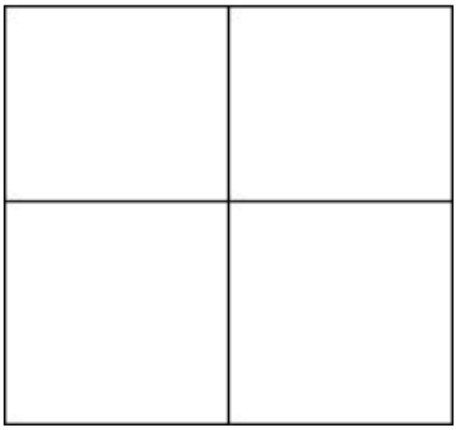

Trait: _____

Percentages: _____

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