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## Complete Blood Count (CBC)

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**Also known as:** CBC; Hemogram; CBC with Differential

**Formal name:** Complete Blood Count

**Related tests:** [Blood Smear](#); [Hemoglobin](#); [Hematocrit](#); [Red Blood Cell Count](#); [White Blood Cell Count](#); [WBC Differential](#); [Platelet Count](#); [Reticulocyte Count](#)



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### At a Glance

#### Why Get Tested?

To determine your general health status; to screen for, diagnose, or monitor any one of a variety of diseases and conditions that affect blood cells, such as [anemia](#), [infection](#), [inflammation](#), [bleeding disorder](#) or cancer

#### When to Get Tested?

As part of a routine medical exam; when you have signs and symptoms that may be related to a condition that affects blood cells; at regular intervals to monitor treatment or when you are receiving treatment known to affect blood cells

#### Sample Required?

A blood sample drawn from a vein in your arm or a fingerstick or heelstick (newborns)

#### Test Preparation Needed?

None

### The Test Sample

#### What is being tested?

The complete blood count (CBC) is a test that evaluates the cells that circulate in blood. Blood consists of three types of cells suspended in fluid called [plasma](#): white blood cells (WBCs), red blood cells (RBCs), and platelets (PLTs). They are produced and mature primarily in the [bone marrow](#) and, under normal circumstances, are released into the bloodstream as needed.

A CBC is typically performed using an automated instrument that measures various parameters, including counts of the cells that are present in a person's sample of blood. The results of a CBC can provide information about not only the number of cell types but also can give an indication of the physical characteristics of some of the cells. A standard CBC includes the following:

- Evaluation of white blood cells: [WBC count](#); may or may not include a [WBC differential](#)
- Evaluation of red blood cells: [RBC count](#), [hemoglobin \(Hb\)](#), [hematocrit \(Hct\)](#) and RBC indices, which includes mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW). The RBC evaluation may or may not include [reticulocyte count](#).
- Evaluation of platelets: [platelet count](#); may or may not include mean platelet volume (MPV) and/or platelet distribution width (PDW)

Significant abnormalities in one or more of the blood cell populations can indicate the presence of one or more conditions. Typically other tests are performed to help determine the cause of abnormal results. Often, this requires visual confirmation by examining a [blood smear](#) under a microscope. A trained laboratorian can evaluate the appearance and physical characteristics of the blood cells, such as size, shape and color, noting any abnormalities that may be present. Any additional information is noted and reported to the healthcare provider. This information gives the health practitioner additional clues as to the cause of abnormal CBC results.

The three types of cells evaluated by the CBC include:

#### *White Blood Cells*

There are five different types of WBCs, also called leukocytes, that the body uses to maintain a healthy state and to fight infections or other causes of injury. They are **neutrophils**, **lymphocytes**, **basophils**, **eosinophils**, and **monocytes**. They are present in the blood at relatively stable numbers. These numbers may temporarily shift higher or lower depending on what is going on in the body. For instance, an infection can stimulate the body to produce a higher number of neutrophils to fight off **bacterial** infection. With **allergies**, there may be an increased number of eosinophils. An increased number of lymphocytes may be produced with a **viral** infection. In certain disease states, such as **leukemia**, abnormal (immature or mature) white cells rapidly multiply, increasing the WBC count.

#### *Red Blood Cells*

Red blood cells, also called erythrocytes, are produced in the bone marrow and released into the bloodstream as they mature. They contain hemoglobin, a protein that transports oxygen throughout the body. The typical lifespan of an RBC is 120 days; thus the bone marrow must continually produce new RBCs to replace those that age and disintegrate or are lost through bleeding. A number of conditions can affect the production of new RBCs and/or their lifespan, in addition to those conditions that may result in significant bleeding.

The CBC determines the number of RBCs and amount of hemoglobin present, the proportion of blood made up of RBCs (hematocrit), and whether the population of RBCs appears to be normal. RBCs normally are uniform with minimal variations in size and shape; however, significant variations can occur with conditions such as **vitamin B12 and folate deficiencies**, iron deficiency, and with a variety of other conditions. If the concentration of red blood cells and/or the amount of hemoglobin in the blood drops below normal, a person is said to have **anemia** and may have symptoms such as fatigue and weakness. Much less frequently, there may be too many RBCs in the blood (erythrocytosis or **polycythemia**). In extreme cases, this can interfere with the flow of blood through the small veins and arteries.

