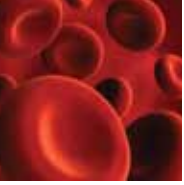

YOUR GUIDE TO

Anemia

Anemia *Healthy Lifestyle Changes*

Prevent ▪ Treat ▪ Control

Iron-Deficiency Anemia
Pernicious Anemia
Aplastic Anemia
Hemolytic Anema

U.S. Department of Health and Human Services
National Institutes of Health
National Heart, Lung, and Blood Institute

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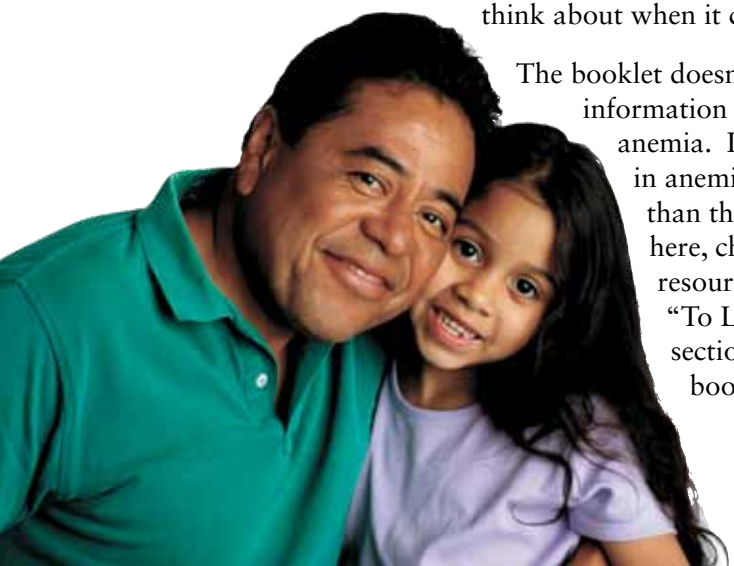
Introduction

You've probably picked up this booklet because you've read about anemia and are curious to learn more. Perhaps you've just been diagnosed, or a family member has been. Or, you've had anemia for a while, and you want to learn more about it.

People of all ages, races, and ethnicities can develop anemia at some point in their lives. There are many types of anemia, and they are linked to a variety of diseases and conditions. Some types of anemia are very common, and some are very rare. Some are very mild and have little or no impact on a person's life. Some are severe and can even be life-threatening if not treated aggressively. All anemias have one thing in common, though: They all affect your blood, and that affects your overall health. The good news is that anemia often can be successfully treated or even prevented.

This booklet gives you an overview of anemia. It starts with general information—what causes anemia, who's at risk, how it's diagnosed, and how it's treated. Then, the booklet goes into more detail about major types of anemia: iron-deficiency, pernicious, aplastic, and hemolytic. The booklet wraps up with some closing thoughts about leading a healthy lifestyle, working with your doctor, and talking with your family. These are important things to think about when it comes to anemia.



The booklet doesn't provide detailed information about all types of anemia. If you're interested in anemia topics other than the ones discussed here, check out the resources listed in the "To Learn More" section at the end of the booklet.

Anemia

What Is Anemia?

Anemia is a blood disorder. Blood is a vital liquid that flows through your veins and arteries. Your body contains about 5 to 6 quarts of blood, which are constantly being pumped throughout your body by your heart. Blood carries oxygen, nutrients, and other essential compounds. It also helps regulate your body temperature, fights infection, and gets rid of waste products. When something goes wrong in your blood, it can have a big impact on your health and quality of life. (For more information about blood, see "What Is Blood Made Of?" on page 3.)

In anemia, your body doesn't have enough red blood cells (RBCs). RBCs are one of the three main types of blood cells. They contain hemoglobin, a protein that carries oxygen throughout your body. When you don't have enough RBCs or the amount of hemoglobin in your blood is low, your body doesn't get all the oxygen it needs. As a result, you may feel tired or have other symptoms.

What Is Blood Made Of?

Blood consists of liquid and solids. The liquid part, called plasma, is mostly water. Plasma carries essential nutrients, hormones, and proteins throughout your body. Plasma also carries waste products from cells to the kidneys and digestive system to be removed from your body.

The solid part of blood contains three types of blood cells—red blood cells, white blood cells, and platelets.

- **Red blood cells (RBCs)** are shaped like discs and are slightly indented in the center. They contain hemoglobin, a protein that carries oxygen from your lungs to all parts of your body. Your body depends on oxygen to carry out its functions. Hemoglobin also carries carbon dioxide (a waste product) from the body to the lungs, where you breathe it out. The hemoglobin in RBCs gives blood its red color.
- **White blood cells (WBCs)** fight infection. They are part of your body's immune system. Your body makes five different types of WBCs. When you get an infection or other type of illness, your body will make more of the specific type of WBC that's needed to fight that illness.
- **Platelets** are tiny oval-shaped blood cell fragments that help your blood clot. If you begin to bleed inside or on the surface of your body, platelets gather at the spot and stick together to seal small cuts or breaks on blood vessel walls. Then, proteins called clotting factors join the platelets to form a stable clot that stops the bleeding.

Blood cells are made in your bone marrow—the spongy tissue inside many of your bones. Blood cells live for various lengths of time. RBCs live about 120 days, and platelets live about 6 days. WBCs have various lifespans. Some types live about 1 day, while others may live a long time. Your bone marrow is always making new blood cells to replace those that have died or are destroyed or lost.

What Causes Anemia?

Anemia occurs when your body makes too few RBCs, destroys too many RBCs, or loses too many RBCs. Many diseases, conditions, and other factors can cause this to happen. (See "What Can Cause Your Body To Make Too Few Red Blood Cells?" on page 5, "What Can Cause Your Body To Destroy Too Many Red Blood Cells?" on page 6, and "What Can Cause Your Body To Lose Too Many Red Blood Cells?" on page 7 for examples of causes of anemia.)

The causes of anemia can be acquired or inherited. "Acquired" means you aren't born with the condition, but you develop it. "Inherited" means your parents passed on the gene for the condition to you. Sometimes, the cause of anemia is unknown.

Making Too Few Red Blood Cells

To make enough healthy hemoglobin and RBCs, your body needs iron, vitamin B12, folate (another B vitamin), small amounts of other vitamins and minerals, and protein. You get these nutrients from the foods you eat. Your body also needs a proper balance of hormones, especially erythropoietin, a hormone that boosts RBC production.

What Can Cause Your Body To Make Too Few Red Blood Cells?

Acquired Causes	Inherited Causes
• Folate or iron deficiency from poor diet • Demand for RBCs outstrips supply • Some cancers (e.g., leukemia, lymphoma, and multiple myeloma) • Toxins (e.g., pesticides) • Radiation and chemotherapy treatments for cancer • Some viral infections (e.g., hepatitis and Epstein-Barr) • Some antibiotics and medicines for rheumatoid arthritis • Autoimmune disorders (e.g., lupus) • Pregnancy	• Fanconi anemia • Shwachman-Diamond syndrome • Dyskeratosis congenita • Diamond-Blackfan anemia • Amegakaryocytic thrombocytopenia

Your body's ability to make RBCs can be affected by acquired or inherited conditions. For example, having a poor diet may prevent you from getting the nutrients you need to make hemoglobin and RBCs. Some people have conditions that stop them from absorbing vitamin B12 from food or that make their bone marrow less able to make all three types of blood cells. These conditions can lead to anemia. Certain chronic (ongoing) diseases—such as cancer, HIV/AIDS, rheumatoid arthritis, chronic inflammatory diseases, and kidney disease—also can harm the body's ability to make enough RBCs.

Destroying Too Many Red Blood Cells

Sometimes, RBCs are destroyed before they reach the end of their natural lifespan of about 120 days (a process called hemolysis). RBCs may be destroyed in such large numbers that the bone marrow can't make enough new RBCs to keep up. Hemolysis can be caused by an acquired or inherited condition.

Certain diseases or infections, such as lupus or hepatitis, are examples of acquired conditions that may cause your body to destroy too many RBCs.

What Can Cause Your Body To Destroy Too Many Red Blood Cells?

Acquired Causes	Inherited Causes
• Immune hemolytic anemia (immune system makes antibodies against RBCs or medicines, leading to RBC destruction) • Physical damage to RBCs • Paroxysmal nocturnal hemoglobinuria • Infection (e.g., malaria)	• Sickle cell anemia • Thalassemias • Hereditary spherocytosis • Hereditary elliptocytosis • Glucose-6-phosphate dehydrogenase (G6PD) deficiency • Pyruvate kinase deficiency

Examples of inherited conditions that make your body destroy too many RBCs include certain blood diseases and autoimmune disorders. These diseases cause your body to make antibodies (proteins made by the immune system) that destroy the RBCs too early. Another condition, in which a person lacks the enzyme glucose-6-phosphate dehydrogenase (G6PD), also can lead to anemia. Without this enzyme, the RBCs can break apart and die before the end of their usual lifespan.

Losing Too Many Red Blood Cells

The third main way in which people develop anemia is through blood loss. When you lose blood you can lose a large number of RBCs, and that can cause anemia. The loss of those RBCs also leads to low levels of iron in your body. Without enough iron, your body will make fewer RBCs than it needs, and the RBCs it does make will have less hemoglobin than normal. That, too, can lead to anemia.

What Can Cause Your Body To Lose Too Many Red Blood Cells?

Chronic Causes	Sudden Causes
• Heavy menstrual bleeding • Heavy, frequent nosebleeds • Bleeding in the digestive or urinary tract • Ulcers • Some cancers (e.g., digestive tract, kidney, and bladder)	• Injuries • Childbirth • Burst blood vessel • Heavy bleeding during surgery

Signs and Symptoms of Anemia

The signs and symptoms of anemia can be mild or severe (see "What Is the Difference Between Signs and Symptoms?" below for an explanation of the differences between signs and symptoms). They depend on how severe the anemia is and how quickly it develops. Generally, signs and symptoms increase as anemia gets worse. Many of the signs and symptoms of anemia also occur in other diseases and conditions.

Mild anemia may have no signs or symptoms. If you do develop signs and symptoms, you may have tiredness, weakness, or pale or yellowish skin. These signs and symptoms also occur in more severe anemia and are far more obvious.

As anemia gets worse, you also may experience faintness or dizziness, increased thirst, sweating, weak and rapid pulse, or fast breathing. Severe anemia may cause lower leg cramps during exercise, shortness of breath, or neurological (brain) damage. A lack of RBCs also may cause heart-related symptoms because your heart has to work harder to carry oxygen-rich blood through your body. These symptoms include arrhythmias (abnormal heart rhythms), heart murmur (an extra or unusual sound heard during a heartbeat), an enlarged heart, or even heart failure.

What Is the Difference Between Signs and Symptoms?

A sign is evidence of a disease or condition that someone else can see or measure. Yellowish skin, a low hemoglobin level, and abnormal heart rhythms are all signs of anemia.

