Sex-Linked Traits

Normal Vision

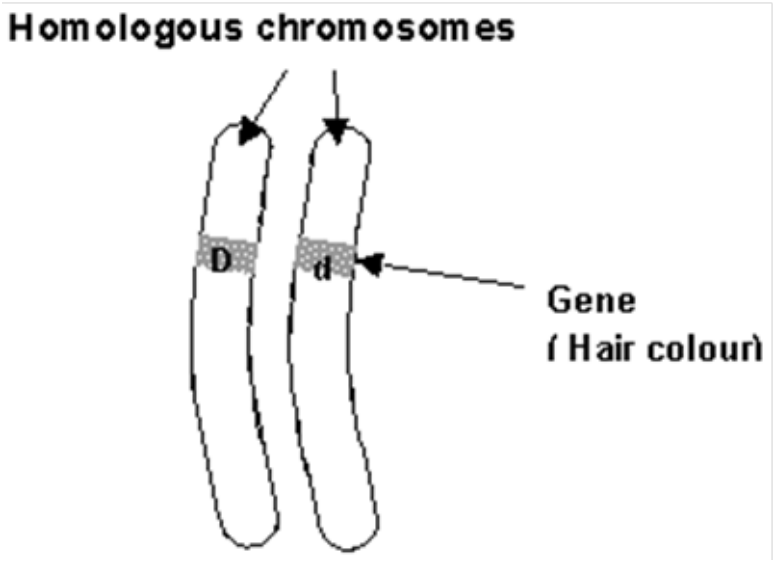
Colourlblind

S1-1-14 Explain the inheritance of sex-linked traits in humans and use a pedigree to track the inheritance of a single trait. Examples: colour blindness, hemophilia

Genes & Alleles…

Genes

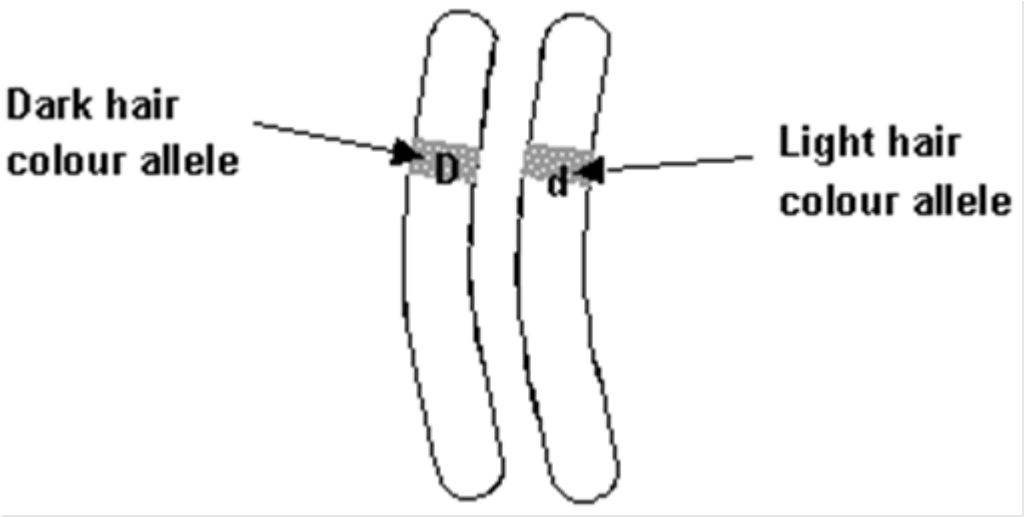
- **Genes** are a **PIECE** of **CHROMOSOME** that contains the actual **CODE** for a certain **TRAIT**.
- There must be a gene for **HAIR COLOUR**, **LEFT**-**HANDEDNESS** and so on.
- Every **CHARACTERISTIC** we have must have a corresponding **GENE** in our chromosomes.



