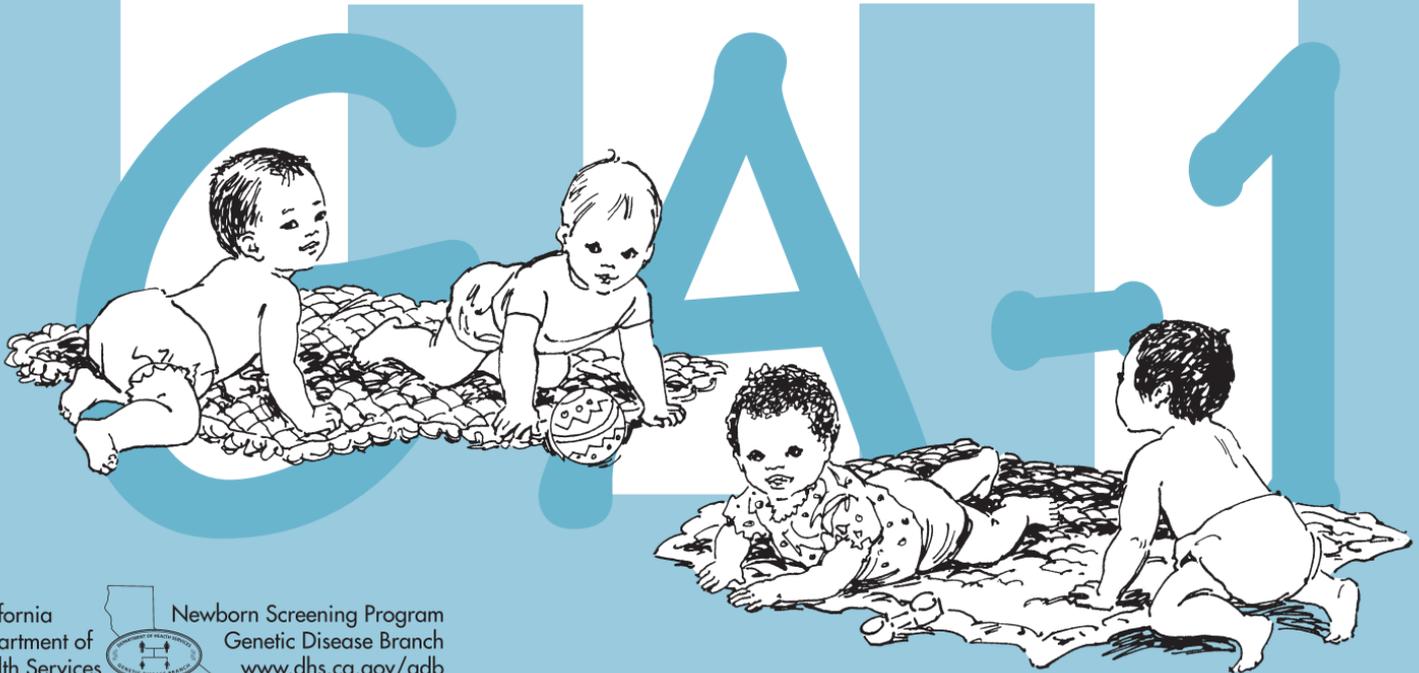


# Parents' Guide to GA-1

Glutaric Acidemia Type-1



California  
Department of  
Health Services



Newborn Screening Program  
Genetic Disease Branch  
[www.dhs.ca.gov/gdb](http://www.dhs.ca.gov/gdb)