#### *Platelets*

Platelets, also called thrombocytes, are special cell fragments that play an important role in normal blood clotting. A person who does not have enough platelets may be at an increased risk of excessive bleeding and bruising. An excess of platelets can cause excessive clotting or, if the platelets are not functioning properly, excessive bleeding. The CBC measures the number and size of platelets present.

#### **How is the sample collected for testing?**

A blood sample is obtained by inserting a needle into a vein in the arm or from a fingerstick (for children and adults) or heelstick (for infants).

#### **Is any test preparation needed to ensure the quality of the sample?**

No test preparation is needed.

## The Test

#### **How is it used?**

The complete blood count (CBC) is often used as a broad screening test to determine an individual's general health status. It can be used to:

- Screen for a wide range of conditions and diseases
- Help diagnose various conditions, such as **anemia**, **infection**, **inflammation**, **bleeding disorder** or **leukemia**, to name just a few
- Monitor the condition and/or effectiveness of treatment after a diagnosis is established
- Monitor treatment that is known to affect blood cells, such as **chemotherapy** or radiation therapy

A CBC is a panel of tests that evaluates the three types of cells that circulate in the blood. (For more on the cells, see the "**What is being tested?**" section.) A CBC includes the following:

- Evaluation of white blood cells, the cells that are part of the body's defense system against infections and cancer and also play a role in **allergies** and inflammation:
  - **White blood cell (WBC) count** is a count of the total number of white blood cells in a person's sample of blood.
  - **White blood cell differential** may or may not be included as part of the panel of tests. It identifies and counts the number of the various types of white blood cells present. The five types include **neutrophils**, **lymphocytes**, **monocytes**, **eosinophils**, and **basophils**.
- Evaluation of red blood cells, the cells that transport oxygen throughout the body:
  - **Red blood cell (RBC) count** is a count of the actual number of red blood cells in a person's sample of blood.
  - **Hemoglobin** measures the total amount of the oxygen-carrying protein in the blood, which generally reflects the number of red blood cells in the blood.

- o **Hematocrit** measures the percentage of a person's total blood volume that consists of red blood cells.
- o Red blood cell indices are calculations that provide information on the physical characteristics of the RBCs:
  - Mean corpuscular volume (MCV) is a measurement of the average size of a single red blood cell.
  - Mean corpuscular hemoglobin (MCH) is a calculation of the average amount of hemoglobin inside a single red blood cell.
  - Mean corpuscular hemoglobin concentration (MCHC) is a calculation of the average concentration of hemoglobin inside a single red blood cell.
  - Red cell distribution width (RDW) is a calculation of the variation in the size of RBCs.
- o The CBC may also include **reticulocyte count**, which is a measurement of the absolute count or percentage of young red blood cells in blood.
- Evaluation of platelets, cell fragments that are vital for normal blood clotting:
  - o The **platelet count** is the number of platelets in a person's sample of blood.
  - o Mean platelet volume (MPV) may be reported with a CBC. It is a calculation of the average size of platelets.
  - o Platelet distribution width (PDW) may also be reported with a CBC. It reflects how uniform platelets are in size.

**When is it ordered?**

The CBC is a very common test. Many people have a CBC performed when they have a routine health examination. If a person is healthy and has results that are within normal limits, then that person may not require another CBC until their health status changes or until their healthcare provider feels that it is necessary.

A CBC may be ordered when a person has any number of **signs** and **symptoms** that may be related to disorders that affect blood cells. When an individual has fatigue or weakness or has an **infection, inflammation**, bruising, or bleeding, a health practitioner may order a CBC to help diagnose the cause and/or determine its severity.

When a person has been diagnosed with a disease known to affect blood cells, a CBC will often be ordered on a regular basis to monitor their condition. Likewise, if someone is receiving treatment for a blood-related disorder, then a CBC may be performed frequently to determine if the treatment is effective.

