

Important points

- Some changes in genes stop the gene from working properly: the gene is said to be faulty (mutated)
- Where there is generally no effect on a person's health or development and a single faulty copy of a gene is present, the mutation is described as being recessive
- There are two copies of every gene located on an autosome (one of the chromosomes numbered 1-22). Both gene copies send a message to the cells to produce a particular product such as a protein
- Individuals who have a faulty gene copy on one chromosome, and a working copy of that gene on the other partner chromosome, are said to be 'carriers' of the faulty gene for a particular condition
- Individuals who are 'carriers' of a faulty autosomal recessive gene for a particular condition are **genetic carriers for the condition**; they do not carry the condition in their body, as would be the case if an individual were a carrier of a virus such as hepatitis
- For the great majority of conditions that are due to autosomal recessive faulty genes, genetic carriers are not usually affected
- Everyone is an unaffected carrier of several autosomal recessive faulty genes
- Autosomal recessive inheritance refers to the pattern of inheritance of a condition directly or indirectly due to a recessive faulty gene copy located on an autosome
- Conditions that follow a pattern of autosomal recessive inheritance usually affect men and women equally and include cystic fibrosis, thalassaemia, Tay-Sachs disease and haemochromatosis. Some autosomal recessive conditions like these are more common in individuals of certain ethnic or cultural backgrounds
- Where both parents are unaffected carriers of the autosomal recessive faulty gene for a particular genetic condition, there is 1 chance in 4 (25% chance) **in every pregnancy** that their child will inherit the faulty gene copy from both parents and be affected by or predisposed to develop the condition
- When only one parent is an unaffected carrier of the autosomal recessive faulty gene, there is no chance that their child will be affected by or predisposed to develop the condition
- Testing to determine whether an individual is a genetic carrier of a condition is only appropriate if there is a family history of the condition or if the condition is common in their ethnic/cultural group
- Testing may be available in pregnancy, in consultation with a genetic counsellor, if both parents are known genetic carriers

Our genes, located on our chromosomes in our cells, provide the information for the growth, development and function of our bodies. When the information in a gene is changed, there is a different message sent to the cells. A change to the genetic code that causes the gene to not work properly is called a **mutation**: the gene is described as being faulty (see Genetics Fact Sheet 1).

A faulty (mutated) gene may directly cause a genetic condition (see Genetics Fact Sheets 2, 4 & 5). Having a faulty gene however, may also be beneficial, as described in Genetics Fact Sheets 4 & 34.

Inheritance patterns in families of conditions due to faulty genes

The inheritance pattern depends on whether the

- Faulty gene is located on one of the chromosomes numbered 1-22 called an *autosome* or on the X chromosome that is one of the *sex chromosomes* (see Genetics Fact Sheet 1)
- Change to the genetic code that makes the gene faulty is 'recessive' or 'dominant' (see Genetics Fact Sheets 4 & 5)

The four most commonly discussed patterns of inheritance of genetic conditions due to a change in a single gene in families are therefore described as:

- Autosomal recessive
- Autosomal dominant
- X-linked recessive
- X-linked dominant

This Fact Sheet addresses autosomal recessive inheritance. See Genetics Fact Sheets 9 & 10 for information about the other traditional patterns of inheritance.

The inheritance of autosomal recessive faulty genes

This type of inheritance refers to the inheritance of a 'recessive' change (mutation) that is in a gene on an autosome (one of the chromosomes numbered 1-22). See Genetics Fact Sheet 5 for an explanation of 'recessive' changes to a gene (mutations) that make the gene faulty.

There are two copies of every autosomal gene. Both copies of the gene send a message to the cells to produce a particular product such as a protein. Individuals who have a faulty gene copy on one chromosome, and a working copy of that gene on the other partner chromosome, are said to be 'carriers' of the faulty gene for a particular condition.

People who are 'carriers' of the faulty autosomal recessive gene for a particular condition are **genetic carriers for the condition**; they do not carry the condition in their body, as would be the case if an individual were a carrier of a virus such as hepatitis.

Genetic carriers for the great majority of conditions that are due to autosomal recessive changes that make the gene faulty are usually not affected by the genetic condition. Although only one of the gene copies is sending the instructions to make the gene product, the cell can usually still work with this reduced amount.