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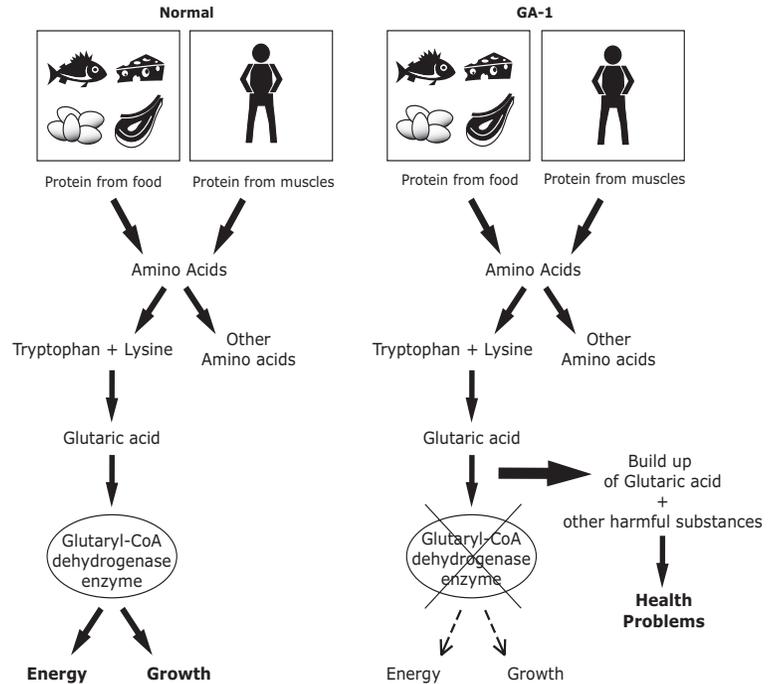
**The information in this booklet is general and is not meant to be specific to each child with GA-1. Certain treatments may be recommended for some children but not others. Children with GA-1 should be followed by a physician specializing in metabolic diseases (metabolic specialist) in addition to their primary doctor. For a list of metabolic centers, see page 19 or visit our website at [www.dhs.ca.gov/gdb](http://www.dhs.ca.gov/gdb).**

\*Underlined words in booklet are defined in the Glossary

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## What is GA-1?

GA-1 stands for “glutaric acidemia, type 1”. It is one type of organic acid disorder. People with these disorders have problems breaking down and using certain amino acids from the food they eat. With GA-1, people have problems breaking down the amino acids lysine and tryptophan from the food they eat.



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## What causes GA-1?

In order for the body to use protein from the food we eat, it is broken down into smaller parts called amino acids. Special enzymes then make changes to the amino acids so the body can use them.

GA-1 occurs when an enzyme called “glutaryl-CoA dehydrogenase” is either missing or not working properly. This enzyme’s job is to break down a substance called glutaric acid. Glutaric acid is made when the amino acids lysine, hydroxylysine, and tryptophan are processed by the body. Whenever a child with GA-1 eats food containing lysine or tryptophan, glutaric acid and other harmful substances build up in the blood. Lysine and tryptophan are found in all foods that contain protein.

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## What causes the glutaryl-CoA dehydrogenase enzyme to be missing or not working correctly?

Genes tell the body to make various enzymes. People with GA-1 have a pair of genes that do not work correctly. Because of the changes in this pair of genes, the glutaryl-CoA dehydrogenase enzyme either does not work properly or is not made at all.

### If GA-1 is not treated, what problems occur?

Babies with GA-1 are usually healthy at birth, although many are born with a larger than average head size. Other symptoms usually start between two months and four years of age.

GA-1 causes episodes of severe illness called metabolic crises. Some of the first symptoms of a metabolic crisis are poor appetite, extreme sleepiness or lack of energy, irritability, jitteriness, nausea, vomiting, low muscle tone (floppy muscles and joints) and muscle weakness.

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If untreated, other symptoms then follow:

- tics or spasms of the muscles
- rigid muscle contractions called spasticity
- involuntary jerking movements of the arms and legs, called dystonia
- poor coordination and balance problems
- increased levels of acidic substances in the blood, called metabolic acidosis
- seizures
- swelling of the brain or blood in the brain
- coma, sometimes leading to death

Metabolic crises are often triggered by:

- illness or infection
- fever

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Other effects of GA-1 that can happen even without a metabolic crisis are:

- poor growth
- enlarged liver
- low muscle tone
- progressive spasticity
- dystonia, an involuntary movement disorder
- repeated episodes of fever
- excessive sweating
- delays in walking and other motor skills
- learning delays and mental retardation
- speech problems
- brain damage

Some people have very mild or no symptoms and are only found after a brother or sister is diagnosed.

