

Pardon the Punnett

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The Punnett Square

This module stems from the work of the Austrian Monk, Gregor Mendel, the father of genetics. In the mid-1800s Mendel studied the patterns of inheritance of physical characteristics of the garden pea, and established the basic laws of genetics still recognized today.

Definitions:

Gene:

Section of a chromosome that carries the information for a specific trait.

Allele:

Alternate forms of a gene.

Genotype:

The fundamental genetic makeup of an organism for a specific trait; the combination of the two alleles located on the homologous chromosomes that determines the expression (phenotype) of the trait. The genotype is represented by two letters, which are in upper and lower case to represent different alleles. *Example: R is genotype for the dominant trait of a round pea seed and r is the genotype for the recessive trait of a wrinkled pea seed.*

Phenotype:

The way a trait physically expresses itself in an organism.

Example: wrinkled seeds vs. smooth seeds, red flowers vs. white flowers.

Homozygous:

The genotype has both letters being exactly the same. This would be either both dominant genes or both recessive genes. (RR or rr)

Heterozygous:

The genotype has a dominant gene and a recessive gene for the same trait. (Rr or Gg)

Dominant Trait:

A genetic trait is considered dominant if it is expressed in an organism who has only one copy of that gene. In genetic terms, a dominant trait is one that is phenotypically expressed in heterozygotes.

Example: RR or Rr is expressed as round seeds.

Recessive Trait:

Refers to an allele that causes a phenotype that is only seen in homozygous genotype and never in a heterozygous genotype. If a genetic trait is recessive, the organism needs to inherit two copies of the gene for the trait to be expressed. Thus, both parents must be carriers of the trait in order for the offspring to express that trait.

Example: rr is expressed as a wrinkled seed

Punnett's Square:

A mathematical tool that helps predict the offspring outcome (both genotypes and phenotypes) of a cross between two parents with known genotypes.

F1 generation:

The first set of offspring from the original parents being crossed.

F2 generation:

The second generation of offspring.

Probability:

The chance/possibility that a specific event will occur.

Cross:

Mating of two parent organisms.

Offspring:

Results of a cross; "young" produced by cross.

MOST*

VOCABULARY

Adenine

Amino acids

Codons

Complementary

Cytosine

DNA

Guanine

Mutation

Nucleotide

Proteins

Thyamine

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New York State Standards

Middle School

Living Environment

Standard 1:

Key idea 1.4a

Key idea 2.3a, 2.3b

Key idea 3.1, 3.3, 3.4c

Standard 4:

1.2a, 1.2e, 1.2f

Key idea 2: 2.1a, 2.1c, 2.1d, 2.1e, 2.1f,

2.1g, 2.1j

Key Idea 4:

Key Idea 5: 5.2j

Key Idea 6

Activity: Using a Punnett Square

MATERIALS NEEDED

Student worksheet

Students should be able to:

Understand how to use and complete a Punnett square.

Steps to using the Punnett square:

- 1) Identify the parents' genotype.
- 2) Place the parents genotype at the top and left side of the boxes.
- 3) Combine the genotypes for each box.
- 4) Write out the genotypes and phenotypes for all offspring.

Try this!

Example A:

In the flowering plant called Scentilia (*made up*), the dominant trait is a red flower and the recessive trait is a white flower. The genotype for one parent is homozygous dominant. This parent is crossed with a Scentilia plant that has a white flower. Determine the phenotypes and genotypes of the offspring.

Solution A:

Draw a Punnett square:

Step 1:

Identify the parent genotypes:

Homozygous Dominant = RR crossed with a white plant that must be homozygous Recessive (rr) in order to be a white flower.

Step 2:

Place the parents' genotypes in place to be crossed.

	R	R
r		
r		

Activity: Using a Punnett Square

Step 3:

Combine the genotypes for each box.

	R	R
r	Rr	Rr
r	Rr	Rr

Step 4:

Write out the genotypes and phenotypes for all offspring

Genotypes: 100% Rr

Phenotypes: 100% Red flower

Try another!

Example B:

What are the phenotypes and genotypes of the offspring of two heterozygous *Scantilia* plants who have Red flowers?

Solution B:

Draw a Punnett square:

Activity: Using a Punnett Square

Step 1:

Identify the parent genotypes:
Heterozygous means one dominant and one recessive gene so each parent has a genotype of Rr.

Step 2:

Place the parent's genotypes in place to be crossed.

	R	r
R		
r		

Step 3:

Combine the genotypes for each box.

	R	r
R	RR	Rr
r	Rr	rr

Step 4:

Write out the genotypes and phenotypes for all offspring

Genotypes: 25% homozygous dominant (RR), 50% heterozygous (Rr),
25% homozygous recessive (rr)

Phenotypes: 75% Red flowers and 25% white flowers

Activity: Using a Punnett Square

Try another!

Try the following examples:

1. Cross a short pea plant with one that is homozygous for tallness.
The dominant trait is tallness and the recessive trait is shortness.
2. What will the offspring be like from the cross of a white hamster and a brown hamster if the brown hamster's mother was white? White is recessive and brown is the dominant trait.
3. Round pea seed is dominant and wrinkled recessive.
Cross two parents who have wrinkled seeds.

Solution 1:

Genotype: 100% heterozygous (Tt)
Phenotype: 100% tall plants

	T	T
t	Tt	Tt
t	Tt	Tt

Solution 2:

Genotype: 50% heterozygous (Bb)
and 50% homozygous recessive (bb)
Phenotype: 50% brown and 50% white

	B	b
B	BB	Bb
b	Bb	bb

Solution 3:

Genotype: 100% homozygous recessive (rr)
Phenotype: 100% wrinkled seeds

	r	r
r	rr	rr
r	rr	rr

Review and More

Review Questions

1. Which of the following is a possible abbreviation for a genotype?
 - A. BC
 - B. Pp
 - C. Ty
 - D. fg
2. What is the best way to determine the phenotype of the feathers on a bird?
 - A. analyze the bird's DNA (genes)
 - B. look at the bird's feathers
 - C. look at the bird's beak
 - d. examine the bird's droppings
3. Which of the following pairs is not correct?
 - A. kk = hybrid
 - B. hybrid = heterozygous
 - C. heterozygous = Hh
 - D. homozygous = RR
4. The genes present in an organism represent the organism's _____.
 - A. genotype
 - B. phenotype
 - C. physical traits
5. Which statement is not true?
 - A. Genotype determines phenotype.
 - B. Phenotype determines genotype.
 - C. A phenotype is the physical appearance of a trait in an organism.
 - D. Alleles are different forms of the same gene.
6. Make up your own Punnett problem for your classmates and show the solution below:

Alternative Project Ideas:

- 1) Research the life of Gregory Mendel and report about his life work to the class.
- 2) Develop a plan to cross several plants to trace the phenotype and genotypes of the offspring.

From Baby Steps Through Punnett Square by Mr. Kousen
Go here <http://www.hobart.k12.in.us/jkousen/Biology/mendel.htm#vocabques> to learn more about Mendel's Genetic Laws.