
Epilepsy and Genetics

Things You Want to Know



Genetics Commission

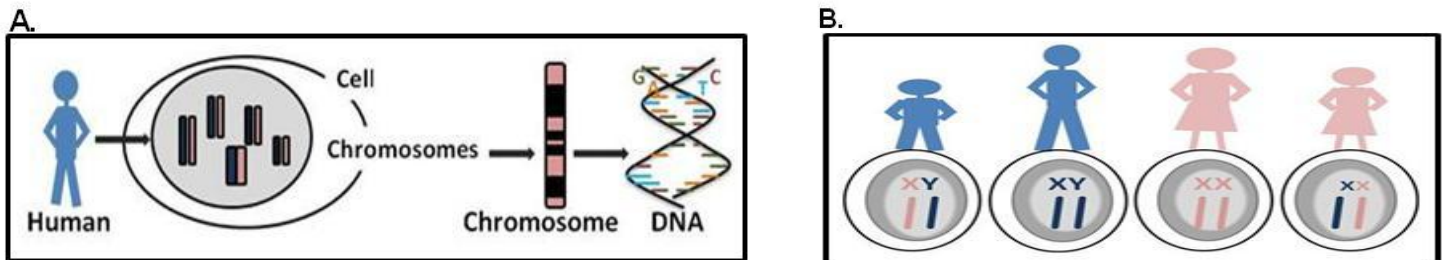
1. What is genetics?

Genetics is the study of genes and inheritance. It studies how parents pass on to their children different characteristics or *traits*. Every person inherits half of their genes from the mother and the other half from the father. Still, everyone is unique in a variety of traits, such as height, eye color, health or disease. Therefore, children are in many ways similar but **not identical** to their parents or their siblings. Most of our traits are determined by a combination of genes and environment (e.g., body weight is caused by genetics and lifestyle).

2. What is the basis of my genetic make up?

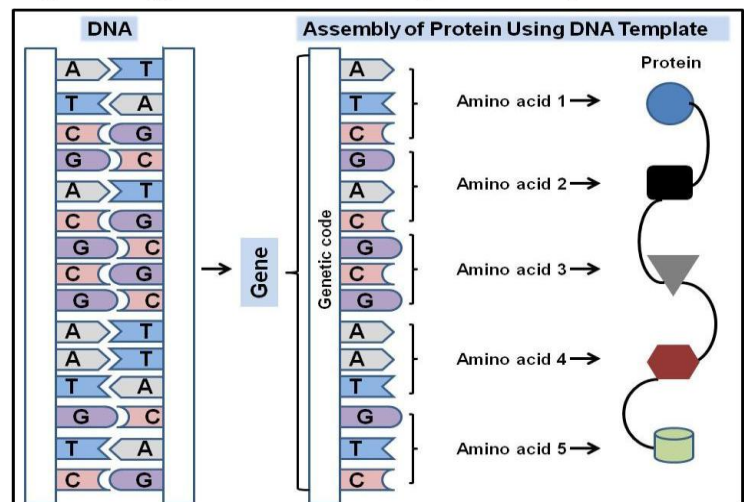
Human cells contain structures called *chromosomes* (see Figure 1A). Chromosomes are thread-like structures that package our genetic information. The genes are lined up on the chromosomes, like beads on a string. Each person has 23 pairs of chromosomes. One member of each pair comes from the mother and the other from the father. In Figure 1, pink bars represent chromosomes that are inherited from the mother and blue bars represent chromosomes inherited from the father. One of the 23 chromosome pairs is special because it determines sex – males have an X and a Y chromosome, and females have two X chromosomes. In Figure 1B, pink and blue bars represent sex chromosomes X and Y. Males inherit an X chromosome from their mother and a Y chromosome from their father. Females inherit an X chromosome from their mother and another X chromosome from their father.

Fig. 1. Human genetic make-up



The most important component of chromosomes is *DNA* (*deoxyribonucleic acid*), a long molecule shaped like a twisted ladder, or double-helix (Fig.1A). The DNA molecule is made up of substances (“bases”) called G, C, T, and A. The order (or “sequence”) of these bases (GCT, GAT, TTT, etc.) makes up our genetic code, which provides the information needed to make proteins, large molecules that are important for proper structure and function of a human body. Proteins are made up of amino acids, and each 3-base unit of DNA determines the specific amino acid that will be included in the protein. A *gene* is a unit containing a blueprint for making a specific protein. There are about 20,000 genes packed in each parental chromosome set (23 pairs of chromosomes).