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## What happens when GA-1 is treated?

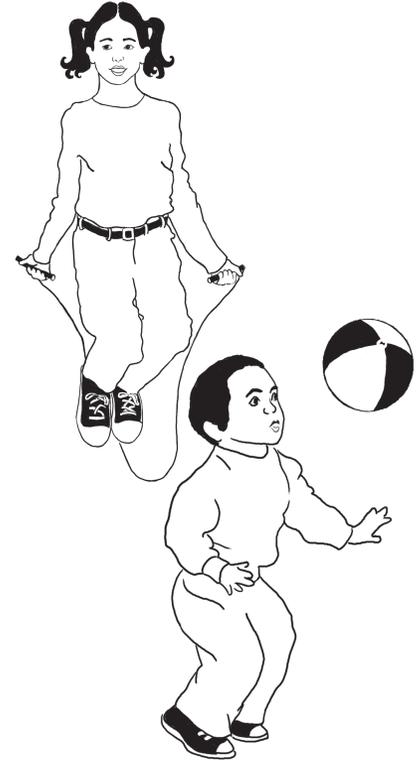
With prompt and lifelong treatment, children with GA-1 can often live healthy lives with typical growth and learning. Early treatment can help prevent episodes of metabolic crisis and the resulting health effects.

Even with treatment, some children continue to have episodes of metabolic crisis. This can lead to brain damage and long-term problems with involuntary movements and spasticity. After age six, metabolic crises are less common.

## What is the treatment for GA-1?

Your baby's primary doctor will work with a metabolic specialist and a dietician to care for your child.

Prompt treatment is needed to prevent episodes of metabolic crisis. You need to start treatment as soon as you know your child has



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GA-1. Certain treatments may be advised for some children but not others. Treatment is usually needed throughout life.

The following are treatments often recommended for babies and children with GA-1:

### **1. Medication**

Riboflavin is a vitamin that helps the body use protein. It may also help remove glutaric acid from the blood. Your doctor may recommend that your child take riboflavin supplements by mouth.

Some children may be helped by L-carnitine. This is a safe and natural substance that helps body cells make energy. It also helps the body get rid of harmful wastes. Your doctor will decide whether or not your child needs L-carnitine supplements. Do not use any medication without checking with your metabolic specialist.

Children with symptoms of a metabolic crisis need medical treatment right away. They often need to be treated in the hospital. During a metabolic crisis, children may be given fluids, glucose,

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insulin, carnitine and other medications by intravenous (IV) to help get rid of harmful substances in the blood.

## 2. Food plan, including medical foods and formula

Most children need to eat a diet made up of foods low in lysine and tryptophan. Special medical foods and a special formula are usually part of the diet. Your dietician will create a food plan that has the right amount of protein, nutrients, and energy for your child.

### Low-protein (lysine and tryptophan) diet

Foods that will need to be avoided or strictly limited include:

- milk, cheese, and other dairy products
- meat and poultry
- fish
- eggs
- dried beans and legumes
- nuts and peanut butter



Do not remove all protein from the diet. Your child still needs a certain amount of protein for normal growth and development.

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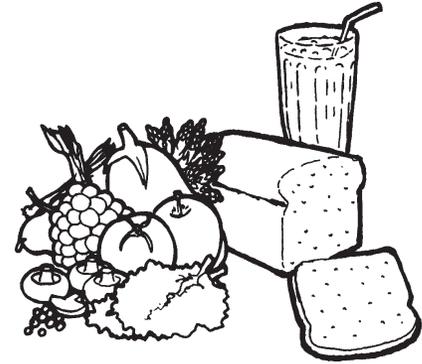
Many vegetables and fruits have only small amounts of lysine and tryptophan and can be eaten in carefully measured amounts. Any changes in the diet should be made under the guidance of a dietician.

