

A Parent's Guide to Genetics & Hearing Loss



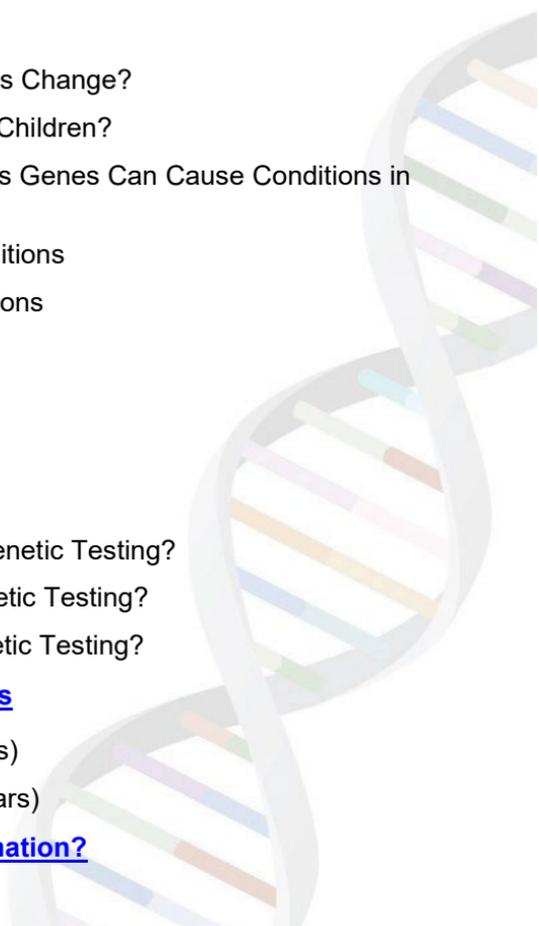
**Centers for Disease
Control and Prevention**
National Center on Birth Defects
and Developmental Disabilities



A Parent's Guide to Genetics and Hearing Loss

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Background

About 1 in 500 infants are born with or develop hearing loss during early childhood. Screening for hearing loss is considered standard care in the United States and in 2019 over 98% of children were screened, usually before leaving the hospital. Hearing loss has many causes, including genetic causes (that is, caused by the instructions in the baby's cells) and non-genetic causes (such as certain infections the mother has during pregnancy or infections affecting the newborn baby). A combination of genetic and non-genetic factors also can lead to hearing loss. In general, [4 out of 5 babies](#) with hearing loss have a genetic cause for their hearing loss, while the rest will have non-genetic cause or a combination of factors.

This resource aims to help answer many of the questions that families may have about the causes of hearing loss. For some of the topics, more extensive details are given in the green shaded boxes.



About the Types of Hearing Loss

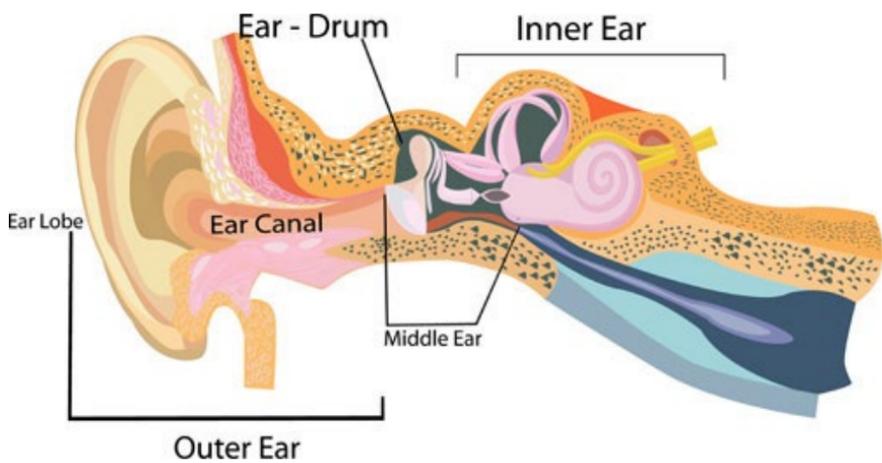
What are the types of hearing loss? There are a few ways to talk about the different types of hearing loss.

- One way is based on whether or not a baby is born with hearing loss. If the baby is born with hearing loss, it is called **congenital**. If the hearing loss occurs after the baby is born, it is called **acquired**.
- Another way depends on whether or not the hearing loss gets worse over time. Hearing loss that gets worse over time is called **progressive**. Hearing loss that does not change is called **non-progressive**.
- A third way depends on whether or not other conditions are present. If they are present it is **syndromic**, if not then it is called **non-syndromic**.
- A fourth way depends on whether or not hearing loss runs in the family. If it does, it is called **familial**; if it does not, it is **sporadic or de novo**.
- A fifth way is based on where in the ear the hearing loss occurs. If the loss occurs in the outer or middle ear it is **conductive**. If it occurs in the inner ear it is **sensorineural**. If the loss occurs in both areas, it is **mixed**.