A symptom is a feeling that a person experiences with a disease or condition. Tiredness and chest pain are symptoms of anemia.

SZE-PING

"It's important to tell your doctor what you are experiencing, so you can help your doctor diagnose your condition."

Diagnosing Anemia

People find out they have anemia in various ways. It may be found when you are being tested for another condition. (Iron-deficiency anemia is often found this way. You also might find out that you have iron-deficiency anemia if you try to give blood and are turned down because you have a low hemoglobin level.)

Or, you may have signs or symptoms and go to your doctor, who discovers the anemia through blood tests. Some signs and symptoms, like pale skin or tiredness, can be due to many causes besides anemia. Other signs and symptoms, like a low number of RBCs or abnormally shaped RBCs, are due only to anemia or even to a specific type of anemia.

Your doctor will likely take a few initial steps to find out whether your signs and symptoms are the result of anemia or some other condition. If these first steps suggest anemia, your doctor may recommend other tests and procedures to find out what kind of anemia you have and how severe it is. This information will help your doctor appropriately treat the anemia and the underlying condition causing it. Most anemias are treatable, so an accurate diagnosis is important.

This section provides general information about the steps in diagnosing anemia. See the "Types of Anemia" section on page 16 for information about diagnostic tests for specific types of anemia.

Medical and Family Histories

The first thing your doctor will do is ask you about your signs and symptoms and how long you've had them. Your doctor also will want to know about things that might possibly be causing anemia. For example, he or she may ask about your diet to see whether you're eating enough nutrient- and iron-rich foods. Or, you may be asked about medicines or supplements you take, whether you have any implanted medical devices (such as an artificial heart valve), or

whether you've been exposed to certain toxins or chemicals. Your answers will help your doctor figure out the possible cause of your anemia. Just as importantly, your answers can help your doctor rule out other possible causes of your signs and symptoms.

Your doctor also will want to learn about your medical and family histories. He or she may ask you about your menstrual and pregnancy history and about illnesses or conditions you've had. Your doctor also may ask about a family history of anemia or anemia-related conditions.

Physical Exam

Your doctor will give you a physical exam. This is done to confirm signs and symptoms and learn what organs or body systems may be involved. The findings will help your doctor determine your type of anemia and what condition may be causing it. The findings also will help your doctor decide how severe the anemia is.

Your doctor may check the color of your skin, gums, and nail beds and look for signs of bleeding or infection. He or she may listen to your heart for a rapid or irregular heartbeat and your lungs for rapid or uneven breathing. Your doctor also may feel your abdomen for an enlarged liver or spleen, check for bone pain, or conduct a pelvic or rectal exam to check for internal bleeding.

Your doctor also may conduct a neurological exam. This involves checking how well your muscles, senses, and reflexes work and testing to check your mental status, coordination, and ability to walk.

Tests and Procedures

Your doctor will recommend tests to figure out the type of anemia you may have and its severity. Often, the first test is a complete blood count (CBC). A CBC is a broad-scale test that provides a count of all the RBCs, white blood cells (WBCs), and platelets in a sample of your blood. It also includes other tests that provide useful information about your blood.

Your doctor can use this information to help determine whether you have anemia, what type you may have, and what underlying condition may be causing the anemia. Depending on the results of the CBC, your doctor may recommend further tests.

"Tests for Anemia" on page 12 summarizes the CBC and other common tests and procedures that your doctor may recommend to diagnose anemia.

Tests for Anemia

Complete Blood Count Tests

Test	What Does This Test Do?	What Clues Does It Reveal About Possible Anemia?
Red blood cell (RBC), white blood cell (WBC), and platelet count	Counts all the RBCs, WBCs, and platelets in a sample of blood. Gives information about the size, shape, and physical characteristics of the blood cells.	A lower than normal number of RBCs suggests anemia. Specific changes in number, size, or shape point to whether the anemia is caused by less production, more destruction, or loss of RBCs.
WBC differential	Identifies the five types of WBCs in a blood sample and the relative percentage of each in the sample.	Specific types of WBCs increase in response to certain diseases and conditions. A WBC differential can help identify a condition that may be causing anemia.
Hemoglobin	Measures the amount of oxygen-carrying protein in the blood.	A low level of hemoglobin points to diseases (such as iron-deficiency anemia) that usually cause the body to make too few RBCs.
Hematocrit	Measures how much space RBCs take up in your blood.	A low hematocrit level points to anemia. An abnormal hematocrit level also may be a sign of a blood or bone marrow disorder.
Mean corpuscular volume (MCV)	Measures the average size of RBCs.	RBC size gives a clue to the type of anemia. Larger than normal RBCs may suggest pernicious anemia caused by vitamin B12 or folate deficiency. Smaller than normal RBCs suggest iron-deficiency anemia or thalassemia (a rare, inherited anemia).
Mean corpuscular hemoglobin (MCH)	Calculates the average amount of oxygen-carrying hemoglobin inside an RBC.	Mirrors MCV results: Larger than normal RBCs have more oxygen-carrying hemoglobin; smaller than normal RBCs often have less.
Mean corpuscular hemoglobin concentra-tion (MCHC)	Calculates average concentration of hemoglobin inside an RBC.	Abnormal values may offer clues to the type of anemia or other possible conditions.
Red cell distribution width	Calculates the difference in size of RBCs.	Amount of difference in size may suggest the body is trying to make new RBCs to correct the anemia or may suggest a cause for the anemia.

Other Blood Tests

Test	What Does This Test Do?	What Clues Does It Reveal About Possible Anemia?
Blood smear	Shows size, shape, and number of RBCs, WBCs, and platelets. Used when complete blood count results are abnormal.	The presence of abnormal or immature blood cells can point to possible causes for the anemia.
Reticulocyte count	Measures the number of young RBCs in the blood. Shows whether the bone marrow is making enough RBCs at the correct rate or at a higher rate in an appropriate response to the anemia.	A markedly higher reticulocyte count may point to hemolytic anemia. A lower reticulocyte count can point to iron-deficiency anemia, pernicious anemia, aplastic anemia, or other anemias caused by reduced RBC production.
Serum iron*	Measures the total amount of iron in the blood.	Abnormal results on these tests can point to iron-deficiency anemia.
Total iron-binding capacity (TIBC)*	Measures the total amount of iron that can be bound by transferrin.	
Unsaturated iron-binding capacity (UIBC)*	Determines the portion of transferrin that is not yet saturated with iron.	
Transferrin saturation*	Shows the percentage of transferrin that is saturated with iron. It is calculated using results of serum iron, TIBC, and UIBC tests.	
Serum ferritin*	Reflects the amount of stored iron in your whole body.	
Coombs test	Looks for antibodies directed against RBCs.	A positive result points to the presence of antibodies (proteins made by the immune system). These results can point to hemolytic anemia.
G6PD test	Measures the amount of glucose-6-phosphate dehydrogenase (G6PD) in RBCs.	If RBCs lack the enzyme G6PD, they become weak and can break apart. (Enzymes are proteins that drive chemical reactions in the body.) Abnormal results can point to a G6PD deficiency, an inherited condition that can lead to hemolytic anemia.

** Iron is a part of hemoglobin. Nearly all iron in the blood is bound to a protein called transferrin. Transferrin transports iron to the bone marrow, where hemoglobin and RBCs are made, or to body tissues for storage.*

Tests for Anemia (continued)

Bone Marrow Tests

Test	What Does This Test Do?	What Clues Does It Reveal About Possible Anemia?
Bone marrow aspiration and bone marrow biopsy	Gives information about the marrow's ability to make enough healthy blood cells. (The doctor collects and evaluates a sample of bone marrow.)	Abnormal results showing only a few cells in the bone marrow can point to aplastic anemia.

Treating Anemia

The good news is that anemia often is easily treated. The treatment your doctor chooses will depend on the type of anemia you have, its cause, and how severe it is.

The main goals of treatment are to:

- Increase your RBC count or hemoglobin level to improve the oxygen-carrying capacity of your blood
- Treat the underlying condition causing your anemia
- Prevent complications of the anemia, such as heart or nerve damage
- Relieve symptoms and improve your quality of life

People who have mild or moderate anemia with no symptoms or whose anemia isn't getting worse may need no treatment. The exceptions include nutritional anemias such as iron-deficiency anemia, in which the low level of iron in the body may have other harmful effects besides anemia. (For more information, see the section on infants and children on page 19 under "Who Is At Risk for Iron-Deficiency Anemia?")

People who have severe anemia or anemia that's getting worse need treatment. Some rare anemias, like severe aplastic anemia, can be fatal without treatment. The risk of death may increase dramatically if a person has low levels of other blood cells besides RBCs, such as WBCs or platelets.

Anemia treatments are evolving and relate to the type of anemia. For example, iron-deficiency anemia and pernicious anemia are generally treated through dietary changes and supplements. Other types of anemia are treated with medicines, procedures, surgery, or lifestyle changes. Occasionally, a person may need blood transfusions, but this treatment is used only with severe anemia. (The "Types of Anemia" section on page 16 provides more detail on the treatments used for specific anemias. For a description of the health care providers who may help treat your anemia, see "Who Will Treat Your Anemia?" below.)

Who Will Treat Your Anemia?

Primary care providers—family doctors, internists, pediatricians, and nurse practitioners—can treat many anemias. Your health care provider also may want to work with one or more specialists to help treat your anemia. These specialists may include a:

- **Hematologist,** a doctor who specializes in treating blood disorders.
- **Gastroenterologist,** a doctor who specializes in treating digestive system and liver diseases and conditions.
- **Obstetrician/gynecologist,** a doctor who specializes in medical and surgical care for women and who focuses on pregnancy, childbirth, and disorders of the reproductive system.
- **Cardiologist,** a doctor who specializes in treating heart and blood vessel diseases and conditions.
- **Neurologist,** a doctor who specializes in treating nervous system disorders, including diseases of the brain, spinal cord, nerves, and muscles.
- **Registered dietitian,** an accredited food and nutrition expert.

