GENETIC INHERITANCE

Lesson Objectives

At the end of this lesson you should be able to

1. Give a definition for a gamete
2. Understand gamete formation
3. Give the function of gamete in sexual reproduction
4. Define fertilisation
5. Define allele
6. Differentiate between the terms homozygous and heterozygous

Lesson Objectives (cont.)

At the end of this lesson you should be able to

6. Differentiate between genotype and phenotype
7. Differentiate between dominant and recessive
8. Show the inheritance to the F_1 generation in a cross involving:

- Homozygous parents
- Heterozygous parents
- Sex determination
- Show the genotypes of parents, gametes and offspring

Sexual Reproduction

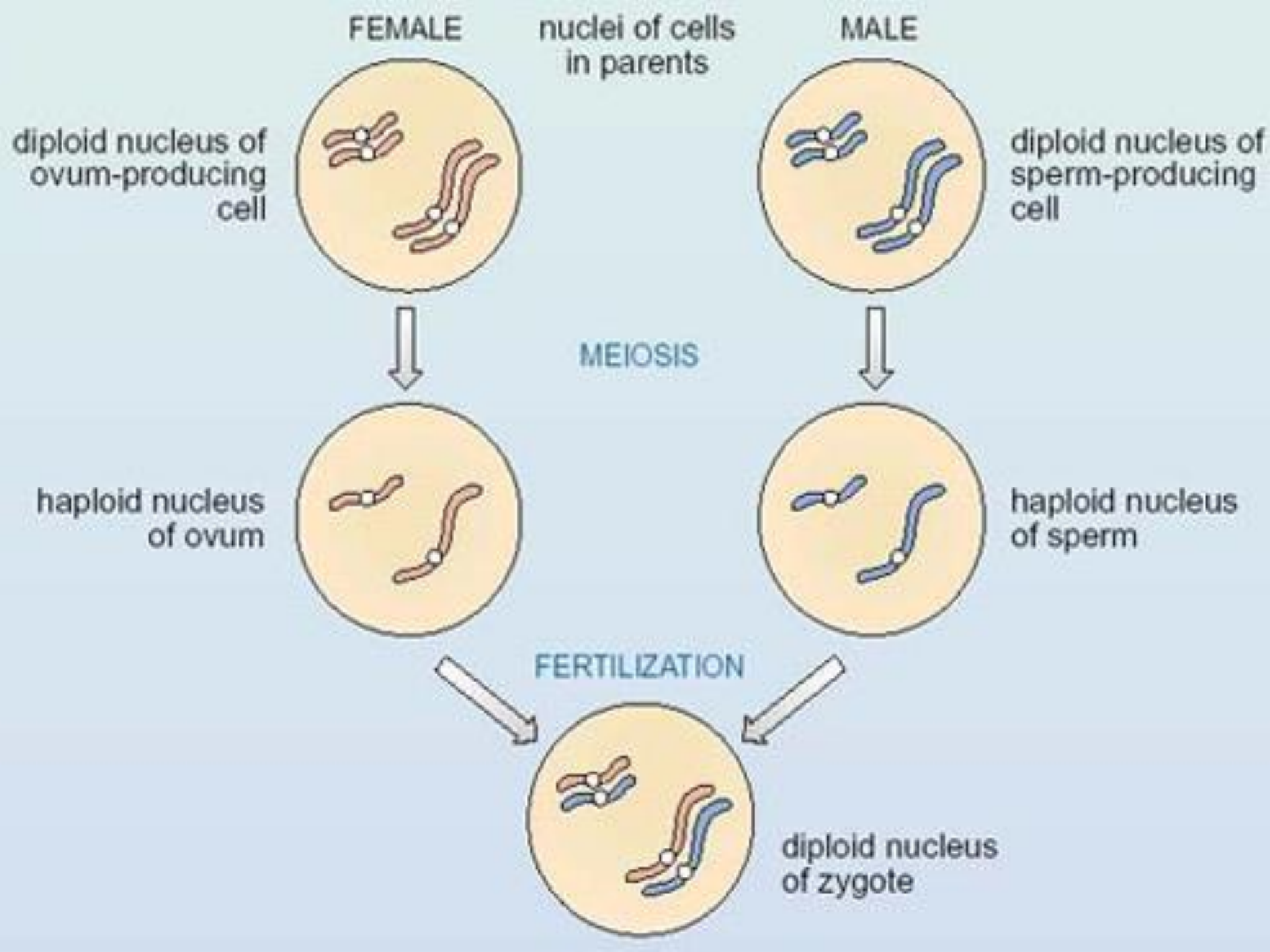
- Involves two parents

- Each parent makes reproductive cells
  - called gametes

Def: Heredity-the passing on of features from one generation to the next

Def: Fertilisation The fusion of male and female gametes to form a diploid zygote

Def: Gametes- haploid cells capable of fusion


FEMALE
nuclei of cells in parents
MALE
diploid nucleus of ovum-producing cell
diploid nucleus of sperm-producing cell
MEIOSIS
haploid nucleus of ovum
haploid nucleus of sperm
FERTILIZATION
diploid nucleus of zygote

What are Gametes?

- Reproductive Cells
- Formed by meiosis
- Contain single sets of chromosomes

  - haploid
- Capable of fusion to form zygote

  - diploid
- Zygote contains genetic information of both gametes

Learning Check

1. What are reproductive cells called?
2. Where are they found?
3. Are they haploid or diploid cells?
4. How are they formed?
5. What is a zygote?