<p>Congenital or Acquired</p>	<ul style="list-style-type: none"> • Congenital: This means a person was born with the hearing loss. Babies born with hearing loss can be identified through a newborn hearing screening test. The test often is done before babies leave the hospitals in which they were born. The screening test does not tell the cause of the baby’s hearing loss. It can tell only whether the baby might have a hearing loss. • Acquired: This means a person could hear at birth but developed hearing loss later in life. Acquired hearing loss also can be described by the age at which it starts. If hearing loss starts before the age when children usually begin talking, it is called “<i>prelingual</i>,” which means “before speaking.” If hearing loss starts after the age when children begin talking, it is called “<i>postlingual</i>,” which means “after speaking.”
<p>Progressive or Non-Progressive</p>	<ul style="list-style-type: none"> • Progressive: If the hearing loss gets worse over time, it is called “progressive.” • Non-progressive: If the hearing loss does not change over time, it is “nonprogressive” or stable.
<p>Syndromic or Non-Syndromic</p>	<ul style="list-style-type: none"> • Syndromic: This means that a person has other conditions besides hearing loss. For example, some people with hearing loss also are blind. There are many different syndromes that have hearing loss as one of the conditions. • Non-syndromic: This means that the person does not have any other conditions.
<p>Familial or Sporadic</p>	<ul style="list-style-type: none"> • Familial: If more than one person in a family has hearing loss, it is said to be “familial.” That is, it runs in the family. • Sporadic: If only one person in the family has hearing loss, it is called “sporadic.” That is, it does not run in the family.
<p>Conductive or Sensorineural</p>	<ul style="list-style-type: none"> • The middle ear contains small bones that help send sound from the air to the inner ear. The inner ear changes these sounds into nerve signals that go to the brain. See Figure 1. • Conductive: This hearing loss is caused by changes in the outer or middle ear. • Sensorineural: This hearing loss is caused by changes in the inner ear or in the hearing nerve, or both. • Mixed: This hearing loss is both conductive and sensorineural.

Figure 1

A Diagram of the Outer, Middle, and Inner Ear



How Is Hearing Loss Identified?

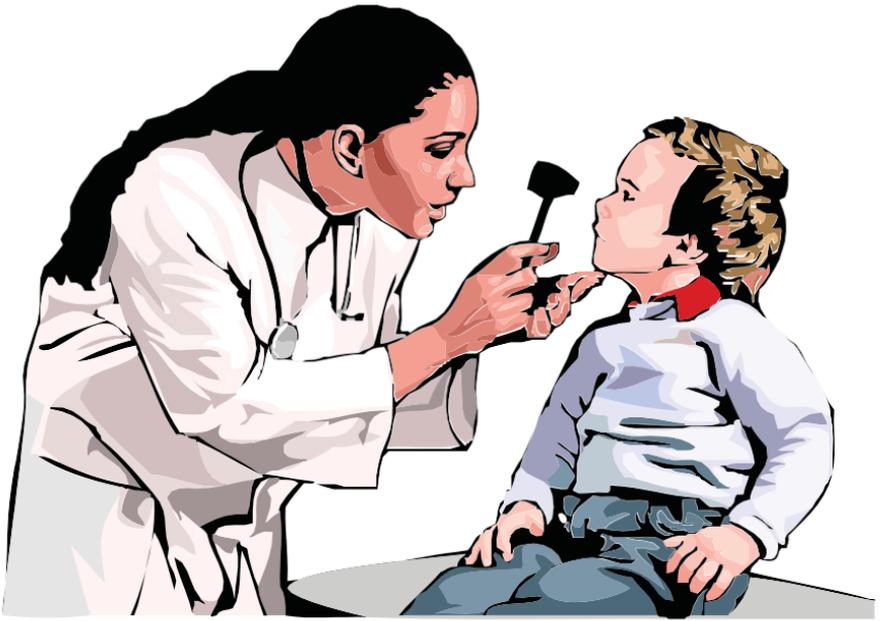
Hearing screening is the first step in the identification process, and it can tell if a young child might have a hearing loss. Hearing screening is easy and is not painful. In fact, babies are often asleep while being screened. It takes a very short time — usually only a few minutes. All babies should have a hearing screening no later than 1 month of age, and in the United States about 98% of newborns are screened before they leave the hospital.

There are two types of technology used to screen a newborn for hearing loss. The first is otoacoustic emissions (OAEs) and the second is auditory brainstem response (ABR). The OAE screen checks the inner ear response to sound. Because this screening does not rely on a person's response behavior, the child can be asleep during the screening. The ABR screen checks the brain's response to sound, and like the OAE screen, the ABR screen does not rely on a child's response behavior, so the child can also be asleep during this screen.

If a child does not pass a hearing screening, it's very important for the child to get a full hearing test (often called an audiologic evaluation) as soon as possible, but no later than 3 months of age. Parents who need help finding audiology services for their child can visit the Early Hearing Detection and Intervention Pediatric Audiology Links to Services ([EHDI PALS](#)). This free resource includes an online national directory of facilities that offer pediatric hearing services to children who are younger than five years of age.

How Do Healthcare Providers Figure Out What Caused a Person's Hearing Loss?

Healthcare providers begin by looking at a person's physical features, medical history, and family history. Based on this, they classify the hearing loss in the ways described earlier (congenital or acquired during prelingual or post-lingual period, progressive or nonprogressive, conductive or sensorineural, syndromic or non-syndromic, and familial or sporadic). The classifications often point to certain causes. The healthcare providers might ask for more medical tests to look for signs of syndromic hearing loss, and they may arrange for genetic tests.



What Causes Hearing Loss?

Hearing loss can be caused by changes in or around genes (which are the instructions in the body's cells), or by external events (such as injuries, illness, and certain medications), or both.

