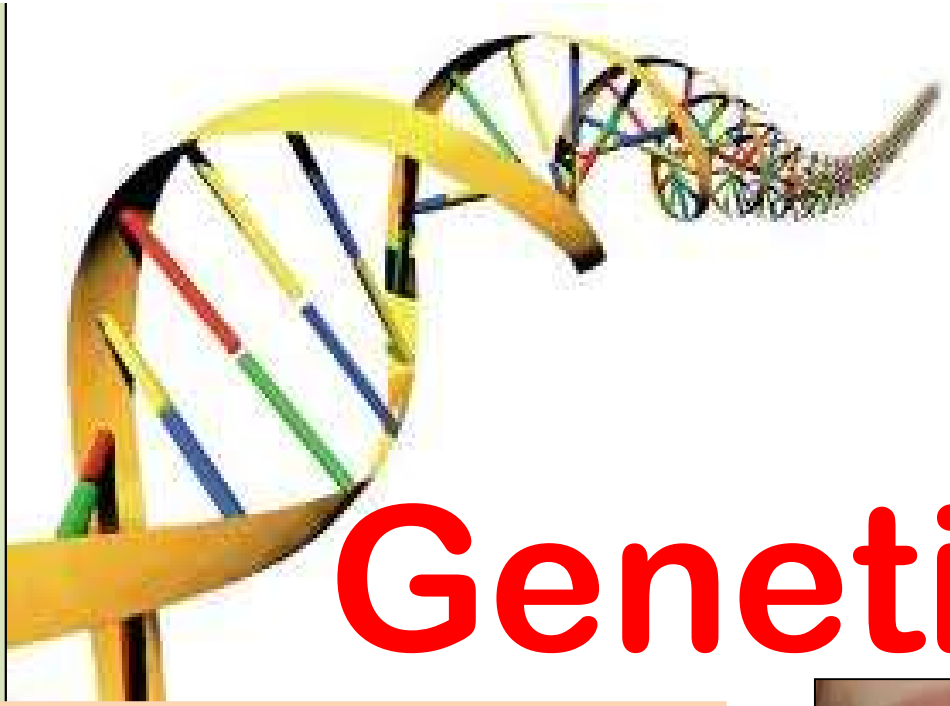


Genetics…

EQ:How can we determine the probability of a particular trait to show up in the offspring?

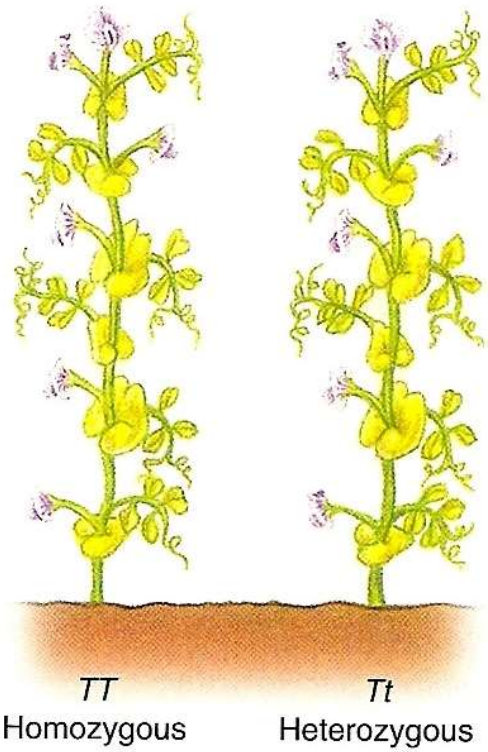
Genotypes and Phenotypes

A genotype is…

…the genetic makeup of an organism.

A phenotype is…

…the physical characteristics of an organism – what the organism looks like.



For example, in Mendel's pea plants, the tall allele was dominant over the dwarf allele:

Genotype	Phenotype
TT	Tall
Tt	Tall
tt	dwarf

If we know the genetic makeup of parents, what type of offspring might they produce?

