Introduction to Genetics

Did you know that

- Before heredity was understood - people use to think:
- That a giraffe came from the mating of a camel and a leopard?
- That an ostrich came from the mating of a camel and a sparrow?

Topics

- Introduction to Genetics and heredity
- Genetic terminology (glossary)
- Gregor Mendel – a brief bio
- Monohybrid crosses

What is genetics?

- The scientific study of heredity

Genetic Vocab

- **Heredity - passing of traits from parent to offspring**
- **Trait – a genetic characteristic which is passed from parent to offspring e.g. eye colour**

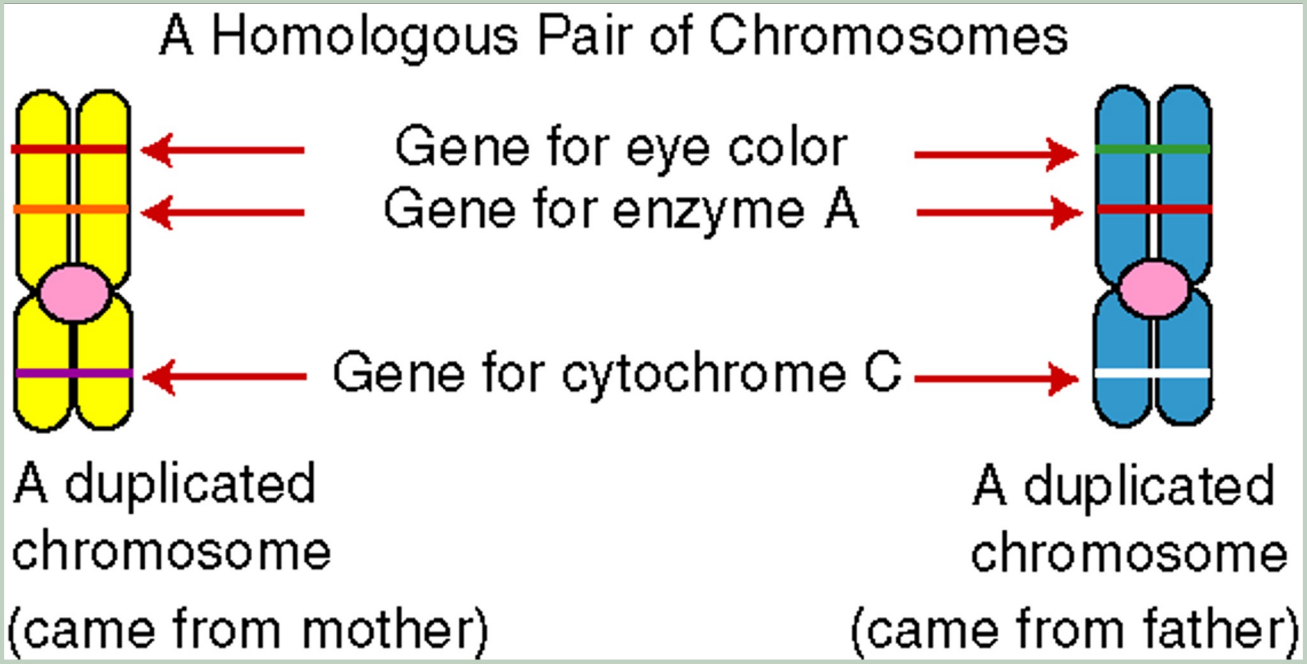
Allele

- **Genes commonly have multiple different possible forms**
- **(e.g. different colors of a flower)**
- **Or different flavours of ice cream**

Each variant of the gene is call an **ALLELE**
Above we see white, purple and yellow alleles for this type of flower.

How does it work?

- **Each trait human has two genes – one which came from the mom and one which came from the dad.**