Hearing depends on the biology of the ear and the way the brain makes sense of sounds. Both of these can be influenced by genes. There are many genes involved in hearing. Genes are passed down from biological parents to their child. If a child has hearing loss, one or more genetic changes can be the cause. These genes may influence either the structure of the ear, the way the brain makes sense of sounds, or both. The child could have received the changed gene(s) from one or both parents (familial) or the changed gene occurred in the family only within the child with hearing loss (sporadic).

There are also non-genetic causes for hearing loss. For example, babies who are born too early or who need help breathing (for example, using a ventilator) are more likely to develop hearing loss than are other babies. Some infections (for example, cytomegalovirus) that the mother has during her pregnancy can cause the baby to have hearing loss. Also, some infections (for example, meningitis) that babies and children sometimes have can cause hearing loss.

Sometimes, both genes and external (i.e., non-genetic) events work together to cause hearing loss. For example, there are some medicines (known as ototoxic medications) that can cause hearing loss but only among people who also have specific gene changes.

About Genetics and Hearing Loss

What Are Genes?

Genes are the basic blocks of information that all of the body's cells use to do what they are supposed to do. For example, genes tell heart cells how to beat, stomach cells how to digest food, and muscle cells how to move. Genes also contain the information for normal growth and development, and they help determine each person's physical features, such as height, eye color, and hair color.

Genes are made up of a chemical called deoxyribonucleic acid (DNA). DNA is made up of two chemical chains joined together like rungs on a ladder. At each rung along the DNA chain there is a part of DNA called a base. Four different bases make up DNA, and they are called A, C, T and G, for short. The specific order, or sequence, of all the As, Cs, Ts, and Gs in DNA determines the exact information carried in each gene, like the way that a specific pattern of letters makes up the words in a sentence. Please see Figure 2 on page 11 for the relationship between bases, genes, DNA, chromosomes, and cells.

What Happens When Genes Change?

When DNA bases are missing, changed, or out of order, instructions for gene are changed so that they can't provide the information that cells need. These changes can cause various conditions, depending upon the types of changes and the genes involved. Some DNA changes can cause hearing loss with other conditions (syndromic) and/or hearing loss by itself (nonsyndromic). Even among families with hearing loss in multiple relatives, DNA changes are not always found. Scientists are working to find all of the DNA-related causes for hearing loss.

Here is an example of a gene change. Suppose part of a gene usually has the sequence *GTAC*. However, in some people, the sequence has changed to *G TTC*. This change can alter the way that the gene works so that people with this DNA change will have a particular condition. Keep in mind that not all DNA changes result in a noticeable change in the person.

How Are Genes Passed to Children?

About half of a child's DNA comes from each parent through the egg from the mother and the sperm from the father. Thus, a child will have features similar to each parent.

Within each cell of a person's body, the genetic instructions (DNA) are packaged into larger units called chromosomes. Each person typically has 23 pairs of chromosomes. One chromosome of each pair is from the person's mother and the other chromosome of each pair is from the father.

Usually, human cells have 46 chromosomes that occur in 23 pairs. The first 22 pairs of chromosomes, called number 1 to 22, are the same in males and females. The 23rd pair is called the sex chromosomes. They help determine if a person is born male or female. A female has two X chromosomes, and a male has one X and one Y chromosome. A mother will give one of her two X chromosomes to each of her children. A father will give either his X or his Y chromosome. A child who gets the father's Y chromosome will be male. A child who gets the father's X chromosome will be female.