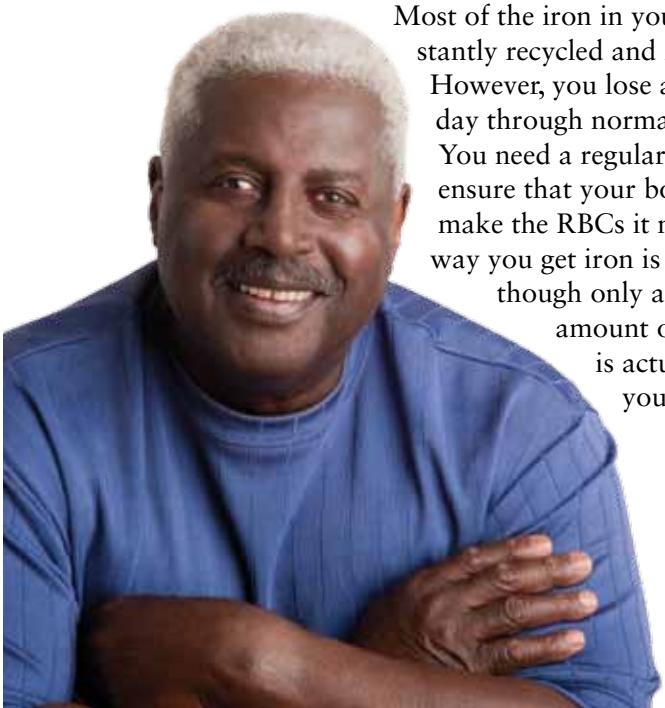
Types of Anemia

Iron-Deficiency Anemia

You probably know iron as a metal used in everyday products, such as wrought-iron fences and furniture. In prehistoric times, humans used iron to make tools. Today, you might use cast-iron cooking pots and pans.

Iron also is part of your body chemistry, and it plays an essential role in keeping you healthy. Your body needs iron to make hemoglobin, the protein in red blood cells (RBCs) that carries oxygen.

Your body has a tightly controlled system for absorbing, using, and recycling iron. In this system, iron first goes to the bone marrow, where it combines with hemoglobin and is used to make RBCs. Any extra iron that isn't immediately needed for RBCs is stored in body tissues. At the end of their lifespans, RBCs are destroyed and the hemoglobin is broken down. The iron is returned to the bone marrow, where it's used to make new RBCs.



Most of the iron in your body is constantly recycled and reused in this way. However, you lose a little iron every day through normal body processes. You need a regular source of iron to ensure that your body has enough to make the RBCs it needs. The main way you get iron is from food, though only a relatively small amount of the iron in food is actually absorbed by your body.

Your body's system of absorbing, using, and recycling iron works well until the iron "supply and demand" balance is upset.

What Is Iron-Deficiency Anemia and What Causes It?

At certain times—such as during pregnancy, growth spurts, or blood loss—your body may need to make more RBCs than usual. It therefore needs more iron than usual. Your body will get the extra iron it needs by increasing the amount of iron absorbed from food, drawing on stored iron, or both.

Iron-deficiency anemia is a condition in which your body can't match its need for iron. This can happen if demands for iron are too high, if supplies of iron are too low, or if iron is lost from the body because of too much bleeding (such as may occur during menstruation). (See "Causes of Iron-Deficiency Anemia" on page 18 for more details about these causes.)

Once you use up all the iron stores in your body and you can't absorb enough iron from food, your body will begin to make fewer RBCs and they will contain less hemoglobin than they should. This leads to iron-deficiency anemia, a common cause of anemia and the most common nutritional deficiency worldwide.

Causes of Iron-Deficiency Anemia

Iron-deficiency anemia may develop because the body's demand for iron is greater than its supply, because of low iron intake or poor iron absorption, or as a result of blood loss.

The body's demand for iron may go beyond its supply as a result of:

- Rapid growth in infancy, childhood, or adolescence
- The body trying to replace blood that is lost
- Pregnancy
- Erythropoietin therapy for kidney disease

Low iron intake or poor absorption of iron may occur as a result of:

- An inadequate diet
- An inability to absorb iron from your diet
- Acute or chronic inflammation (such as inflammatory bowel disease)

Blood loss that can lead to iron-deficiency anemia may occur as a result of:

- Chronic bleeding (for example, from a bleeding ulcer or other internal bleeding)
- Heavy blood loss from injury or surgery
- Heavy menstrual periods
- Frequent blood donation or phlebotomy (a medical procedure similar to blood donation) over a short time

Who Is At Risk for Iron-Deficiency Anemia?

Infants and children. Getting enough iron is essential for normal growth and development. Infants and children can be at high risk for iron-deficiency anemia because they are growing so quickly. They generally eat less than teens and adults, so it can be hard for them to get enough iron from their diets.

Some infants are at particularly high risk for iron-deficiency anemia. These include premature or low-birth-weight babies and babies who are fed formula that is not fortified with iron. Infants who are fed only breast milk for longer than 6 months and not given iron supplements also are at high risk.

Infants and young children who follow a diet with few iron-containing foods also are at high risk. Drinking more than recommended amounts of cow's milk can be a problem if it takes the place of iron-rich foods. Also, milk contains calcium, which can block iron absorption.

Finally, young children who had iron-deficiency anemia as infants also are at high risk for continuing to have this form of anemia.

Studies have shown that normal iron levels are needed for healthy brain development. Therefore, it is important to identify and treat iron-deficiency anemia, even if the anemia is not severe.

Adolescents. The body's need for iron is higher during the teen years. Teen boys and girls need extra iron because their bodies are growing and developing quickly.

Many teens can't keep up with this demand because their diets are low in iron-containing foods and, for girls, because of blood loss duing menstruation.

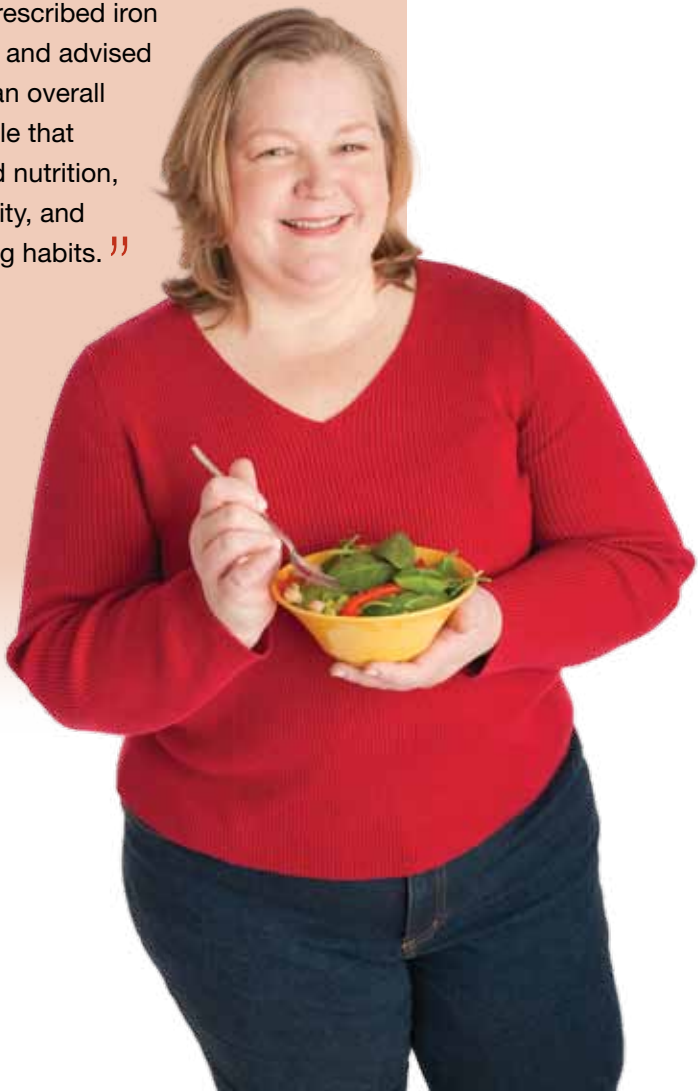
Women of childbearing age. During the childbearing years, women are at greater risk for iron-deficiency anemia because of blood loss during menstruation and high iron demands during pregnancy. About 1 in every 5 women of childbearing age has iron-deficiency anemia. (For more information about the body's iron needs during pregnancy, see "During Pregnancy, Your Body Needs More Iron" on page 21.)

SUSAN

"Before my diagnosis I was always very, very tired. I thought my busy lifestyle—a full-time job and part-time school—was to blame. I didn't think I had a medical condition.

"Some years later, I had surgery for a different health problem. At that time, doctors told me that my extreme tiredness was due to iron-deficiency anemia.

"My doctor prescribed iron supplements, and advised me to adopt an overall healthy lifestyle that includes good nutrition, physical activity, and better sleeping habits."



During Pregnancy, Your Body Needs More Iron

During pregnancy, your body changes in many ways. Your blood responds to meet these demands. The total amount of the fluid portion (plasma) of your blood expands by about half, and the number of your red blood cells (RBCs) increases by about 25 percent.

As a result, you need more iron and vitamins than usual to make hemoglobin for your RBCs. You'll also need extra iron to help your baby grow and develop normally and to support the placenta (the organ that connects your baby to you in the womb during pregnancy). You'll also need to build up iron stores to help your body recover from blood loss during delivery.

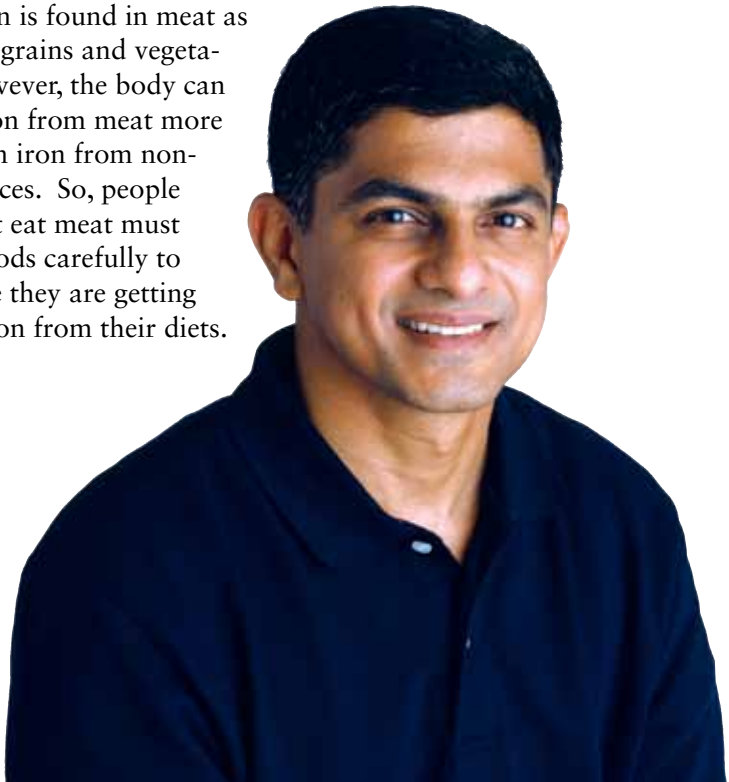
Some women enter pregnancy with very little iron stored in their bodies and with diets that are low in iron, B vitamins, and other nutrients needed to make hemoglobin. This is especially true for teens who become pregnant. About half of all pregnant women develop iron-deficiency anemia.

Iron-deficiency anemia during pregnancy is a serious problem because it can raise the risk for low birth-weight, preterm delivery, or death of the baby just before or after birth. It also may be related to maternal depression after the baby's birth.