### **Medical foods and formula**

There are medical foods such as special low-protein flours, pastas, and rice that are made especially for people with organic acid disorders.

A special medical formula that contains the right level of amino acids and nutrients for your child may be recommended. Your metabolic specialist and dietician will tell you whether your child should be on this formula and how much to use.

Your child's exact food plan will depend on many things such as his or her age, weight, general health, and blood test results. Your dietician will fine-tune your child's diet over time.



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The long-term benefits of the special diet and medical foods are not yet known. However, it is important to follow the food plan as long as your doctor advises.

### 3. Regular blood tests

Your child will have regular blood tests to measure his or her amino acid levels. Urine tests may also be done. Your child's diet and medication may need to be adjusted based on blood and urine test results.

### 4. Call your doctor immediately if your child has signs of illness

For some babies and children, even minor illness can lead to a metabolic crisis. In order to prevent problems, call your doctor right away when your child has any of the following symptoms:

- loss of appetite
- vomiting
- fever
- low energy or extreme sleepiness
- infection or illness
- behavior or personality changes



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Children with GA-1 need to eat more carbohydrates and drink more fluids when they are ill – even if they’re not hungry – or they could have a metabolic crisis. Also, they need to avoid eating protein during any illness.

Children who are sick often don’t want to eat. If they can’t eat, or if they show signs of a metabolic crisis, they may need to be treated in the hospital.

Even with treatment, some children continue to have episodes of metabolic crisis. This can lead to brain damage and long-term problems with involuntary movements and spasticity. After age six, metabolic crises are less common.



## How is GA-1 inherited?

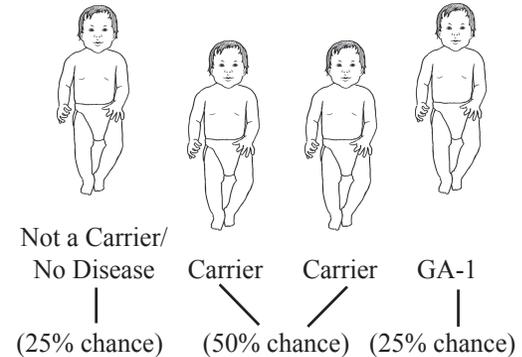
GA-1 affects both boys and girls equally.

Everyone has a pair of genes that make the glutaryl-CoA dehydrogenase enzyme. In children with GA-1, neither of these genes works correctly. These children inherit one non-working gene for the condition from each parent. This is called autosomal recessive inheritance.

Parents of children with GA-1 rarely have the disorder. Instead, each parent has a single non-working gene for GA-1. They are called carriers. Carriers are not affected because their other gene of this pair is working correctly.

When both parents are carriers, there is a 25% chance in each pregnancy for the child to have two working genes. This means the child is not a carrier and does not have the disease. There is a 50% chance for the child to be a carrier, just like the parents. There is a 25% chance for the child to have GA-1.

GA-1 Carrier GA-1 Carrier



*Chances apply to each pregnancy*

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Genetic counseling is available to families who have children with GA-1. Genetic counselors can answer your questions about how GA-1 is inherited, options during future pregnancies, and how to test other family members. Other family members can also ask about genetic counseling and testing for GA-1.

### Is genetic testing available?

Genetic testing for GA-1 can be done on a blood sample. Genetic testing, also called DNA testing, looks for changes in the pair of genes that cause GA-1.

DNA testing may not be necessary to diagnose your child. However, it can be helpful for carrier or prenatal testing.

### What other testing is available?

Special tests on blood, urine, or skin samples can be done to confirm GA-1. Talk to your metabolic specialist or genetic counselor if you have questions about testing for GA-1.



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## Can you test during pregnancy?

If both gene changes are known in your child with GA-1, DNA testing can be done during future pregnancies to determine if the sibling also has GA-1. The sample needed for this test is obtained by either CVS or amniocentesis.

If the gene changes are not known in the child with GA-1, an enzyme test can be done during pregnancy on cells from the fetus. The sample needed for this test is obtained by either CVS or amniocentesis.