Figure 2

The Relationship Between Cells, Chromosomes, DNA, Bases, and Genes

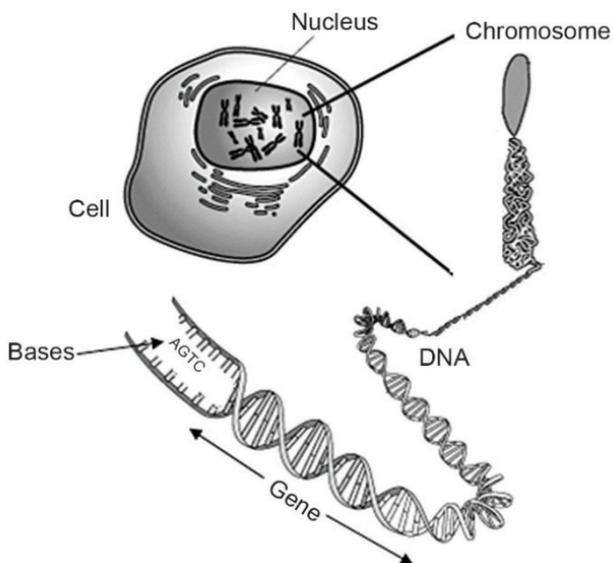


Figure 3

An Example of How Chromosomes Are Passed From Parents To Children

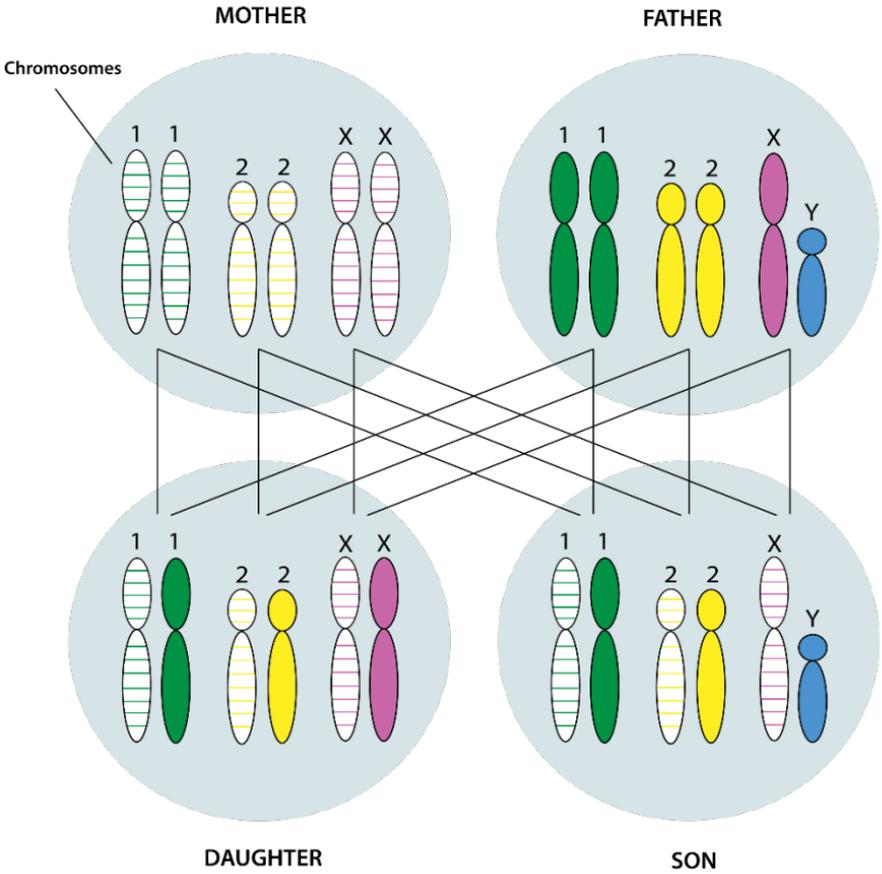


Figure 3 shows how children get their chromosomes and, therefore, their genes and DNA from their parents. In this figure, three of the 23 pairs of chromosomes are shown: pair #1 (green), pair #2 (yellow), and the sex chromosomes (purple and blue). The father's chromosomes are shown in solid color, and the mother's are striped. A child randomly gets one of each pair of chromosomes from the child's mother (striped) and one of each pair from the father (solid). Each daughter gets an X from her mother (striped) and an X from her father (solid). Each son gets an X from his mother (striped) and a Y from his father (solid).

What Are the Different Ways Genes Can Cause Conditions in Children?

Genetic conditions can be described by the chromosome that contains the gene or DNA change. If the gene is part of one of the first 22 pairs of chromosomes, called autosomes, the genetic condition is called an “autosomal” condition. If the gene or DNA change is part of the X chromosome, the condition is called “X-linked” or “sex-linked.”

Genetic conditions can be further grouped based on who they affect in families. Changes in and around genes cause conditions to occur within members of the same family in certain patterns, called autosomal “dominant,” autosomal “recessive,” and X-linked “recessive.”

Autosomal Dominant Conditions

“Autosomal” conditions affect both males and females equally. In “dominant” conditions, the condition is passed from parent to child. Even when only one parent has a dominant condition, the condition can still be passed on to their children. When one parent has a dominant condition, each child has a 50% (1 in 2) chance of having it as well. All members of the family with one gene with the dominant change will have the condition because it takes only one gene with a dominant change to cause the condition.

Figure 4 shows how children acquire dominant conditions from their parents. In this example shown, the chromosome with the usual gene is symbolized by (1) and the chromosome with the dominant gene change is symbolized by (2). When one parent has the dominant condition, he or she has the usual gene (1) and a gene with the dominant gene change (2). He or she will pass on to each child one or the other. Therefore, each child has a 50% (1 in 2) chance of getting the gene with the dominant gene change and having the condition.

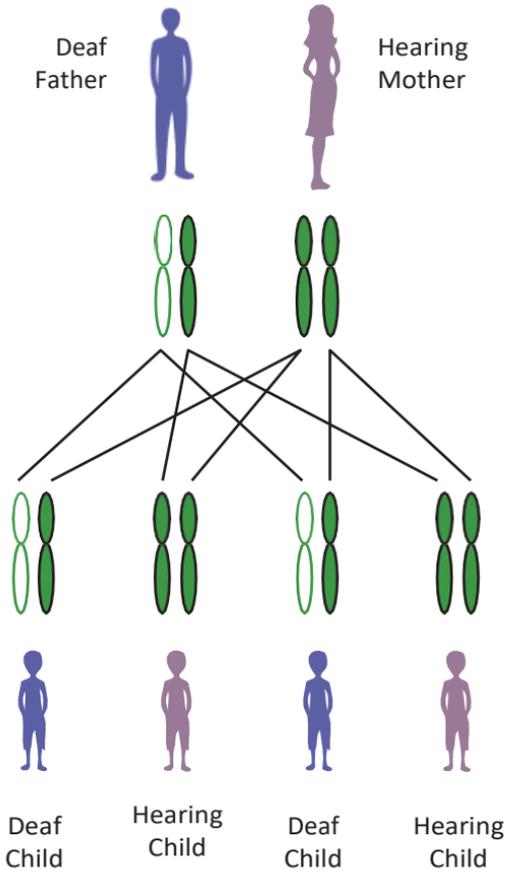
If the other parent has two chromosomes with the usual genes, and therefore does not have the condition, he or she will pass on to each child one of the two usual genes (1). Even though a child gets one of the usual genes from the parent who does not have the condition, if he or she gets a dominant changed gene from the parent with the condition, the child also will have the condition.