All pregnant women should be tested for iron-deficiency anemia when they visit their doctors. Depending on the results, your doctor may talk to you about taking iron or other supplements and making changes in your diet. (See "Make Sure You Get Enough Iron From Your Diet" on page 23 for tips.)

Other at-risk groups. Several other groups also are at risk of developing iron-deficiency anemia:

- People who have gastrointestinal bleeding because of cancer, ulcers, or long-term use of aspirin or nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen or naproxen.
- People who have certain intestinal disorders, such as Crohn's disease or celiac disease.
- People who regularly use medicines to decrease stomach acid. These medicines affect the intestine's ability to absorb nutrients, including iron.
- People who have kidney failure and who are on dialysis. This group is at higher risk for iron-deficiency anemia because some bleeding occurs during dialysis and because the kidneys are no longer able to make erythropoietin, a hormone the body needs to make RBCs.
- People who eat few iron-rich foods or few foods that help the body absorb iron (such as foods with vitamin C).
- People who follow a vegetarian or vegan diet. (A vegetarian diet is meat-free and may include dairy products and eggs; a vegan diet includes no animal products.) Iron is found in meat as well as in grains and vegetables. However, the body can absorb iron from meat more easily than iron from non-meat sources. So, people who don't eat meat must choose foods carefully to make sure they are getting enough iron from their diets.



Make Sure You Get

Enough Iron From Your Diet

Iron is found in a variety of foods that come from animals and plants. Red meat, seafood (fish and shellfish), and poultry are the best sources because they contain heme, a form of iron that your body can absorb more easily than the iron in plant foods (called nonheme iron).

These tips can help you choose iron-rich foods and boost your body's absorption of iron. Check the Nutrition Facts label and ingredients list to learn more about the iron content of foods. Foods that have less than 5 percent of the Daily Value (DV) are low in iron. Foods with 20 percent or more of the DV are high in iron.

Choose foods that are sources of iron, such as:

- Clams, oysters, shrimp, and sardines
- Iron-fortified, ready-to-eat cereals and instant cooked cereals
- Organ meats (liver and giblets)
- Cooked dry beans and peas (white beans, lentils, chickpeas, kidney beans, and lima beans)
- Spinach and turnip greens
- Lean beef, lamb, and duck (without skin)

Make Sure You Get Enough Iron From Your Diet (continued)

Get the most out of the iron in your foods:

- To make the most of the iron from plant foods, combine them with meat and/or vitamin C-rich foods. For example, enjoy a bowl of chili made with kidney beans, beef, canned tomatoes, and tomato puree. The protein in the meat and the vitamin C in the tomatoes will boost absorption of the iron in the beans. Or, have a bowl of iron-fortified breakfast cereal with a glass of 100 percent orange juice.
- Include iron-enriched cereals, breads, and pasta (including iron-fortified whole-grain varieties) in your diet. Most refined-grain cereals, breads (such as white bread), and pasta available in grocery stores are enriched with iron and other nutrients. Check the Nutrition Facts label and ingredients list to learn more about the iron content of grain foods.
- Some foods and substances block absorption of iron—for example, coffee, tea, egg yolks, phytates in fiber-containing foods, and soy protein. Try to avoid these when you eat foods high in iron.

What Are the Signs and Symptoms of Iron-Deficiency Anemia?

Iron-deficiency anemia has a variety of signs and symptoms. They generally depend on how serious the anemia is. Often, mild anemia has no signs or symptoms. Many of the signs and symptoms of iron-deficiency anemia are found in other types of anemia as well.

Infants and young children who have iron-deficiency anemia can have poor appetite, slowed growth, and developmental or behavioral problems.

For adults, the most common symptom of iron-deficiency anemia is tiredness, which is caused by not having enough hemoglobin to

transport all the oxygen your body needs. Other signs and symptoms include pale skin, weak nails, swelling or soreness of the tongue, headaches, and dizziness or light-headedness. Shortness of breath during exercise, a fast heartbeat, cold hands and feet, and higher risk of infection also can occur in severe cases of iron-deficiency anemia.

People who have iron-deficiency anemia may get an unusual craving for nonfood substances, such as ice, dirt, or laundry starch. This craving is called pica. People also sometimes develop restless legs syndrome (RLS). RLS is a disorder in which people have a strong urge to move their legs. This urge can occur with strange tingling or crawling feelings in the legs.

Some signs and symptoms of iron-deficiency anemia are related to the cause of the anemia. For example, a sign of bleeding in the digestive tract is bright red blood in the stool or black stools.

How Is Iron-Deficiency Anemia Diagnosed?

Your doctor will use the basic tests described earlier (under "Diagnosing Anemia" on page 10) to diagnose iron-deficiency anemia. If your anemia is mild, you may have no signs or symptoms at all. Your doctor may discover the anemia while testing you for something else.

If you do have symptoms, your doctor will ask you about them and how long you've had them. He or she also will be interested in your diet and other illnesses or conditions you have that could be related (such as intestinal disorders that affect your ability to absorb iron from food). If you're a woman, your doctor will ask about your menstrual and pregnancy history. During the physical exam, your doctor may check your skin and nails and listen to your heart and lungs.

If your doctor suspects iron-deficiency anemia, he or she will likely recommend a complete blood count. If this blood test confirms the diagnosis, your doctor may recommend other blood tests to find out what's causing the anemia and how severe it is. These tests include a blood smear, a reticulocyte count, and blood iron tests. (See "Tests for Anemia" on page 12 for more details on these tests.)

Your doctor also may recommend tests to check the level of erythropoietin in your blood. This hormone stimulates the bone marrow to make RBCs.

If iron-deficiency anemia is confirmed and your doctor thinks it may be caused by internal bleeding, you may have one or more of the following tests to identify the cause:

- **Fecal occult blood test,** which detects blood in the stool.
- **Endoscopy,** a test in which a thin, flexible tube equipped with a video camera is passed down your throat to your stomach. This test allows your doctor to see whether you have any bleeding in your esophagus (the passage that runs from your mouth to your stomach) or stomach.
- **Colonoscopy,** a test in which a thin, flexible tube equipped with a video camera is passed through your rectum and into your colon. This test allows your doctor to check for internal bleeding in your lower digestive tract. In adult men and in teen boys who have gone through puberty who have no other obvious cause of anemia, this procedure may be necessary to prove that the cause is not from bleeding in the lower intestine. This may be the only way to be sure that the person doesn't have colon cancer, which can cause scarcely noticeable bleeding over a long period.
- **Ultrasound,** a painless and harmless test that uses high-frequency sound waves to create pictures of structures inside your body. Your doctor may order a pelvic ultrasound to see whether uterine fibroids (noncancerous tumors in the uterus) or other conditions are causing heavy menstrual bleeding.

How Is Iron-Deficiency Anemia Treated?

The two most common ways to treat iron-deficiency anemia are dietary changes and iron supplements. To get your blood iron up to a healthy level quickly, your doctor may suggest that you take an iron supplement, such as prescription ferrous sulfate tablets or an over-the-counter supplement. You may need to take the supplement for several months or longer to build up your body's iron stores.

Supplements come in pill form or in liquid form for children. Too-large amounts of iron can be harmful, so be sure to follow your doctor's instructions about how much to take. (Also see the safety note on page 27.)

Here are some additional tips on taking iron supplements:

- As the amount of iron you take increases, the amount that your body absorbs drops. Thus it's best to take a prescribed amount in two or three doses throughout the day rather than in a single dose.
- Iron supplements can upset your stomach. Taking them with food can help lessen this side effect. Your doctor also may suggest that you start with half the recommended dose and gradually build up to the full dose.
- Iron supplements can make you constipated, so your doctor may suggest a stool softener. Drinking plenty of water also can help. (Iron also tends to turn stools black, which is harmless.)
- Vitamin C helps with iron absorption, so your doctor may suggest that you take your iron supplement with 100 percent orange juice or a vitamin C tablet.

SAFETY NOTE

Keep Iron Supplements Out of Reach of Children

The high doses of iron in these supplements can quickly cause life-threatening poisoning if your child eats them.

This is particularly important for pregnant women taking prenatal vitamins. Because prenatal vitamins are often brightly colored capsules, your young child may think they are candy.

Your doctor also may suggest dietary changes, such as eating more iron-rich foods, iron-enriched breads and cereals, and fruits and vegetables that contain vitamin C. If you are a vegetarian or vegan, talk to your doctor or a registered dietitian about the best choices for your diet. This is especially important for vegetarian or vegan women who are pregnant or thinking about becoming pregnant.

In rare cases or if iron-deficiency is severe or caused by certain conditions, people may need other treatments for their iron-deficiency anemia. These treatments include blood transfusions, medicines such as erythropoietin therapy to help the bone marrow make more RBCs, or surgery to treat internal bleeding.

Pernicious Anemia

Iron-deficiency anemia isn't the only anemia that involves vitamins and minerals. A second type of anemia, called pernicious anemia, involves vitamin B12. Your body needs vitamin B12 and folate (another B vitamin) to make healthy red blood cells (RBCs). Vitamin B12 also is needed to make DNA (the building blocks of the body's genetic code) and for normal nerve function.

Unlike most B vitamins, B12 is found naturally in foods that come from animals—such as seafood, meat, poultry, eggs, and dairy products—and in brewer's yeast. Some breads, cereals, and soy beverages also are fortified with vitamin B12. Your body absorbs B12 from these foods and stores it in your liver until it is needed.

Pernicious anemia got its name (which means "deadly") because it usually was fatal in the past, before vitamin B12 shots were available. Today, pernicious anemia is easily treated.

What Is Pernicious Anemia and What Causes It?

Pernicious anemia is a condition in which the body can't make enough healthy RBCs because it can't absorb enough vitamin B12 from food. The body's inability to absorb vitamin B12 is due to a lack of intrinsic factor, a protein made in the stomach.

Other conditions also can cause pernicious anemia. For example, problems with the small intestine can prevent the body from absorbing vitamin B12. A lack of vitamin B12 in the diet also can lead to pernicious anemia. A vitamin B12 deficiency may occur with a folate deficiency.

Without enough vitamin B12, RBCs don't divide normally and are too big. They can have trouble getting out of the bone marrow and into the bloodstream.

Who Is At Risk for Pernicious Anemia?

Pernicious anemia is most common among people of Northern European descent, though it's also found in other populations. Those at increased risk of developing the condition include people who lack intrinsic factor, who can't properly absorb vitamin B12, or who don't get enough vitamin B12 in their diets.

People who lack intrinsic factor. Intrinsic factor attaches to vitamin B12 and takes it to the intestines, where it is absorbed. An autoimmune response may cause a lack of intrinsic factor in the body. This type of response can occur if the immune system makes antibodies (proteins made by the immune system) that attack the stomach cells that make intrinsic factor. Conditions such as Addison's disease, type 1 diabetes, Graves' disease, and vitiligo can cause this type of autoimmune response. Rarely, children are born with a condition called congenital pernicious anemia. This disorder prevents their bodies from making intrinsic factor. Surgery to remove part or all of the stomach also can lead to a lack of intrinsic factor because the surgery removes the cells that make the protein.