Sex Chromosomes

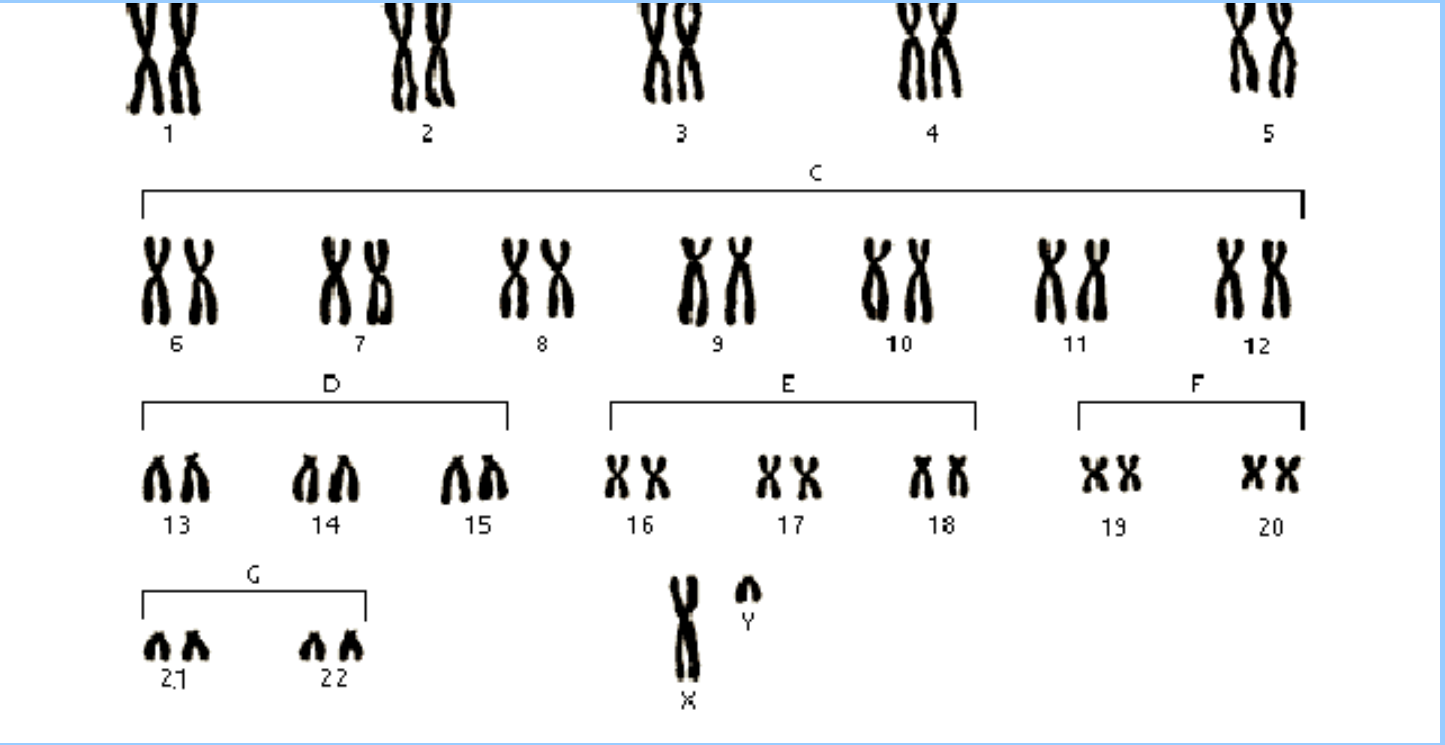
- We have 46 chromosomes, or 23 pairs.

- Autosomes are non sex chromosomes- We have 44 Autosomes (no 1 –22)

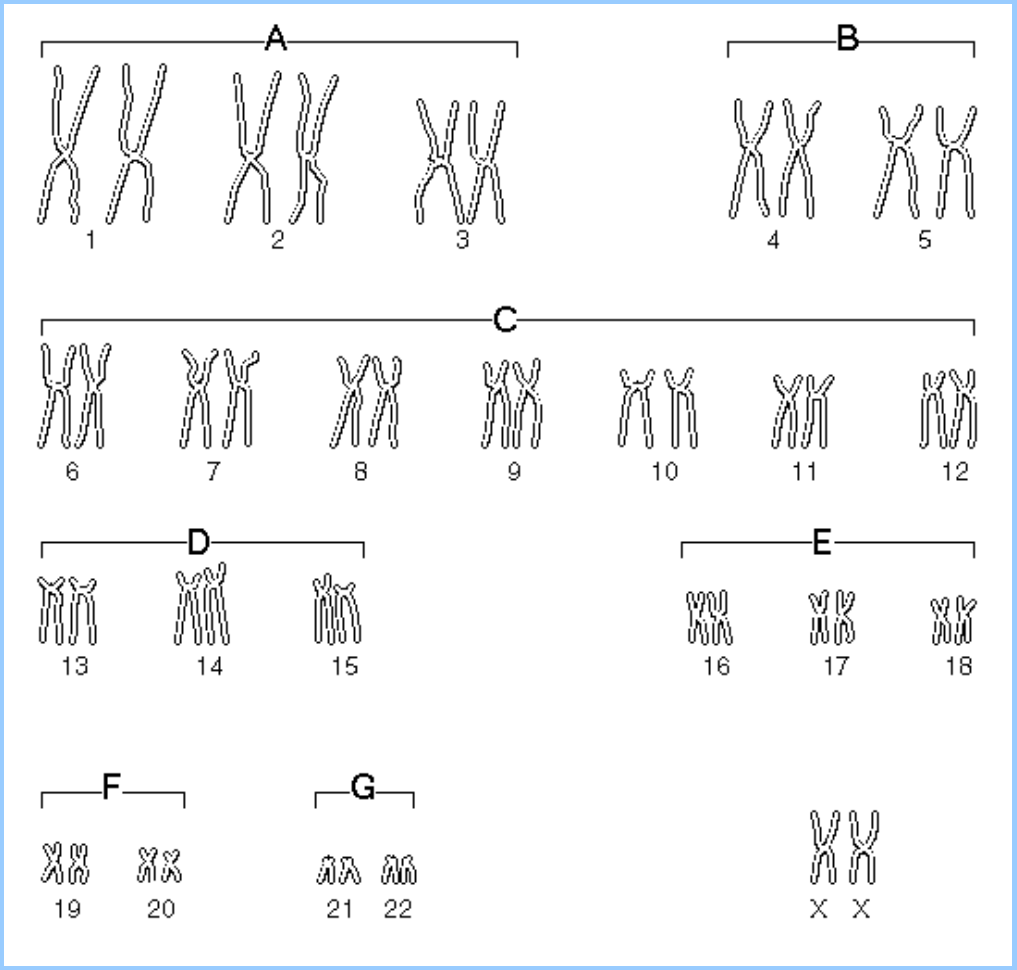
- The other 2 chromosomes are the sex chromosomes: the X chromosome and the Y chromosome.