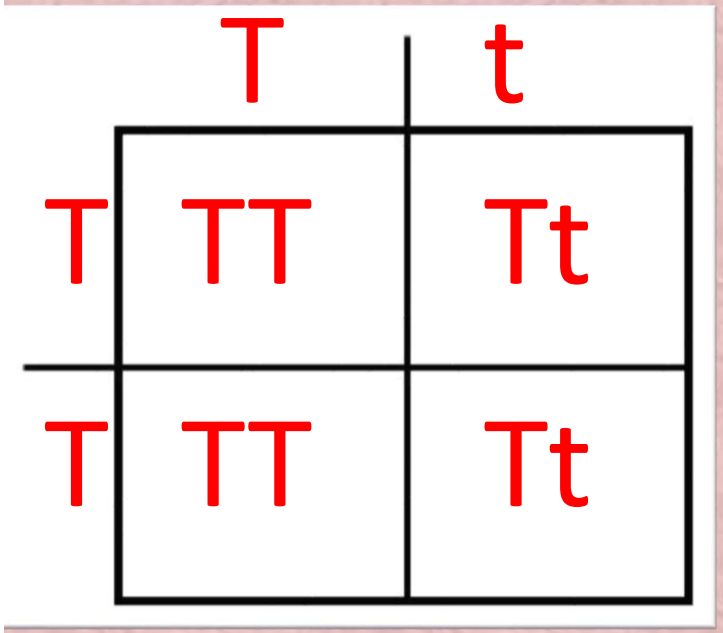
What is the probability of producing different types of offspring?

Probability:

Probability: The likelihood that a particular event will occur.

Using Probability and Punnett Squares to Work Genetics Problems

Punnett Square



1. A Punnett square is a diagram showing the allele combinations that might result form a genetic cross between two parents.
2. The alleles of the first parent will be placed across the top of the square.
3. The alleles of the second parent will be placed along the left side of the square.
4. The possible gene combinations of the offspring will be placed inside the squares.
5. Letters will represent the alleles.

6. A capital letter represents a dominant allele.
7. A lower case letter represents a recessive allele.

Mendel's Peas

Mendel began his experiments using true-breeding parents. He soon discovered that the tall trait was dominant over the dwarf trait. Cross a true-breeding tall pea plant to a true-breeding dwarf pea plant.

What is the genotype of the first parent? TT

What is the genotype of the second parent? tt

Place the alleles of the first parent on the top of the square. Place the alleles for the second parent on the left of the square.

	T	T
t	Tt	Tt
t	Tt	Tt

Fill in the squares to show all the possible combinations of alleles that the offspring might inherit.

Use this table to show all possible genotypes and phenotypes of the offspring, and the probabilities of each.

Genotypes	Phenotypes
4/4 Tt	4/4 tall

In the above problem, none of the offspring will show the dwarf trait. As we learned earlier, Mendel wondered what had happened to the dwarf trait. He allowed the F_1 generation to self-pollinate.
Show this cross using the Punnett square below.

What is the genotype of each parent?

Tt x Tt

	T	t
T	TT	Tt
t	Tt	tt

Genotypes	Phenotypes
1/4 TT	¾ Tall
2/4 Tt	
1/4 tt	¼ dwarf

Having dimples is dominant over the absence of dimples. Cross a heterozygous dimpled man with a woman who does not have dimples. Show all work in the Punnett square and summarize your findings in the table.

What is the genotype of the man? Dd

What is the genotype of the woman? dd

	D	d
d	Dd	dd
d	Dd	dd

Genotypes	Phenotypes
2/4 Dd	2/4 dimples
2/4 dd	2/4 no dimples

Normal skin is dominant over albino skin. A woman who has normal skin, but whose father was albino, marries a heterozygous, normal skinned man. What type of offspring might they expect?

What is the genotype of the woman? Aa

What is the genotype of the man? Aa

	A	a
A	AA	Aa
a	Aa	aa

Genotypes	Phenotypes
1/4 AA 2/4 Aa 1/4 aa	¾ Normal ¼ albino

How many different genotypes are possible among the offspring?	3
How many different phenotypes are possible among the offspring?	2
What is the probability of getting homozygous offspring?	2/4
What is the probability of getting heterozygous offspring?	2/4
What is the probability of getting normal offspring?	3/4
What is the probability of getting albino offspring?	1/4

In dogs, the allele for short hair (B) is dominant over the allele for long hair (b). Two short haired dogs have a litter of puppies. Some of the puppies have short hair and some of the puppies have long hair.