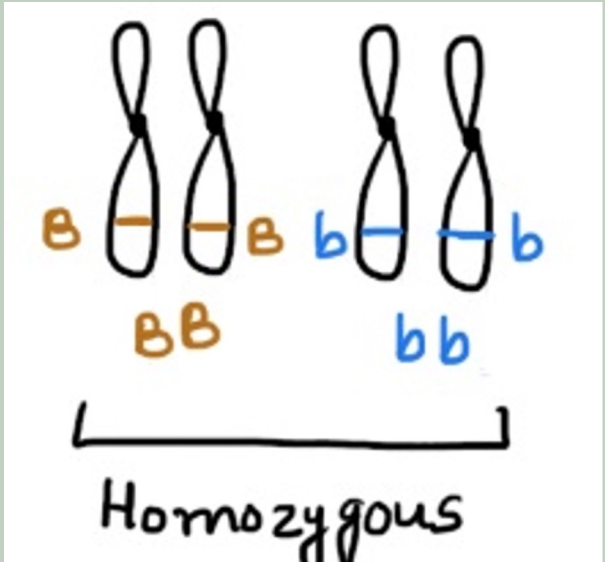
Two ways to describe traits

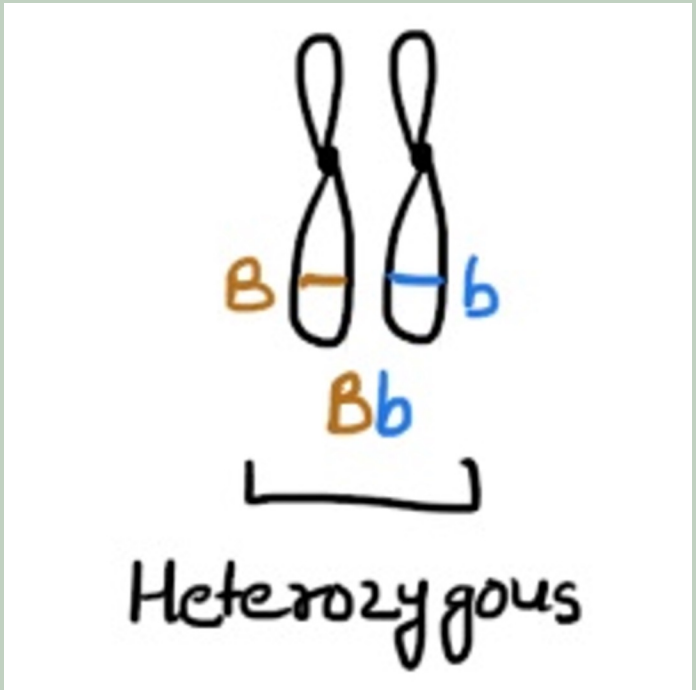
- **Genotype** – states the two genes (alleles) that are present for the trait (e.g. Purple Purple, Purple white,white white, yellow white)
- **Phenotype** – states the physical appearance of the trait – the result of genes (e.g. purple flowers or white flowers)
- (and sometimes environment) e.g. Brown hair may lighten up due to exposure to the sun (genes and environment)
-

Genotype & Phenotype practice

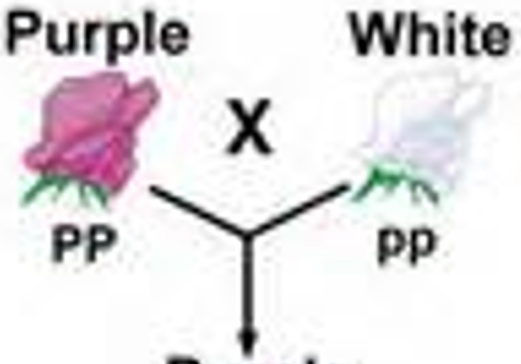
Genotypes	PP	pp
Phenotypes	purple	white

- **MORE VOCAB**
- **Homozygous** – having identical genes (alleles) for a particular characteristic. (e.g. Purple purple, or white white)
- **Heterozygous** – having two different genes (alleles) for a particular characteristic. (e.g. Purple white)



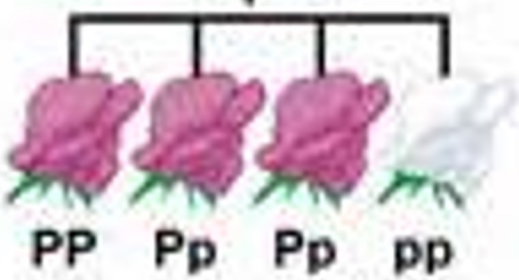


PARENTAL GENERATION (P)



FIRST FILIAL GENERATION (F1)

SECOND FILIAL GENERATION (F2)



3 Purple: 1 White

History of Genetics

Gregor Mendel – Father of Genetics (1822-1884)