- Males -XY;
- females have XX
- All embryos start life as female

Male Karyotype



Female Karyotype



Sex Determination

The basic rule:

If the Y chromosome is present, the person is male.

If absent, the person is female.

Meiosis

- the X and Y chromosomes separate and go into different sperm cells:
- ½ the sperm carry the X and the other half carry the Y.
- All eggs have one of the mother's X chromosomes
- The Y chromosome has the main sex-determining gene on it, called SRY

Sex Determination

- About 4 weeks after fertilization, an embryo that contains the SRY gene develops testes, the primary male sex organ.
- The testes secrete the hormone testosterone.
- Testosterone signals the other cells of the embryo to develop in the male pattern.

Learning Check

1. How many pairs of chromosomes does a human somatic cell have?
2. Which pair of chromosomes determines the sex of the offspring?
3. If you are male what does chromosome pair number 23 look like?
4. If you are female what does chromosome pair number 23 look like?

- Def Genetics -The study of **heredity**.
- **Gregor Mendel (1860's)** discovered the fundamental **principles** of **genetics** by **breeding garden peas**.

Genetic Terms

- Alleles- Alternative forms of **genes.**
- **Dominant alleles** (**TT** - **tall pea plants**)

<u>Dominant-allele that is always expressed if present</u>

- **Recessive alleles (tt - dwarf pea plants)**

<u>Recessive-the allele that is prevented from being expressed by dominant allele</u>

Phenotype

- Outward appearance
- Physical characteristics

- **Examples:**
    1. tall pea plant
    2. dwarf pea plant

Genotype

The genetic make up of the organism

Example:

1. **tall pea plant**

   TT = tall (homozygous dominant)

2. **dwarf pea plant**

   tt = dwarf (homozygous recessive)

3. **tall pea plant**

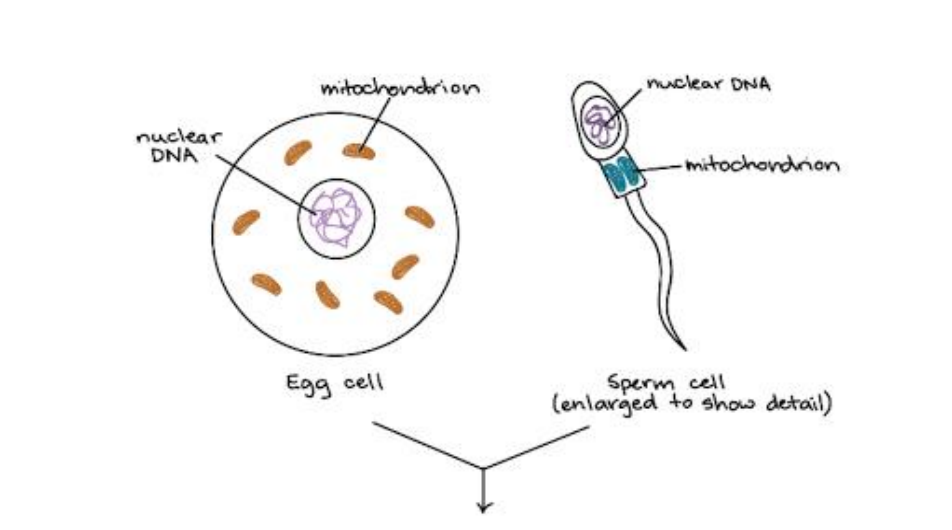
   Tt = tall (heterozygous)

- Homozygous-Two alleles that are identical ex. TT

- Heterozygous- Two alleles that are different ex. Tt

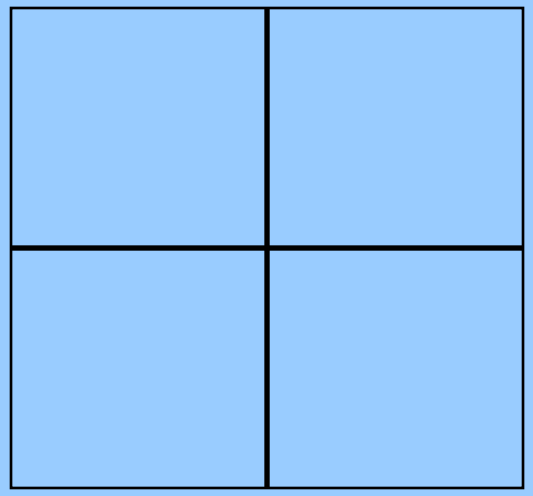
- Non-nuclear DNA- DNA which is found in mitochondria and chloroplast which can also be inherited via the egg (ovum)