Most of the time, children with autosomal dominant hearing loss will have a parent with the same dominant gene change and hearing loss. However, the child may be the first one diagnosed in the family. The parent and child may not show the same symptoms or level of hearing loss, or the symptoms may not appear at the same time.

If a child has an autosomal dominant type of hearing loss, but the parents are hearing, the child may be the first in the family to have the changed gene (sporadic). When this child grows up and has children, each of the children has a 1 in 2 chance of getting the changed gene.

Figure 4

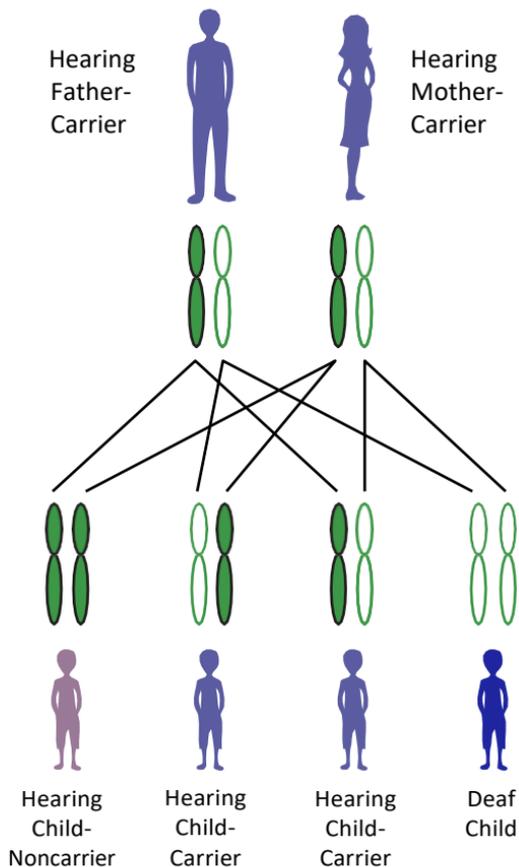
An Example of Autosomal Dominant Inheritance



In this figure, (🟩) is the chromosome with the usual gene and (🟪) is the chromosome with the dominant gene change.

Figure 5

An Example of Autosomal Recessive Inheritance



In this figure, (●) is the chromosome with the usual gene and (○) is the chromosome with the recessive gene change.

Autosomal Recessive Conditions

“Autosomal” conditions affect males and females equally. “Recessive” conditions are due to changes in or around genes, but they appear in families in a different way than dominant conditions. This is because people who have one recessive gene change do not have the condition. They are called “carriers.” If two carriers have a child together, there is a 25% (1 in 4) chance that the child will get two recessive changed genes, one from each parent. This child will have the recessive condition. Only children who have no usual genes will have the recessive condition.

Figure 5 shows how recessive conditions appear in families. In this example, each parent is a carrier and has a chromosome with one usual gene (U) and one chromosome with a recessive gene change (R). Each parent will pass on to a child either the usual gene (U) or the gene with the recessive change (R). Each has a 50% (1 in 2) chance of happening. If the child gets one usual gene (U) from one parent and one gene with the recessive change (R) from the other parent, the child will be a carrier, just like both parents. If the child gets a gene with the recessive change (R) from both parents, and therefore doesn't have the usual gene, the child will have the condition. When both parents are carriers, there is a 25% (1 in 4) chance that each child will get a gene with a recessive change from both parents and, therefore, have the condition.

Two people with the same recessive condition caused by the same gene change will not necessarily have the same level of hearing loss nor will the hearing loss appear at the same age. Predicting the exact outcome of the changed genes in another person (or sibling) may not be straightforward.

X-Linked Recessive Conditions

Hearing loss can also occur as an X-linked condition. These conditions usually affect only males. In such instances, a change in or around a gene is passed in the family through female carriers who do not have the condition. However, each son of a female carrier has a 50% chance of getting the changed gene and, therefore, of having the condition.

Figure 6 shows an example of inheritance of an X-linked recessive condition. “X-linked” genes are genes that are part of the X chromosome. “Recessive” means that a person who does not have at least one usual gene will have the condition.

A female has two X chromosomes and, therefore, two of each X-linked gene. A woman who has one usual gene and one gene with a recessive change is called a carrier. A carrier does not have the condition but can pass the gene with the recessive change on to her children.