Some therapies, such as chemotherapy, can affect **bone marrow** production of cells. Some medications can decrease **WBC counts** overall. A CBC may be ordered on a regular basis to monitor these drug treatments.

**What does the test result mean?**

A health practitioner typically evaluates and interprets results from the components of the CBC together. Depending on the purpose of the test, a number of additional or follow-up tests may be ordered for further investigation.

The following tables briefly and generally explain what the result for each component of the CBC may mean.

- [WBC evaluation](#)
- [RBC evaluation](#)
- [Platelet evaluation](#)

*For detailed information on each test component, click on the name of the component to go to the specific article.*

[View this Sample Report](#)

To see an example of a CBC lab report, see this [sample report](#).

**Components of the CBC**

WBC Evaluation		<a href="#">Expand Table</a>	
TEST	FULL NAME	EXAMPLES OF CAUSES OF A LOW COUNT	EXAMPLES OF CAUSES OF A HIGH COUNT

<p><b>WBC</b></p>	<p>White Blood Cell Count (See <a href="#">reference range</a>)</p>	<p>Known as leukopenia</p> <ul style="list-style-type: none"> <li>• <b>Bone marrow disorders</b> or damage</li> <li>• <b>Autoimmune conditions</b></li> <li>• Severe infections (<b>sepsis</b>)</li> <li>• <b>Lymphoma</b> or other cancer that spread to the <b>bone marrow</b></li> <li>• Dietary deficiencies</li> <li>• Diseases of immune system (e.g., <b>HIV/AIDS</b>)</li> </ul>	<p>Known as leukocytosis</p> <ul style="list-style-type: none"> <li>• <b>Infection</b>, most commonly <b>bacterial</b> or <b>viral</b></li> <li>• <b>Inflammation</b></li> <li>• <b>Leukemia, myeloproliferative disorders</b></li> <li>• <b>Allergies, asthma</b></li> <li>• Tissue death (trauma, burns, <b>heart attack</b>)</li> <li>• Intense exercise or severe stress</li> </ul>
<p><b>Diff</b></p>	<p>White Blood Cell Differential  (Not always performed; may be done as part of or in follow up to CBC; see <a href="#">reference range</a>)</p>		
<p>Neu, PMN, polys</p>	<p>Absolute <b>neutrophil</b> count, % neutrophils (See <a href="#">reference range</a>)</p>	<p>Known as neutropenia</p> <ul style="list-style-type: none"> <li>• Severe, overwhelming infection (<b>sepsis</b>)</li> <li>• Autoimmune disorders</li> <li>• Dietary deficiencies</li> <li>• Reaction to drugs, chemotherapy</li> <li>• Immunodeficiency</li> <li>• <b>Myelodysplasia</b></li> <li>• Bone marrow damage (e.g., chemotherapy, radiation therapy)</li> <li>• Cancer that spreads to the bone marrow</li> </ul>	<p>Known as neutrophilia</p> <ul style="list-style-type: none"> <li>• <b>Acute</b> bacterial infections</li> <li>• Inflammation</li> <li>• Trauma, heart attack, or burns</li> <li>• Stress, rigorous exercise</li> <li>• Certain leukemias (e.g., chronic myeloid leukemia)</li> <li>• <b>Cushing syndrome</b></li> </ul>
<p>Lymph</p>	<p>Absolute <b>lymphocyte</b> count, % lymphocytes (See <a href="#">reference range</a>)</p>	<p>Known as lymphocytopenia</p> <ul style="list-style-type: none"> <li>• Autoimmune disorders (e.g., <b>lupus</b>, <b>rheumatoid arthritis</b>)</li> <li>• Infections (e.g., HIV, <b>viral hepatitis</b>, typhoid fever, <b>influenza</b>)</li> <li>• Bone marrow damage (e.g., chemotherapy, radiation therapy)</li> <li>• Corticosteroids</li> </ul>	<p>Known as lymphocytosis</p> <ul style="list-style-type: none"> <li>• Acute viral infections (e.g., <b>chicken pox</b>, <b>cytomegalovirus (CMV)</b>, <b>Epstein-Barr virus (EBV)</b>, <b>herpes</b>, <b>rubella</b>)</li> <li>• Certain bacterial infections (e.g., <b>pertussis (whooping cough)</b>, <b>tuberculosis (TB)</b>)</li> <li>• Toxoplasmosis</li> <li>• <b>Chronic</b> inflammatory disorder (e.g., ulcerative colitis)</li> <li>• Lymphocytic leukemia, lymphoma</li> <li>• Stress (acute)</li> </ul>