- Most DNA is found in chromosomes in the nucleus



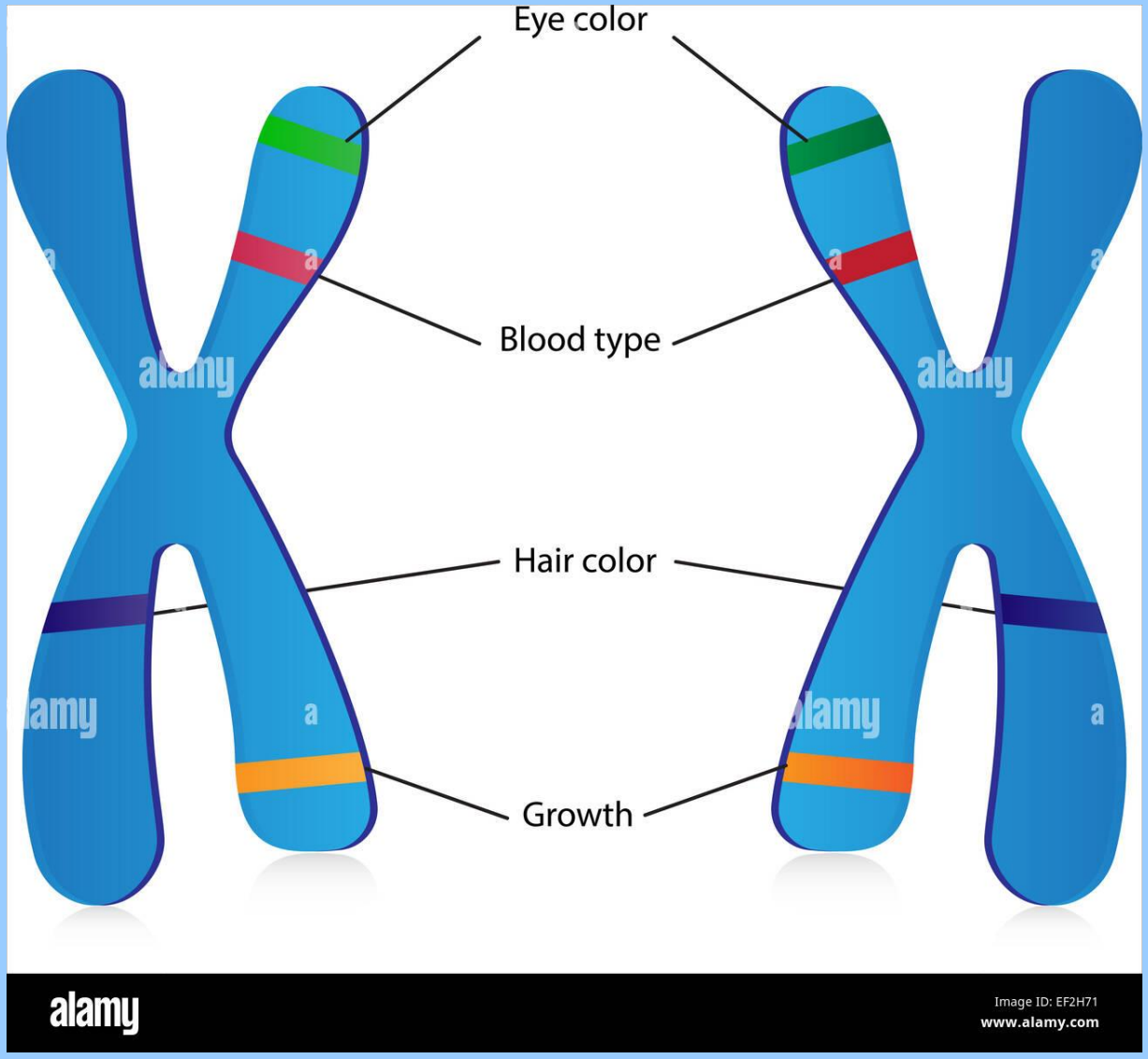
Punnett square

A **Punnett square** is used to show the possible **combinations** of **gametes**.



Learning Check

1. What is genetics?
2. What is an allele?
3. What is the difference between phenotype and genotype?
4. What is a punnett square used for?


Eye color
Blood type
Hair color
Growth
alamy
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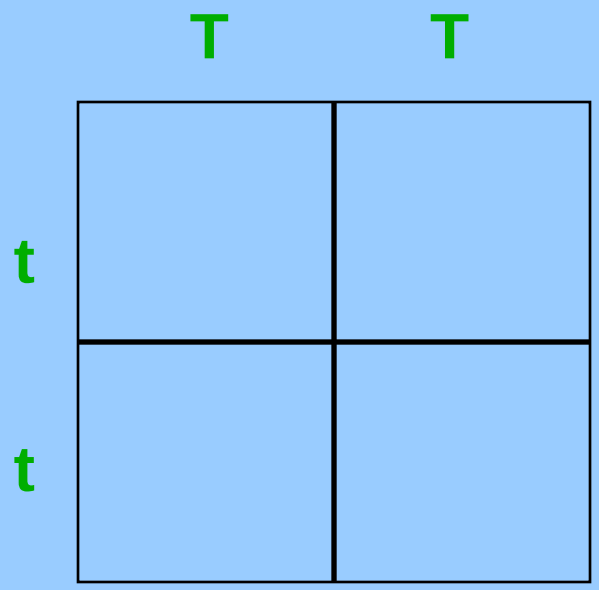
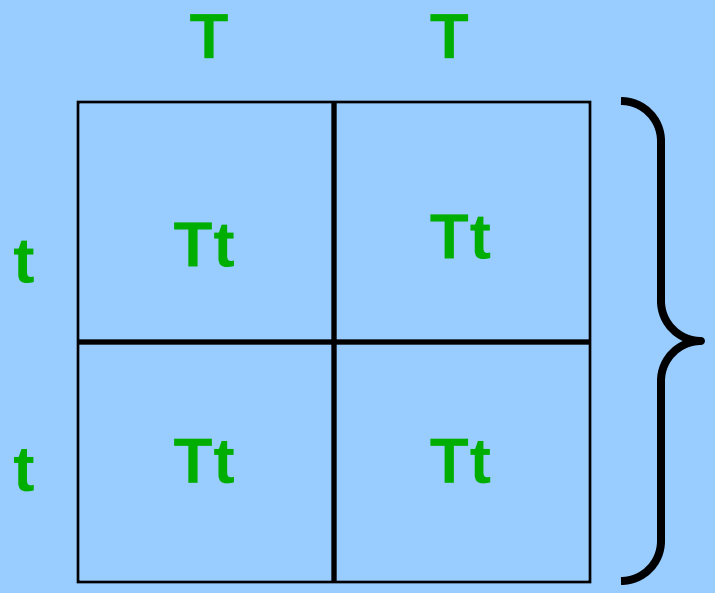
www.alamy.com

