

2.4 Genetic Information

What you need to know...

- That our genes determine our features
- Where our genes come from
- How to do basic genetic crosses

Task

- Use classroom resources to find the definition of the following words
 - Gamete
 - Zygote
 - Genetic Information
 - Gene
 - Phenotype
 - Genotype
 - Allele
 - Dominant Allele
 - Recessive Allele
 - True Breeding

Inherited Characteristics

- Inherited characteristics are passed from parents to offspring.
- These characteristics are determined by **GENETIC INFORMATION** which passes from the parents in their sex cells (**GAMETES**) to their offspring.
- Half of our genetic material comes from our mum and half comes from our dad. This ensures variation of our species.

- Each parent passes **ONE** piece of information about each characteristic, and so each individual receives **TWO** pieces of information for every characteristic. This information is carried by the **GENES**.
- The **TWO GENES** which determine any characteristic may be the **SAME** or they may be **DIFFERENT**.

- In humans, many characteristics are inherited e.g. eye colour, blood groups, hair colour, tongue rolling
- Inherited characteristics in other animals include fur colour and type in guinea pigs; eye colour, body colour and wing type in fruit flies.
- Plants also show inherited characteristics e.g. flower colour, stem length, seed colour.

Phenotypes

- An organism's **PHENOTYPE** is its appearance which results from the genetic information passed from its parents.

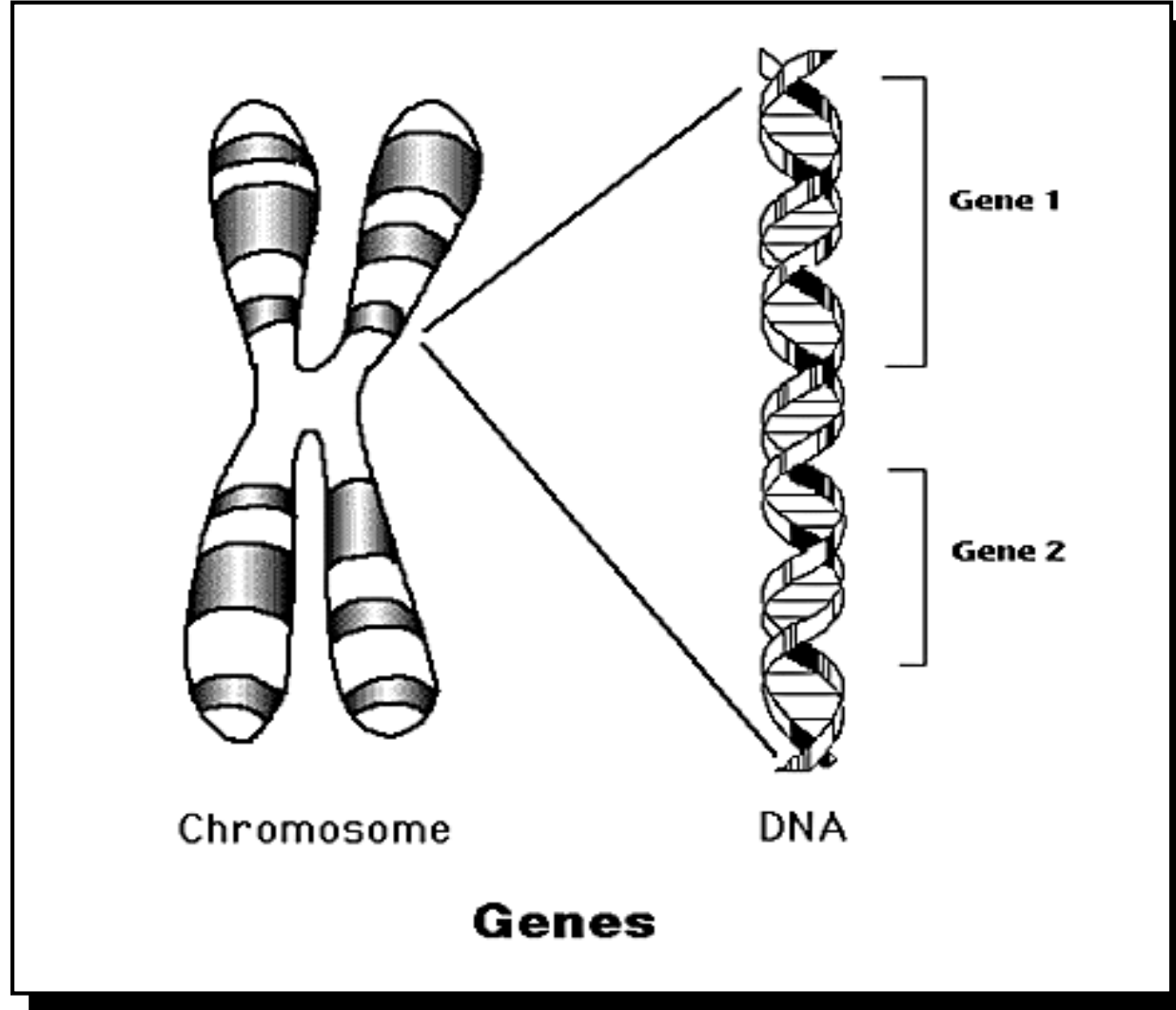
Examples of Phenotypes

Organism	Characteristic	Phenotypes
human	tongue rolling	can roll tongue can't roll tongue
	blood groups	A; B; AB; O
guinea pig	Fur type	rough/smooth fur
fruit fly	body colour	black/grey body
	wing length	short/long
pea plants	Height	tall, dwarf
	seed colour	green/yellow seeds
	seed shape	smooth/wrinkled seeds

