Important points

- Women have two X chromosomes; men have an X and a Y
- Genes located on the X chromosome are called X-linked genes. There are very few genes located on the Y chromosome.
- Some variations in genes stop the gene from working properly: the gene is said to be faulty (mutated). The gene variation can be either 'dominant' or 'recessive'
- A woman who has a 'recessive' gene variation in one of her X-linked gene copies and the other copy is working as it should, is a carrier of the recessive faulty gene. She will generally not be affected by the condition.
- Males have no 'back-up' working copy and so will generally be affected by the condition if they have the X-linked faulty gene
- A woman who has a 'dominant' change in one of her X-linked gene copies and the other copy is working as it should, is a carrier of the dominant faulty gene. She will generally be affected by the condition
- The expression of genes on the X chromosome is also influenced by **epigenetics** which involves 'switching off' most of one of the X chromosomes in each cell of a woman. This process ensures that women and men have generally the same number of X chromosome genes working in the cell
- X-linked inheritance refers to the pattern of inheritance of a condition caused by a faulty gene on the X chromosome. The faulty gene may be recessive or dominant
- Conditions that follow a pattern of **X-linked recessive inheritance** include haemophilia and Duchenne and Becker types of muscular dystrophy
- The chance that a child will inherit an X-linked recessive condition in every pregnancy is different for sons and daughters and depends on whether the mother or father has the faulty gene:
  - When the mother is a carrier of an X-linked recessive faulty gene there is 1 chance in 2 (50% chance) that a **son** will be affected by the condition and a 1 chance in 2 that a **daughter** will be a usually unaffected genetic carrier like the mother
  - When the father is affected by a condition due to an X-linked recessive faulty gene, **none** of his **sons** will be affected but **all** of his **daughters** will be carriers of the X-linked recessive faulty gene, although they will generally be unaffected by the condition
- Information regarding the appropriateness and availability of testing to determine if a woman is a carrier of an X-linked recessive faulty gene and can be obtained from the local genetic counselling service.
- Information regarding the appropriateness and availability of testing in pregnancy or testing of an embryo for an X-linked condition can be obtained from the local genetic counselling service
- There are very few conditions that have been shown to follow a pattern of X-linked dominant inheritance. Rett syndrome is one example

The inheritance of X-linked dominant faulty genes

If the body cannot work normally with less than the usual amount of working gene product, a woman may be affected by the X-linked faulty gene that she is carrying. In these cases, the change making the gene copy faulty appears to override or 'dominate' the unchanged information in the working copy of the gene. It is described as an X-linked dominant faulty gene.

It is very rare for a woman to have a dominant faulty gene copy on both copies of her X chromosome.

In *Figure 10A.1,* where the X-linked dominant faulty gene copy is represented by 'D' and the working copy by 'd', the mother is affected by a condition due to carrying an X-linked dominant faulty gene copy and the father has only working copies of the X-linked gene.

There are four possible combinations of the genetic information that a child can inherit from his/her parents.

What happens if the mother is affected by the X -linked dominant faulty gene?

Unlike with X-linked recessive inheritance, there is no difference in risks for their sons and daughters, if the mother has the X-linked dominant condition *(see Figure 10a.1).*

When the mother is an affected X-linked dominant faulty gene carrier, **in every pregnancy,** there is

- 1 chance in 2 (50% chance) that both her **sons** and **daughters** will inherit **the faulty gene copy** from her and be affected by the condition. No working gene product or the right amount of the gene product will be able to be made by the cells