Breed the P generation

- **tall (TT) vs. dwarf (tt) pea plants**



tall (TT) vs. dwarf (tt) pea plants

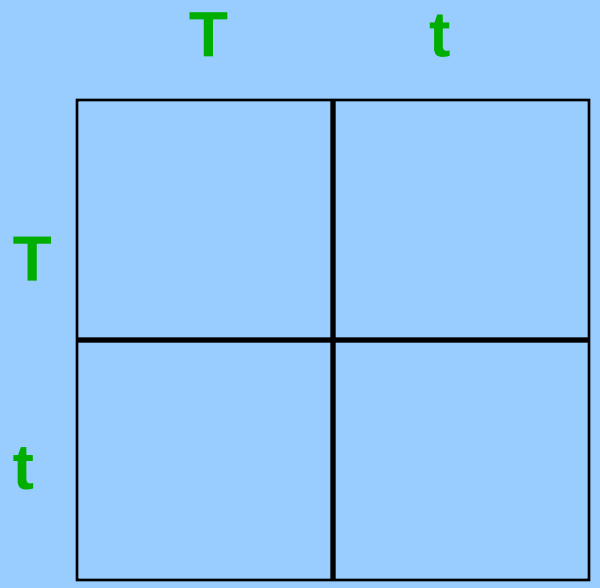


produces the
F_1 generation

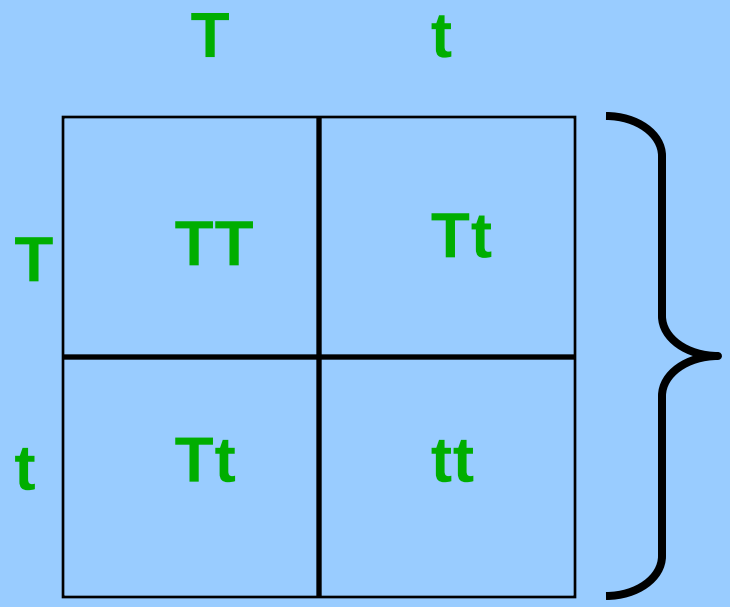
All Tt = tall
(heterozygous tall)

Breed the F_1 generation

- **tall (Tt) vs. tall (Tt) pea plants**



tall (Tt) vs. tall (Tt) pea plants



produces the
F_2 generation

1/4 (25%) = TT
1/2 (50%) = Tt
1/4 (25%) = tt

1:2:1 genotype
3:1 phenotype

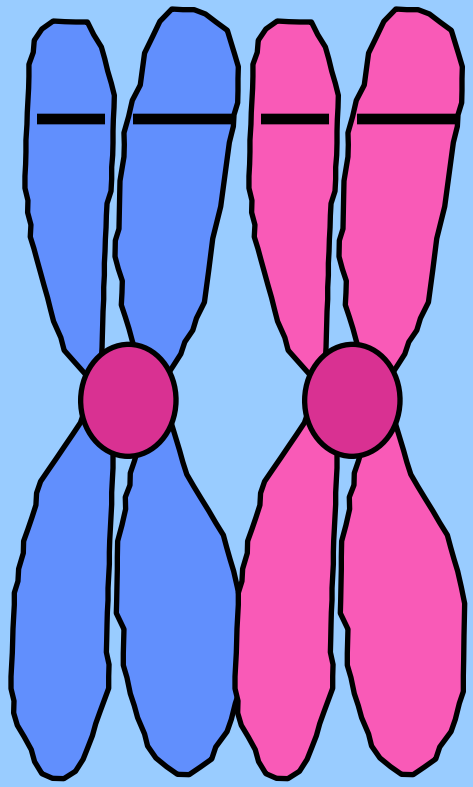
Monohybrid Cross

- A breeding experiment that tracks the inheritance of a **single trait.**
- **Mendel's LAW of segregation 1st law**
  a. pairs of genes separate during **gamete** formation **(meiosis).**

  b. the fusion of **gametes** at fertilization pairs genes once again.

Homologous Chromosomes

eye color locus
B = brown eyes



eye color locus
b = blue eyes

Paternal Maternal

This person would have brown eyes (Bb)

Mendels Law of Independent Assortment 2nd law

When gametes are formed either of a pair of alleles is equally likely to combine with either of another pair of alleles

Monohybrid Cross

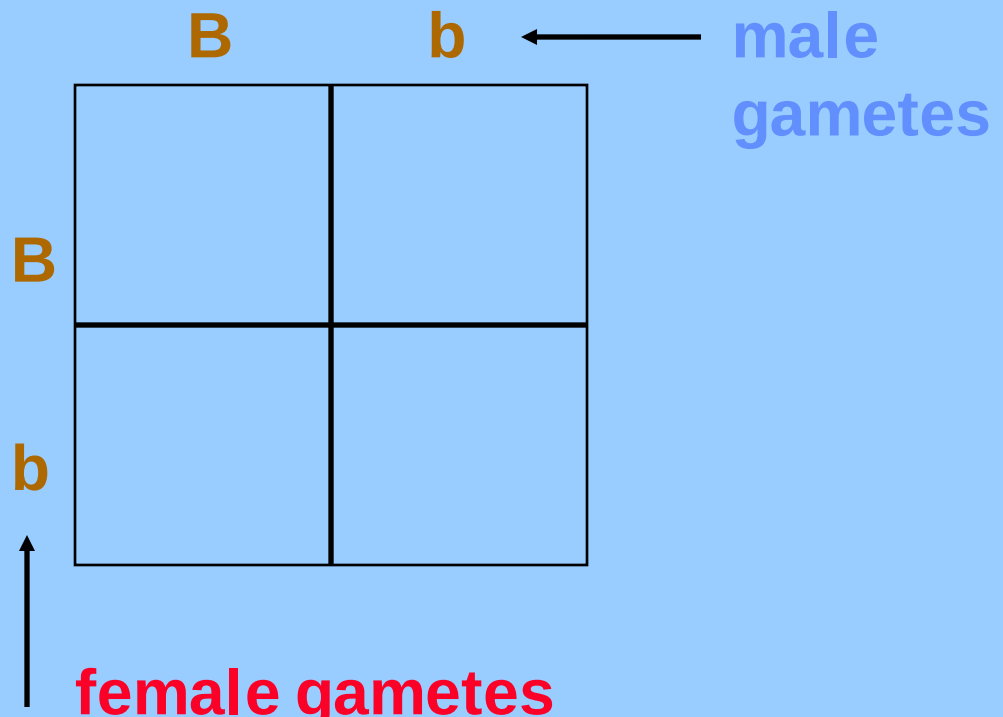
- **Example**: Cross between two **heterozygotes** for **brown eyes (Bb)**