People who can't properly absorb vitamin B12. Conditions in which too many bacteria grow too fast in the intestine can prevent the body from absorbing vitamin B12. The bacteria use up all the vitamin B12 before the intestine can absorb it. This is a common cause of pernicious anemia in older people. Some gastrointestinal conditions, such as celiac disease and Crohn's disease, also interfere with vitamin B12 absorption.

Certain medicines can alter bacterial growth in the intestine or prevent proper absorption of vitamin B12. Also, the body may not be able to absorb enough vitamin B12 if all or part of the stomach is surgically removed.

Additionally, tapeworm infections can prevent the body from properly absorbing vitamin B12.

People who don't get enough vitamin B12 in their diets. Because vitamin B12 is naturally found only in foods that come from animals and in brewer's yeast, vegans must take vitamin B12 supplements and eat foods fortified with vitamin B12 to ensure that they get enough of this vitamin. Breastfed babies of strict vegetarians and vegans are at risk because they are not able to store up enough vitamin B12 in their bodies. Older people and people who suffer from alcoholism also may be at risk for pernicious anemia if they don't get enough vitamin B12 in their diets.

What Are the Signs and Symptoms of Pernicious Anemia?

Your body stores large amounts of vitamin B12 that it absorbs from food. It can take 3 to 5 years for your body to exhaust its stores and for signs and symptoms of pernicious anemia to occur. Some signs and symptoms are specific to a vitamin B12 deficiency. Others are the result of the anemia that the vitamin B12 deficiency causes.

Signs and symptoms of pernicious anemia develop slowly. The most common symptom, which occurs in all types of anemia, is tiredness. Tiredness occurs because your body doesn't have enough RBCs to carry all of the oxygen it needs.

Too few RBCs also can cause light-headedness and dizziness, palpitations and rapid heartbeats, and shortness of breath. (Palpitations are feelings that your heart is skipping a beat, fluttering, or beating too hard or too fast.) Other possible signs and symptoms of pernicious anemia include cold hands and feet, pale or yellowish skin, pale gums and nail beds, and chest pain. Heart-related symptoms also can occur, such as heart murmur (an extra or unusual sound heard during a heartbeat), an enlarged heart, or even heart failure.

Over time, a vitamin B12 deficiency can lead to nerve damage. This can cause symptoms such as tingling and numbness in the hands and feet, muscle weakness, problems walking, and irritability. Nerve damage also can cause problems such as memory loss, dementia (a loss of brain function), depression, and psychosis (mental illness).

Digestive tract problems—such as nausea, poor appetite, weight loss, and diarrhea—also can happen with a vitamin B12 deficiency.

SHERMAN

"I went to the doctor for some routine blood tests and found out I had vitamin B12 deficiency (pernicious anemia). I didn't have any symptoms, and didn't know I had a B12 deficiency until the doctor told me.

"The doctor said that taking vitamin B12 shots would give me more pep. He started me out with vitamin B12 shots once a week for 6 weeks. Now I only need them once a month.

"I've always eaten pretty healthy. And while I've slowed down a bit since my diagnosis of pernicious anemia, I still walk 2 miles 3–4 times a week."

Infants who are lacking vitamin B12 may have poor reflexes and unusual movements. They also may have trouble feeding and be irritable. In severe cases, these infants may fail to thrive and have permanent growth problems.

How Is Pernicious Anemia Diagnosed?

Pernicious anemia is diagnosed based on your medical and family histories, a physical exam, and the results from tests. Your doctor will ask you about your symptoms, diet, and history of medical conditions and surgeries. He or she also will ask whether you or anyone in your family has had a vitamin B12 deficiency or anemia. This information will give your doctor important clues about whether you have pernicious anemia and its possible cause.

During the physical exam, your doctor may check your skin and tongue, listen to your heart, and check for signs of nerve damage. This will help your doctor learn more about the severity of your anemia and how the disorder is affecting your body.

Your doctor may recommend tests to help diagnose pernicious anemia and find out what's causing it. Often, the first test used to diagnose anemia is a complete blood count (CBC). This test measures many parts of your blood and looks at the number and appearance of your blood cells. In pernicious anemia, the RBCs are larger than normal. (For more information about the CBC, see "Tests for Anemia" on page 12.)

If the CBC shows that you have anemia, your doctor may recommend other tests, including:

- **A reticulocyte count.** This test measures the number of young RBCs in your blood. The results tell your doctor whether your bone marrow is making enough healthy RBCs. People who have pernicious anemia have low reticulocyte counts.
- **A test for blood levels of vitamins.** This test measures levels of vitamin B12, folate, and vitamin C in your blood.
- **A test for homocysteine and methylmalonic acid levels.** People who have pernicious anemia have higher than normal levels of these substances in their blood.

- **An antibodies test.** This test measures whether your body is making antibodies to attack the stomach cells that make intrinsic factor. Results of this test will reveal the cause of your pernicious anemia.
- **Bone marrow tests.** These tests show whether your bone marrow is healthy and making enough healthy RBCs. People who have pernicious anemia have larger than normal bone marrow cells.

How Is Pernicious Anemia Treated?

The two main treatments for pernicious anemia are vitamin B12 supplements and dietary changes. It's important to begin treatment as soon as pernicious anemia is diagnosed. A vitamin B12 deficiency can cause nervous system problems that may become permanent if the deficiency isn't treated promptly. With the right treatment, symptoms of vitamin B12 deficiency and pernicious anemia improve quickly.

If you have severe pernicious anemia that's due to a lack of intrinsic factor, vitamin B12 shots usually are recommended. The shots are given often at first—every day or several times a week—until your vitamin B12 levels return to normal. After that, you will continue to need shots less often—perhaps only once a month.

If your pernicious anemia is due to bacteria in your intestine that prevent you from absorbing vitamin B12, your doctor may prescribe antibiotics.

If your pernicious anemia is due to a lack of vitamin B12 in your diet, your doctor may recommend vitamin B12 supplements. These supplements come in pill, nasal spray, and gel forms. Your doctor also will suggest dietary changes so that you eat plenty of foods that contain vitamin B12. These foods include:

- Fish, shellfish, meat, and poultry
- Eggs and dairy products (such as yogurt and cheese)
- Breads, cereals, and other foods fortified with vitamin B12
- Soy-based beverages and vegetarian burgers fortified with vitamin B12

Aplastic Anemia

The term "anemia" usually refers to a condition in which your blood has a lower than normal number of red blood cells (RBCs). However, some types of anemia, such as aplastic anemia, cause lower than normal numbers of other blood cells, too.

Your bone marrow makes stem cells, which develop into the three types of blood cells—RBCs, white blood cells (WBCs), and platelets. (These stem cells are different from embryonic stem cells, which can develop into any type of cell in the body. Embryonic stem cells aren't found in bone marrow.)

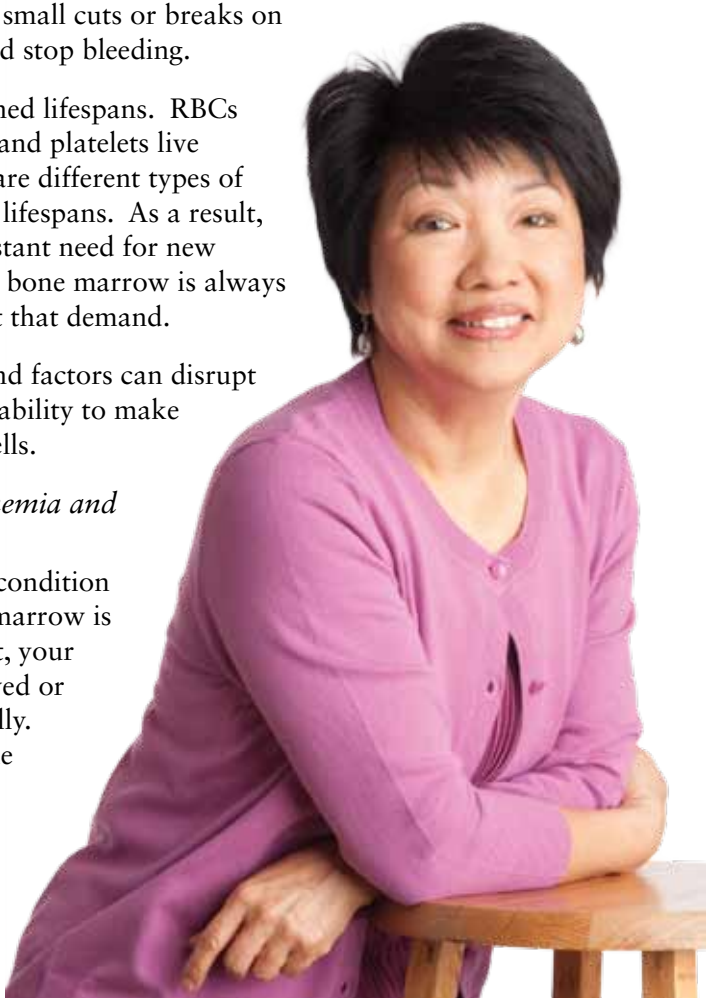
RBCs carry oxygen to all parts of your body. They also remove carbon dioxide (a waste product) from your body's cells and carry it to the lungs to be exhaled. WBCs help your body fight infections. Platelets are blood cell fragments that help your blood clot. They stick together to seal small cuts or breaks on blood vessel walls and stop bleeding.

Blood cells have defined lifespans. RBCs live about 120 days, and platelets live about 6 days. There are different types of WBCs with different lifespans. As a result, your body has a constant need for new blood cells, and your bone marrow is always hard at work to meet that demand.

Certain conditions and factors can disrupt your bone marrow's ability to make healthy new blood cells.

What Is Aplastic Anemia and What Causes It?

Aplastic anemia is a condition in which your bone marrow is damaged. As a result, your stem cells are destroyed or don't develop normally. Your body can't make



enough RBCs, WBCs, or platelets. This type of anemia is rare, but it can be fatal.

Aplastic anemia can be acquired or inherited. Many times, the cause of the aplastic anemia or the condition that triggers it is unknown.

Known causes of acquired aplastic anemia include:

- **High-dose radiation or chemotherapy.** These cancer treatments kill cancer cells, but they also may damage other cells, such as stem cells. When stem cells are damaged, they can't develop into healthy RBCs, WBCs, and platelets. Aplastic anemia may go away after these cancer treatments are stopped.
- **Environmental toxins.** Substances such as pesticides, arsenic, and benzene can damage your bone marrow, causing aplastic anemia.
- **Certain medicines.** Medicines used to treat rheumatoid arthritis and some antibiotics, such as chloramphenicol (which is rarely used in the United States), can damage the bone marrow and cause aplastic anemia.
- **Viral infections.** Hepatitis, Epstein-Barr virus, parvovirus B-19, human immunodeficiency virus (HIV), mononucleosis, and cytomegalovirus can damage the bone marrow and lead to aplastic anemia.
- **Autoimmune diseases.** These diseases, such as lupus and rheumatoid arthritis, may cause your immune system to attack its own cells. This can damage bone marrow cells and prevent them from making enough healthy, new blood cells.