First person to describe the Laws governing <u>Inheritance of Traits</u>

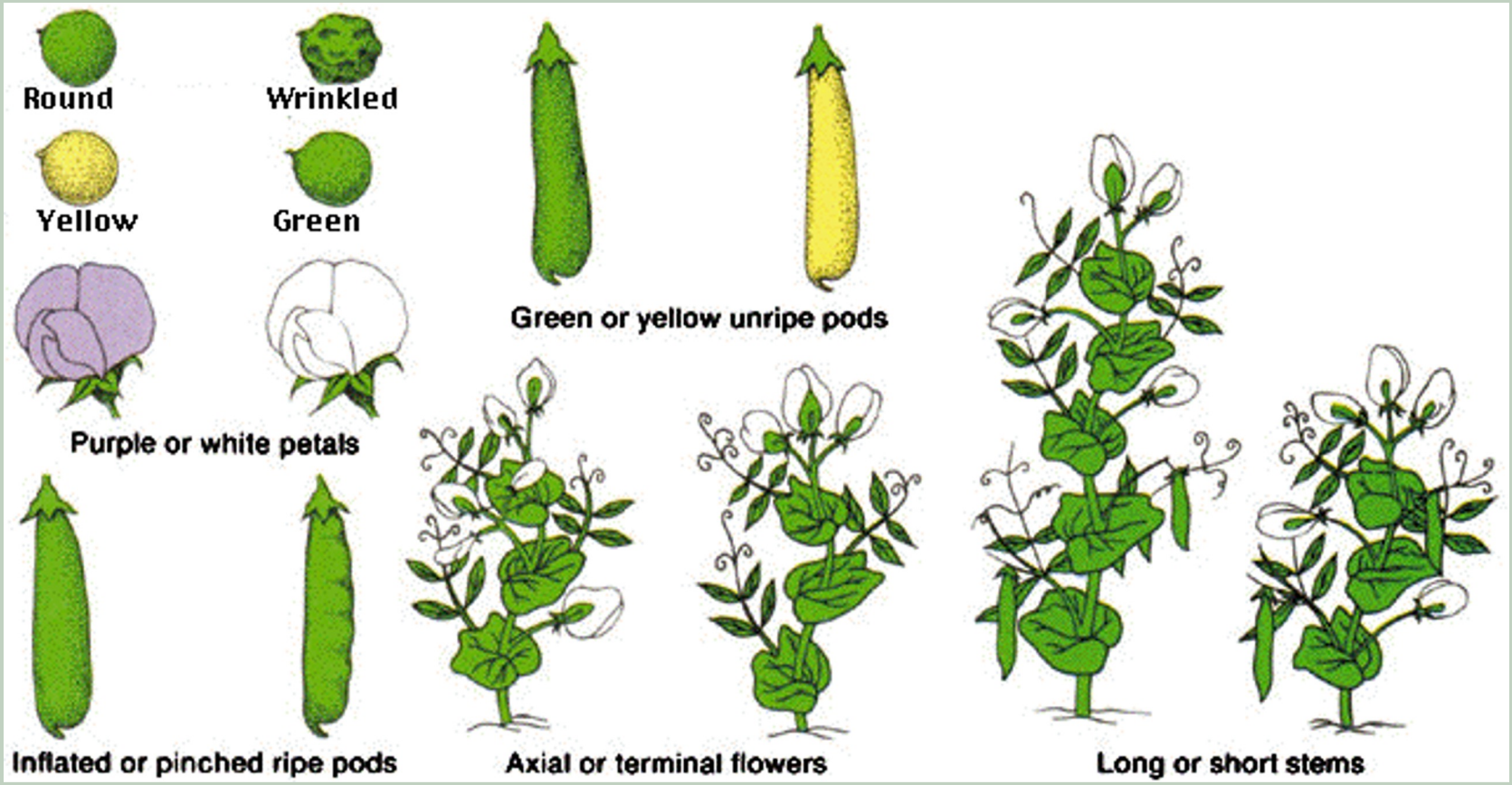
Mendel's Garden

Austrian Monk

- Between 1856 and 1863 Mendel grew and tested over 28,000 pea plants for inherited characteristics

Mendel's peas

- Mendel looked at seven traits or characteristics of pea plants which were controlled by a single gene:

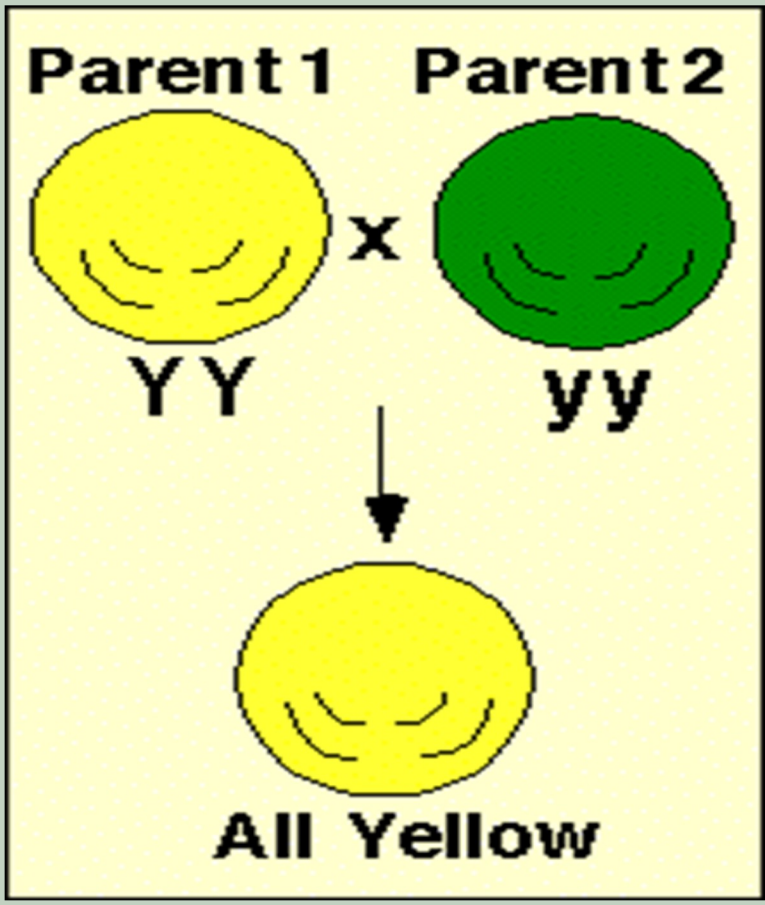


Mendel's experiments

- The first thing Mendel did was create a "pure" generation or **true-breeding** generation for that characterisitic
- This first group is the **PARENTAL** GENERATION

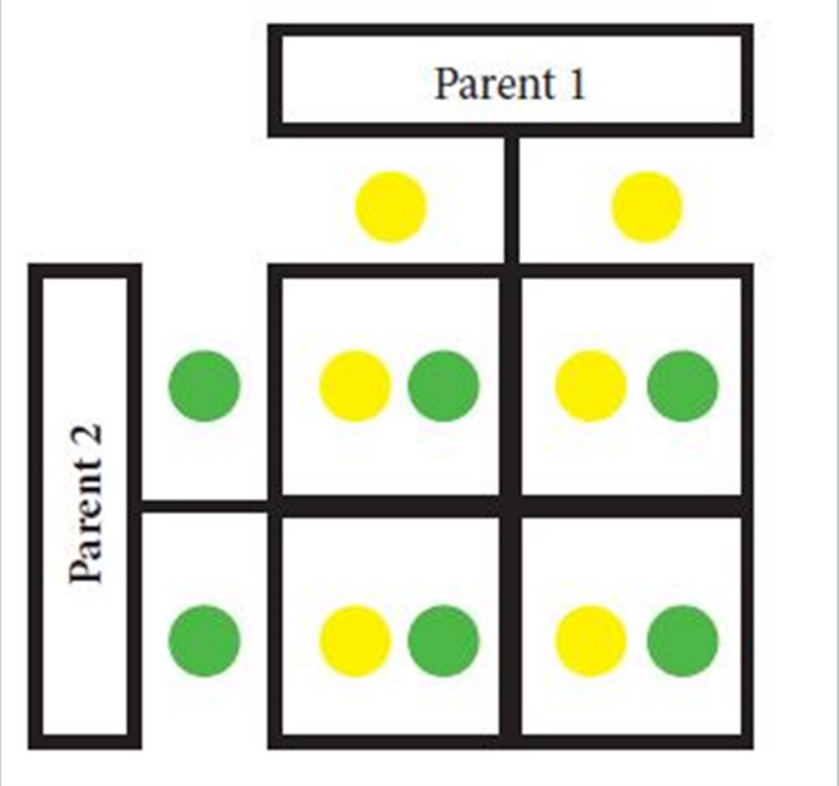
Mendel's First Cross

- When Mendel crossed pure yellow peas with pure green peas –> all the offspring were **yellow**



