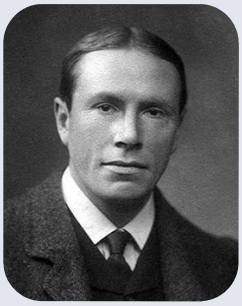
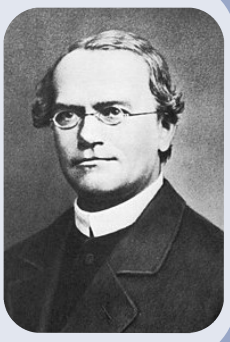
Punnett Squares



In the early 20th century, British **biologist** Reginald Punnett *("PUH-nit")* came up with **Punnett squares** as a tool for predicting **outcomes** of crossbreeding.

Punnett's work was based on **laws of Mendelian inheritance** established in the 19th century by Gregor Mendel *("MEHN-duhl")*, who famously experimented with **crossbreeding** pea plants.



In Punnett squares, **dominant alleles** are represented by **uppercase letters**.

Recessive alleles are represented by **lowercase letters**.

	A	a
A	**AA**	**Aa**
a	**Aa**	**aa**

In the Punnett square above:

***Circle** each letter that represents a **DOMINANT allele**.*

***Cross out** each letter that represents a **RECESSIVE allele**.*

Do you understand **key words** on this page?

*Below, draw lines to **match** each term on the left with its definition on the right.*

allele •	• **ALWAYS expressed WHENEVER it's an option**
recessive •	• **NOT expressed UNLESS it's the ONLY option**
dominant •	• **variant form of a gene (DNA sequence encoding a trait)**

Punnett Squares

There are certain **prefixes**, or word-beginners, you'll often encounter when discussing Punnett squares and Mendelian inheritance.

*Below, draw lines to **match** each prefix on the left to the words on the right that are most closely related in meaning.*

geno-	**passed along from parents to offspring (inherited)**
pheno-	**identical (the same)**
homo-	**distinct (different)**
hetero-	**can be observed (apparent)**

Below, look at the letters representing pairs of **alleles**. Some of the pairs listed here are ***homozygous*** and while others are ***heterozygous***.

Based on the meanings of the prefix **HOMO-** *and the prefix* **HETERO-**, *sort the pairs of alleles into the appropriate **columns**.*

Pairs of alleles: Gg | RR | gg | Pp | TT | rr | Tt | Rr

HOMOZYGOUS	HETEROZYGOUS
_____	_____
_____	_____
_____	_____
_____	_____

Punnett Squares

In Punnett squares, the possible **input from one parent** is shown along the top of the square while the possible **input from the other parent** is shown down the left side of the square.

Each possible **output** combination that could result in the **offspring** of the parents examined is recorded inside the corresponding cells.

👀 *Look at the **Punnett square** below. Read the **key**.*

possible input from ***FATHER***

possible input from ***MOTHER***

	B	**b**
b	**Bb**	**bb**
b	**Bb**	**bb**

KEY

B = allele for **brown** eye color (dominant)
b = allele for **blue** eye color (recessive)

Usually, when a **dominant** allele is present, that allele will be the one **expressed**. Typically, the only way a **recessive** allele can be expressed is if **BOTH** alleles in a pair are recessive.

✏️ *Answer the **questions** below by writing on the appropriate lines.*

QUESTION	*ANSWER*
In the Punnett square above, we see that the FATHER has two alleles he could possibly contribute: **B** (brown, dominant) or **b** (blue, recessive). **What color are the father's eyes?**	_____
Both alleles the MOTHER in this example could possibly contribute are **b** (blue, recessive). **What color are the mother's eyes?**	_____

Punnett Squares

✏️ ***Circle** the correct answer(s) to each question below.*

The first question has two correct answers. Other questions have only one correct answer.

In the example on page 3, what **combinations of alleles** could possibly occur in these parents' **offspring?**

BB Bb bb

What is the **probability** that a child of these two parents will inherit the combination **BB**?

0% 25% 50% 100%

What is the **probability** that a child of these two parents will inherit the combination **Bb**?

0% 25% 50% 100%

What is the **probability** that a child of these two parents will inherit the combination **bb**?

0% 25% 50% 100%

What is the **probability** that a child of these two parents will have **brown eyes**?

0% 25% 50% 100%

What is the **probability** that a child of these two parents will have **blue eyes**?

0% 25% 50% 100%

Punnett Squares

👀 *Look at the **Punnett square** from page 3 again.*

*possible input from **FATHER***

*possible input from **MOTHER***	**B**	**b**
b	**Bb**	**bb**
b	**Bb**	**bb**

KEY

B = allele for **brown** eye color (dominant)
b = allele for **blue** eye color (recessive)

✏️ *Answer the **questions** below by writing on the appropriate lines.*

QUESTION	*ANSWER*
Is the FATHER in this example **heterozygous** or **homozygous**?	_____
Is the MOTHER in this example **heterozygous** or **homozygous**?	_____
Is it possible for these parents to have any **homozygous recessive** offspring?	_____
Is it possible for these parents to have any **homozygous dominant** offspring?	_____
If these parents had **6 children**, how many of those children would you expect to have **blue eyes**?	_____
If these parents had **4 children**, how many of those children would you expect to be **heterozygous dominant**?	_____

Punnett Squares

The **output cells** of the Punnett square below have been left blank.