BB = brown eyes

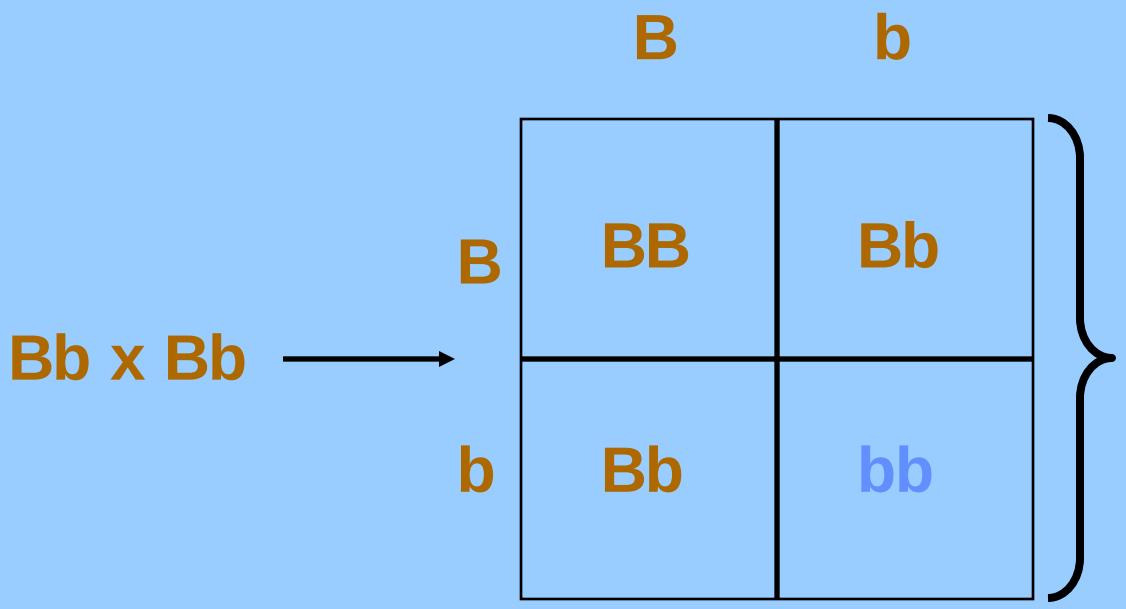
Bb = brown eyes

bb = blue eyes

Bb x Bb →



Monohybrid Cross



1/4 = BB - brown eyed
1/2 = Bb - brown eyed
1/4 = bb - blue eyed

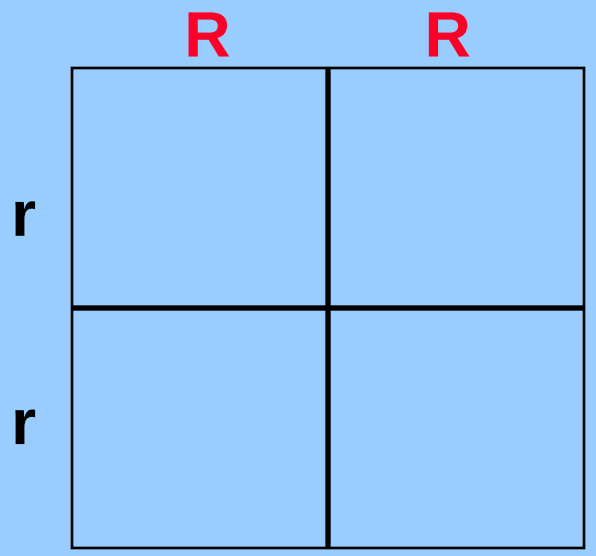
1:2:1 genotype
3:1 phenotype

Incomplete Dominance

- **F1 hybrids** have an appearance somewhat **in between** the **phenotypes** of the two parental varieties.
- **Example: snapdragons (flower)**
- **red (RR) x white (rr)**