Results

- The offsprings of the pure yellow and pure green cross (F1 generation) each have <u>one yellow and one green gene</u> – BUT ALL OF THEM LOOKED YELLOW



Why were the offspring yellow? – Dominant and recessive genes

- **Dominant gene – Dominant alleles turn off (mask) recessive alleles. In Mendel's peas - Yellow was dominant --so this is the colour seen in the offspring**
- **(Dominant genes are represented by a capital letter – e.g. Y for yellow)**

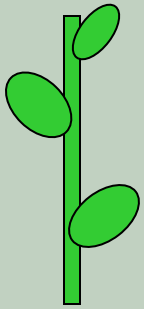
- **Recessive gene – the weaker gene, only seen if there is no dominant gene present.**
- **(Recessive genes are represented by a small letter version of the dominant gene e.g. y for green)**

Mendel's conclusions

- Characteristics are **inherited.**
- Characteristics (genes) may have multiple different forms called ***alleles***
- Some alleles are dominant and some are **recessive.**

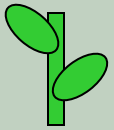
Practice - cross for stem length:

P = parentals
true breeding,
homozygous plants:



T T × *t t*

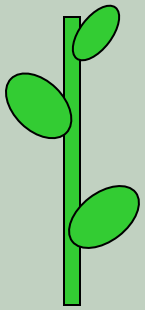
(tall) (short)



F_1 generation
is heterozygous:

T *t*

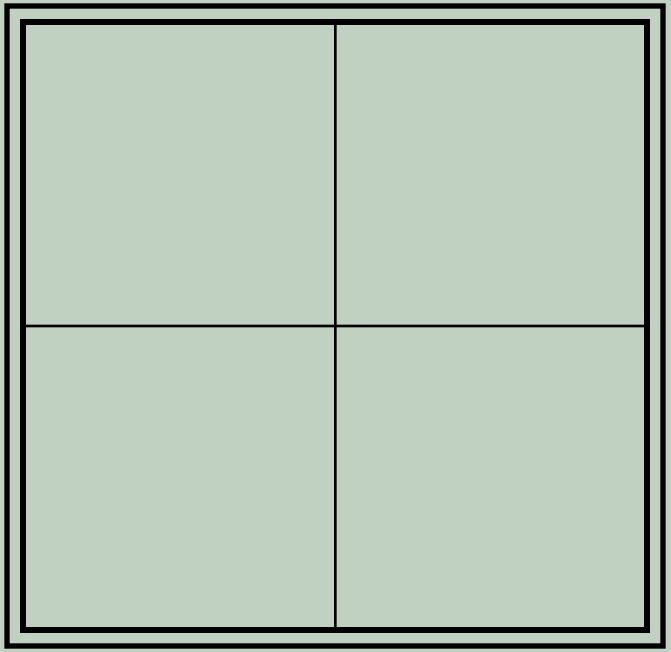
(all tall plants)



Punnett square

- A useful tool to do genetic crosses
- For a monohybrid cross, you need a square divided by four….
- Looks like a window pane…

We use the
Punnett square
to predict the
genotypes and phenotypes of
the offspring.



Using a Punnett Square

STEPS:

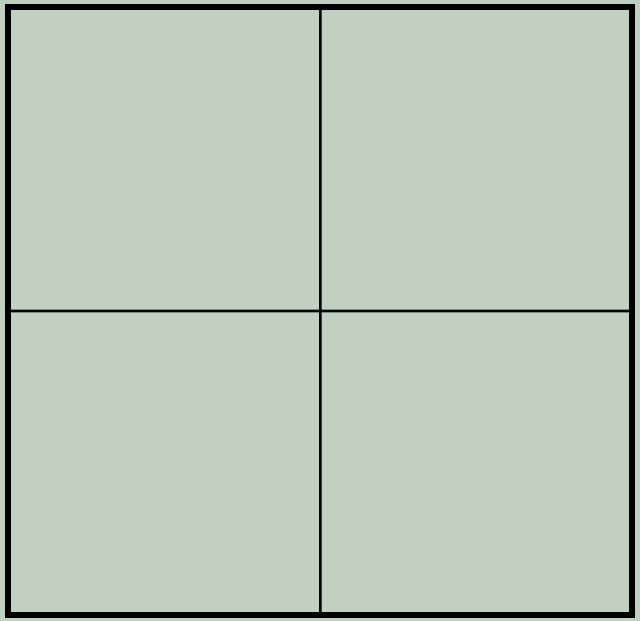
1. determine the genotypes of the parent organisms
2. write down your "cross" (mating)
3. draw a p-square

Parent genotypes:

TT and *t t*

Cross

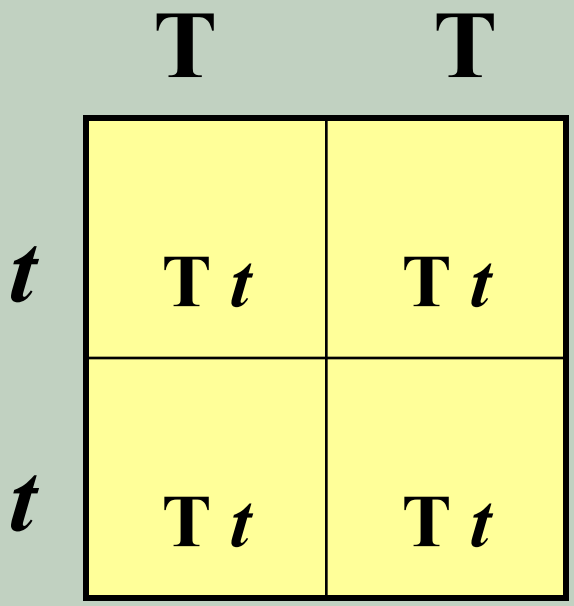
T T × *t t*



Punnett square

4. **"split" the letters of the genotype for each parent & put them "outside" the p-square**
5. determine the possible genotypes of the offspring by filling in the p-square
6. summarize results (genotypes & phenotypes of offspring)

