



American Society of Human Genetics

How Do Geneticists Analyze DNA?

Genetic testing is used to examine and analyze your DNA, the molecular blueprint that carries all instructions needed for your body's development and function. This analysis can identify changes, often referred to as mutations or variants, in your DNA. People can use genetic tests to learn more about their health, ancestry, or genetic traits.

Genetic testing has benefits as well as limitations and risks. A geneticist or genetic counselor can provide information before and after genetic testing to make sure that you understand the results and help you with the personal, social, and emotional aspects of testing.

How is genetic testing done?

Whether it is a clinical genetic test ordered by your doctor to study your risk of disease or a direct-to-consumer genetic test that can provide information about ancestry and physical traits, the process of testing is similar. Genetic tests are performed on a sample of blood, hair, saliva, or other tissue. The sample is sent to a laboratory where technicians extract and examine DNA for changes.

What are the types of genetic tests?

There are several types of genetic tests, and there is no single test that can detect all genetic changes. Genetic testing examines:

- ◆ **Molecular Testing:** These tests reveal the specific pattern of DNA building blocks, or nucleotides, in the genetic code of the individual being tested, using a process called DNA sequencing. These tests can vary in scope:
 - **Targeted single variant tests** look for specific changes in one gene. Usually, the specific variant being studied is known to cause a disorder. This type of test is often used to determine whether someone has a genetically heritable health condition. For instance, a test may look for the specific variant in the HBB gene that causes Sickle cell disease. Direct-to-consumer genetic testing companies typically analyze specific variants in specific genes when providing health risk information.
 - **Single gene tests** look for genetic changes in one specific gene. These tests are often used to confirm or reduce suspicion of a specific diagnosis. For example, the DNA within the BRCA1 and BRCA2 genes can be analyzed for changes when studying an individual's risk for certain types of breast cancer.
 - **Gene panel tests** look for changes in more than one gene. These tests are used to pinpoint a diagnosis when a suspected condition can be caused by changes in many genes (for example, epilepsy or cancer).

- **Whole exome/whole genome tests** are large-scale genetic tests that analyze the bulk of an individual's DNA to find genetic changes. These tests are often used by doctors in people with complex medical histories and by researchers to learn more about the genetic causes of conditions. For instance, whole genome sequencing can be used to identify rare genetic disorders underlying developmental disabilities.
- ◆ **Chromosomes:** DNA is packed into structures called chromosomes. Humans each have 23 pairs of chromosomes, with each pair containing one maternal and one paternal copy of the chromosome. Chromosomal genetic tests involve examining chromosomes to identify changes, such as an extra or a missing copy of a chromosome, which cause genetic conditions. Examples of chromosomal conditions include Williams syndrome (individuals are missing a large piece of chromosome 7) and Down syndrome (individuals have an extra copy of chromosome 21).
- ◆ **Proteins:** Also referred to as biochemical tests are tests that do not directly analyze DNA but instead examine the amount or activity-level of proteins that are produced from genes. Abnormalities in proteins can indicate underlying changes in the DNA and/or a genetic disorder.
- ◆ **Gene expression:** These tests look at which genes are turned on or off (expressed) in different types of cells. Too much or too little activity of certain genes can indicate genetic disorders, as seen in many types of cancer.

What are genetic tests used for?

Genetic testing can provide important information on the risk of developing certain diseases. Genetic tests can also reveal information about a person's ancestry and family background. Different types of tests are done for different reasons:

- ◆ **Diagnostic testing** can be used to identify or reduce suspicion of a specific genetic or chromosomal condition, such as Huntington disease or cystic fibrosis, at any time during a person's life. However, it is not available for all genes or genetic conditions.
- ◆ **Carrier testing** is used to identify people who carry one copy of a gene mutation that, when present in both copies, causes a genetic disorder. This test can provide information about a couple's risk of having a child with a genetic condition, such as Tay-Sachs disease or spinal muscular atrophy.

Rosalind Franklin's contributions to genetics



Dr. Rosalind Franklin, the trailblazing chemist whose X-ray diffraction image of DNA was crucial to determining its double helix structure, was born 102 years ago this summer. Though her images and data were integral to the 1953 description of the structure

of DNA, her discoveries went largely unrecognized for nearly 50 years. Her work enabled the field of molecular biology, leading to new ways to prevent, diagnose, and treat diseases. It is because of Franklin, her collaborators, and her successors that today's scientists can use tools such as DNA sequencing.

- ◆ **Presymptomatic and predictive testing** are used to detect gene changes associated with disorders that appear after birth, often later in life. If you have a family history of a genetic condition, getting tested before you have symptoms may show if you are at heightened risk for developing that condition. Knowing this early on can give individuals time to make appropriate plans for later in life. This type of test can be useful for identifying one's risk of certain types of breast and colorectal cancer.
- ◆ **Prenatal testing** is used to detect changes in the genes or chromosomes of the fetus before birth. Prenatal genetic tests can identify chromosomal abnormalities such as trisomy 13 or 21.
- ◆ **Newborn screening** is the most common type of genetic testing and is used immediately after birth to identify genetic disorders that can be treated early in life. For example, most newborns are screened for phenylketonuria, a genetic disease in which the body cannot metabolize a protein called phenylalanine, because early nutritional intervention can prevent the manifestation of disease.
- ◆ **Ancestry testing** involves comparing a large number of genetic variants in an individual's genome with the frequencies of these variants in reference populations from around the world. It can provide clues about where a person's ancestors might have come from and the relationships between families.