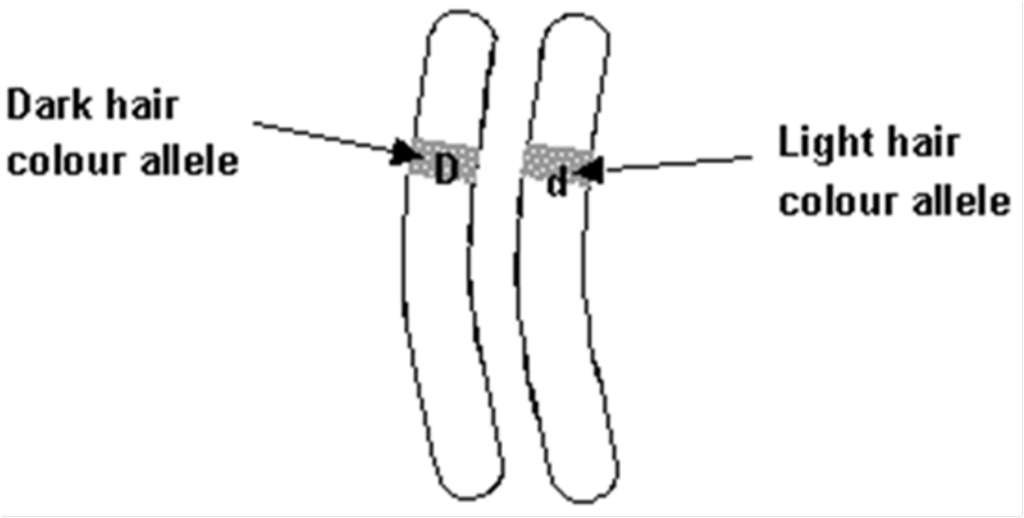
Genes & Alleles…

Alleles

- An **allele** is a **FORM** of the **GENE**. For example in the homologous chromosomes shown in the diagram there is a **GENE** for **HAIR COLOUR**.
- Alleles for hair colour can be **DARK**(**D**) or **LIGHT**(**d**), where **DARK** hair colour is the **DOMINANT** allele.