T T × ***t t***



Genotypes:
100% T t

Phenotypes:
100% Tall plants

Mendel's second cross – Monohybrid cross

- He allowed the F_1 generation to self-pollinate thus producing the F_2 generation.
- Did the recessive allele completely disappear?
- What happened when he crossed two tall pea hybrid (F_1) plants? (Tt)

Monohybrid cross F_2 generation

- If you let the F1 generation self-fertilize, the F2 generation would be:

T *t* × **T *t***

(tall) (tall)

	T	***t***
T	**T T**	**T *t***
t	**T *t***	***t t***

Genotypes:

1 TT= Tall

2 T*t* = Tall

1 *tt* = short

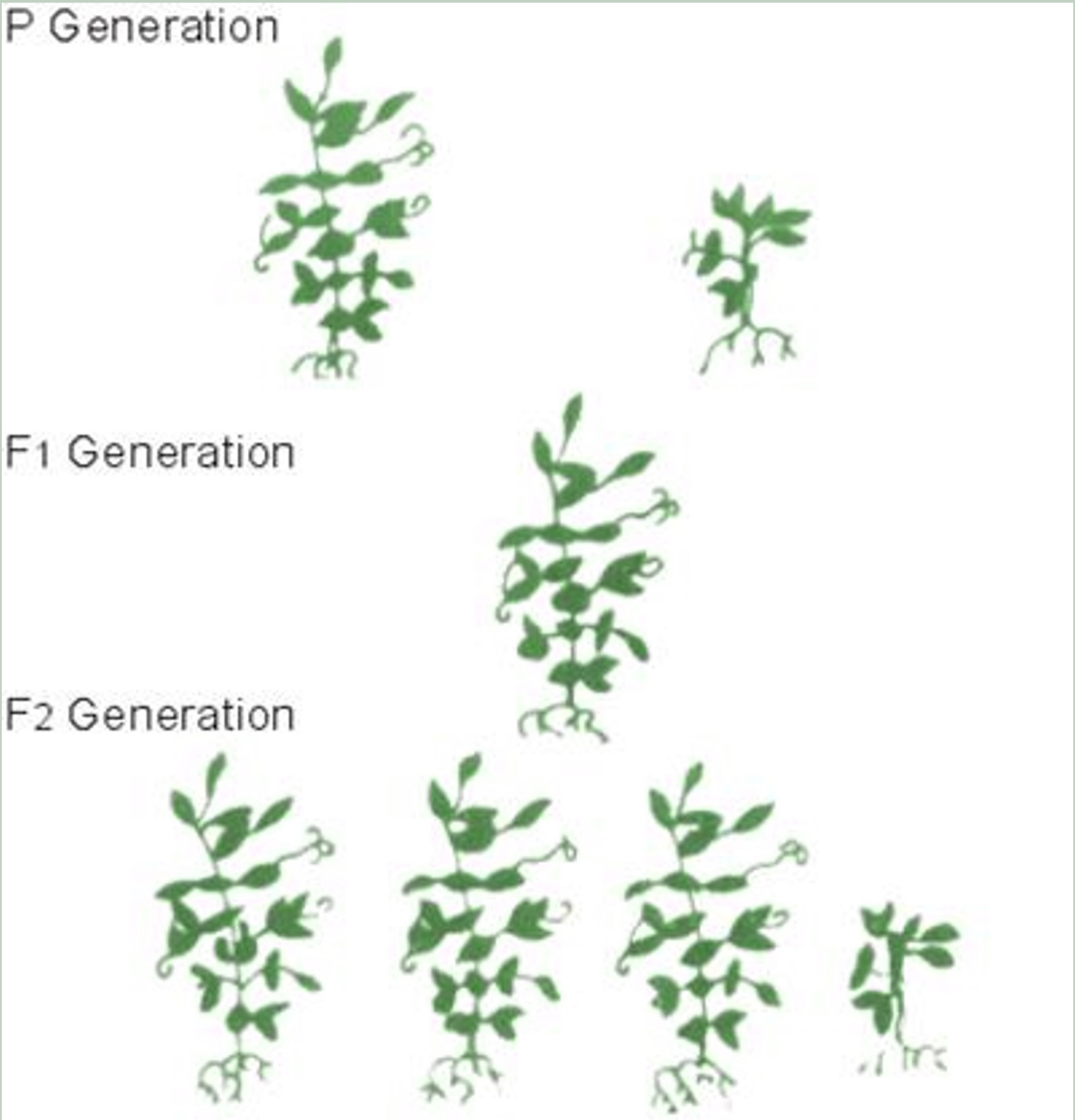
Genotypic ratio= 1:2:1

Phenotype:

3 Tall

1 short

Phenotypic ratio= 3:1



Experiment of Mendel's monohybrid ratio

Another example: Flower color

For example, flower color:

P = purple (dominant)

p = white (recessive)

If you cross a homozygous Purple (PP) with a homozygous white (*pp*):