Parents may either choose to have testing during pregnancy or wait until birth to have the baby tested. A genetic counselor can talk to you about your choices and answer questions about prenatal testing or testing your baby after birth.



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## Can other members of the family have GA-1 or be carriers?

The brothers and sisters of a baby with GA-1 have a chance of also having GA-1 even if they have had no symptoms. Finding out if other children in the family have GA-1 is important because early treatment may prevent serious health problems. Talk to your metabolic specialist or genetic counselor about testing your other children for GA-1.

Brothers and sisters who do not have GA-1 still have a chance to be carriers like their parents. Carriers do not have the disorder and will never develop it.

Each of the parents' brothers and sisters has a chance to be a GA-1 carrier. It is important for other family members to be told that they could be carriers. There is a small chance they are also at risk to have children with GA-1.

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When both parents are known GA-1 carriers or have had a baby with GA-1, subsequent newborns should have special diagnostic testing in addition to the newborn screen to test for GA-1.

If DNA testing would not be helpful, other methods of carrier testing may be available. Your metabolic doctor or genetic counselor can answer your questions about carrier testing.

## **How many people have GA-1?**

About one in every 40,000 Caucasian babies in the United States is born with GA-1.

## **Does GA-1 happen more frequently in a certain ethnic group?**

GA-1 occurs in people from all parts of the world. It is more common in people of Amish background in the United States, the Ojibway Indians in Canada, and people of Swedish ancestry.

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## Does GA-1 go by any other names?

GA-1 is sometimes also called:

- glutaric aciduria type 1
- glutaryl-CoA dehydrogenase deficiency
- dicarboxylic aminoaciduria
- glutarate-aspartate transport defect

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## RESOURCES

Organic Acidemia Association  
13210 35<sup>th</sup> Avenue North  
Plymouth, MN 55441  
(763) 559-1797  
[www.oaanews.org](http://www.oaanews.org)

International Organization of Glutaric Acidemia  
RD #4, Box 299-A  
Blairsville, PA 15717  
(724) 459-0179  
United Kingdom  
[www.glutaricacidemia.org](http://www.glutaricacidemia.org)

Save Babies through Screening Foundation  
4 Manor View Circle  
Malvern, PA 19355-1622  
(888) 454-3383  
[www.savebabies.org](http://www.savebabies.org)

Genetic Alliance  
4301 Connecticut Ave. NW, Suite 404  
Washington, DC 20008-2369  
(202) 966-5557  
[www.geneticalliance.org](http://www.geneticalliance.org)

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## CALIFORNIA METABOLIC CENTERS

Cedars-Sinai Medical  
Center, Los Angeles  
(310) 423-9914

Children's Hospital Central  
California, Madera  
(559) 353-6400

Children's Hospital &  
Research Center, Oakland  
(510) 428-3550

Children's Hospital  
Los Angeles  
(323) 660-2450

Children's Hospital of  
Orange County, Orange  
(714) 532-8852

Children's Hospital San Diego  
Health Center, La Jolla  
(619) 543-7800

Harbor/UCLA Medical Center  
Torrance  
(310) 222-3756

Kaiser Permanente - No. Cal.  
(510) 752-7703

Kaiser Permanente - So. Cal.  
(323) 783-6970

LAC/USC Medical Center  
Los Angeles  
(323) 226-3816

Lucile Salter Packard Children's  
Hospital at Stanford  
(650) 723-6858

Sutter Medical Center  
Sacramento  
(916) 733-6023

UC Davis Medical Center  
(916) 734-3112

UC San Francisco Medical Center  
(415) 476-2757

UCLA Medical Center  
(310) 206-6581

UCI Medical Center, Orange  
(714) 456-8513

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## GLOSSARY

**Amniocentesis** - Test done during pregnancy (usually between 16 and 20 weeks). A needle is used to remove a small sample of fluid from the sac around the fetus. The sample can be used to test for certain genetic disorders in the fetus.