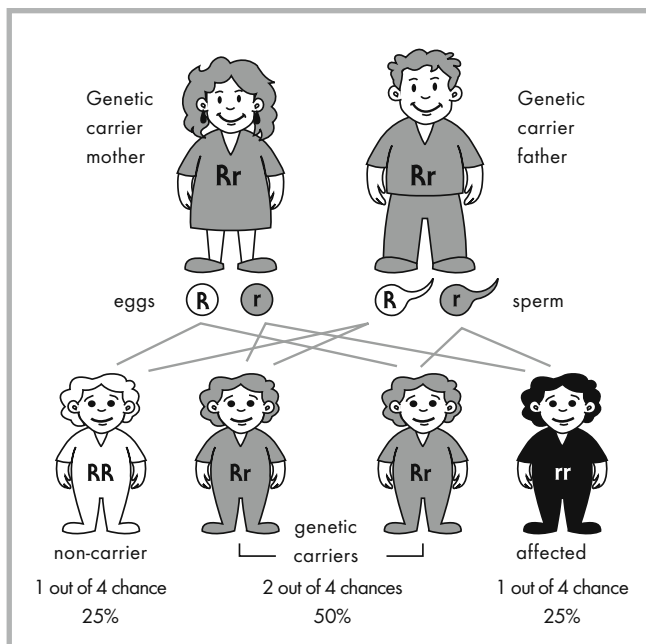


Figure 8.1: Autosomal recessive inheritance when both parents are unaffected genetic carriers for the condition. The faulty copy of the gene containing a recessive mutation is represented by 'r'; the working copy of the gene by 'R'.

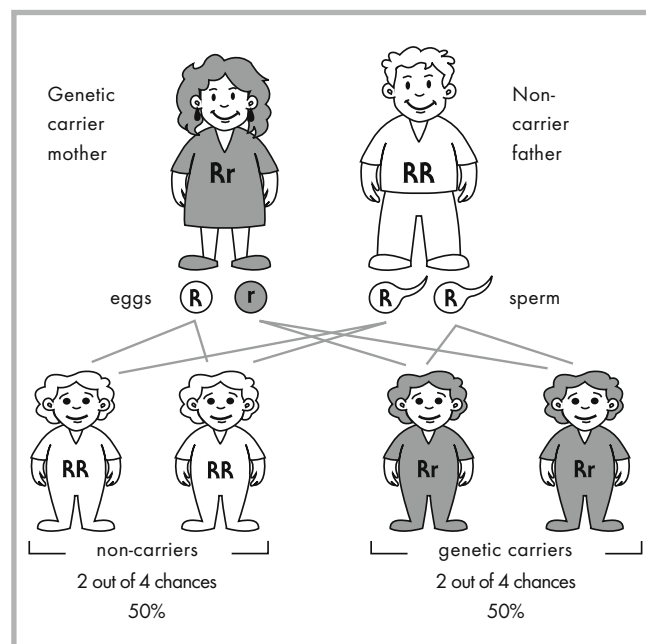


Figure 8.2: Autosomal recessive inheritance when only one of the parents is an unaffected genetic carrier for the condition. The faulty copy of the gene containing a recessive mutation is represented by 'r'; the working copy of the gene by 'R'.

We are all carriers of a small number of autosomal recessive changes in genes that cause no symptoms.

What happens if both parents are unaffected carriers of the same autosomal recessive faulty gene?

When a baby is conceived, each parent has passed on one copy of each of his or her genes to the baby. Therefore the baby is a 'mixture' of the genetic information from each of his/her parents. When two carriers of the same faulty gene have a baby, each parent has a chance of passing on **either** the faulty gene or the working copy of the gene to the baby.

As shown in *Figure 8.1*, where the autosomal recessive faulty gene copy is represented by 'r' and the working copy by 'R', there are four possible combinations of the genetic information passed on by the parents, in every pregnancy. There is 1 chance in 2 (or 50%) that each parent will pass on the faulty copy of the gene. There is also 1 chance in 2 (or 50%) i.e. an equal chance, that each parent will pass on the working gene copy.