Some inherited conditions can damage your stem cells, leading to aplastic anemia. These conditions include Fanconi anemia, Shwachman-Diamond syndrome, dyskeratosis congenita, Diamond-Blackfan anemia, and amegakaryocytic thrombocytopenia.

Some women may develop mild aplastic anemia during pregnancy. This anemia tends to go away after the baby is born.

In some cases, aplastic anemia is associated with another blood disorder called paroxysmal nocturnal hemoglobinuria (PNH). A genetic mutation causes PNH. The disorder develops when abnormal stem cells in the bone marrow make blood cells with a

faulty outer membrane (outside layer). This destroys RBCs and prevents the body from making enough WBCs and platelets.

Aplastic anemia may only last a short time if it's due to a short-term condition, illness, or other factor. However, aplastic anemia can be a long-term condition if its cause is unknown or if an inherited condition or long-term illness or other factor causes it.

Who Is At Risk for Aplastic Anemia?

People of all ages can develop aplastic anemia, but it is more common in adolescents, young adults, and the elderly. The condition also is more common in Asian countries than in the United States.

Aplastic anemia is a rare disease. People at increased risk may include those who:

- Are undergoing high-dose radiation or chemotherapy for cancer
- Are exposed to certain environmental toxins, such as pesticides, arsenic, and benzene
- Take certain medicines, such as those used to treat rheumatoid arthritis and some types of antibiotics
- Have certain infectious diseases, autoimmune disorders, and inherited conditions that can damage the bone marrow

What Are the Signs and Symptoms of Aplastic Anemia?

Lower than normal numbers of RBCs, WBCs, and platelets cause the signs and symptoms of aplastic anemia. Signs and symptoms can be mild, moderate, or severe. Severe aplastic anemia can be life-threatening.

A lower than normal number of RBCs can cause tiredness; weakness; shortness of breath; pale skin, gums, and nail beds; dizziness; headaches; cold hands and feet; and chest pain. A lower than normal number of WBCs can cause fever, frequent or severe infections, and lingering flu-like symptoms. A lower than normal number of platelets can cause easy bleeding or bruising, petechiae (pinpoint red spots on the skin), nosebleeds, bleeding gums, blood in the stool, and heavy menstrual periods.

Other signs and symptoms of aplastic anemia can include nausea and skin rashes.

People who have PNH and aplastic anemia may have other signs and symptoms, including blood in the urine, swelling or pain in the abdomen, swelling in the legs, headaches, and jaundice (a yellowish color of the skin or whites of the eyes).

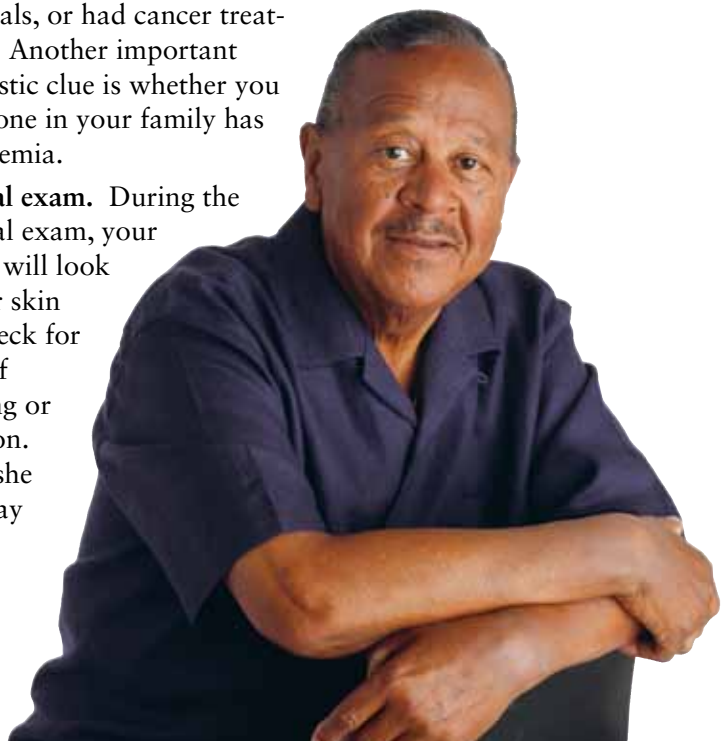
How Is Aplastic Anemia Diagnosed?

You may have aplastic anemia if a complete blood count (CBC) shows that you have lower than normal numbers of more than one blood cell type (RBCs, WBCs, or platelets) in your bloodstream. If these numbers are very low, you also may have symptoms. For example, you may have bruising or petechiae if your platelet count is very low.

Bone marrow tests are needed to confirm a diagnosis of aplastic anemia. Results from these tests will confirm low numbers of RBCs, WBCs, and platelets in the bone marrow.

Your doctor will use your medical and family histories, a physical exam, and other tests to determine possible causes of aplastic anemia.

- **Medical and family histories.** Your doctor will ask about your symptoms and how long you've had them. He or she also will want to know whether you've had any viral infections, been exposed to toxins or chemicals, or had cancer treatments. Another important diagnostic clue is whether you or anyone in your family has had anemia.
- **Physical exam.** During the physical exam, your doctor will look at your skin and check for signs of bleeding or infection. He or she also may



listen to your heart and lungs for any abnormal sounds and feel your abdomen and legs to see whether they feel normal. The physical exam findings will help your doctor learn how severe your condition is and what may be causing it.

- **Other tests.** In addition to the bone marrow test, your doctor may recommend a chest x ray, a computed tomography (CT) scan, ultrasound imaging, liver tests, tests for viral infections, tests for vitamin B12 and folate levels in your blood, and/or a specialized test for PNH. These tests can tell your doctor how severe your anemia is, what's causing it, and whether you have PNH. The signs and symptoms of aplastic anemia are similar to those of other conditions and other types of anemia. So, these tests can help your doctor rule out certain conditions as a cause of your anemia.

How Is Aplastic Anemia Treated?

Treatments for aplastic anemia are designed to relieve your symptoms, limit or prevent complications, and improve your quality of life. If you have mild or moderate aplastic anemia, you may not need treatment if your condition isn't getting worse. If you have severe aplastic anemia, you'll need treatment to prevent complications. Very severe aplastic anemia, which causes very low blood cell counts, can be fatal and requires treatment as soon as possible.

Aplastic anemia is treated with blood transfusions, medicines, blood and marrow stem cell transplants, and other treatments and lifestyle changes.

Blood transfusions. Blood transfusions are a common procedure in which you get blood through an intravenous (IV) line inserted in one of your blood vessels. The blood you get is carefully matched to your own blood type. Transfusions can help bring your blood cell counts up to a normal level. They help relieve symptoms but are not a permanent treatment.

Medicines. Your doctor may recommend medicines to treat the cause of your anemia or help prevent or treat complications. For example, your doctor may prescribe medicines to suppress your immune system or stimulate your bone marrow to make RBCs. One example of a medicine that can stimulate your bone marrow is

erythropoietin therapy. Your doctor also may prescribe medicines to prevent or treat an infection that may occur because your WBC count is low.

Blood and marrow stem cell transplants. Blood and marrow stem cell transplants replace damaged stem cells in your bone marrow with healthy ones. For this procedure, high doses of chemotherapy and possibly radiation are used to destroy your faulty stem cells. Then, donor stem cells are put into a blood vessel through an IV tube placed in your chest. These cells are carefully matched to your own cell type. Once the stem cells are in your body, they travel to your bone marrow and begin making new RBCs, WBCs, and platelets.

Blood and marrow stem cell transplants generally are the best treatment option for people who have severe aplastic anemia and are eligible for this treatment. This type of transplant works best in children and young adults who are in good health and have donors with closely matching cell types.

Other treatments and lifestyle changes. Aplastic anemia also is treated in other ways. For example, removing a known cause of aplastic anemia may cure the condition. Examples of known causes include high-dose radiation or chemotherapy treatment, exposure to environmental toxins, and certain medicines.

Lifestyle changes also can help protect you from problems linked to aplastic anemia. For example, because your RBC count is low, you may feel tired or short of breath. Conserve your energy and don't overdo physical activity. Because your platelet count is low, you're at risk of bleeding. Avoid activities in which you might cut or injure yourself. Because your WBC count is low, your body is less able to fight infections. Protect yourself by washing your hands often and avoiding crowds and people who are sick. See your doctor if you develop a fever (a sign of infection). Talk to your doctor about other lifestyle changes that can protect you from problems linked to aplastic anemia.

SHIRAH

"I found out I had aplastic anemia in an odd way. The day after a scuba diving trip, I was covered with bruises that I could not explain. I went to the doctor and was immediately hospitalized and given a blood transfusion. The doctors told me I almost didn't have enough blood in my body. They diagnosed me with aplastic anemia, a blood disorder where your body has trouble making new blood cells.

"Looking back, there were little signs that I ignored—previous bruising and tiredness—and I now know that I should have seen a doctor much earlier than I did."

Hemolytic Anemia

Normally, red blood cells (RBCs) have a lifespan of about 120 days. At the end of that time, your body breaks them down. Then, an organ called the spleen removes the RBCs from your bloodstream. Your body is constantly making new RBCs to replace the ones that die. Sometimes, RBCs are destroyed and removed from the bloodstream before their normal lifespan is up, a process called hemolysis.

Your bone marrow can try to make up for hemolysis by increasing the number of RBCs it makes. However, over time, your body sometimes can't make enough RBCs to replace the ones that are destroyed too early. This leads to lower than normal levels of RBCs in your body.

What Is Hemolytic Anemia and What Causes It?

Hemolytic anemia is a condition in which your bone marrow can't make enough new RBCs to replace the ones that are destroyed too early. There are many types of hemolytic anemia and many causes. Hemolytic anemia can be acquired or inherited. Sometimes, the cause isn't known.

In **acquired hemolytic anemia,** your body gets a signal that something is wrong with its RBCs even though they are normal. For example, antibodies (proteins made by the immune system) may tell your body's immune system that the RBCs do not belong. In response, your body destroys the RBCs before their usual lifespan is up.

Causes of acquired hemolytic anemia include:

- Autoimmune responses
- Physical damage to RBCs from certain conditions and factors
- Exposure to certain infectious organisms and toxins
- Reactions to certain medicines

The destruction of RBCs commonly occurs in your spleen, but it also can happen in your bloodstream.