*Complete the Punnett square by writing in the possible **combinations of alleles** that could be inherited by these parents' offspring.*

possible input from **FATHER**

possible input from **MOTHER**	**F**	**F**
F		
f		

KEY

F = allele for **freckles** (dominant)

f = allele for **no freckles** (recessive)

*Answer the **questions** below by writing on the appropriate lines.*

QUESTION	*ANSWER*
Do **both** or do **neither** of the parents in this example likely have visible freckles?	_____
What is the probability (%) that a child of these parents will have the **genotype** FF?	_____
What is the probability (%) that a child of these parents will have the **genotype** Ff?	_____
What is the probability (%) that a child of these parents will have the **genotype** ff?	_____
What is the probability (%) that a child of these parents will have a freckle-positive **phenotype** (likely to have visible freckles)?	_____

Punnett Squares

The **inputs** of the Punnett square below have been left blank.

*Complete the Punnett square by writing **alleles** that could be contributed by the **parents** along the top and the left side of the table.*

possible input from ***FATHER***

possible input from ***MOTHER***

H h	**h h**
H h	**h h**

KEY

H = allele for **white wool** (dominant)
h = allele for **black wool** (recessive)

*Answer the **questions** below by writing on the appropriate lines.*

QUESTION	*ANSWER*
What is the probability (%) that a lamb born to the parents in this example will have a **black wool phenotype**?	_____
If **2 lambs** were born from a cross of these parents, how many would you expect to have **black wool**?	_____
If **4 lambs** were born from a cross of these parents, how many would you expect to have **white wool**?	_____
What is the mother's **genotype**?	_____
What is the father's **genotype**?	_____

Punnett Squares

The **outputs** of the Punnett square below have been left blank.

*Complete the Punnett square by writing the possible **output combinations** in the appropriate cells of the table.*

possible input from ***FATHER***

possible input from ***MOTHER***

	Q	**q**
Q		
q		

KEY

Q = allele for **short hair** (dominant)

q = allele for **long hair** (recessive)

*Answer the **questions** below by writing on the appropriate lines.*

QUESTION	*ANSWER*
Are the parents in this example **long-haired** cats or **short-haired** cats?	_____
What is the probability (%) that a kitten born to these parents will have **short hair**?	_____
What is the probability (%) that a kitten born to these parents will have **long hair**?	_____
What is the probability (%) that a kitten born to these parents will have the QQ **genotype**?	_____
If a kitten with a QQ **genotype** grows up and has offspring of its own, what is the probability (%) that any of those kittens would have **long hair**?	_____

Punnett Squares

Below, read each **scenario** on the left carefully.

*Draw a corresponding **Punnett square** in the space immediately to the right. Then answer the **question** that accompanies the scenario. If a scenario does not specify a letter to represent the alleles discussed, use **whatever letter you'd like** when creating your Punnett square.*

SCENARIO 1

For clovers, the trait of having three leaves is dominant to the trait of having four leaves.

A heterozygous three-leaf clover plant is crossed with a homozygous four-leaf clover plant.

PUNNETT SQUARE 1

QUESTION 1

What is the probability (%) that an offspring clover plant in this scenario will have four leaves?

SCENARIO 2

Sickle cell anemia is an inherited disorder of the circulatory system that results in chronic fatigue and other serious symptoms. The allele for sickle cell anemia is recessive to the allele for a healthy circulatory system.

A woman showing no signs of sickle cell anemia is heterozygous (Aa) while her parter has the disorder.

PUNNETT SQUARE 2

QUESTION 2

If the woman and her partner in this scenario have 4 children, how many of those children would you expect to have sickle cell anemia?

Punnett Squares

Below, read each **scenario** on the left carefully.

*Draw a corresponding **Punnett square** in the space immediately to the right. Then answer the **question** that accompanies the scenario. If a scenario does not specify a letter to represent the alleles discussed, use **whatever letter you'd like** when creating your Punnett square.*

SCENARIO 3

For a certain species of butterfly, the allele for yellow wings is dominant to the allele for purple wings.

A homozygous purple-winged butterfly of this species mates with another homozygous purple-winged butterfly.

PUNNETT SQUARE 3

QUESTION 3

What is the probability (%) that the offspring of the butterflies in this scenario will have yellow wings?

SCENARIO 4

One of the offspring butterflies from the preceding scenario mates with a heterozygous yellow-winged butterfly.

PUNNETT SQUARE 4

QUESTION 4

If the butterflies in this example have 100 offspring caterpillars that grow to maturity, how many of those 100 offspring butterflies would you expect to have yellow wings?