HEALTH BASICS

Hemoglobin

Hemoglobin is the iron-containing protein in red blood cells that carries oxygen.

WHAT IT IS
Iron-containing protein in red blood cells that carries oxygen

WHERE IT COMES UP
Complete blood counts and evaluations for anemia or blood disorders

WHY IT MATTERS
Determines how much oxygen your blood can carry

WHAT IT IS NOT
Not a disease or diagnosis

WHO TO ASK
Primary care clinician or clinician who ordered the test

HOW IT IS CHECKED
Hemoglobin measurement, usually within a complete blood count

Overview

Hemoglobin is a protein inside red blood cells. Its main job is to pick up oxygen in your lungs and carry it to tissues throughout your body. It also helps transport some carbon dioxide, a waste gas, back toward the lungs.

Each hemoglobin molecule contains iron. This iron allows oxygen to bind to hemoglobin without being permanently trapped. Your body can then release the oxygen where it is needed.

"Hemoglobin" may also refer to the amount of this protein measured in a blood sample. The result usually appears as part of a complete blood count, often called a CBC. A CBC also reports information about red blood cells, white blood cells, and platelets.

Hemoglobin is not a disease or a diagnosis. A result outside the laboratory's reference range is a finding that may need to be interpreted alongside your health history, other test results, and current circumstances.

How it works

Hemoglobin has two main parts: globin, which is protein, and heme, which contains iron.

Oxygen attaches to the iron in heme.

Red blood cells collect oxygen as they pass through the lungs. The heart then pumps these cells around the body. In tissues that need oxygen, hemoglobin releases it. Cells use that oxygen to produce energy.

Red blood cells and their hemoglobin are made in bone marrow, the soft tissue inside certain bones. This process requires iron and several vitamins. It is also influenced by erythropoietin, a hormone made mainly by the kidneys. A hormone is a chemical signal that helps control body processes.

When old red blood cells are removed from circulation, much of their iron is recycled. Other parts of hemoglobin are broken down and processed by the liver and other tissues.

Several normal and inherited forms of hemoglobin exist. Fetal hemoglobin is the main form before birth and during early infancy. Most adults mainly have hemoglobin A. Hemoglobin variants, such as hemoglobin S, have a different protein structure because of an inherited gene change.

Why it matters for your health

The amount and type of hemoglobin affect how well blood can carry oxygen.

A low hemoglobin result may mean that the blood has less oxygen-carrying capacity. When hemoglobin is below the appropriate cutoff, this is called anemia. Anemia is a diagnosis, but it is not a single cause. It can result from blood loss, reduced red blood cell production, or faster-than-normal destruction of red blood cells.

A high result may mean there are more red blood cells than expected or that the liquid part of the blood is reduced. For example, dehydration can concentrate the blood and temporarily raise the measured hemoglobin.

Reference ranges are not universal. Interpretation may take account of age, sex-related physiology, pregnancy, altitude, smoking, medicines, hormone treatment, and the laboratory's measurement method. A result slightly outside a printed range does not by itself explain why it occurred.

Hemoglobin is related to, but different from, several other measurements:

A pulse oximeter estimates oxygen saturation. It does not measure how much hemoglobin you have. Someone can have a normal oxygen saturation but a low hemoglobin level.

- Hematocrit estimates the proportion of blood made up of red blood cells

- Red blood cell count measures the number of red cells in a sample
- Ferritin helps assess stored iron
- Hemoglobin A1c measures glucose attached to hemoglobin over time
- Oxygen saturation estimates how much available hemoglobin is carrying oxygen

What can go wrong

A low hemoglobin result may relate to iron deficiency, vitamin B12 or folate deficiency, kidney disease, long-term inflammation, bone marrow disorders, or blood loss. Blood loss can come from heavy menstrual bleeding, surgery, an injury, childbirth, or bleeding in the digestive tract.

Hemolysis means red blood cells are being destroyed earlier than expected. It can occur with certain immune conditions, infections, medicines, mechanical heart devices, or inherited red blood cell disorders.

Inherited hemoglobin conditions affect the structure or production of hemoglobin. Sickle cell disease involves hemoglobin S, which can change the shape and behavior of red blood cells. Thalassemia reduces production of particular globin chains. Tests such as hemoglobin electrophoresis or high-performance liquid chromatography can help identify hemoglobin types.

A high hemoglobin result can occur with dehydration or long-term exposure to lower oxygen levels. Possible related situations include living at high altitude, smoking, sleep apnea, and some lung or heart conditions. Polycythemia vera, a bone marrow cancer that causes excess blood cell production, is another possible cause. A single high result does not establish any of these conditions.

Some factors can affect the accuracy or meaning of a result. Recent bleeding, a blood transfusion, pregnancy, dehydration, and changes in fluid balance may all matter. Hemoglobin variants can also interfere with some hemoglobin A1c testing methods.

An unexpected result without severe symptoms usually needs routine follow-up rather than emergency care. Seek urgent or emergency help for severe difficulty breathing, chest pain, fainting, new confusion, signs of a stroke, or bleeding that will not stop. These problems can have many causes and should not be judged from a hemoglobin number alone.

What you can do

If you have a hemoglobin result, check whether it was low, high, or within the laboratory's

reference range. Keep the full CBC rather than recording only the hemoglobin number. Other measurements, including cell size and hematocrit, may help show what should be checked next.

Compare results only when the units and reference ranges are clear. Ask the clinician who ordered the test:

Tell the clinician about heavy menstrual bleeding, blood in stool or urine, recent surgery, blood donation, pregnancy, dietary restrictions, and any family history of anemia or inherited blood conditions.

Do not start iron solely because hemoglobin is low. Iron helps when iron deficiency is present, but not every low result is caused by a lack of iron. A ferritin test and other iron measurements can help assess iron stores.

If your result is normal and no follow-up was advised, there may be nothing specific you need to do. Hemoglobin testing is repeated when it is relevant to your care, not because the protein itself needs monitoring by everyone.

- Whether the result needs to be repeated
- How it compares with your earlier results
- Whether recent bleeding, pregnancy, altitude, medicines, or hydration could matter
- Whether iron studies, vitamin tests, kidney tests, or hemoglobin-type testing are appropriate

Common questions

Is hemoglobin the same as iron?

No. Iron is one component of hemoglobin. You can have changes in iron stores before hemoglobin becomes low, and a low hemoglobin result can have causes unrelated to iron deficiency.

Is hemoglobin the same as hemoglobin A1c?

No. A hemoglobin test measures the amount of hemoglobin in blood. Hemoglobin A1c measures the percentage of hemoglobin with glucose attached and is used in diabetes screening and monitoring.

Can food raise hemoglobin quickly?

Food supports production of red blood cells, but it does not correct every cause of a low result. The useful next step is to identify whether iron, vitamin intake, blood loss, or another issue is

involved.

Can a normal pulse oximeter result rule out low hemoglobin?

No. A pulse oximeter estimates the percentage of hemoglobin carrying oxygen. It does not show whether the total amount of hemoglobin is low.

Why might my result differ between tests?

Hydration, bleeding, pregnancy, altitude, recent transfusion, laboratory methods, and changes in an underlying condition can affect results. Looking at the trend and the rest of the CBC is often more useful than comparing one number in isolation.

Sources

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- World Health Organization: Guideline on haemoglobin cutoffs to define anaemia in individuals and populations , 2024
- Clinical Methods: Hemoglobin and Hematocrit , NCBI Bookshelf
- Centers for Disease Control and Prevention: A1C Test for Diabetes and Prediabetes , CDC
- U.S. Food and Drug Administration: Pulse Oximeter Accuracy and Limitations , FDA