Genotype

- The cells of living organisms have **CHROMOSOMES** in their nuclei.
- These chromosomes contain **GENES** which determine and individual's characteristics such as eye colour, nose shape, blood groups etc.
- The genes are arranged along each chromosome like a string of beads.
- Each gene controls a specific characteristic.

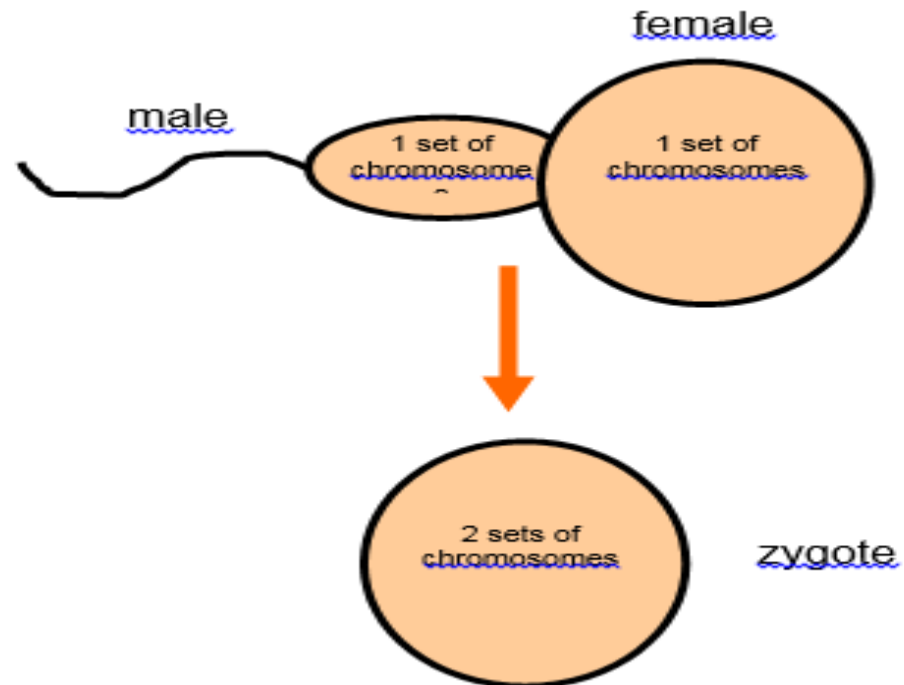
The set of genes possessed by an organism is called the **GENOTYPE**



Producing a Zygote

- All body cells have **TWO** matching sets of chromosomes ($2n$). They are said to be diploid
- Sex cells (**GAMETES**) contain only one set of chromosomes ($1n$). They are said to be haploid
- During Fertilisation the nuclei of 2 haploid gametes fuse to form a diploid **ZYGOTE**.

- The resulting Zygote contains **TWO** sets of chromosomes. One set is from the father and the other set from the mother



- All the body cells of the individual which are formed from this zygote are the result of **MITOSIS** and so will also have two sets of chromosomes. Each characteristic of the individual will therefore be controlled by **TWO GENES**, one inherited from each parent.

In Summary

- The combination of genes which controls any characteristic is called the **GENOTYPE**. This will determine the organisms **PHENOTYPE**.

True Breeding

- An organism is **TRUE-BREEDING** if, when it is crossed with another organism of the same strain, it always produces offspring of exactly the same kind.
- This means that the organisms will contain 2 genes which are the same for that characteristic (homozygous)
- For example, red-flowered plants crossed with red-flowered plants are true breeding if they produce **ONLY** more red flowered plants.

Monohybrid Crosses

- In a **MONOHYBRID CROSS** we consider only **ONE** difference between the parents. The parents are **TRUE BREEDING** for this inherited characteristic.
- The parents will have **DIFFERENT FORMS** of the **GENE** which controls the characteristic. For example in humans, one parent may possess the gene for brown eyes while the other parent may have the gene for blue eyes

- These different forms of a gene are called **ALLELES**.
- Heterozygous organisms have two alleles that are different. One allele will hide the effect of the other. This allele is called the **DOMINANT** allele. The allele that is hidden is called the **RECESSIVE** allele.

- If an organism possesses two identical forms of the same gene, the organism is said to be homozygous and is true breeding. If an organism possesses two different forms of a gene, it is said to be heterozygous.
- Alleles can be represented using symbols, a capital letter is used to represent the dominant allele, and a small case letter is used to represent the recessive allele.

