The Complete Blood Count

The complete blood count (CBC) is a screening test used to diagnose many diseases. The test can reveal problems with red blood cell (RBC) production and destruction, and it can help diagnose infection, allergies, and problems with blood clotting and fluid volume. It actually consists of several tests that examine different parts of the blood, including the following:

- RBC count is the number of RBCs per volume of blood.
- White blood cell (WBC) count is the number of WBCs per volume of blood.
- Hemoglobin measures the amount of oxygen-carrying protein in the blood.
- Hematocrit measures the percentage of RBCs in a given volume of whole blood.
- Mean corpuscular volume (MCV) is a measurement of the average size of RBCs. MCV increases when the RBCs are larger than normal (macrocytic) and decreases when the RBCs are smaller than normal (microcytic).
- The MCV:RBC ratio is obtained by dividing the mean corpuscular volume by the red blood cell count.
- RBC distribution width (RDW) is a measure of variation in RBC width. Normally, RBCs are fairly uniform in size and shape. In some diseases, a given blood sample may have a high RDW, meaning that there is a great deal of variation in the size of the RBCs in the sample.
- Total iron-binding capacity (TIBC) shows whether there is too much or too little iron in the blood.
- The serum ferritin concentration indicates the body’s stores of iron.

Appearance of Normal RBCs

In a normal blood sample prepared for viewing under the microscope, the RBCs are 7–8 micrometers (µm) in diameter. They are very similar in size to each other and have a smooth surface. RBCs are usually dark red. (However, because of their biconcave shape, the center of the cell may look lighter when viewed in the microscope.) Mature RBCs (the kind seen in a blood sample in a microscope) do not have a nucleus. WBCs are often larger than RBCs and have nuclei that are irregularly shaped and darkly stained.

Abbreviations

The blood test data use the following abbreviations.

- Deciliter (dL) is a unit of volume equivalent to $10^{-1}$ liter, or 100 milliliters (one-tenth of a liter).
- Milliliter (mL) is a unit of volume equivalent to $10^{-3}$ liter (one-thousandth of a liter).
- Microliter (µL) is a unit of volume equivalent to $10^{-6}$ liter (one-millionth of a liter).
- Femtoliter is a unit of volume equivalent to $10^{-15}$ liter (one-quadrillionth of a liter).
- Nanogram is a unit of mass equal to $10^{-9}$ grams (one-billionth of a gram).
- Picogram is a unit of mass equal to $10^{-12}$ grams (one-trillionth of a gram).
Disease: Alpha-thalassemia

**Brief Description:** Alpha-thalassemia refers to a disease characterized by reduced or no production of the alpha-globin proteins that form hemoglobin.

**Cause:** Alpha-thalassemia is caused by changes in the alpha-globin genes on chromosome 16. Each person has four copies of this gene.

**Diagnosis:** Doctors usually use blood tests to diagnose alpha-thalassemia. Because it is an inherited disease, they will also check family history. In some cases, they may order DNA testing. Thalassemia affects both males and females.

**Appearance of Red Blood Cells (RBCs):** In patients with alpha-thalassemia, RBCs are often smaller than normal (microcytosis; normal RBCs are 7–8 micrometers (µm) in diameter). The size of the RBCs usually relates to the number of nonfunctional copies of the alpha-globin gene. If a person has one nonfunctional copy, the cells may only be slightly smaller than normal. The RBCs are significantly smaller than normal in people with two or more nonfunctional copies. RBCs in a person with thalassemia may be lighter in color.

The **mean corpuscular volume:**RBC ratio (MCV:RBC ratio) is a way to distinguish thalassemia from other kinds of anemia. In individuals with alpha-thalassemia, the MCV:RBC ratio is less than 13. In iron deficiency anemia, the ratio is above 13.

The **hematocrit** (percentage of blood taken up by RBCs) is usually decreased in people with alpha-thalassemia.

The **total iron-binding capacity (TIBC)** is usually normal in thalassemia.

The **RBC distribution width (RDW)** value is normal in thalassemia. The RBCs in a sample from a patient who has thalassemia may be somewhat smaller than normal, but they are similar in size to the other cells in the sample.