What are the genotypes of the parents? Bb and Bb

	B	b
B	BB	Bb
b	Bb	bb

Genotypes	Phenotypes
1/4 BB	¾ short hair
2/4 Bb	¼ long hair
1/4 bb	

If the litter of puppies contained 12 pups, how many would you expect to have short hair? ¾ of the 12 should have short hair. ¾ of 12 = 9 pups

How many would you expect to have long hair? ¼ of 12 = 3 pups

The Principle of Independent Assortment

Mendel needed to answer one more question: When alleles are being segregated during gamete formation, does the segregation of one pair alleles have any affect on the segregation of a different pair of alleles? In other words, does the gene that determines if a pea plant is tall or dwarf have any affect on the gene for seed color?

Mendel designed a second set of experiments to follow two different genes as they passed from parent to offspring. This is known as a:

Two-factor cross or a dihybrid cross

One parent had peas that were round and yellow and the other parent had peas that were wrinkled and green. The round and yellow traits were <u>dominant</u>.

First, Mendel crossed true-breeding parents.

Round, yellow peas x wrinkled, green peas → All F_1 offspring had round, yellow peas.

RRYY x rryy

If round and yellow are dominant, what is the genotype of all of the F_1 offspring? RrYy

Next, Mendel allowed these hybrid F_1 offspring to self-pollinate.

When the first generation was allowed to self-pollinate (RrYy x RrYy), it resulted in the production of 556 seeds:

315 round, yellow (dominant, dominant)
105 round, green (dominant, recessive)
104 wrinkled, yellow (recessive, dominant)
32 wrinkled, green (recessive, recessive)

This meant that the alleles for seed shape had segregated independently of the alleles for seed color.
The alleles for one gene had no effect on the alleles of another trait.
This is known as "independent assortment".

The Principle of Independent Assortment states:

When gametes are formed, the alleles of a gene for one trait segregate independently of the alleles of a gene for another trait.

Using a Punnett square for a two-factor or dihybrid cross

- ✓ When two traits are being considered, the Punnett square will need 16 squares.
- ✓ Each parent will pass one allele of each gene pair to the offspring.

Given the following parental genotypes, what alleles could each parent pass to their offspring?

If the parent was AaBb: AB, Ab, aB, ab

If the parent was Aabb: Ab, Ab, ab, ab

If the parent was aaBb: aB, ab, aB, ab

If the parent was AABB: AB, AB, AB, AB

Use the following Punnett square to illustrate Mendel's experiments.

True-breeding Round and Yellow x True-breeding wrinkled and green

What is the genotype of each parent? RRYY and rryy

What allele combinations can be passed to the offspring?

	RY	RY	RY	RY
ry	RrYy	RrYy	RrYy	RrYy
ry	RrYy	RrYy	RrYy	RrYy
ry	RrYy	RrYy	RrYy	RrYy
ry	RrYy	RrYy	RrYy	RrYy

Genotypes	Phenotypes
16/16 RrYy	16/16 Round, yellow

If the offspring from the above cross are allowed to self-pollinate:

Round and Yellow x Round and Yellow

What is the genotype of each parent? RrYy and RrYy

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

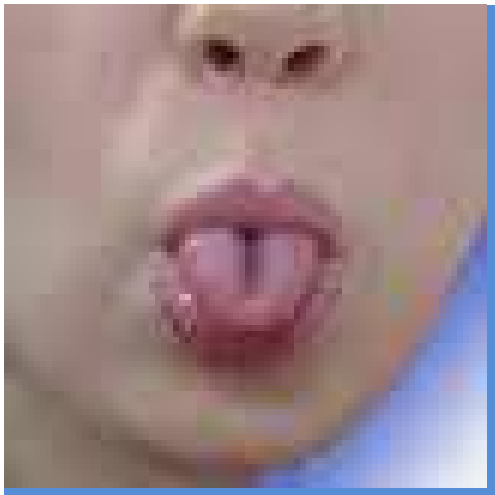
Genotypes	Phenotypes
1/16 RRYY 2/16 RRYy	Round,yellow 9/16
1/16 RRyy 2/16 RrYY	Round, green 3/16
4/16 RrYy	Wrinkled, Yellow 3/16
2/16 Rryy 1/16 rrYY	Wrinkled, green 1/16
2/16 rrYy 1/16 rryy	

Practice Problem: Right handedness (R) is dominant over left handedness (r). The ability to roll your tongue (T) is dominant over the inability to roll your tongue (t).