Inherited hemolytic anemia is related to problems with the genes that control how your RBCs are made. This causes defects in the outer membranes of the RBCs, enzyme deficiencies inside RBCs, or hemoglobin disorders. The abnormal RBCs are fragile and may break down as they move through your bloodstream. If this happens, your spleen may remove the faulty RBCs from your blood.

For more information about the various types of acquired and inherited hemolytic anemia, see "Types of Hemolytic Anemia" on page 42.

Types of Hemolytic Anemia

Types of Acquired Hemolytic Anemia

Type	Characteristic
Immune hemolytic anemia	● The immune system destroys RBCs. The three types of immune hemolytic anemia are: – **Autoimmune hemolytic anemia (AIHA).** AIHA is the main cause of hemolytic anemia. The immune system makes antibodies (proteins) that attack the RBCs. AIHA can develop very suddenly. Certain diseases or infections can raise the risk for AIHA (for example, lupus, chronic lymphocytic leukemia, non-Hodgkin's lymphoma, other blood cancers, Epstein-Barr virus, cytomegalovirus, mycoplasma pneumonia, hepatitis, and HIV). Some AIHA antibodies become active only in warm temperatures; others only in cold temperatures. – **Alloimmune hemolytic anemia.** In this hemolytic anemia, a person's immune system makes antibodies against blood that is a different type than his or her own blood. This may occur in a blood transfusion from a donor who has a different blood type. It also can occur during pregnancy if the fetus has a different blood type than the mother (this condition is called Rh incompatibility). – **Drug-induced hemolytic anemia.** Some medicines (like penicillin, acetaminophen, antimalaria medicines, and levodopa) may cause an immune reaction that destroys RBCs.
Mechanical hemolytic anemia	● Hemolytic anemia develops because RBCs are physically damaged. This damage may result from a heart-lung bypass machine (used during open-heart surgery); an artificial heart valve that's not working well; an increase in body temperature due to exposure to extreme heat or extensive burns; or preeclampsia (very high blood pressure during pregnancy).
Paroxysmal nocturnal hemoglobinuria (PNH)	● Abnormal stem cells in the bone marrow make blood cells with a faulty outer membrane. This causes the body to destroy its RBCs and make too few WBCs and platelets.
Other causes of acquired hemolytic anemia	● Some infections and toxic substances can damage or destroy RBCs, leading to hemolytic anemia. Examples include malaria, blackwater fever, tick-borne diseases, snake venom, and toxic chemicals.

Types of Inherited Hemolytic Anemia

Type	Characteristic
Sickle cell anemia	• The body makes abnormal hemoglobin that causes red blood cells (RBCs) to have a sickle, or "C," shape. These sickle cells are sticky and don't travel easily through the blood vessels. • Sickle cells live only about 10–20 days, and the bone marrow can't make new RBCs fast enough to replace the dying ones. • In the United States, sickle cell anemia mainly affects people of African and Hispanic descent. • All States require sickle cell anemia screening for newborn babies.
Thalassemias	• The body doesn't make enough of certain types of hemoglobin, which prevents it from making enough healthy RBCs. • Thalassemias often affect people of Southeast Asian, Indian, Chinese, Filipino, Mediterranean, or African descent.
Hereditary spherocytosis	• A defect in the RBCs' outer membranes that causes them to have a spherical, or ball-like, shape. • The ball-shaped RBCs have a shorter than normal lifespan. • Hereditary spherocytosis is the most common cause of hemolytic anemia among people of Northern European descent.
Hereditary elliptocytosis (ovalocytosis)	• A defect in the RBCs' outer membranes makes them oval-shaped and less flexible than normal. They have a shorter than normal lifespan.
Glucose-6-phosphate dehydrogenase (G6PD) deficiency	• The RBCs are missing an enzyme called G6PD. (Enzymes are proteins that drive chemical reactions in the body.) The missing enzyme makes the RBCs fragile and more likely to break down. • If the RBCs come in contact with certain substances in the bloodstream, they rupture and die. • Many factors, including those in certain medicines, foods (like fava beans), and infections, can trigger the breakdown of the RBCs. • G6PD deficiency mostly affects men of African or Mediterranean descent. • Most States require G6PD deficiency screening for newborn babies.
Pyruvate kinase deficiency	• The RBCs are missing an enzyme called pyruvate kinase. This causes them to break down easily. • Pyruvate kinase deficiency is more common among the Amish.

Who Is At Risk for Hemolytic Anemia?

Hemolytic anemia affects people of all ages and races and both sexes. The different types of hemolytic anemia affect various populations. For example, some types of inherited hemolytic anemia, such as glucose-6-phosphate dehydrogenase (G6PD) deficiency, are most common in people of African or Mediterranean descent.

Some types of acquired hemolytic anemia also affect certain populations. For example, alloimmune hemolytic anemia can occur in pregnant women and their fetuses. Mechanical hemolytic anemia may happen in people who have artificial heart valves or who use a heart-lung bypass machine during open-heart surgery.

What Are the Signs and Symptoms of Hemolytic Anemia?

The signs and symptoms vary widely and depend on the type and severity of the hemolytic anemia. Some signs and symptoms are common to all types of anemia, such as:

- Tiredness and weakness
- Pale skin, gums, and nail beds
- Dizziness
- Shortness of breath
- Headaches
- Cold hands and feet
- Chest pain

Other signs and symptoms are specific to hemolytic anemia; they reflect what is happening in the body as RBCs are destroyed and the number of RBCs decreases. These signs and symptoms include:

- Jaundice (a yellowish color of the skin or whites of the eyes); this sign often is very severe in hemolytic anemia
- Pain in the upper abdomen
- Reddish or brown urine
- An enlarged spleen (see "The Spleen: Your Body's Natural Filter" on page 45 for more information)
- Chills

The Spleen: Your Body's Natural Filter

The spleen is a small organ that lies behind the stomach on the left side of the abdomen. This organ filters blood and helps fight infections. One of the spleen's jobs is to remove red blood cells (RBCs) when they come to the end of their lifespan. If large numbers of RBCs are destroyed in a short period, they will become trapped in the spleen. Over time, this can cause the spleen to become larger than normal.

How Is Hemolytic Anemia Diagnosed?

Like other types of anemia, hemolytic anemia is diagnosed based on your personal and family medical histories, a physical exam, and the results of tests.

First, your doctor may ask about your symptoms and how long you've had them. He or she also will review your and your family's medical histories and may ask whether:

- Any of your relatives have an inherited anemia, such as sickle cell anemia, thalassemia, or G6PD deficiency
- Any of your family members have had jaundice
- You've recently had any illnesses or other medical conditions
- You take medicines, and which ones
- You've been exposed to any chemicals or toxic substances
- You have an artificial heart valve

Your answers to these questions will help indicate whether you have hemolytic anemia and provide clues about the cause and severity of the condition.

During the physical exam, your doctor will check for signs of anemia, such as pale skin and fingernails, fast breathing, and rapid heartbeats. He or she also may feel your abdomen to see whether you have an enlarged spleen.

Many tests are used to confirm a diagnosis of hemolytic anemia and determine the specific type of this anemia. Often, the first test used to diagnose anemia is a complete blood count (CBC). This test measures many parts of your blood and looks at the number and appearance of your blood cells. (For more information about the CBC, see "Tests for Anemia" on page 12.) If the CBC confirms that you have anemia, your doctor may recommend additional blood and other tests.

Blood Tests

- **A reticulocyte count.** This test measures the number of young RBCs in your blood. The results tell your doctor whether your bone marrow is making enough healthy RBCs.
- **A blood smear.** This test shows the shape of your RBCs. An abnormal shape is a sign of an inherited hemolytic anemia; the exact shape tells the type of inherited hemolytic anemia. For example, sphere-shaped RBCs indicate hereditary spherocytosis.
- **Coombs' test.** This test determines whether your immune system is making antibodies to destroy your RBCs.
- **Haptoglobin and bilirubin tests.** When RBCs break down, they release hemoglobin into your bloodstream. Hemoglobin combines with a chemical called haptoglobin. A low level of haptoglobin in the blood indicates hemolytic anemia. Hemoglobin also breaks down into a compound called bilirubin. High levels of bilirubin may suggest hemolytic anemia.
- **Hemoglobin electrophoresis.** This test shows the different kinds of hemoglobin in your blood; it also can help identify the type of anemia you may have.
- **Test for paroxysmal nocturnal hemoglobinuria (PNH).** This test shows whether RBCs lack a particular protein involved in PNH.
- **Osmotic fragility.** This test shows whether your RBCs are more fragile than normal. It also can point to the type of anemia you may have.
- **Test for G6PD deficiency.** A lack of G6PD enzymes in your RBCs indicates that you have G6PD deficiency.

LINDA

"I have an inherited genetic type of hemolytic anemia—G6PD deficiency. My Italian heritage was an important clue to figuring out my illness, because it is an inherited illness that is common in Sicily, where my family came from.

"Since being diagnosed, my whole life has changed. I follow a healthy diet, avoiding triggers like fava beans and certain medications.

"Staying healthy and avoiding the foods and other triggers can almost totally prevent the symptoms."

Other Tests

- **Liver function tests.** Various liver and gallbladder problems can cause a high bilirubin level in the blood. Liver function tests are done to find out why your bilirubin level is too high.
- **Bone marrow tests.** If the results of blood tests don't clearly show that you have hemolytic anemia, your doctor may recommend bone marrow tests. These tests show whether your bone marrow is making enough healthy blood cells.

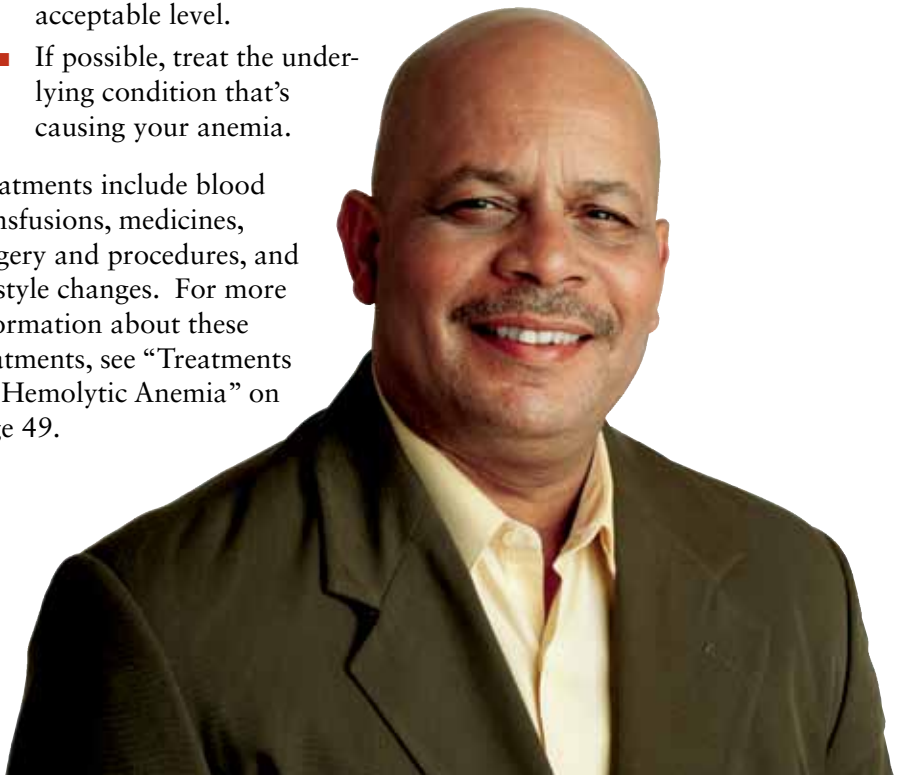
How Is Hemolytic Anemia Treated?