Mono	Absolute <b>monocyte</b> count, % monocytes (See <a href="#">reference range</a> )	Usually, one low count is not medically significant.  Repeated low counts can indicate: <ul style="list-style-type: none"> <li>• Bone marrow damage or failure</li> <li>• Hairy cell leukemia</li> <li>• <b>Aplastic anemia</b></li> </ul>	<ul style="list-style-type: none"> <li>• Chronic infections (e.g., tuberculosis, <b>fungal infection</b>)</li> <li>• Infection within the heart (bacterial endocarditis)</li> <li>• Collagen vascular diseases (e.g., lupus, <b>scleroderma</b>, rheumatoid arthritis, <b>vasculitis</b>)</li> <li>• Monocytic or myelomonocytic leukemia (acute or chronic)</li> </ul>
Eos	Absolute <b>eosinophil</b> count, % eosinophils (See <a href="#">reference range</a> )	Numbers are normally low in the blood. One or an occasional low number is usually not medically significant	<ul style="list-style-type: none"> <li>• Asthma, allergies such as hay fever</li> <li>• Drug reactions</li> <li>• <b>Parasitic infections</b></li> <li>• Inflammatory disorders (<b>celiac disease</b>, <b>inflammatory bowel disease</b>)</li> <li>• Some cancers, leukemias or lymphomas</li> <li>• <b>Addison disease</b></li> </ul>
Baso	Absolute <b>basophil</b> count, % basophils (See <a href="#">reference range</a> )	As with eosinophils, numbers are normally low in the blood; usually not medically significant	<ul style="list-style-type: none"> <li>• Rare allergic reactions (hives, food allergy)</li> <li>• Inflammation (rheumatoid arthritis, ulcerative colitis)</li> <li>• Some leukemias</li> <li>• <b>Uremia</b></li> </ul>

RBC Evaluation		<a href="#">Expand Table</a>	
TEST	FULL NAME	EXAMPLES OF CAUSES OF LOW RESULT	EXAMPLES OF CAUSES OF HIGH RESULT
<b>RBC</b>	Red Blood Cell Count (See <a href="#">reference range</a> )	Known as <b>anemia</b> <ul style="list-style-type: none"> <li>• Acute or chronic bleeding</li> <li>• RBC destruction (e.g., <b>hemolytic anemia</b>, etc.)</li> <li>• Nutritional deficiency (e.g., iron deficiency, vitamin B12 or folate deficiency)</li> <li>• Bone marrow disorders or damage</li> <li>• Chronic inflammatory disease</li> <li>• Chronic kidney disease</li> </ul>	Known as <b>polycythemia</b> <ul style="list-style-type: none"> <li>• <b>Dehydration</b></li> <li>• <b>Lung (pulmonary) disease</b></li> <li>• Kidney or other tumor that produces excess erythropoietin</li> <li>• Smoking</li> <li>• Living at high altitude</li> <li>• Genetic causes (altered oxygen sensing, abnormality in hemoglobin oxygen release)</li> <li>• Polycythemia vera—a rare disease</li> </ul>
<b>Hb</b>	Hemoglobin (See <a href="#">reference range</a> )	Usually mirrors RBC results, provides added information	Usually mirrors RBC results
<b>Hct</b>	Hematocrit (See <a href="#">reference range</a> )	Usually mirrors RBC results	Usually mirrors RBC results; most common cause is dehydration
<b>RBC indices</b>			