- If one or more dominant alleles is present the dominant phenotype will be expressed.
- The recessive phenotype will only be expressed if both alleles are recessive.

Example

- In peas round seed is dominant to wrinkled seed. This can be represented in symbols.
 - Round = dominant allele = R
 - Wrinkled = recessive allele = r

Parents
(true breeding)

red flower

X

white flower

Genotype

RR

rr

Gametes

all R

all r

F₁ genotype

|

all Rr

F₁ phenotype

all red flower



F₁ self-cross

red flower

X

red flower

Genotype

Rr

Rr

Gametes

R and r

R and r

F₂ genotypes

(use punnet square)

gametes	R	r
R	RR	Rr
r	Rr	<u>rr</u>

F₂ genotype ratio

RR : Rr : Rr : rr

F₂ phenotype ratio

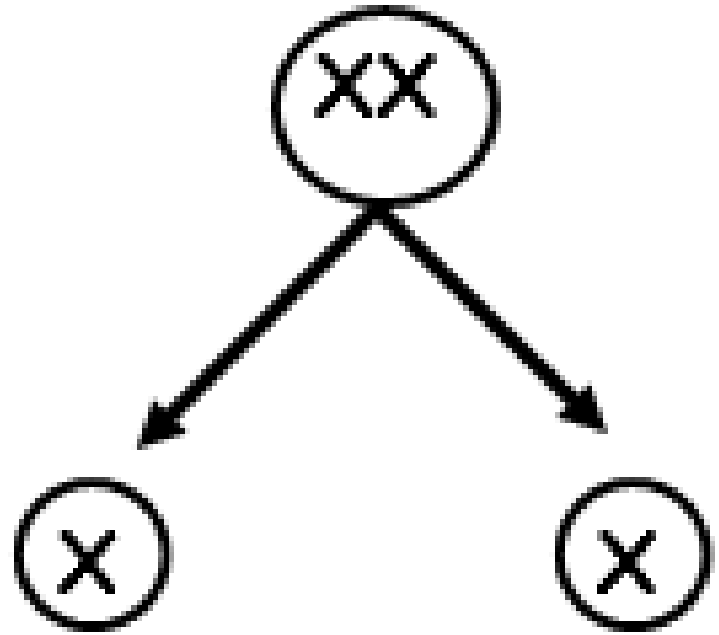
3 red flower : 1 white flower

Sex Determination

- Whether a fertilised egg (**ZYGOTE**) develops into a boy or a girl depends upon what kind of **CHROMOSOMES** it inherits from the parents.
- **ONE PAIR OF CHROMOSOMES** determines the sex of an individual. These are the **SEX CHROMOSOMES**. There are two types of sex chromosome, **X** and **Y**.

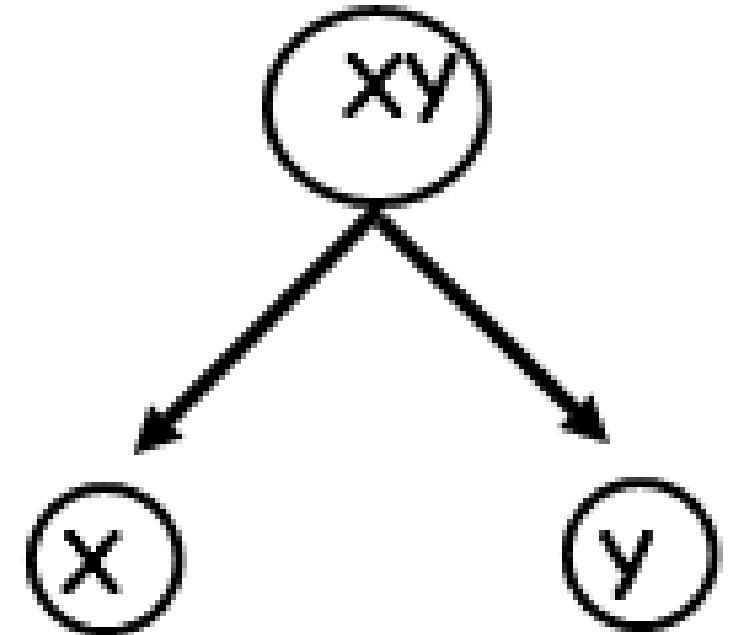
- Males contain an **X** and a **Y** chromosome in their cells. The **GENOTYPE** of a male is **XY**.
- Females have **two X chromosomes**. The **GENOTYPE** of a female is **XX**.
- This means that the **SPERM CELLS** which a male produces will contain **EITHER an X or a Y chromosome**. The **EGGS** which a female produces will **ALL contain only an X chromosome**.

egg forming cell



gametes

sperm forming cell



- When **FERTILISATION** takes place, the egg may be fertilised by an **X sperm** **OR** a **Y sperm** with an **EQUAL CHANCE** of either happening.
- If an **X sperm** fertilises the egg, the zygote will have the **genotype XX** and will develop into a **FEMALE**. However, if a **Y sperm** fertilises the egg, the zygote will have the **genotype XY** and will develop into a **MALE**.

Female gametes (eggs)

Male gametes (sperm)