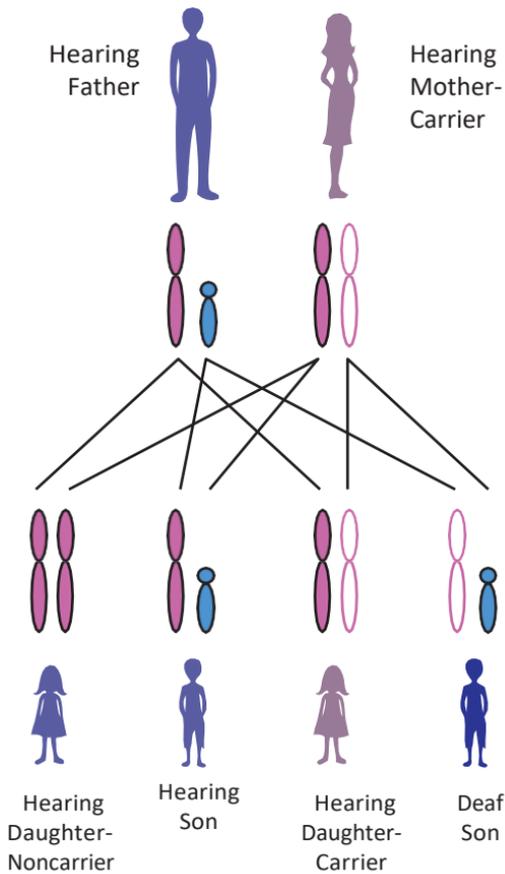
A male has only one X chromosome, which was passed down from his mother. His other sex chromosome is a Y chromosome that he received from his father. Therefore, a male has only one of every gene on the X chromosome. If the male gets his mother’s X chromosome that has the recessive gene change, he will have the condition. If he gets his mother’s X chromosome that has the usual gene, he will not have the condition. Therefore, a son of a carrier mother has a 50% chance of having the condition. A daughter of a carrier mother will similarly have a 50% chance of getting the X chromosome with the recessive gene change from her mother, but if her father has an X chromosome with the usual gene, the daughter will not have the condition, but will be a carrier, like her mother. A daughter of a carrier mother also has a 50% chance of getting the X chromosome with the usual gene from her mother, and if the daughter also gets an X chromosome with the usual gene from her father, she won’t be a carrier but instead will be a non-carrier.

Figure 7 shows X-linked inheritance from a father with the condition. A male has only one X chromosome, and if he passes the X chromosome to his child, the child will be female. If the X chromosome he passes has the recessive gene change, each daughter will be a carrier. A male has only one Y chromosome, and if the father passes the Y chromosome to his child, the child will be male. None of his sons will have the condition or be carriers, as long as the mother did not pass an X chromosome with the recessive gene.

When a male child has hearing loss caused by a changed gene that is part his X chromosome, but neither of his mother’s X chromosomes have the changed gene, she is not a carrier. In this case, the child may be the first in the family to have the changed gene (sporadic). If this child has children, then all of his daughters will get the changed gene and be carriers, and all of his sons will not get the changed gene, so they will not have the condition.

Figure 6

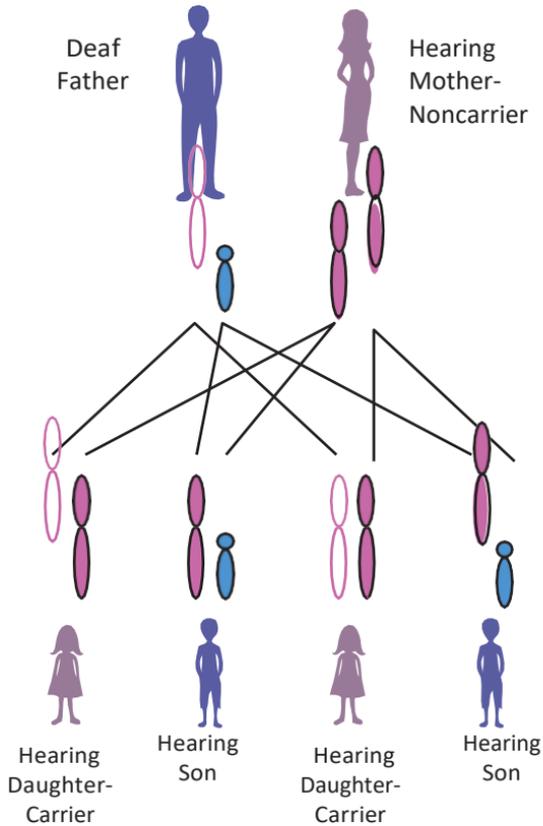
An Example of X-linked Recessive Inheritance



In this figure, () is an X chromosome with a usual gene, and () is an X chromosome with a recessive gene change. () is a Y chromosome.

Figure 7

An Example of X-linked Inheritance from Affected Father



In this figure, () is an X chromosome with a usual gene, and () is an X chromosome with a recessive gene change. () is a Y chromosome.

What are GJB2 and Connexin 26?

The [GJB2 gene](#) contains the instructions for a protein called Connexin 26. This protein is needed for a part of the ear called the cochlea to do its job. The cochlea is a very complex and specialized part of the body. It needs many instructions to form and work correctly. These instructions come from many genes, including *GJB2*, *GJB3*, and *GJB6*. Changes in any one of these genes can result in hearing loss. However, unlike other autosomal recessive causes for hearing loss where severity or progression may not be predictable, *GJB2*-related hearing loss can be predicted based on the specific gene change. Click [here](#) for more detailed information about changes in the *GJB2* gene and hearing loss.

Among some populations, about 50% of children with a genetic hearing loss who do not have a syndrome will have a DNA change in the *GJB2* gene. There are many different gene changes that can cause hearing loss. Most of these changes are recessive, meaning that a person can have one usual copy of the gene and one copy of the changed *GJB2* gene and will have full hearing function. (Everyone has two *GJB2* genes, one from each parent.) However, a person who has two changed *GJB2* genes, one from each parent, will have hearing loss. This means that if both parents have just one changed *GJB2* gene, they can have a child with hearing loss, even though both parents can hear. In fact, most babies with hearing loss are born to parents who can hear.