P P × *p p*

↓

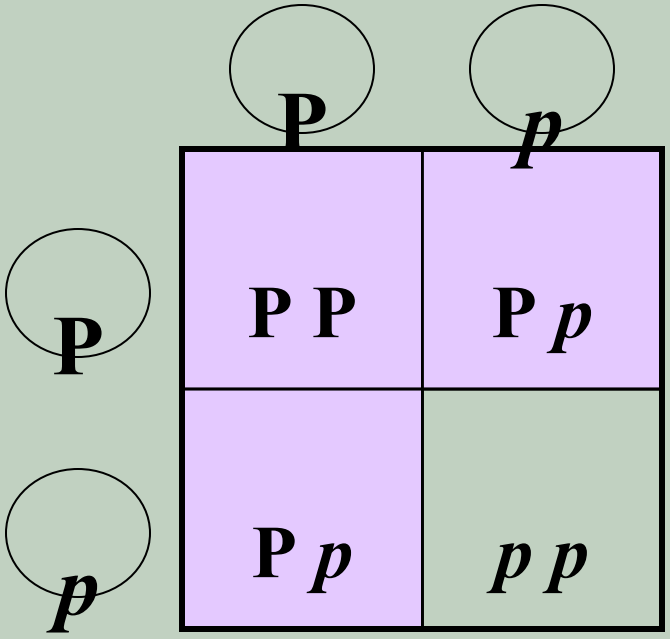
P *p*

ALL PURPLE (P*p*)

Cross the F1 generation ⍰ F2

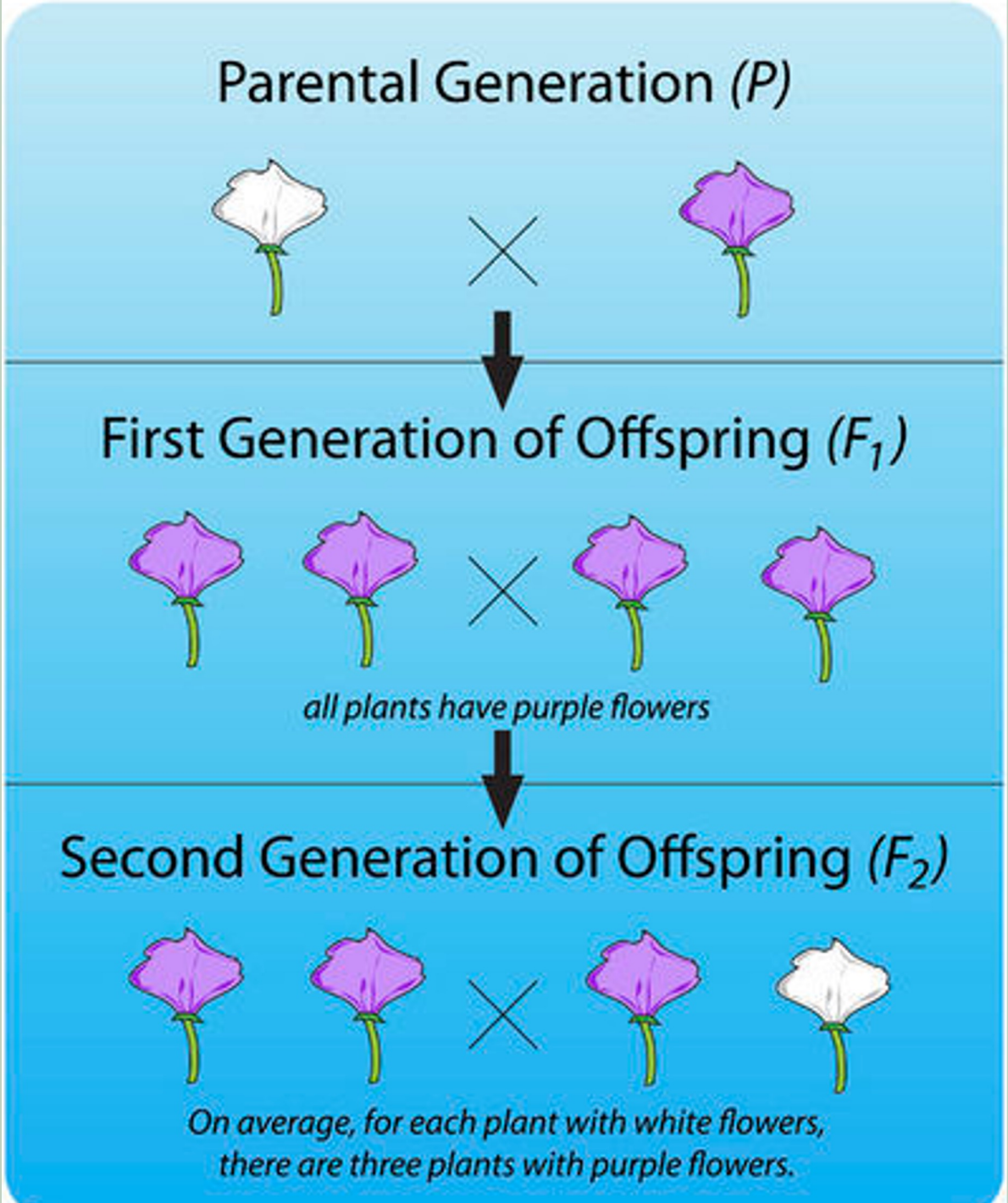
Monohybrid cross

P *p* × P *p*



F2 Genotypes:
1 PP
2 Pp
1 pp

F2 Phenotypes:
3 Purple
1 White


Parental Generation (P)
First Generation of Offspring (F_1)
all plants have purple flowers
Second Generation of Offspring (F_2)
On average, for each plant with white flowers,
there are three plants with purple flowers.

Did you know that?

Dominant alleles are not necessarily **better** or **more common** than a recessive allele.