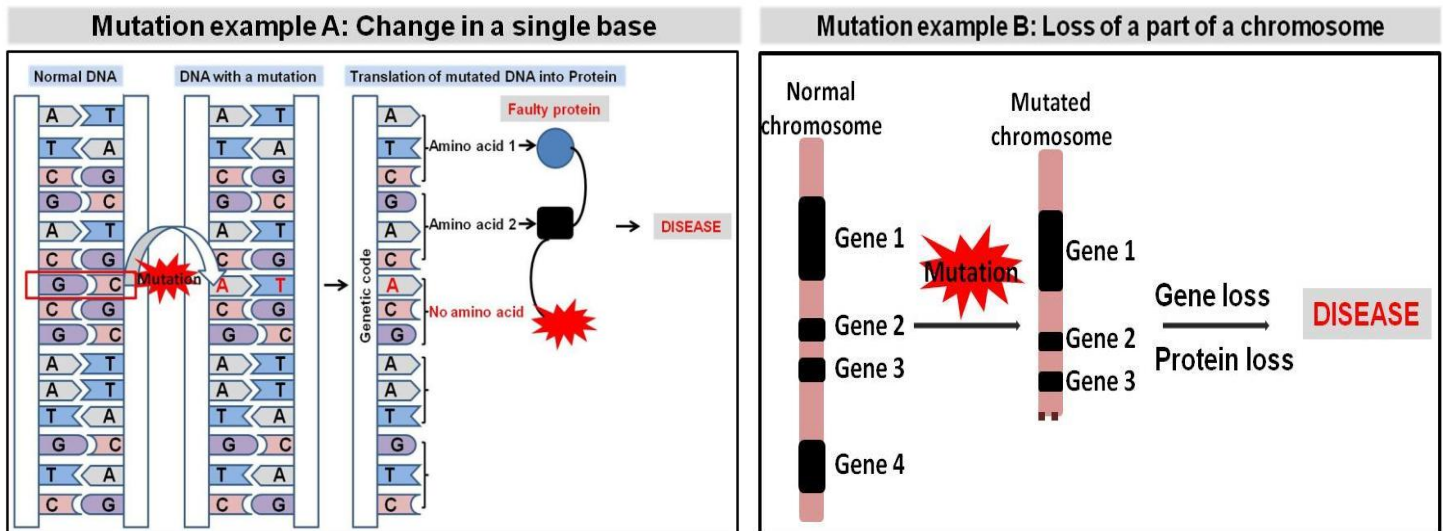
Fig. 2. DNA, genetic code and making of a human protein



3. What is a genetic mutation?

A gene mutation is a permanent change in the DNA sequence of a gene that leads to problems with the gene's protein product. There are many different kinds of mutations, ranging from a change in a single base (A, T, C, or G) or a few bases (Fig. 3A), to much larger changes involving extra or missing pieces of genetic material that could include several genes or even a whole chromosome (Fig. 3B). Gene mutations occur in two ways: they can be inherited from a parent (*hereditary mutations*) or occur for the first time in a person (*de novo mutations*).

Figure 3. Examples of genetic changes that can predispose to disease such as epilepsy.



4. Is epilepsy a genetic disorder?

Genetics is believed to play a role in most forms of epilepsy. However, perhaps surprisingly, most people with epilepsy do not have any affected relatives. Current scientific evidence suggests that the role of genetics in epilepsy is complex – many genes with a small or modest effect on risk are likely involved – so that it is difficult to predict which people are at high risk. In some unusual families, however, many people develop epilepsy, consistent with an effect of a mutation in a single gene with a strong effect on risk in the family. Studies of these rare families have been very informative for identifying genes that cause epilepsy.

5. I am pregnant and I have epilepsy. Is my child going to have seizures, too?

Certain epilepsy types do seem to run in families. However, for most people with epilepsy, the amount of increased risk appears to be modest. The risk of epilepsy in the close relatives (parents, offspring, and brothers and sisters) of people with epilepsy is about two to four times higher than that of people in the general population, depending on the type of epilepsy. The risk is higher in the relatives of a person with generalized epilepsy than in the relatives of a person with focal epilepsy. Studies suggest that, except in some unusual cases, the chance is less than 1 in 10 that a child of a person with epilepsy will also develop epilepsy.

6. How can I find out about the risk of epilepsy for myself or my children?

Genetic testing is available for several known epilepsy genes. Genetic counseling is an important part of the testing process. Talk to your neurologist or an epilepsy specialist about a referral to a genetic counselor. You will meet with a specially trained health care professional who will review in detail your medical and family

history. He or she may recommend additional laboratory and/or genetic testing and will calculate the risk of developing epilepsy within your family.

7. How can I participate in a research study on epilepsy?

Genes play an important role in epilepsy. Still, in the majority of patients, the exact genetic mechanisms or causes have not been identified. Participation in research studies on genetic mechanisms of epilepsy is critical for improving our knowledge and ability to diagnose disease, predict who will or will not develop epilepsy, and develop better treatments.

There are many studies in epilepsy genetics or epilepsy mechanisms conducted locally, nationally, and internationally. There are several ways to get involved;

1. You may talk to your physician or contact your local academic center. You will either be able to participate locally or you will be referred to a research center.
2. In the US, you may visit the following sites;
 - a. Epilepsy Foundation, who might be able to refer you to a research site. The Epilepsy Foundation also has a web site that lists some ongoing studies: <http://www.epilepsyfoundation.org/research/participateinresearch/current-open-studies.cfm>.
 - b. HERO: Human Epilepsy Research Opportunities (<http://www.epilepsyhero.org/>)
 - c. Search through the national research funding agencies, such as The National Institutes of Health: [http://www.clinicaltrials.gov/ct2/results?cond="Epilepsy"](http://www.clinicaltrials.gov/ct2/results?cond=)
3. Browse the internet since many universities post links to their research studies.

Resources:

To learn more about genetics, visit:

- The American Society for Human Genetics (<http://www.ashg.org/education/>)
- The National Human Genome Research Institute (<http://www.genome.gov/education/>)

To learn more about epilepsy, visit:

- Epilepsy Foundation <http://www.epilepsyfoundation.com>