Treatment for hemolytic anemia depends on the type of hemolytic anemia you have and its severity. Your doctor will consider your age, medical history, and overall health when planning your treatment. You may not need treatment if your anemia is mild and isn't getting worse. Severe hemolytic anemia generally needs ongoing treatment and can be fatal if not treated properly.

When planning your treatment, your doctor will have several goals in mind:

- Reduce or stop the destruction of RBCs.
- Increase your RBC count to an acceptable level.
- If possible, treat the underlying condition that's causing your anemia.

Treatments include blood transfusions, medicines, surgery and procedures, and lifestyle changes. For more information about these treatments, see "Treatments for Hemolytic Anemia" on page 49.



Treatments for Hemolytic Anemia

Treatments for Acquired Hemolytic Anemia

Type	Possible Treatments
Immune hemolytic anemia	• Corticosteroids and other medicines to suppress the immune system. • Removal of the spleen. • Plasmapheresis (a procedure to remove antibodies from the blood). • Avoidance of cold temperatures (for example, wear gloves, a hat, and a scarf; dress warmly in air conditioning; keep your car warm when driving in cold weather). • Intravenous gammaglobulin, a medicine that may increase the lifespan of RBCs and possibly reduce the amount of antibodies produced.
Mechanical hemolytic anemia	• Folic acid supplements. • Blood transfusions.
Paroxysmal nocturnal hemoglobinuria	• Iron and folic acid supplements. • Eculizumab (an antibody that blocks the destruction of RBCs in this form of anemia).

Treatments for Inherited Hemolytic Anemia

Type	Possible Treatments
Hemoglobin disorders (sickle cell anemia and thalassemias)	• **For sickle cell anemia:** Folic acid supplements (made from the synthetic form of folate), antibiotics to prevent infection, medicine to reduce the number of faulty red blood cells (RBCs) in the blood, and a medicine called hydroxyurea. Hydroxyurea may help the body make more healthy hemoglobin and reduce the amount of faulty hemoglobin that leads to sickle cells. • **For thalassemias:** Blood transfusions to replace destroyed RBCs, and blood and marrow stem cell transplants.
Disorders of the RBC outer membrane (hereditary spherocytosis and hereditary elliptocytosis)	• Folic acid supplements. • Blood transfusions. • Removal of the spleen (rarely).
Enzyme deficiencies	• **For glucose-6-phosphate dehydrogenase (G6PD) deficiency:** Avoidance of substances that trigger the condition, such as fava beans, naphthalene (a substance in mothballs), and certain medicines. • **For pyruvate kinase deficiency:** Folic acid supplements and blood transfusions.

Research on Anemia

For many years, the National Heart, Lung, and Blood Institute (NHLBI) has supported research aimed at finding the causes of blood disorders and ways to prevent or treat them. Researchers have learned a lot about anemia and other blood disorders through these studies. That knowledge has led to improvements in prevention and care.

Common types of anemias are generally straightforward and easily treated. As a result, NHLBI's clinical research on anemias is focused on a few specific, rarer types, including sickle cell and thalassemia. Research on these and other blood disorders continues to be an important priority for the NHLBI.

This effort depends on the willingness of volunteers to participate in clinical research. If you would like to help researchers gather information about your disorder and possible treatments, talk to your doctor. (For more information, see "Clinical Research" below.)

Clinical Research

To fully understand a disorder and how best to diagnose and treat it, researchers need to do clinical research with people who have the disorder. This type of research is called clinical research because it is often conducted in clinical settings, such as hospitals or doctors' offices.

- **Clinical trials** test new ways to diagnose, prevent, or treat various disorders. For example, treatments (such as medicines, medical devices, surgery, or other procedures) for a disorder need to be tested in people who have the disorder. A trial helps determine whether a treatment is safe and effective in humans before it is made available for public use. In a clinical trial, participants are randomly assigned to groups. One group receives the new treatment being

tested. Other groups may receive a different treatment or a placebo (an inactive substance resembling a drug being tested). Comparing results from the groups gives researchers confidence that changes in the test group are due to the new treatment and not to other factors.

- **Other types of clinical studies** are done to discover the factors, including environmental, behavioral, or genetic factors, that cause or worsen various disorders. Researchers may follow a group of people over time to learn what factors contribute to becoming sick. These types of studies gave us the important information that smoking is a risk factor for both heart disease and lung cancer, for example.

Clinical studies and trials may be relatively brief, or they may last for years and require many visits to the study sites. These sites usually are university hospitals or research centers, but they can include private doctors' offices and community hospitals.

If you participate in clinical research, the research will be explained to you in detail, you will be given a chance to ask questions, and you will be asked to provide written permission. You may not directly benefit from the results of the clinical research you participate in, but the information gathered will help others and will add to scientific knowledge. Taking part in clinical research has other benefits, as well. You'll learn more about your disorder, you'll have the support of a team of health care providers, and your health will likely be monitored closely. However, participation also can have risks, which you should discuss with your doctor. No matter what you decide, your regular medical care will not be affected.

If you're thinking about participating in a clinical study, you may have questions about the purpose of the study, the types of tests and treatment involved, how participation will affect your daily life, and whether any costs are involved. Your doctor may be able to answer some of your questions and help you find clinical studies in which you can participate. You also can visit the following Web sites to learn about being in a study and to search for clinical trials being done on your disorder:

- www.clinicaltrials.gov
- http://clinicalresearch.nih.gov
- www.nhlbi.nih.gov/studies/index.htm

Tips for Preventing or Controlling Anemia

Many types of anemia can be mild, short-term, easily treated, and even prevented. Other types may last a lifetime, but are easily treated. Still other anemias are severe, life-threatening conditions that need prompt and intense treatment.

You can take action to prevent, treat, and control anemia. These actions can give you greater energy, improve your quality of life, and help you live a long and healthy life.

Lead a Healthy Lifestyle

You can take steps to prevent or control anemia. Here are a few simple things you can do.

Follow a healthy diet to ensure that you get enough iron, vitamin B12, folate, and vitamin C to make healthy blood cells. These nutrients are found in a variety of foods that also will promote your overall health. (See "The Basics of Healthy Eating" on page 54 for details.)

Make following a healthy diet a family goal. Infants, young children, and teens grow rapidly. A healthy diet supports growth and development and can help prevent anemia. Have healthy foods at home, and show your children how to make healthy choices when they're away from home. Also, help your parents or other older relatives enjoy a healthy, nutrient-rich diet. Anemia is common in older adults because of chronic (ongoing) diseases, lack of iron, and poor diet.

SHIRAH

"My main lifestyle change has been to commit to regular physical activity. My physical therapist gave me an exercise plan that I try to stick to every day.

"The key to living with a chronic illness is not to let it limit you. Just because I can't always do something I used to do, I still look for new ways to enjoy life.

"I'm grateful for the emotional support I get from my husband and family in helping me manage my condition."

The Basics of **Healthy Eating**

- Focus on nutrient-dense foods and beverages—vegetables, fruits, whole grains, fat-free or low-fat dairy products, seafood, lean meats and poultry, eggs, beans and peas, and nuts and seeds.
- Limit intake of salt, solid fats, added sugars, and refined grains.
- Maintain a healthy weight by balancing the calories you get from foods and beverages with the calories you use through physical activity.
- Follow food safety guidelines when preparing and eating foods to reduce the risk of foodborne illnesses.

Avoid substances that can cause or trigger anemia. For example, exposure to chemicals or toxins in the environment can cause some types of anemia. Other types of anemia are triggered by certain foods or cold temperatures. If you have one of these types of anemia, avoid these triggers if you can. If you have hemolytic anemia, reduce your chances of getting an infection by washing your hands often, avoiding people who have colds, and staying away from crowds.

Work With Your Doctor

Visit your doctor if you develop signs or symptoms of anemia. If you're diagnosed with anemia, follow your doctor's advice about diet, supplements, medicines, and other treatment methods.

Visit your doctor regularly for checkups and ongoing care, and tell him or her about any new or changing symptoms.

Older children and teens who have severe anemia may have an increased risk for injury or infection. Talk with your doctor about ways to keep them as healthy as possible and whether they need to avoid certain activities.

Girls and women who have heavy menstrual periods may need regular screenings and followup with their doctors to prevent or control iron-deficiency anemia.

Talk To Your Family

Some types of anemia—such as pernicious anemia, Fanconi anemia, or thalassemia—can be inherited. If you've been diagnosed with one of these kinds of anemia, talk to your family members. Suggest they visit their doctors for a checkup to see whether they also might have anemia.

If you have children or teens who have anemia, talk to them about how they can take an active role in their own care by learning about their condition and making decisions with their doctor. This can help young people feel more in control and have a more positive outlook about their health.

A Final Thought

You can do a lot to keep yourself and your family healthy. The tips above can help you prevent or cope with anemia and improve your overall health and well-being. So make the choice today for a brighter tomorrow!

To Learn More

The National Heart, Lung, and Blood Institute (NHLBI) provides information about the causes, prevention, diagnosis, and treatment of anemia and other blood diseases, as well as heart and lung diseases and conditions and sleep disorders. Resources include numerous publications, tools, and the NHLBI Web site.

NHLBI Health Information Center
P.O. Box 30105
Bethesda, MD 20824–0105
Phone: 301–592–8573
TTY: 240–629–3255
Fax: 301–592–8563
Web site: www.nhlbi.nih.gov/health/infoctr/index.htm

NHLBI Web Site
The NHLBI Web site offers health education materials, health assessment tools, and resources for patients, the public, and health professionals.
www.nhlbi.nih.gov

Diseases and Conditions A–Z Index
The NHLBI's Diseases and Conditions Index (DCI) provides complete, dependable, plain-language information about heart, lung, and blood diseases and sleep disorders.
www.nhlbi.nih.gov/health/dci/index.html

USDA ChooseMyPlate.gov
The U.S. Department of Agriculture's (USDA's) ChooseMyPlate.gov Web site has information, tips, and resources to help you learn more about healthy eating.
www.choosemyplate.gov

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