What offspring might be expected from a cross involving the following parents: RRtt x RRTt

	Rt	Rt	Rt	Rt
RT	RRTt	RRTt	RRTt	RRTt
Rt	RRtt	RRtt	RRtt	RRtt
RT	RRTt	RRTt	RRTt	RRTt
Rt	RRtt	RRtt	RRtt	RRtt

Genotypes	Phenotypes
8/16 RRTt	8/16 Right handed, tongue roller
8/16 RRtt	8/16 Right handed, nonroller



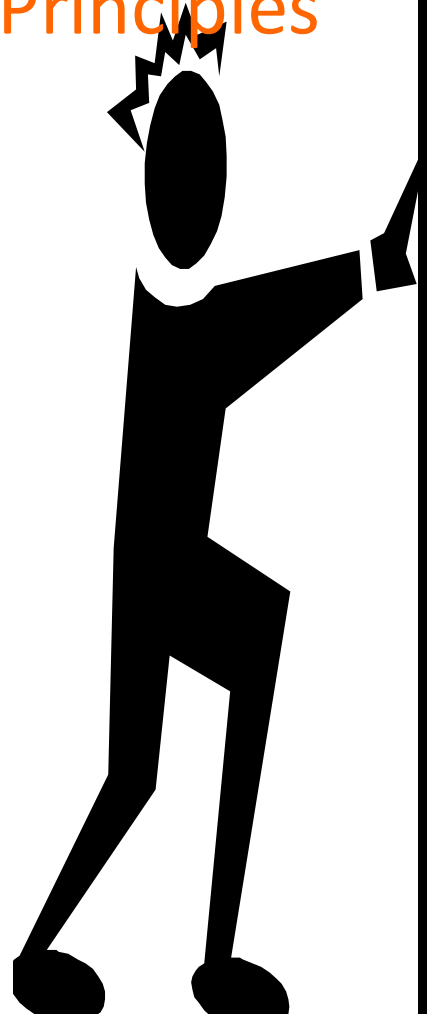
A woman, who is right handed and a tongue roller, has a father who is left handed and cannot roll his tongue. She marries a heterozygous right handed, tongue rolling man. What possible offspring might they expect?

What is the genotype of the woman? RrTt
What is the genotype of the man? RrTt

	RT	Rt	rT	rt
RT	RRTT	RRTt	RrTT	RrTt
Rt	RRTt	RRtt	RrTt	Rrtt
rT	RrTT	RrTt	rrTT	rrTt
rt	RrTt	Rrtt	rrTt	rrtt

Genotypes	Phenotypes
1/16 RRTT 2/16 RRTt	9/16 Right handed tongue rollers
1/16 RRtt 2/16 RrTT	3/16 right handed nonrollers
4/16 RrTt 2/16 Rrtt	3/16 left handed tongue rollers
1/16 rrTT 2/16 rrTt	1/16 left handed nonrollers
1/16 rrtt	

A Summary of Mendel's Principles



Mendel's principles form the basis of modern genetics. Mendel's principles include the following:

1.The inheritance of traits is determined by individual units known as genes.

2. Genes are passed from parent to offspring.

3. Each gene has two or more forms called alleles.

4.Some alleles are dominant, while other alleles are recessive.

5.Each parent has two alleles for a particular trait that they inherited from their parents. They will pass one allele to their offspring when the alleles are segregated into gametes.

6.The alleles for one trait segregate independently of the alleles for another trait.

Left Side Activity

1. In Mendel's pea plants, tall is dominant to dwarf and yellow is dominant to green. Draw a dihybrid cross between two tall and yellow pea plants TtYy.
2. List all of the possible genotypes and phenotypes. (Hint the possible alleles for both of the parents are TY, Ty, tY, ty)
3. What is the ratio for the phenotypes?
4. Choose two of the offspring and mate them. List all of the possible phenotypes and genotypes.