Genes & Alleles…

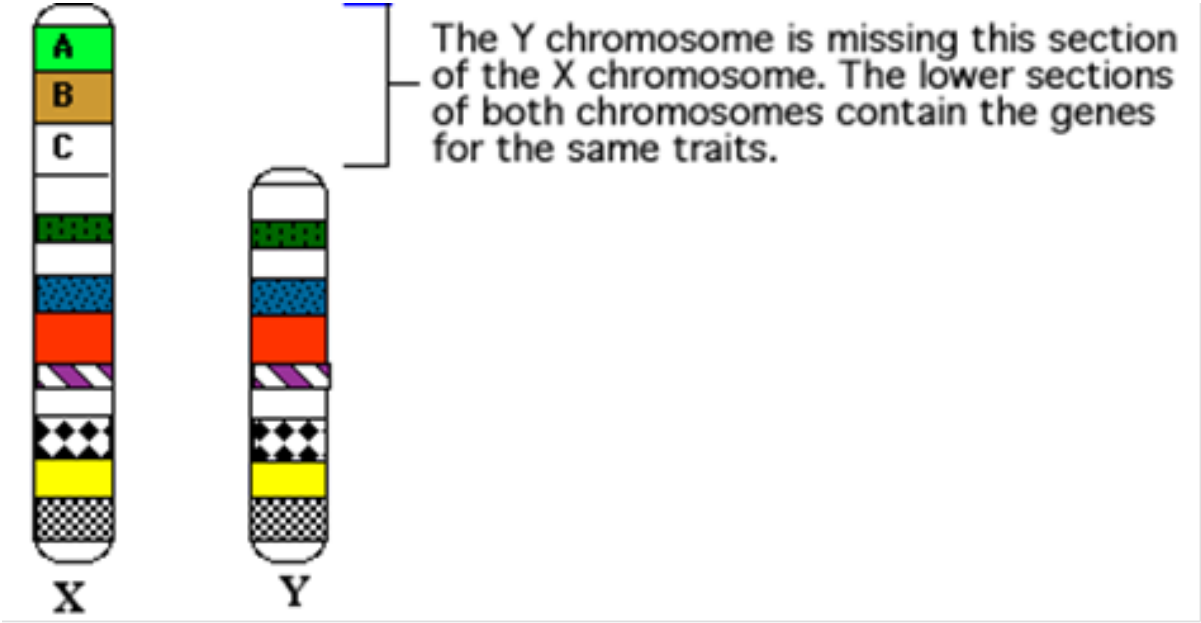


- After **MEIOSIS** has taken place, only one of the **HOMOLOGOUS CHROMOSOMES** will give genetic information from this parent to the offspring.
- This means the parent in the example can contribute either a **DARK** hair **DOMINANT** allele or **LIGHT** hair **RECESSIVE** allele to the offspring.
- Whether the offspring will have light or dark hair will depend on the **ALLELES** contributed by **BOTH PARENTS**.

Sex-Linked Traits…

Sex-linked traits are traits carried on **SEX CHROMOSOMES** (**X AND Y**).

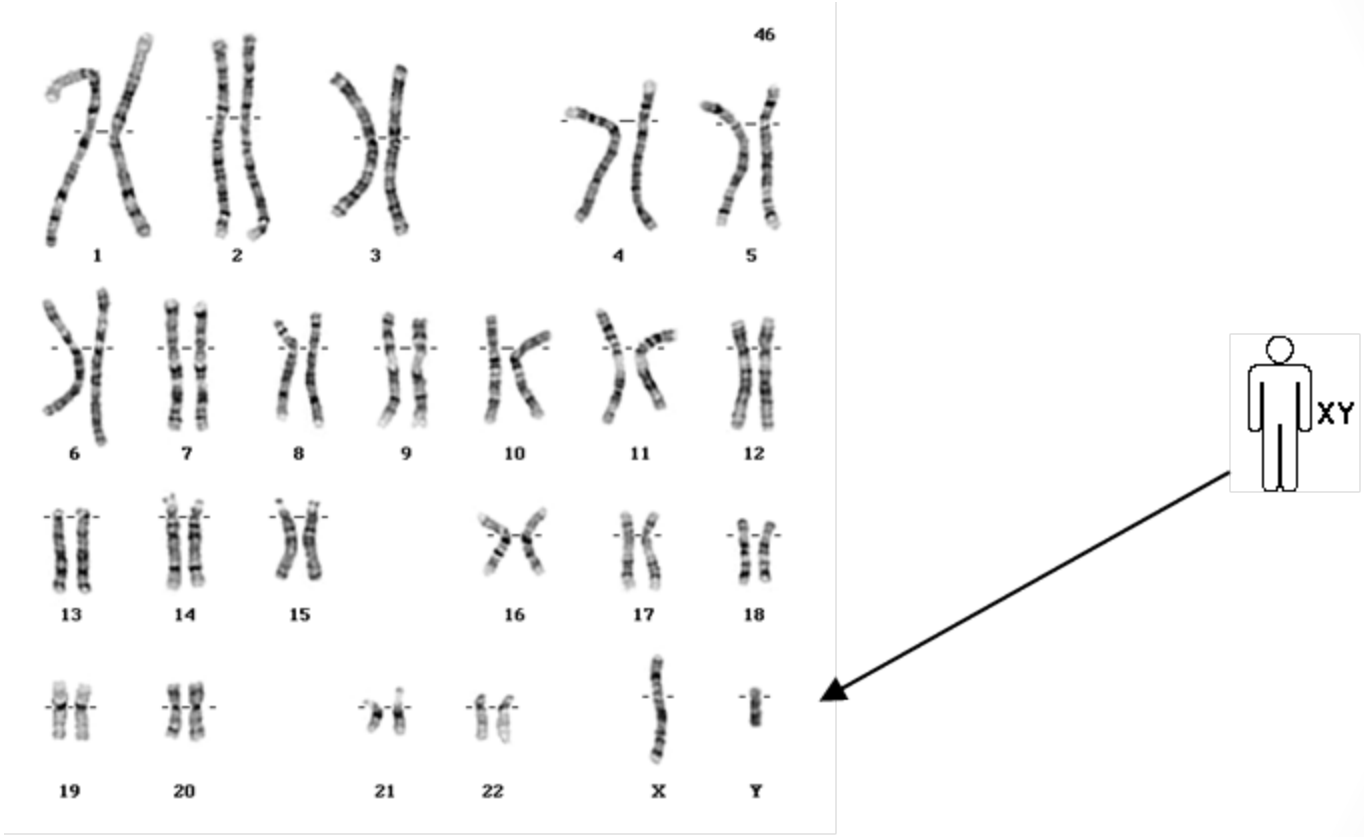
The male determining chromosome(**Y**) has no corresponding **ALLELES** on the **X** chromosome to **MASK ITS EFFECTS**.