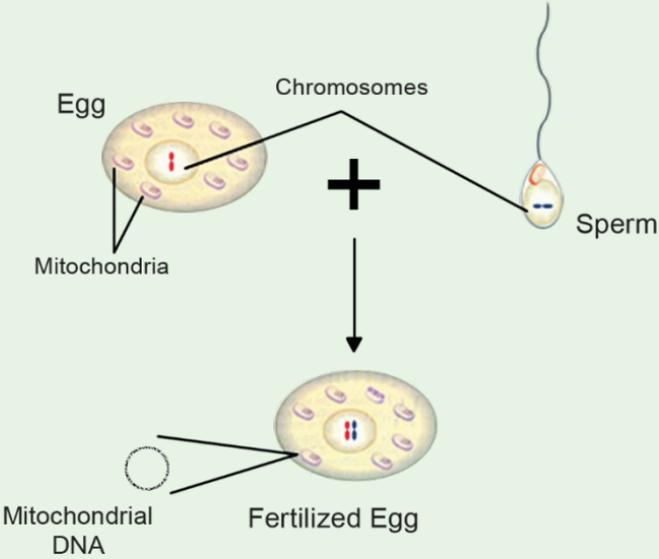
Multifactorial Conditions

Some conditions, such as hearing loss, can be caused by a combination of genetic and non-genetic factors. These conditions are said to be “multifactorial.” People who have multifactorial conditions often are born into families with no other affected members. Parents of a child with any such condition have a greater chance of having another child with the same condition than parents who do not have a child with the condition.

If a couple without hearing loss has a child with hearing loss, there are no other relatives with hearing loss, and a specific cause of the hearing loss has not been sought, the couple’s chance of having another child with hearing loss is about 18%. However, if the child has been tested for the known genetic and non-genetic causes of hearing loss and none are identified, then the child is considered to have multifactorial hearing loss. In this case, the couple’s chance of having another child with hearing loss is 3-5%.

Figure 8

The Relationship Between Chromosomes, Mitochondria, and Mitochondrial DNA



Mitochondrial Conditions

“Mitochondrial” conditions are different from most other genetic conditions because only the mother can pass them to her children. Also, the child receives a mixture of mitochondria that have a proportion of mitochondria with and without the changed genes. The amount of each type can be very different, ranging from all mitochondria with no gene change or all with the changed genes to a combination of everything in between. If a woman has a mitochondrial condition, the chance that she will pass it on to her children depends on the particular condition and on the amount of changed mitochondrial genes that the child receives. Fathers with a mitochondrial condition do not pass it on to their children.

There are genes that exist outside of chromosomes within a person's cells. A few genes are found on small, circular pieces of DNA in the mitochondria called the mitochondrial chromosome. Mitochondria are tiny parts of cells that make energy, and the mitochondrial genes are particularly important for cells with high energy needs, particularly in the brain, nerves, eyes, ears, heart, and muscles. Each cell has many mitochondria, and every mitochondrion has many copies of the mitochondrial chromosome. The chance that a person will have a mitochondrial condition depends on the number of mitochondrial chromosomes in each cell that have a changed gene as well as the number of cells in an organ or tissue that have many mitochondria with the changed genes.

Mitochondrial genes are passed on to children in a different way than genes on the other 23 pairs of chromosomes are passed on because children get their mitochondrial chromosomes only from their mothers. Therefore, if a woman carries changes in her mitochondrial genes, each child has a chance of having the condition ranging from a severe form to being an unaffected carrier. The chance of having symptoms of a mitochondrial condition depends on the number of mitochondrial chromosomes that were in the egg cell with the changed gene and how the mitochondrial chromosomes were distributed among the mitochondria in the egg cell. A male with a mitochondrial condition will not pass the condition to his children because mitochondria in sperm cells usually don't get into the fertilized egg cell.

Figure 8 shows how a fertilized egg (which will grow into a baby) gets chromosomes from the mother's egg and the father's sperm (shown as red and blue chromosomes) but gets mitochondrial chromosomes only from the mother's egg.

About Genetic Testing

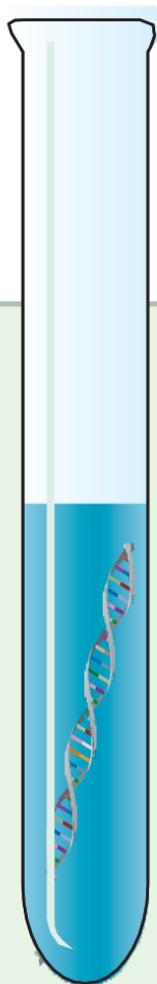
What Is Genetic Testing?

One type of genetic test involves looking at a person's DNA to see if certain changes are present that are known to cause hearing loss. A person's DNA sample can be obtained from different sources: (1) a small sample of a person's blood, or (2) cheek cells from a person's mouth using a cheek swab or from saliva. The DNA obtained from this method is sometimes unstable and might not be usable. Therefore, blood samples are the preferred source.

Once a person's DNA sample is obtained, there are different ways to look for gene changes. In the past, tests would look at one gene at a time. If the gene change has been found in the family before, then this very specific test can focus only on that change.

