

HEMATOLOGY

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Complete Blood Count



Also known as:

- CBC; Hemogram

Sample Required?

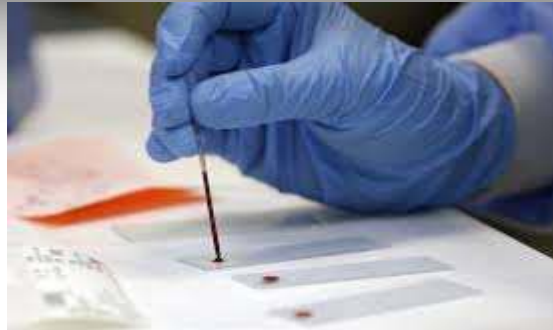
- A blood sample drawn from a vein in your arm or a finger stick or heel stick (new borns)

- 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 & WHAT



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

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



PRINCIPLE



- Blood is diluted in a solution of potassium ferricyanide and potassium cyanide. The potassium ferricyanide oxidizes Hb to Hi (methemoglobin), and potassium cyanide provides cyanide ions (CN^-) to form HiCN, which has a broad absorption maximum at a wavelength of 540 nm.
- The absorbance of the solution is measured in a spectrophotometer at 540 nm and is compared with that of a standard HiCN solution.



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`.
- 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. 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.
 - Evaluation of red blood cells, the cells that transport oxygen throughout the body.
 - Evaluation of platelets, cell fragments that are vital for normal blood clotting.



WHY & WHEN



- Hemoglobin Also known as:
- Hgb; Hb; H and H (Hemoglobin and Hematocrit)
- Sample Required?
- A blood sample drawn from a vein in your arm or by a fingerstick (children and adults) or heelstick (newborns)
- Test Preparation Needed?
None.

• Why Get Tested?

To evaluate the hemoglobin content of your blood as part of a general health checkup; to screen for and help diagnose conditions that affect red blood cells (RBCs); if you have anemia (low hemoglobin) or polycythemia (high hemoglobin), to assess the severity of these conditions and to monitor response to treatment

• When to Get Tested?

With a hematocrit or as part of a complete blood count (CBC), which may be ordered as a component of a general health screen; when you have signs and symptoms of anemia (weakness, fatigue) or polycythemia (dizziness, headache); at regular intervals to monitor these conditions or response to treatment



WHAT & HOW



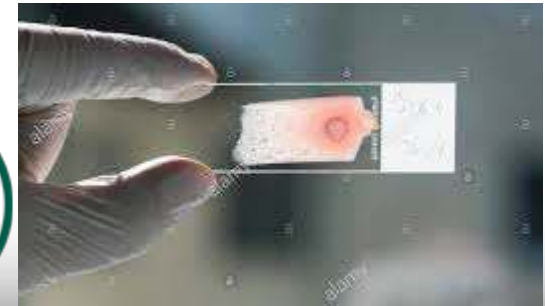
What is being tested?

- Hemoglobin is the iron-containing protein found in all red blood cells (RBCs) that gives the cells their characteristic red color.
- Hemoglobin enables RBCs to bind to oxygen in the lungs and carry it to tissues and organs throughout the body. It also helps transport a small portion of carbon dioxide, a product of cell metabolism, from tissues and organs to the lungs, where it is exhaled.

How is it used?

A hemoglobin test may be used to:

- Screen for, diagnose, and measure the severity of anemia (low RBCs, hemoglobin and hematocrit) or polycythemia (high RBCs, hemoglobin and hematocrit)
- Monitor the response to treatment of anemia or polycythemia
- Help make decisions about blood transfusions or other treatments if the anemia is severe



What does the test result mean?



- Low hemoglobin with low RBC count and low hematocrit indicates ANEMIA.
- High hemoglobin with a high RBC count and high hematocrit indicates polycythemia.



Hematocrit



Also known as:

- Hct; Crit; Packed Cell Volume; PCV; H and H (Hemoglobin and Hematocrit)
- Sample Required?
- A blood sample drawn from a vein in your arm or by a fingerstick (children and adults) or heel stick (newborns)
- Test Preparation Needed?