The presence of the Y chromosome causes "**MALENESS"**. The female determining chromosome(**X**) does not carry **MALE GENES** of the Y chromosome

Sex-Linked Traits…

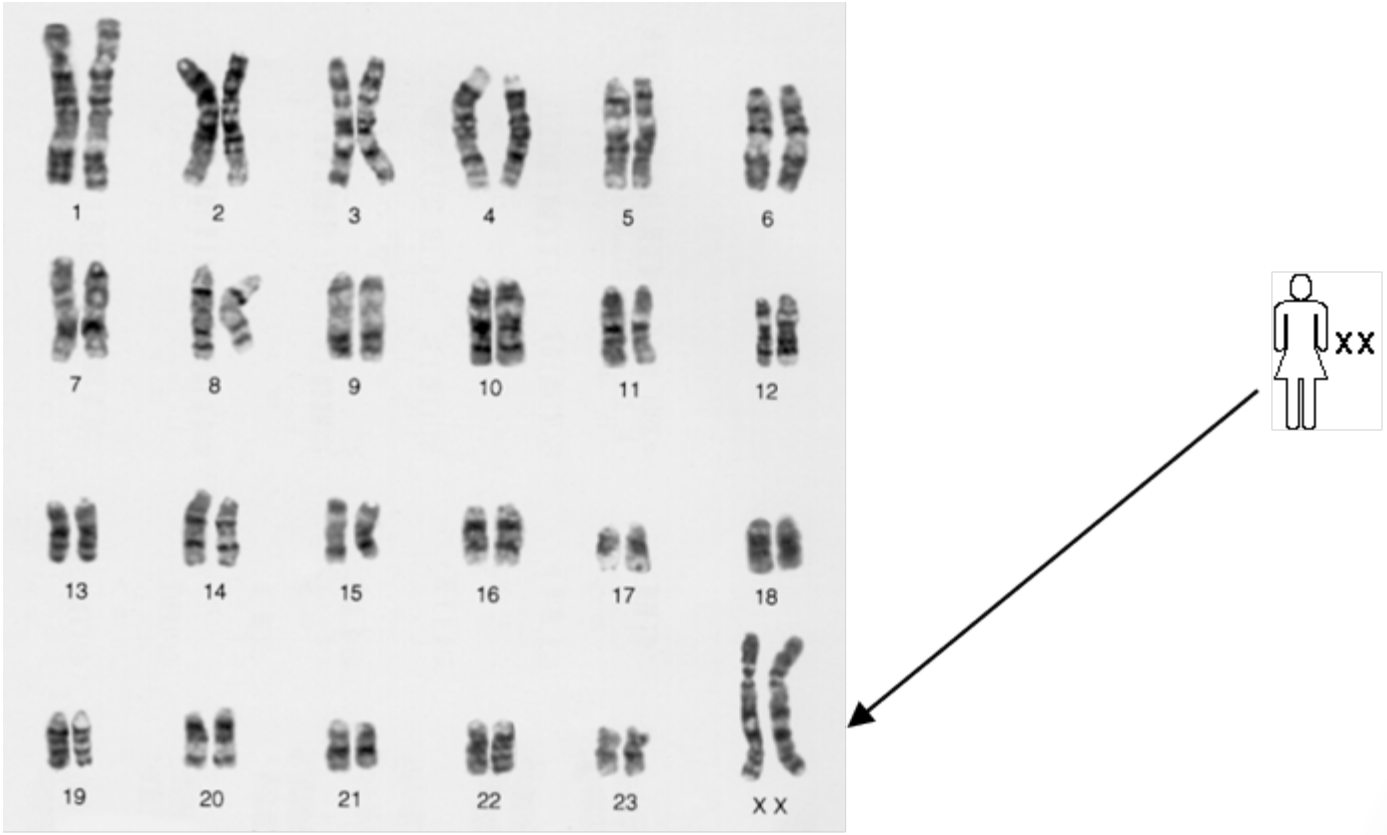
A male **has <u>XY</u>** homologous chromosomes for sex determination