**Symptoms:** Symptoms of alpha-thalassemia range from no or mild symptoms to severe. One form of alpha-thalassemia is almost always fatal. In general, the symptoms are more serious in patients with more nonfunctional copies of alpha-globin genes.
Disease: Iron deficiency anemia

Brief Description: Iron deficiency anemia is a common type of anemia—a condition in which the blood lacks adequate healthy red blood cells (RBCs). These cells carry oxygen to the body's tissues.

Cause: Normally, people get iron from the food they eat. In addition, iron can be recycled from old RBCs. Iron deficiency anemia occurs if people do not consume enough iron in the diet, do not produce enough of the iron-containing hemoglobin, or lose too much iron, which occurs most commonly through blood loss.

Diagnosis: Doctors use blood tests to diagnose iron deficiency anemia. Indications of iron deficiency anemia include the following:
- Abnormal RBCs. The RBCs in someone with iron deficiency anemia are smaller than normal (microcytosis; normal RBCs are 7–8 µm in diameter) and paler in color than normal (hypochromic). The cells also may be irregular in size and shape. (RBCs within a sample may have different sizes and not be as smooth and round as normal RBCs.)
- Hemoglobin levels. Hemoglobin levels in someone with iron deficiency anemia are lower than normal.
- Hematocrit. In a person who has iron deficiency anemia, the hematocrit readings are below normal.

Serum Ferritin Concentration: At times, it may be hard to distinguish between iron-deficiency anemia and thalassemia. The serum ferritin concentration is one way that doctors can determine whether a person has alpha-thalassemia or iron deficiency anemia. Iron deficiency anemia is diagnosed when a person's serum ferritin concentration is less than 12 ng/mL.

Also, in iron deficiency anemia,
- the mean corpuscular volume:RBC (MCV:RBC) ratio is greater than 13,
- the RBC distribution width (RDW) is high, indicating a larger variation in size of the RBCs, and
- the total iron-binding capacity (TIBC) measurement is above normal.

Symptoms: In mild cases, a person who has iron deficiency anemia may not have any noticeable symptoms. As the deficiency becomes more serious, a person may notice symptoms including the following:
- extreme fatigue
- irregular heartbeat
- pale skin
- shortness of breath
- dizziness
- weakness
- increased number of infections
- headaches
Disease: Sickle cell disease

Brief Description: Sickle cell disease is an inherited form of anemia. As in other types of anemia, in sickle cell disease there are not enough healthy red blood cells (RBCs) to carry adequate oxygen to all the cells of the body.

Cause: Sickle cell disease is a genetic disease caused by an abnormal type of hemoglobin called hemoglobin S. Hemoglobin S distorts the shape of red blood cells, especially when oxygen levels are low.

In someone who has sickle cell disease, the RBCs are distorted. Instead of the smooth, circular, biconcave shape of normal RBCs, some of the cells are shaped like crescents. The crescent-shaped cells can clog small blood vessels.

Diagnosis: Sickle cell disease is diagnosed by examining cells under a microscope and with a blood test.

Appearance of RBCs: In sickle cell disease, some of a person's RBCs have a characteristic shape that can be observed under a microscope. Sickle cells are crescent shaped—or shaped like the tool called a “sickle.”

In an individual with sickle cell disease,
• the total iron-binding capacity (TIBC) measurement is sometimes below normal.
• the white blood cell (WBC) count is usually somewhat high.

Symptoms: Sickle cells are destroyed rapidly in the body, causing anemia, jaundice, and gallstones.

The sickle cells also block the flow of blood through vessels, resulting in lung tissue damage, pain episodes, and strokes. These cells also cause damage to most organs including the spleen, kidneys, and the liver. Patients with sickle cell disease, especially young children, with damage to the spleen can be easily overwhelmed by certain bacterial infections.

Symptoms may include the following:
• attacks of abdominal pain
• bone pain
• delayed growth and puberty
• jaundice
• rapid heart rate
• chest pain
• poor eyesight/blindness
• strokes
• skin ulcers