None



WHY & WHEN



When to Get Tested?

With a test for hemoglobin or as part of a complete blood count (CBC) during a routine health exam or when you have signs and symptoms of anemia (weakness, fatigue) or polycythemia (dizziness, headache); at regular intervals to monitor a disorder that affects RBCs and to evaluate the effectiveness of treatment

Why Get Tested?

To determine the proportion of your blood that is made up of red blood cells (RBCs) in order to screen for, help diagnose, or monitor conditions that affect RBCs; as part of a routine health examination or if your healthcare provider suspects that you have anemia or polycythemia



WHAT & HOW



What is being tested?

A hematocrit is a test that measures the proportion of a person's blood that is made up of red blood cells (RBCs). Blood consists of RBCs, white blood cells (WBCs), and platelets suspended in a fluid portion called plasma. The hematocrit is a ratio of the volume of red blood cells to the volume of all these components together, called whole blood. The value is expressed as a percentage or fraction.



How is it used?

A hematocrit may be used to:

- Identify and evaluate the severity of anemia (low RBCs, low hemoglobin, low hematocrit) or polycythemia (high RBCs, high hemoglobin, high hematocrit)
- Monitor the response to treatment of anemia or polycythemia and other disorders that affect RBC production or lifespan
- Help make decisions about blood transfusions or other treatments if anemia is severe
- Evaluate dehydration



What does the test result mean?



- Low hemoglobin with low RBC count and low hematocrit indicates ANEMIA.
- High hemoglobin with a high RBC count and high hematocrit indicates polycythemia.



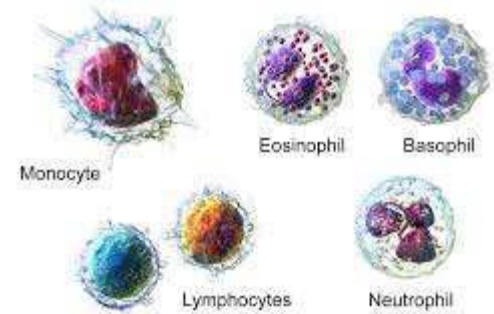
WBC, DIFERENTIAL COUNT



Also known as:

- Leukocyte Differential Count; Peripheral Differential; WBC Count Differential; Diff; Blood Differential; Differential Blood Count
- Formal name:
- White Blood Cell Differential

- Sample Required?

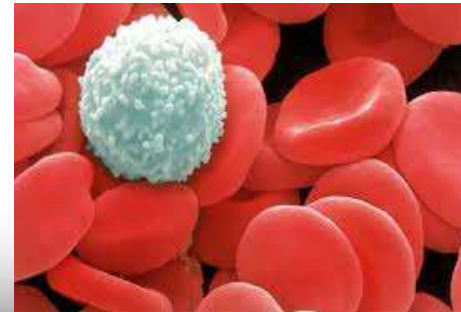


White Blood Cells

A blood sample drawn from a vein in your arm or by a finger stick (children and adults) or heelstick (infants)

- Test Preparation Needed?

None



WHY, WHEN & WHAT



Why Get Tested?

- To help determine the cause of abnormal results on a white blood cell (WBC) count; to help diagnose and/or monitor an illness affecting your immune system, such as an infection or inflammatory condition, or cancers that affect your white blood cells, such as leukemia



When to Get Tested?

- As part of a complete blood count (CBC), when you have a routine health examination; when results of a CBC fall outside the reference range; when you have any number of signs and symptoms that may be related to a condition affecting white blood cells, such as infection, inflammation, or cancer; when you are receiving treatment that is known to affect WBCs, such as chemotherapy

What is being tested?

White blood cells (WBCs) also called leukocytes, are cells that circulate in the blood and the lymphatic system that help protect the body against infections. They are an important part of the body's immune system and also have a role in inflammation, allergic responses, and protection against cancer. A WBC differential totals the number of each of the different types of WBCs in a person's sample of blood.

There are five types of white blood cells, each with different functions.



How is it used?