**Autosomal recessive** - Autosomal recessive conditions affect both boys and girls equally. How autosomal recessive inheritance works: Everyone has a pair of genes responsible for making each enzyme in the body. A person with a metabolic disorder has one enzyme that is either missing or not working properly. The problem is caused by a pair of "recessive" genes that are not working correctly. They do not make the needed enzyme. A person has to have two non-working "recessive" genes in order to have an autosomal recessive metabolic disorder. A person with an autosomal recessive disorder inherits one non-working gene from their mother and the other from their father.

**Carrier** - A person who has a gene mutation in one of their genes that cause a disease, but does not have any symptoms of the disease. The mutation is often recessive, which means that both copies of the gene have to be mutated in order for disease symptoms to develop. Carriers are able to pass the mutation onto their children and therefore have an increased chance of having a child with the disease.

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**CVS** - Chorionic Villus Sampling (CVS) is a special test done during early pregnancy (usually between 10 and 12 weeks). A small sample of the placenta is removed for testing. This sample can be used to test for certain genetic disorders in the fetus.

**DNA** - Deoxyribonucleic acid (DNA) is a molecule that makes up chromosomes. It is composed of four units (called bases) that are designated A, T, G, and C. The sequence of the bases spell out instructions for making all of the proteins in an organism. The instructions set for each individual protein is a gene. A change in one of the DNA letters making up a gene is a mutation. In some cases, these mutations can alter the protein instructions and lead to disease. Each individual passes their chromosomes on to their children, and therefore pass down the DNA instructions. It is these instructions that cause certain traits, such as eye or hair color, to be inherited.

**Enzyme** - A molecule that helps chemical reactions take place. For example, enzymes in the stomach speed up the process of breaking down food. Each enzyme can participate in many chemical reactions without changing or being used up.

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**Gene** - A segment of DNA that contains the instructions to make a specific protein (or part of a protein). Genes are contained on chromosomes. Chromosomes, and the genes on those chromosomes, are passed on from parent to child. Errors in the DNA that make up a gene are called mutations and can lead to diseases.

**Genetic Counseling** - Genetic counseling gives patients and their families education and information about genetic-related conditions and helps them make informed decisions. It is often provided by Genetic Counselors or Medical Geneticists who have special training in inherited disorders.

**Glucose** - A type of sugar made from the carbohydrates in food. Glucose is found in the blood. It is the main source of energy for the body and brain.

**Hydroxylysine** - An amino acid made by the body. When it is broken down, it makes glutaric acid.

**Insulin** - A hormone made in the pancreas. It controls the level of glucose (sugar) in the blood.

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**Lysine** - One of 20 amino acids that make up protein. It is not made by the body and must be eaten in the diet. It is found in all foods that contain protein.

**Metabolic Crisis** - A serious health condition caused by low blood sugar and the build-up of toxic substances in the blood. Symptoms of a metabolic crisis are: poor appetite, nausea, vomiting, diarrhea, extreme sleepiness, irritable mood and behavior changes. If not treated, breathing problems, seizures, coma, and sometimes even death can occur. Metabolic crises happen more often in people with certain metabolic disorders (some fatty acid oxidation disorders, amino acid disorders, and organic acid disorders). They are often triggered by things like illness or infection, going without food for a long time, and, in some cases, heavy exercise.

**Riboflavin** - One type of B vitamin (vitamin B2). It helps change carbohydrates, protein, and fat into energy for the body. Some foods high in riboflavin are dairy products, yogurt, cheese, meats, poultry, whole and enriched grains, and green vegetables. Some children with metabolic disorders may be helped by taking riboflavin supplements.

**Seizure** - Also called “convulsions” or “fits.” During a seizure, a person loses consciousness and control of their muscles. It may also cause involuntary

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movements. Seizures can happen for many reasons. Some causes are metabolic disorders, a metabolic crisis, brain injury, and infection.

**Tryptophan** - One of 20 amino acids that make up protein. It is not made by the body and must be eaten in the diet. It is found in all foods that contain protein.

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- California Newborn Screening Area Service Center staff
- Parents of children with GA-1