Technological advances now allow scientists to read the DNA sequence of multiple genes as part of a single genetic test. This test is called a multigene sequencing panel. Only a small amount of blood is needed for this and it usually takes a few weeks to get the results. Multigene sequencing panels for hearing loss can contain hundreds of genes known to cause dominant, recessive, X-linked, and mitochondrial hearing loss, along with genes that might cause hearing loss.

Because all the genes related to hearing loss are not yet known and because many different genes may work together in different combinations to cause a certain child's hearing loss, the results of genetic testing may not provide all the answers.



What Are the Benefits of Genetic Testing?

If a gene change is found, it might explain why the person has a condition, such as hearing loss. In some cases, knowing what the gene change is will allow doctors to predict how severe the condition might become and what other symptoms might be expected. Then, the person can get any other medical care that might be needed. Also, knowing the cause of a person's condition will let him or her know what the chances are of passing the condition on to his or her children. It can also let other family members know the chances that they might have a child with the same condition.

What Are Some Limits of Genetic Testing?

- Not all of the genes that cause hearing loss are known. So, even if a condition runs in a family, it might not be possible to find the gene change that causes it.
- Some tests are hard to do. For example, the gene doesn't sequence well, or the test does not cover all the regions where the DNA sequence can change.
- Sometimes, it is not possible to tell if a change in the DNA is the cause of a condition or just a coincidence.

What Are the Risks of Genetic Testing?

Some people have strong feelings when they get the results of a genetic test. Some people feel angry, sad, or guilty if they find out that they or their child has a change in their genes. It is important to remember that everyone carries gene changes of some kind, and that a person's DNA sequence is no one's "fault."

Genetic tests are different from other medical tests in that the results provide information about other members of the family, and not just the person being tested. Some family members do not want to know that a gene or DNA change runs in their family. Also, because children get their genes from their parents, genetic tests that involve several family members can reveal personal information, such as a child having been adopted or having a different biological father.

Sometimes, people are concerned about keeping the results of their medically related genetic tests private. For example, they do not want their friends, relatives, or coworkers to find out. Companies that offer genetic testing are very careful to make sure that test results are kept private. Test results ordered by a health provider in the U.S. cannot be seen by anyone who is not involved in the testing unless the person tested or his or her parents or guardians give permission.

Interventions for Hearing Loss

No single treatment or intervention is the answer for every child or family. Good intervention plans will include close monitoring of the child and family needs, follow-ups to check progress, and making needed adjustments along the way to help support the child and family. There are many different options for children with hearing loss and their families. Some intervention options include the following:

- Working with a professional (or team) who can help a child and family learn to communicate.
- Getting a hearing device, such as a hearing aid.
- Joining support groups.
- Taking advantage of other resources available to children with a hearing loss and their families.

Early Intervention (0-3 years)

Hearing loss can affect a child's ability to develop speech, language, and social skills. The earlier a child who is deaf or hard-of-hearing starts getting services, the more likely the child's speech, language, and social skills will reach their full potential.

Early intervention program services help young children with hearing loss learn language skills and other important skills. This intervention involves a therapist, such as a speech-language pathologist, teaching communication strategies to the child and parent(s) or helping the parent or other caregivers blend extra lessons into the day.

Babies who are diagnosed early with hearing loss should begin to get intervention services as soon as possible, ideally before 6 months of age.

There are many services available through the [Individuals with Disabilities Education Improvement Act 2004 \(IDEA 2004\)](#). Services for children from birth through 36 months of age are called Early Intervention or Part C services. Even if a child has not been diagnosed

with a hearing loss, he or she may be eligible for early intervention treatment services. The IDEA 2004 says that children under the age of 3 years (36 months) who are at risk of having developmental delays may be eligible for services. These services are provided through an early intervention system in every jurisdiction. Through this system, parents can ask for an evaluation.

Special Education (3-22 years)

Special education is instruction specifically designed to address the educational and related developmental needs of older children with disabilities or those who are experiencing developmental delays. Services for these children are provided through the public school system. These services are available through the Individuals with Disabilities Education Improvement Act 2004 (IDEA 2004), Part B.

Additional information about interventions for hearing loss can be found at www.cdc.gov/ncbddd/hearingloss/treatment.html.

Where Can I Find More Information?

For more information about genes related to hearing loss and about genetic testing, please [contact a genetic counselor in your area](#).

For more information about hearing and hearing loss, see the National Institute on Deafness and Other Communication Disorders at www.nidcd.nih.gov/health/hearing/

The Genetic Science Learning Center has some information about basic genetics, genetic conditions and genetic counseling at <http://learn.genetics.utah.edu/>

Cold Spring Harbor Labs has a tutorial about genetics that is a little more in-depth than those at some of the other sites. It can be found at www.dnafb.org/dnafb/

The Hereditary Hearing Loss Homepage gives an up-to-date overview of the genetics of hereditary hearing loss for researchers and clinicians working in the field. This site can be found at <http://hereditaryhearingloss.org/>

For suggested questions to ask a geneticist or genetics counselor, see the resource developed by the Centers for Disease Control and Prevention at www.cdc.gov/ncbddd/hearingloss/freematerials/genetics-questions_eng.pdf

For more information about Early Hearing Detection and Intervention (EHDI) and CDC's work in this area, please visit www.cdc.gov/ncbddd/hearingloss

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