- The white blood cell differential is often used as part of a complete blood count (CBC) as a general health check. It may be used to help diagnose the cause of a high or low white blood cell (WBC) count, as determined with a CBC. It may also be used to help diagnose and/or monitor other diseases and conditions that affect one or more different types of WBCs. The five types include: neutrophils, lymphocytes, monocytes, eosinophils and basophils. This information is useful in helping to diagnose the specific cause of an illness,
- such as:
 - Infections caused by bacteria, viruses, fungi or parasites
 - Inflammation
 - Allergies, asthma
 - Immune disorders (e.g., autoimmune disorders, immune deficiency)
 - Leukemia (e.g., chronic myeloid leukemia, chronic lymphocytic leukemia)
 - Myelodysplastic syndrome
 - Myeloproliferative neoplasms (e.g., myelofibrosis)



Procedure.



- 1. Well-mixed blood is diluted 1 : 20 in diluting fluid and the vial rotated for about 5 minutes. The chamber is loaded with just enough fluid to fill the space beneath the cover glass.
- 2. The cells are permitted to settle for several minutes, and the chamber is surveyed with the low-power objective to verify uniform cell distribution.
- 3. Counting is performed.



Platelet Count



Also known as:

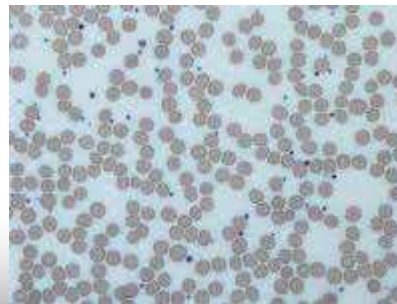
- Thrombocyte Count; PLT; Platelet Distribution Width; PDW; Mean Platelet Volume; MPV.

Sample Required?

- A blood sample drawn from a vein in your arm or by a fingerstick (children and adults) or heelstick (newborns).

Test Preparation Needed?

None



WHY, WHEN & WHAT



Why Get Tested?

- To determine the number of platelets in a sample of your blood as part of a health exam; to screen for, diagnose, or monitor conditions that affect the number of platelets, such as a bleeding disorder, a bone marrow disease, or other underlying condition.

When to Get Tested?

- As part of a routine complete blood count (CBC); when you have episodes of unexplained or prolonged bleeding or other symptoms that may be due to a platelet disorder

What is being tested?

Platelets, also called thrombocytes, are tiny fragments of cells that are essential for normal blood clotting. They are formed from very large cells called megakaryocytes in the bone marrow and are released into the blood to circulate. The platelet count is a test that determines the number of platelets in a person's sample of blood. When there is an injury to a blood vessel or tissue and bleeding begins, platelets help stop bleeding.



Procedure



- 1. Well-mixed blood is diluted 1 : 100 in diluting fluid, and the vial containing the suspension is rotated on a mechanical mixer for 10–15 minutes.
- 2. The hemocytometer is filled in the usual fashion, using a separate capillary tube for each side.
- 3. The chamber is covered with a Petri dish for 15 minutes to allow settling of the platelets in one optical plane. A piece of wet cotton or filter paper is left beneath the dish to prevent evaporation.
- 4. The platelets appear round or oval and frequently have one or more dendritic processes. Their internal granular structure and a purple sheen allow the platelets to be distinguished from debris, which is often refractile. Ghosts of red cells that have been lysed by the ammonium oxalate are seen in the background.



How is it used?



- A platelet count is used to detect the number of platelets in the blood. The test is included in a complete blood count (CBC), a panel of tests often performed as part of a general health examination.
- Platelets are tiny fragments of cells that are essential for normal blood clotting. A platelet count may be used to screen for or diagnose various diseases and conditions that can cause problems with clot formation. It may be used as part of the workup of a bleeding disorder, bone marrow disease, or excessive clotting disorder, to name just a few.
- The test may be used as a monitoring tool for people with underlying conditions or undergoing treatment with drugs known to affect platelets. It may also be used to monitor those being treated for a platelet disorder to determine if therapy is effective.



What does the test result mean?