TEST	FULL NAME	EXAMPLES OF CAUSES OF LOW RESULT	EXAMPLES OF CAUSES OF HIGH RESULT
MCV	Mean Corpuscular Volume (See <a href="#">reference range</a> )	Indicates RBCs are smaller than normal (microcytic); caused by <a href="#">iron deficiency anemia</a> or <a href="#">thalassemias</a> , for example.	Indicates RBCs are larger than normal (macrocytic), for example in <a href="#">anemia caused by vitamin B12 or folate deficiency</a> , <a href="#">myelodysplasia</a> , <a href="#">liver disease</a> , <a href="#">hypothyroidism</a>
MCH	Mean Corpuscular Hemoglobin (See <a href="#">reference range</a> )	Mirrors MCV results; small red cells would have a lower value.	Mirrors MCV results; macrocytic RBCs are large so tend to have a higher MCH.
MCHC	Mean Corpuscular Hemoglobin Concentration (See <a href="#">reference range</a> )	May be low when MCV is low; decreased MCHC values (hypochromia) are seen in conditions such as iron deficiency anemia and thalassemia.	Increased MCHC values (hyperchromia) are seen in conditions where the hemoglobin is more concentrated inside the red cells, such as autoimmune hemolytic anemia, in burn patients, and hereditary spherocytosis, a rare congenital disorder.
RDW (Not always reported)	RBC Distribution Width	Low value indicates uniformity in size of RBCs.	Indicates mixed population of small and large RBCs; young RBCs tend to be larger. For example, in iron deficiency anemia or pernicious anemia, there is high variation (anisocytosis) in RBC size (along with variation in shape – poikilocytosis), causing an increase in the RDW.
<a href="#">Reticulocyte Count</a> (Not always done)	Reticulocytes (absolute count or %) (See <a href="#">reference range</a> )	In the setting of anemia, a low reticulocyte count indicates a condition is affecting the production of red blood cells, such as bone marrow disorder or damage, or a nutritional deficiency (iron, B12 or folate).	In the setting of anemia, a high reticulocyte count generally indicates peripheral cause, such as bleeding or <a href="#">hemolysis</a> , or response to treatment (e.g., iron supplementation for iron deficiency anemia).

Platelet Evaluation			<a href="#">Expand Table</a>
TEST	FULL NAME	EXAMPLES OF CAUSES OF LOW RESULT	EXAMPLES OF CAUSES OF HIGH RESULT
<a href="#">Plt</a>	Platelet Count (See <a href="#">reference range</a> )	Known as thrombocytopenia: <ul style="list-style-type: none"> <li>• Viral infection (<a href="#">mononucleosis</a>, <a href="#">measles</a>, hepatitis)</li> <li>• Rocky mountain spotted fever</li> <li>• Platelet autoantibody</li> <li>• Drugs (acetaminophen, quinidine, sulfa drugs)</li> <li>• <a href="#">Cirrhosis</a></li> <li>• Autoimmune disorders</li> <li>• Sepsis</li> <li>• Leukemia, lymphoma</li> <li>• Myelodysplasia</li> <li>• Chemo or radiation therapy</li> </ul>	Know as thrombocytosis: <ul style="list-style-type: none"> <li>• Cancer (lung, gastrointestinal, <a href="#">breast</a>, <a href="#">ovarian</a>, lymphoma)</li> <li>• Rheumatoid arthritis, inflammatory bowel disease, lupus</li> <li>• Iron deficiency anemia</li> <li>• Hemolytic anemia</li> <li>• Myeloproliferative disorder (e.g., essential thrombocythemia)</li> </ul>
<a href="#">MPV</a> (Not always reported)	Mean Platelet Volume	Indicates average size of platelets is small; older platelets are generally smaller than younger ones and a low MPV may mean that a condition is affecting the production of platelets by the bone marrow.	Indicates a high number of larger, younger platelets in the blood; this may be due to the bone marrow producing and releasing platelets rapidly into circulation.
<a href="#">PDW</a> (Not always reported)	Platelet Distribution Width	Indicates uniformity in size of platelets	Indicates increased variation in the size of the platelets, which may mean that a condition is present that is affecting platelets

**Is there anything else I should know?**

Many different conditions can result in increases or decreases in blood cell populations. Some of these conditions may require treatment, while others may resolve on their own.

Recent blood transfusions affect the results of the CBC.

Normal CBC values for babies and children are different from adults. The laboratory will supply the reference ranges for various age groups, and a health practitioner will take these into consideration when interpreting data.

## Common Questions

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### 1. My CBC report includes a result for immature platelet fraction (IPF). What is it?