Some dominant alleles are definitely less **desirable**

Dominant Allele Disorders

Polydactyl

- The presence of more than the normal number of fingers or toes.
- Can usually be corrected by surgery

Another example (not in notes) Dominant Allele Disorders

Achondroplasia

- Dwarfism
- Person grows no taller than 4’4

Recessive Allele Disorders

Albinism

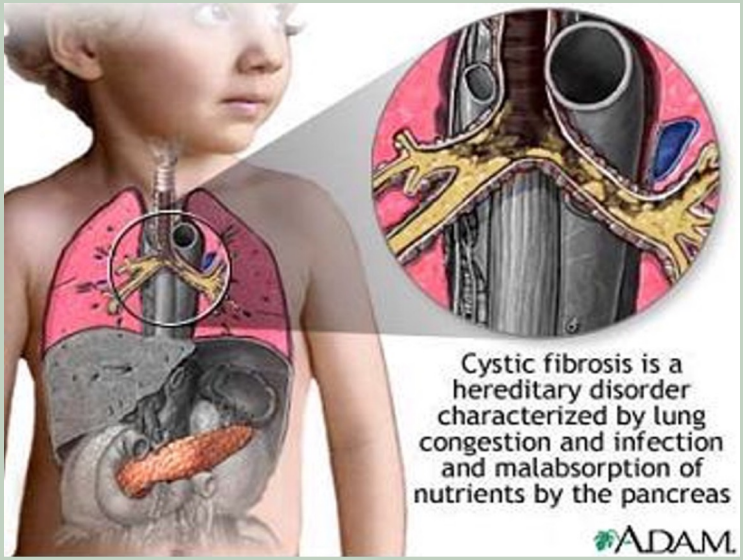
- Lack of pigment in skin, hair, and eyes
- Mutation in one of several genes which provide the instructions for producing one of several proteins in charge of making melanin.

Recessive Allele Disorders

<u>Cystic Fibrosis (CF)</u>

- Caused by recessive allele on chromosome 7 carried by 2.5% of Europeans

- Small genetic change (removes one Amino Acid) ⇒ changes protein



Inheritance pattern of CF

IF two parents carry the recessive gene of Cystic Fibrosis (*c*), that is, they are heterozygous (C *c*), one in four of their children is expected to be homozygous for *cf* and have the disease:

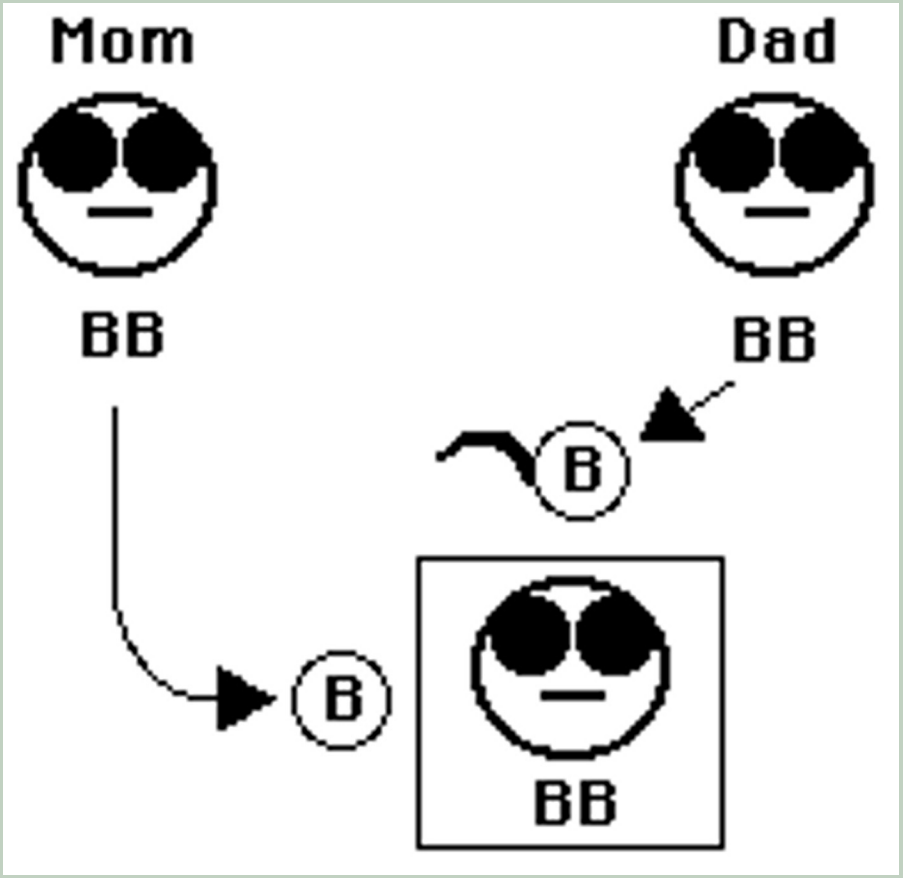
C C = normal
C *c* = carrier, no symptoms
c *c* = has cystic fibrosis