- A low platelet count, also called thrombocytopenia, and accompanying signs and symptoms may be caused by a number of conditions and factors. Examples of conditions causing a low platelet count include:
- Viral infections such as mononucleosis, hepatitis, HIV or measles
- Leukemia, lymphoma, or another cancer that has spread (metastasized) to the bone marrow
- Aplastic anemia
- Long-term bleeding problems (e.g., chronic bleeding from stomach ulcers)
- Sepsis
- Cirrhosis
- Chemotherapy or radiation therapy, which may affect the bone marrow's ability to produce platelets
- Certain drugs, such as aspirin and ibuprofen, some antibiotics (including those containing sulfa), colchicine and indomethacin, H₂-blocking agents, hydralazine, isoniazid, quinidine, thiazide diuretics, and tolbutamide





A high platelet count may be referred to as thrombocytosis. This is usually the result of an existing condition such as:

- Cancer, most commonly lung, gastrointestinal, ovarian, breast or lymphoma
- Anemia, in particular iron-deficiency anemia and hemolytic anemia
- Infectious diseases such as tuberculosis
- If an individual has had their spleen removed surgically
- Use of birth control pills (oral contraceptives)



Reticulocytes



Also known as:

- Retic Count; Reticulocyte Percent; Reticulocyte Index; Corrected
- Reticulocyte; Reticulocyte Production Index; RPI

Formal name:

- Reticulocyte Count



Sample Required?

- A blood sample obtained by inserting a needle into a vein in your arm or sometimes from a fingerstick or heelstick (infant)

- Test Preparation Needed?

None



WHY & WHEN



Why Get Tested?

- To help evaluate the bone marrow's ability to produce red blood cells (RBCs); to help distinguish between various causes of anemia; to help monitor bone marrow response and the return of normal marrow function following chemotherapy, bone marrow transplant, or post-treatment follow-up for iron deficiency anemia, vitamin B12 or folate deficiency anemia, or renal failure.

When to Get Tested?

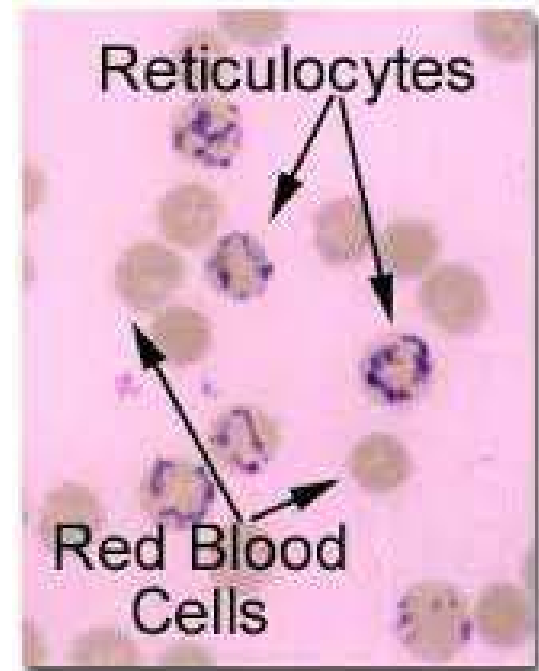
- When you have a low RBC count, hemoglobin, and hematocrit and/or symptoms of anemia; when a healthcare practitioner wants to evaluate your bone marrow function; sometimes as part of a complete blood count (CBC)



What is being tested?



- Reticulocytes are newly produced, relatively immature red blood cells (RBCs).
- A reticulocyte test determines the number and/or percentage of reticulocytes in the blood and is a reflection of recent bone marrow function or activity. Red blood cells are produced in the bone marrow, where blood-forming (hematopoietic) stem cells differentiate and develop, eventually forming reticulocytes and finally becoming mature RBCs. Reticulocytes are approximately 24% higher in volume in comparison with mature RBCs.



How is it used?