IPF is the relative number of immature platelets (also called reticulated platelets) in the blood. Platelets are produced in the **bone marrow** and are normally not released into the bloodstream until they have matured. When platelet numbers in the blood are low (thrombocytopenia), it stimulates the bone marrow to produce platelets faster. When the need is great and when production cannot keep up with "demand," then an increased number of immature platelets will be released into the bloodstream.

This IPF test result would be one of the values reported when blood is evaluated using an automated hematology analyzer. The IPF may be used to help a healthcare provider determine the likely cause of a person's thrombocytopenia, that is, decrease in production by the bone marrow (IPF is low) versus increased loss of platelets in the blood (IPF is higher). Lab test results including platelet count and IPF can also help determine if a person needs a platelet transfusion and help monitor bone marrow recovery, such as after a bone marrow transplant. Other uses are being studied and the test's ultimate clinical utility has not yet been well determined.

### 2. My CBC report includes a result for reticulocyte hemoglobin. What is it?

The hemoglobin inside of reticulocytes can be measured and reported as either a mean reticulocyte hemoglobin content (CHr) or a reticulocyte hemoglobin equivalent (Ret-He), depending upon the test method used. This test result would be one of the values reported when blood is evaluated using an automated hematology analyzer.

Reticulocytes are "young" red blood cells that are released by the bone marrow before they become fully mature. The amount of hemoglobin inside of reticulocytes can help determine if there has been enough iron available, to be incorporated into hemoglobin production and then into red blood cell production in the bone marrow, within the past few days. This makes the test useful in identifying functional iron deficiency in certain clinical conditions and in assessing **iron deficiency anemia** in children.

### 3. My CBC report includes a result for immature granulocytes (IG). What are they?

Some automated hematology analyzers report the total number of immature granulocytes (IG) present in a person's blood sample. Immature granulocytes are white blood cells that have not fully developed before being released from the bone marrow into the blood. They may include metamyelocytes, myelocytes, and promyelocytes. These cells are normally only present in the bone marrow because they are **precursors** of neutrophils, the predominant type of white cells in blood. The presence of immature granulocytes in the blood may occur in various diseases, such as infection or a blood cancer, and thus will often prompt further investigation, which may include additional laboratory testing.

### 4. Is there anything I can do to improve results of my CBC?

People who have a keen interest in their own health care frequently want to know what they can do to change their WBCs, RBCs, and platelets. Unlike "good" and "bad" cholesterol, cell populations are not generally affected by lifestyle changes unless the individual has an underlying deficiency (such as **vitamin B12** or **folate deficiency** or iron deficiency). There is no way that a person can directly raise the number of his WBCs or change the size or shape of his RBCs.

Addressing any underlying diseases or conditions and following a healthy lifestyle will help optimize your body's cell production, and your body will take care of the rest.

### 5. If I have an abnormal result on my CBC, what other tests might my doctor order as follow up?

It depends on the results that are abnormal and the suspected cause as well as your medical history and findings from your physical examination. Your healthcare provider may request that a **blood smear examination** be done. Other general tests to check your health and to look for possible causes may include a **comprehensive metabolic panel (CMP)**. A few other general examples include:

- Abnormal results for WBCs may be followed by a culture of the affected area (e.g., **blood culture**, **urine culture**, **sputum culture**), a **strep test** or tests for viruses such as **mononucleosis** or **EBV**. If inflammation is suspected, then a **CRP** or **ESR test** may be done.
- Abnormal RBC results may prompt a **reticulocyte count**, **iron studies**, **tests for vitamin B12 and folate**, **G6PD**, or **hemoglobinopathy evaluation** to help make a diagnosis.
- An abnormal platelet count may be followed by tests that further evaluate platelets, such as **platelet function tests** or **HIT antibody**. Additional tests may be done to check for **bleeding disorders** or **excessive clotting disorders** such as **PT**, **PTT**, **von Willebrand factor** or **coagulation factors**.

When a serious condition such as **leukemia**, myelodysplasia or another **bone marrow disorder** is suspected, then a **bone marrow biopsy and examination** may be necessary. Numerous other tests specific for certain conditions may be needed to establish a diagnosis. Talk to your healthcare provider about the results of

your CBC, whether additional tests are necessary, and why.

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