The male has one X and one Y sex chromosome. Since **<u>Y</u>** genes can't be masked by genes on the **<u>X CHROMOSOME</u>**, he is male.

Sex-Linked Traits…

A female **has <u>XX</u>** homologous chromosomes for sex determination



The female has two **<u>X</u>** sex chromosomes. Since there are no male, **<u>Y-BASED GENES</u>**, she is female.

Sex-Linked Traits…

The X and Y chromosomes also carry genes that code for traits other than gender. Traits determined by genes on the **X CHROMOSOME** are called **SEX-LINKED**.

Some of these sex-linked traits show up as **DISORDERS** like **HEMOPHILIA** and **COLOUR BLINDNESS**.

→ the genes for these disorders are **RECESSIVE** and found only on the **X-CHROMOSOME**.

Ex) Colour blindness is recessive to normal vision. This is disorder mostly found in men. Why?

Males and Sex-Linked Traits…

Males receive X chromosomes from their mothers only.

Sex-linked traits are always on the **X CHROMOSOME** and a male only has one

If he receives an X chromosome with a **SEX**-**LINKED** allele on it, he will always **DEMONSTRATE** that trait because there is no corresponding **ALLELE** on the **Y** chromosome to **MASK IT**.

Females and Sex-Linked Traits…

Females receive X chromosomes from both parents and therefore can inherit sex linked traits from either parent.

If a female is to show a sex-linked trait, she must have one **DOMINANT ALLELE** on an **X** chromosome or two **RECESSIVE ALLELES** on both **X** chromosomes.

If a female receives **ONE RECESSIVE** sex-linked allele from her mother or father she **WILL NOT** show the trait, but she is a **CARRIER** and there is a probability that she will pass the sex-linked trait **TO ONE-HALF OF HER SONS**.

Punnett Squares & Sex-Linked Traits…

Example:

A woman who is heterozygous for colour-blindness (a carrier) has children with a man with normal vision. What genotypes and phenotypes will result?

The heterozygous mother who does not exhibit colour-blindness has a **50%** chance of producing a **COLOUR**-**BLIND** son and **ZERO** chance of producing a **COLOUR**-**BLIND** daughter.

The **HOMOZYGOUS DAUGHTER** will not have any **COLOUR**-**BLIND** offspring if she has children with a **NORMAL VISION** male. The **HETEROZYGOUS DAUGHTER** will produce offspring with the **SAME RESULTS** as the mother.

Punnett Squares & Sex-Linked Traits…

Example 2:

What kind of offspring result from a colour-blind father and heterozygous normal mother?

The colour-blind father has

- A **25%** chance of producing a **COLOUR BLIND DAUGHTER**
- A **25%** chance of producing a **COLOUR-BLIND SON**.

If the colour-blind daughter now married a colour-blind male, the offspring would have **100% COLOUR-BLINDNESS**

Punnett Squares & Sex-Linked Traits…

The probability of having a homozygous colour-blind female and a colour-blind male producing offspring is not common in the general population.

If however, there were significant inbreeding, that is if relatives with a sex linked disease intermarried, then a problem can develop.

An example genetic diseases and sex linking can be seen in European aristocracy. Royalty knew no national boundaries in Europe. Intermarriage among nations was so common that a Russian Prince could have a genetic background that was mostly British. A sex-linked gene for hemophilia was introduced through marriage. Through intermarriage the female carrier would infect the males to such an extent that it became a problem.