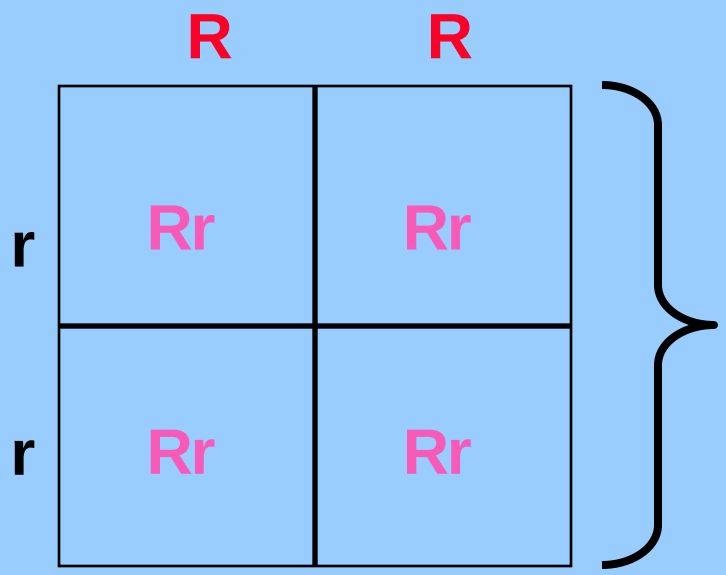
RR = red flower

rr = white flower



Examples from Exploring Biology and Biology Plus-On Board

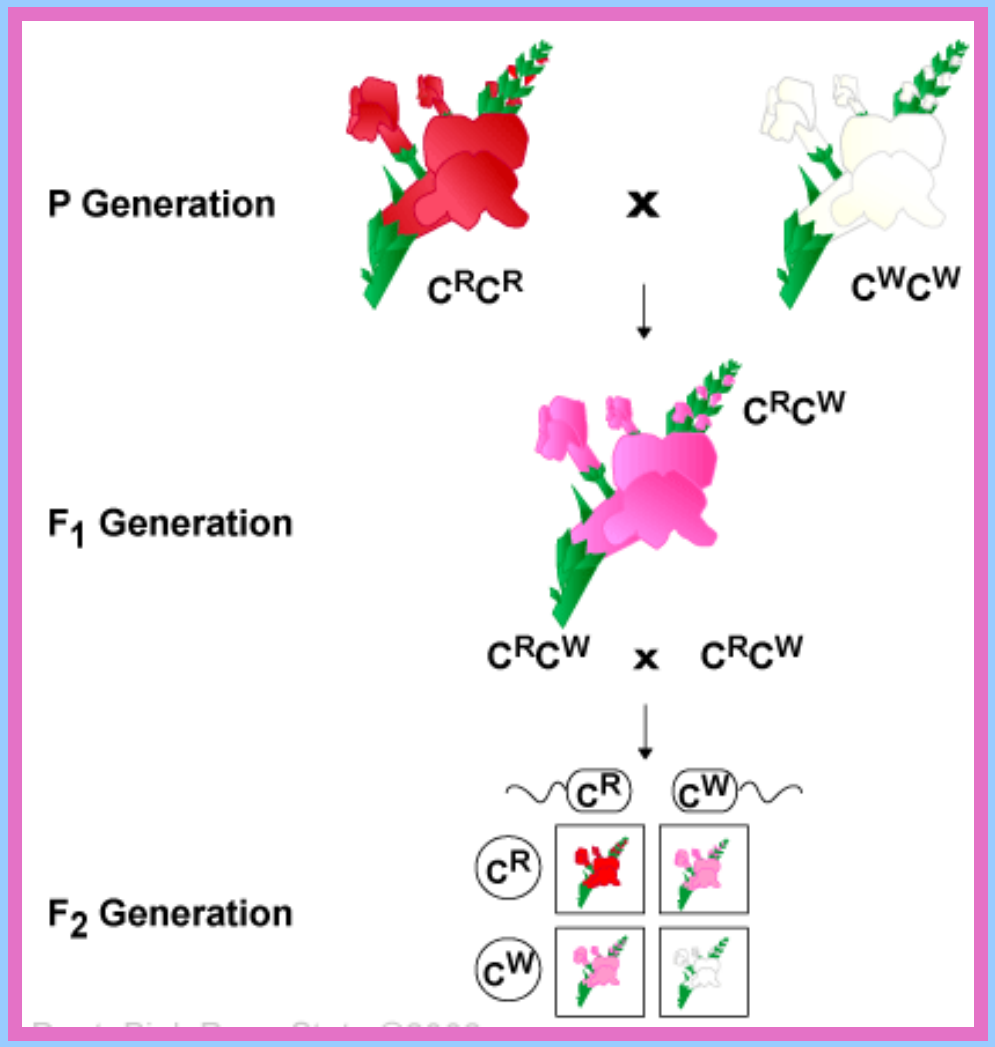
Incomplete Dominance



produces the F_1 generation

All Rr = pink (heterozygous pink)

Pink Flowers?



Co-dominance(Interdependance)

- **Two alleles** are expressed (**multiple alleles**) in **heterozygous individuals**.
- **Example: blood**

1. **type A = I^AI^A or I^Ai**
2. **type B = I^BI^B or I^Bi**
3. **type AB = I^AI^B**
4. **type O = ii**

Co-dominance

- **Example:** homozygous male B (I^BI^B)

  x

  heterozygous female A (I^Ai)

	I^B	I^B
I^A	I^AI^B	I^AI^B
i	I^Bi	I^Bi

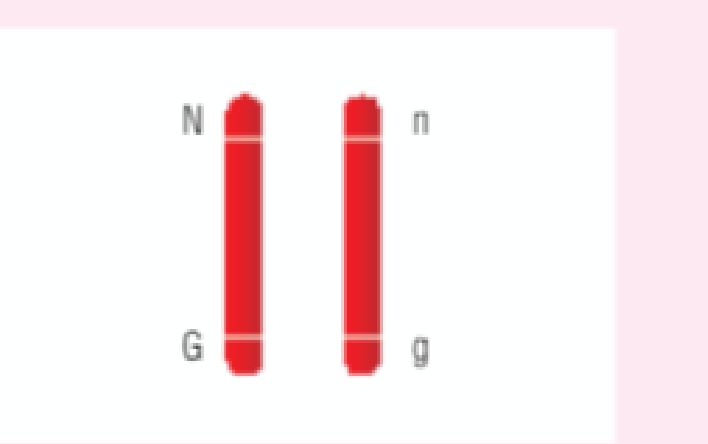
1/2 = I^AI^B

1/2 = I^Bi

Learning Check

1. What is a monohybrid cross?
2. What do the terms homozygous and heterozygous represent?
3. What is the difference between co dominance and incomplete dominance

- **Linked genes-**genes that are located on the same chromosomes and are therefore inherited together



16.21 Diagram of linked genes

- DiHybrid Cross –cross involving two characteristics at a time

Example

TB Pg 171

Sex linked Genes-genes found normarily on the X Chromosome

(recessive gene)