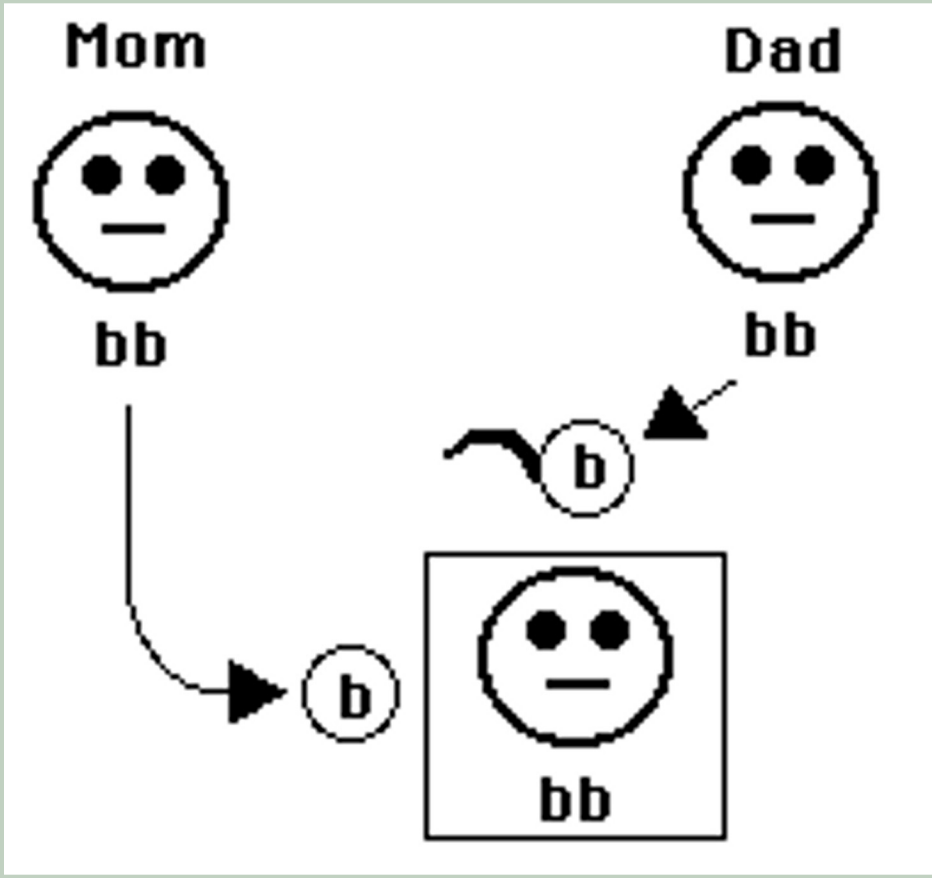
	C	***c***
C	**C C**	**C *c***
c	**C *c***	***c c***

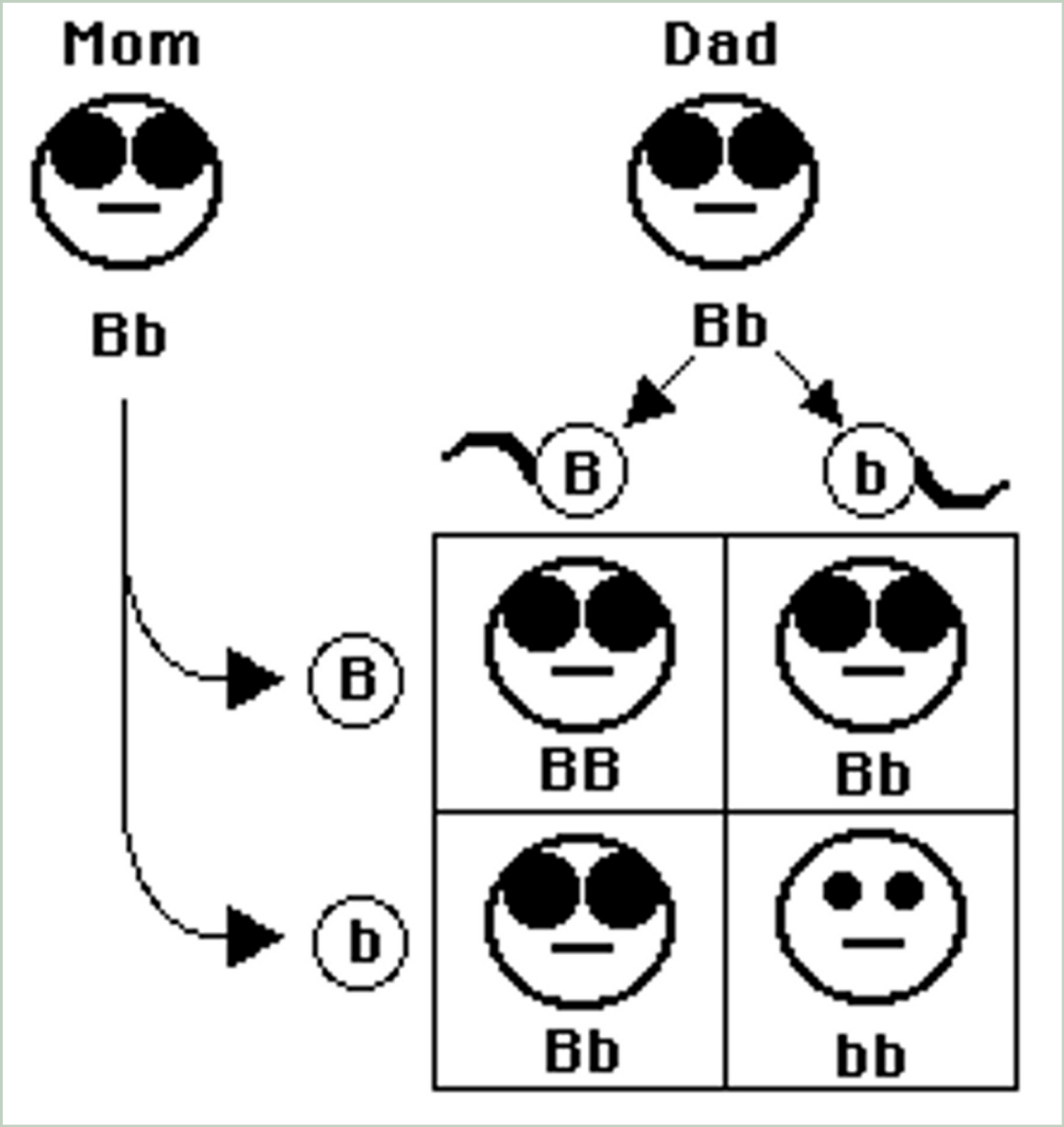
Punnet squares only give us Probability

- The **likelihood** of a particular event occurring. Chance
- Can be expressed as a fraction or a percent.
- Example: coin flip.

Punnett square review:






Mom
Dad
Bb
Bb
B
b
B
b
BB
Bb
Bb
bb