This means that in every pregnancy there is

- 1 chance in 4 (25% chance) that they will have a child who inherits **both copies of the faulty gene** from his/her parents. In this case, no working gene product will be produced and their child will be affected by the condition
- 1 chance in 4 (25% chance) that their child will inherit **both copies of the working gene** and will be unaffected by the condition
- 1 chance in 2 (i.e. 2 chances in 4; 50% chance) that their child will inherit **the faulty copy of the gene and the working copy of the gene** from each parent and he/she will be an unaffected carrier of the faulty gene, just like the parents; i.e. a genetic carrier for the condition

What happens if only one of the parents is an unaffected carrier of an autosomal recessive faulty gene?

As shown in *Figure 8.2*, where the autosomal recessive faulty gene copy is represented by 'r' and the working copy by 'R', there are four possible combinations of the genetic information passed on by the parents, in every pregnancy.

This means that in every pregnancy, there is:

- No chance that the couple will have a baby affected with the particular condition
- 1 chance in 2 (i.e. 2 in 4 chances; 50% chance) that they will have a child who inherits **both copies of the working gene** from his/her parents. In this case, the child will be unaffected by the condition
- 1 chance in 2 (i.e. 2 in 4 chances; 50% chance) that their child will inherit **the faulty copy of the gene and the working copy of the gene** and he/she will be an unaffected carrier of the faulty gene; i.e. a genetic carrier for the condition

What types of conditions follow an autosomal recessive pattern of inheritance?

Cystic fibrosis, thalassaemia, Tay-Sachs disease and hereditary haemochromatosis are examples of conditions that follow a pattern of autosomal recessive inheritance (see Genetics Facts Sheets 33, 34, 35 & 36). Autosomal recessive genetic conditions usually affect men and women equally.

How does a person know that he or she is a carrier of an autosomal recessive faulty gene?

It is now possible to test an individual to determine whether they are a carrier of certain recessive changes in autosomal

genes involved in a small but growing number of conditions (see Genetics Fact Sheet 21). This type of genetic testing is called **genetic carrier testing**. In some cases, the gene product is analysed: in others the gene itself is tested to see if it is faulty.

Genetic carrier testing is only appropriate if there is some indication that the individual may be a carrier of a particular faulty gene. For example:

- Having a family history of a condition that follows an autosomal recessive pattern of inheritance
- Where a condition is more common in people of certain ethnic or cultural backgrounds and therefore the chance of a person from these population groups being a carrier is much higher than in others (see Genetics Fact Sheet 5)

It is not possible to check every gene in the body to see if it is faulty.

Contact the local genetic counselling service for information regarding the appropriateness and availability of genetic carrier testing (see Genetics Fact Sheets 3 and 21).

What can be done if both parents are carriers of the same autosomal recessive faulty gene?

If both partners in a couple are genetic carriers for an autosomal recessive condition, they can find out information about the condition, their risk for having an affected child and discuss their reproductive options with a genetic counsellor (see Genetics Fact Sheet 3).

Testing in pregnancy to determine the presence of the faulty gene may be possible. For more information about prenatal testing options see Genetics Fact Sheet 17C.

Testing of the embryo in association with assisted reproductive technologies (ART) using preimplantation genetic diagnosis (PGD) may also be possible (see Genetics Fact Sheet 18).

A discussion with a genetic counsellor will assist in enabling a couple to make an informed decision with the most up-to-date information.

Other Genetics Fact Sheets referred to in this Fact Sheet: 1, 2, 3, 4, 5, 9, 10, 17C, 18, 21, 34

Information in this Fact Sheet is sourced from:

Harper P. (2004). *Practical Genetic Counselling*. London: Arnold.

Online Mendelian Inheritance in Man, OMIM. McKusick-Nathans Institute for Genetic Medicine, Johns Hopkins University (Baltimore, MD) and National Center for Biotechnology Information, National Library of Medicine (Bethesda, MD) [online]. Available from: <http://www.ncbi.nlm.nih.gov/omim/>. [Accessed June 2007]

Trent R. (1997). *Molecular medicine*. 2nd ed. New York: Churchill Livingstone Ltd.

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