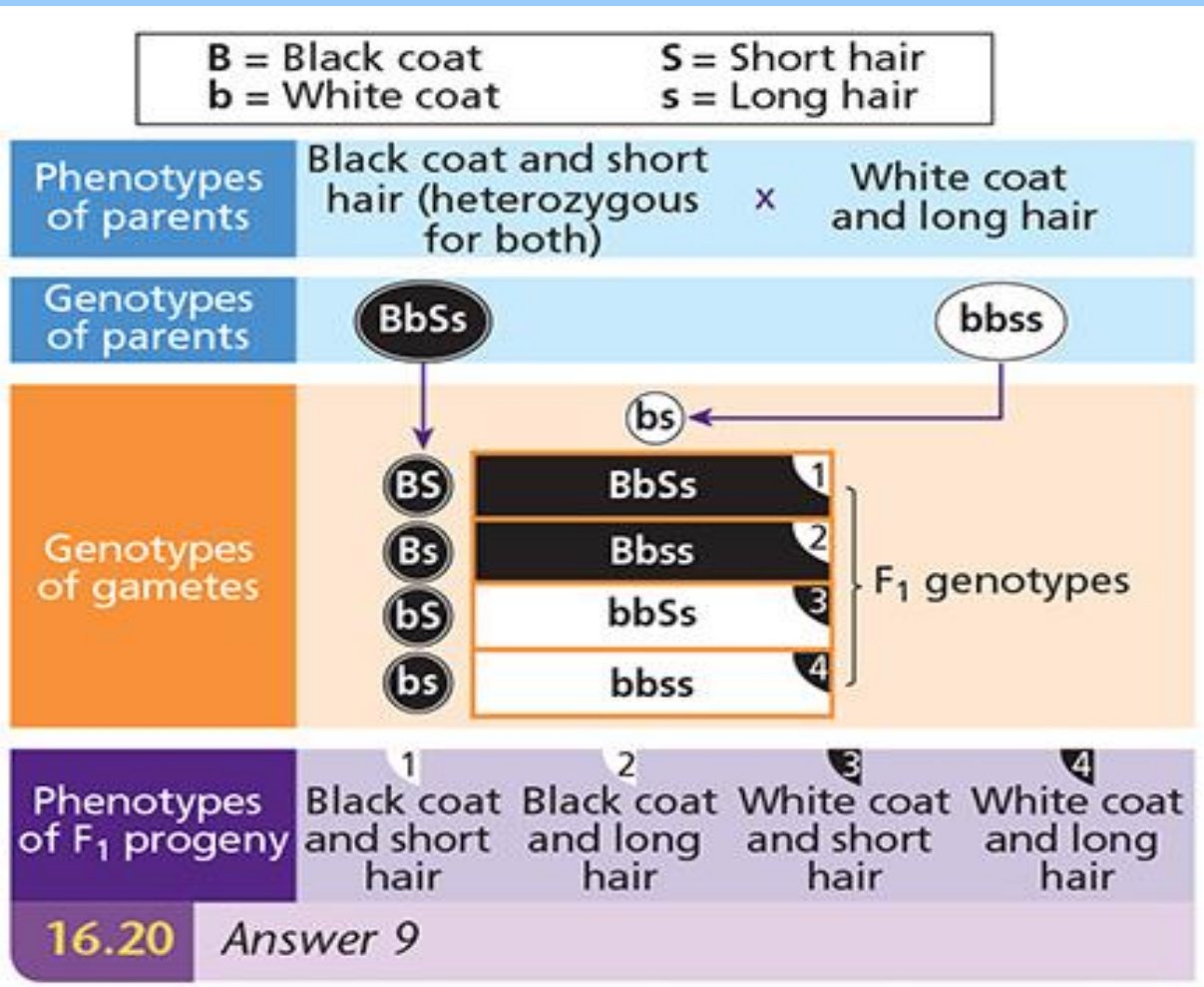
Carrier- a female who has an allele for the abnormal condition but does not show it

In guinea pigs, black coat (B) is dominant to white coat (b). Also short hair (S) is dominant to long hair (s).

(a) Show the genotypes and phenotypes of the F_1 progeny for a cross involving a black-coated, short-haired guinea pig (heterozygous for both traits) and a white-coated, long-haired guinea pig.

(b) State the expected ratio of the offspring.

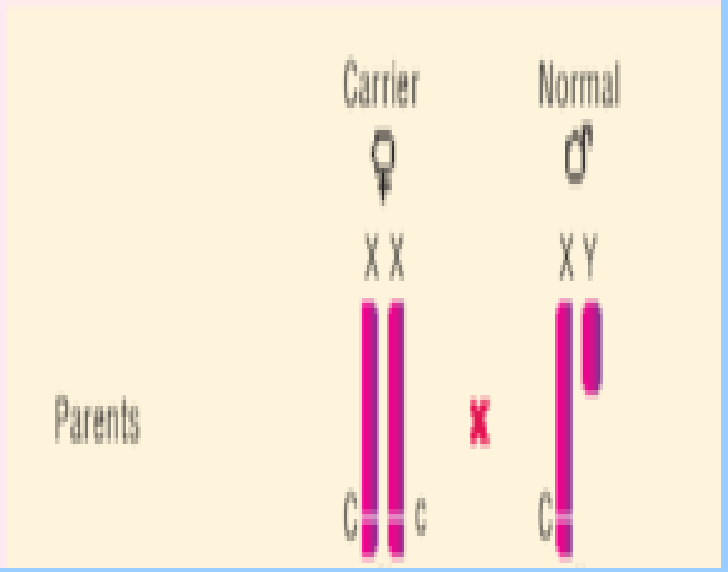
(a)



(b) The offspring are expected to occur in equal numbers (i.e. the ratio is 1:1:1:1).

Sex-linked example

Red–green colour-blindness is a sex-linked trait. If a normal man marries a woman who is a carrier of the trait, what is the likelihood that their first son would be colour blind?



Chromosomes and Genetics

- Chromosomes are long pieces of DNA, with supporting proteins
- Genes are short regions of this DNA that hold the information needed to build and maintain the body
- Genes have fixed locations: each gene is in a particular place on a particular chromosome
- Diploids have 2 copies of each chromosome, one from each parent. This means 2 copies of each gene.

What have you learned?

Can you ……..

1. Define a gamete and understand gamete formation
2. Define fertilisation and sex determination
3. Define allele
4. Differentiate between the terms homozygous and heterozygous
5. Differentiate between genotype and phenotype
6. Differentiate between dominant and recessive
7. Understand incomplete dominance
8. Be able to complete monohybrid crosses and state the genotypes and phenotypes of parents and offspring
9. Understand the 3:1 ratio for heterozygous crosses

Practice with Crosses

http://www.zerobio.com/drag_gr11/mono.htm

http://www.brooklyn.cuny.edu/bc/ahp/MGInv/MGI.Intro.html

End