The reticulocyte test may be used:

- As a follow up to abnormal results on a complete blood count (CBC), RBC count, hemoglobin or hematocrit, to help determine the cause
- To determine if the bone marrow is functioning properly and responding adequately to the body's need for red blood cells
- To help detect and distinguish between different types of anemia
- To monitor response to treatment, such as that for iron deficiency anemia
- To monitor bone marrow function following treatments such as chemotherapy
- To monitor function following a bone marrow transplant



Principle



- Reticulocytes are immature nonnucleated red cells that contain ribonucleic acid (RNA) and continue to synthesize Hb after loss of the nucleus. When blood is briefly incubated in a solution of new methylene blue or brilliant cresyl blue, the RNA is precipitated as a dye-ribonucleoprotein complex. Microscopically, the complex appears as a dark blue network (reticulum or filamentous strand) or at least two dark blue granules that allow reticulocytes to be identified and enumerated (ICSH, 1998). A proposed reference method for reticulocyte counting based on determination of the reticulocyte/red cell ratio has been published (ICSH, 1998), expanding on the 1994 ICSH red cell count reference method.

Procedure

- Three drops each of reagent and blood are mixed in a test tube, incubated 15 minutes at room temperature, and remixed. Two wedge films are made on glass slides and air dried. Viewed microscopically with an oil immersion lens, reticulocytes are pale blue and contain dark blue reticular or granular material, and red cells stain pale blue or blue-green. The percentage of reticulocytes is determined in at least 1000 red cells



What does the test result mean?



A high reticulocyte count with low RBCs, low hemoglobin, and low hematocrit (anemia) may indicate conditions such as:

- **Bleeding:** If an individual bleeds (hemorrhage), then the number of reticulocytes will rise a few days later in an attempt to compensate for the red cell loss. If someone has chronic blood loss, then the number of reticulocytes will stay at an increased level as the marrow tries to keep up with the demand for new RBCs (although it may not be high if the blood loss leads to iron deficiency).
- **Hemolytic anemia:** In this condition, anemia is caused by increased destruction of RBCs. The bone marrow increases RBC production to compensate, resulting in a high reticulocyte count.
- **Hemolytic disease of the newborn:** This condition causes increased RBC destruction, similar to hemolytic anemia described above.





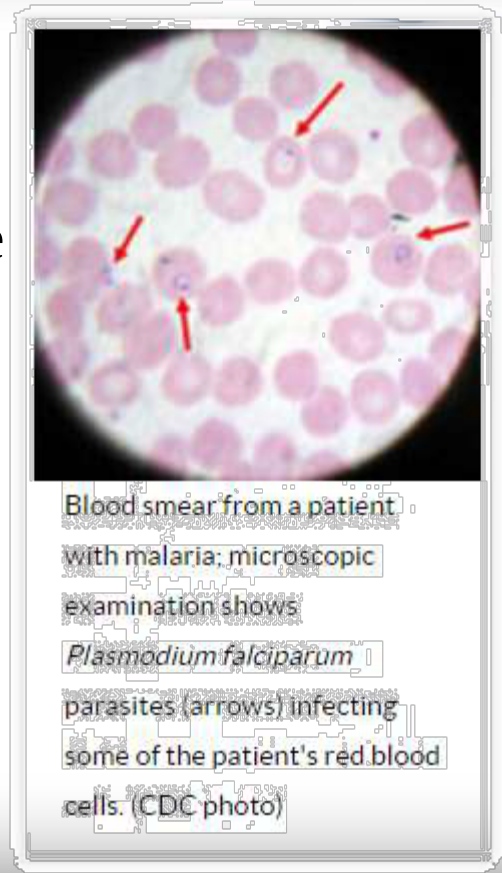
- A low reticulocyte count with low RBCs, low hemoglobin, and low hematocrit (anemia) may be seen, for example, with:
- Iron deficiency anemia
- Pernicious anemia or folic acid deficiency
- Aplastic anemia
- Radiation therapy
- Bone marrow failure caused by infection or cancer
- Severe kidney disease; this may cause a low level of erythropoietin.
- Alcoholism
- Endocrine disease



Malarial Smear



- Malaria is an infectious disease caused by Plasmodium parasites.
- These parasites are primarily spread by the bite of infected female Anopheles mosquitos.



Blood smear from a patient with malaria: microscopic examination shows *Plasmodium falciparum* parasites (arrows) infecting some of the patient's red blood cells. (CDC photo)