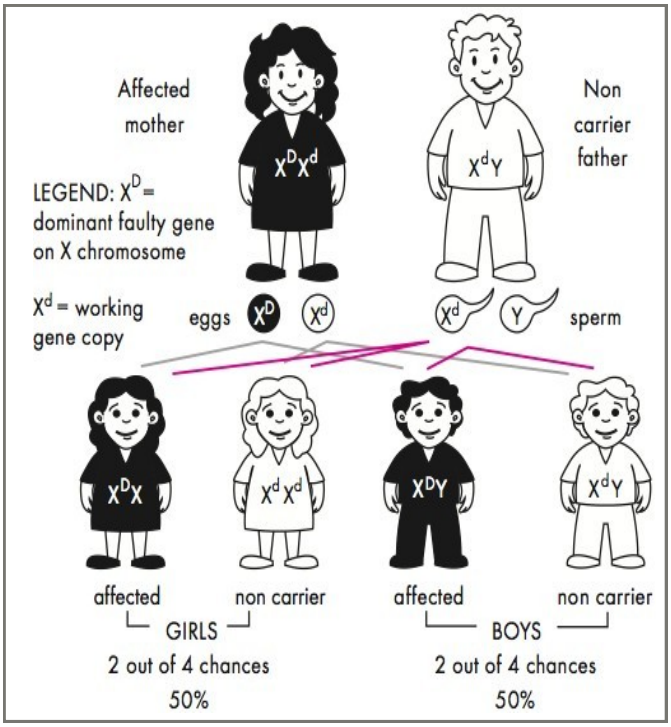

Figure 10a.1: *X-Linked dominant inheritance where the mother carries the faulty X-linked dominant gene and is affected. The faulty copy of the X-linked gene is represented by 'D', the working copy by 'd'.*

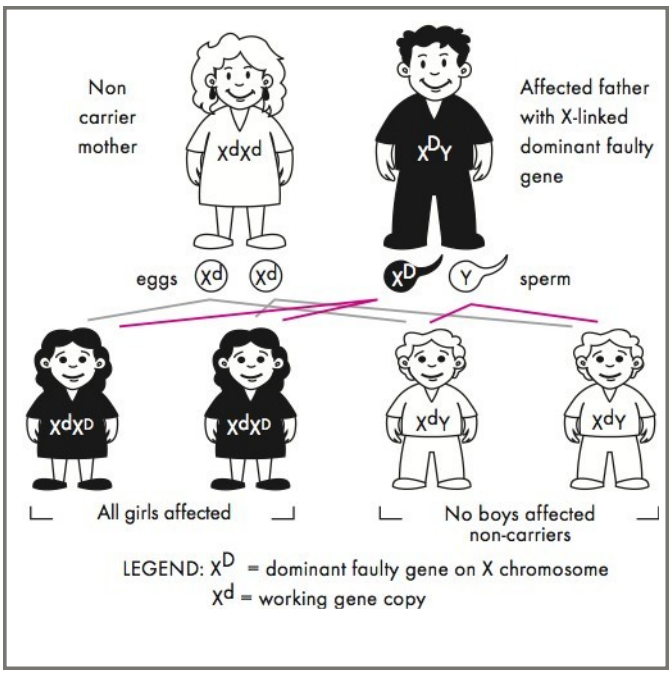

Figure 10a.2: *X-linked dominant inheritance where the father carries the faulty X-linked dominant gene and is affected. The faulty copy of the X-linked gene is represented by 'D', the working copy by 'd'.*

- 1 chance in 2 (50% chance) that her children (both **sons** and **daughters**) will inherit the working copy of the gene ('d') from her and not be affected by the condition

This pattern of inheritance is superficially similar to that of autosomal dominant inheritance (see Genetics Fact Sheet 9).

What happens if the father is affected the X-linked dominant faulty gene?

When the father is affected by a condition due to an X-linked dominant faulty gene *(Figure 10a.2*), the unaffected mother will only give working copies of the gene to her children but the father will pass his X chromosome to his daughters.

There are four possible combinations of the genetic information the child can receive from the parents.

This means that **in every pregnancy**:

- None of his **sons** can inherit the faulty gene since the son only inherits the Y chromosome from the father that does not have the faulty gene copy. They will inherit the **working copy** from their mother. None of their sons will have the condition
- All of their **daughters** will inherit the **working gene copy** from their mother **and the faulty gene copy** from their father. All of their daughters will have the condition.

What types of conditions follow a pattern of X-linked dominant inheritance in families?

There are very few conditions that have been shown to follow a pattern of X-linked dominant inheritance. Rett syndrome that causes physical and intellectual disability is one example.

The local genetic counselling service can provide information regarding the appropriateness and availability of genetic testing for X-linked dominant conditions (see Genetics Fact Sheet 3). Information can also be provided regarding testing in pregnancy.

Other Genetics Fact Sheets referred to in this Fact Sheet: 1, 2, 3, 4, 5, 8, 9, 14, 17C, 18, 21, 35, 40, 41