

# Understanding Your Blood Tests

## What is blood?

We think of blood as a liquid, but it contains many components.

- **Red blood cells (RBCs or erythrocytes)** contain hemoglobin, the protein that carries oxygen (O<sub>2</sub>) to your cells.
- **White blood cells (WBCs or leukocytes)** are part of the body's defense against foreign substances. They respond to fight off infections and are responsible for the inflammatory process and allergic reactions.
- **Platelets (PLTs or thrombocytes)** are essential for normal blood clotting.
- **Plasma**, the liquid part of blood, brings nutrients to your cells and carries away wastes.

## Why do they take blood so often?

Blood tests provide a wealth of information for doctors. Depending on the tests ordered, your health care team can monitor your condition and check:

- the quantity of each type of blood cell
- how well your treatments are working
- the effects of your medications
- if your blood is clotting normally
- the levels of electrolytes, minerals, hormones, oxygen, and carbon dioxide in your blood
- how well your organs and systems are working
- if you have an infection

## How is a blood sample taken?

Your blood may be drawn with a needle, same as a routine blood test. If your treatment requires frequent blood tests, you may have a port, central line, or peripheral line (PICC) in place. If so, your blood samples can be drawn from your port or line.

## Blood Tests

### Complete Metabolic Panel (CMP)

The CMP includes 14 tests that provide your doctor with a lot of information. The tests measure electrolytes, proteins, liver enzymes, and kidney waste products. Abnormal results can indicate an imbalance or problem that may need attention.

Substance Measured	Normal Range	Causes of a Low Result	Causes of a High Result
<b>Albumin</b>	3.5-5.0 g/dL	Liver disease Malnutrition Inflammation	Dehydration
<b>Calcium (Ca)</b>	8.4-10.2 mg/dL	Vitamin D or magnesium deficiency Extreme calcium deficiency in your diet Certain medications Alcoholism Malnutrition Chronic kidney failure Underactive parathyroid gland	Excess vitamin D intake Medications Prolonged immobilization Cancer Overactive parathyroid gland
<b>Total Protein</b>	6.3-8.2 g/dL	Malnutrition Liver disorder Kidney disorder	Chronic inflammation Infection Bone marrow disorders
<b>Glucose</b>	75-125 mg/dL	Exercise Medications (acetaminophen/Tylenol®) Excessive alcohol Starvation Underactive thyroid or adrenal glands	Lack of exercise Medications (steroids, estrogen) Acute stress Excessive food intake Overactive thyroid or adrenal glands
<b>Sodium (Na)</b>	137-145 mEq/L	Severe vomiting Diuretic or lithium medications Drinking too much water	Hyperventilation Severe diarrhea Not enough water Medications (Alka-Seltzer)
<b>Potassium (K)</b>	3.4-5.0 mEq/L	Prolonged vomiting Severe diarrhea Medications (antibiotics, diuretics, steroids) Low potassium diet	Kidney failure Severe infection Transfusions from a stored blood bank High potassium diet
<b>CO2</b>	22-30 mEq/L	Severe diarrhea Kidney disease Aspirin overdose	Severe vomiting Lung disease (COPD)
<b>Chloride</b>	100-110 mEq/L	Prolonged vomiting Excessive sweating Poor chloride absorption Diuretic medication Heart disease (inefficient pumping)	Dehydration Severe diarrhea Hyperventilation Anemia Steroid medications

Kidney Tests	Normal Range	Causes of a Low Result	Causes of a High Result
<b>BUN (Blood Urea Nitrogen)</b>	Male 9-20 mg/dL  Female 7-17 mg/dL	Drinking excessive amounts of water Liver disease Malnutrition (rare)	Stress Dehydration Decreased kidney function Congestive heart failure
<b>Creatinine</b>	Male 0.66-1.2 mg/dL  Female 0.52-1.04 mg/dL	Any condition that causes a decrease in muscle mass	Dehydration Decreased kidney function Damage to the kidney's blood vessels Pyelonephritis (kidney infection) Complication of diabetes
Liver Tests	Normal Range	Causes of a Low Result	Causes of a High Result
<b>ALP (alkaline phosphate)</b>	38-126 IU/L	Zinc deficiency Blood transfusion	Blocked bile duct Liver disease
<b>ALT</b>	11-66 IU/L	<i>Uncommon and not a concern</i>	Liver disease/damage Obstruction of the bile duct
<b>AST</b>	15-46 IU/L	<i>Uncommon and not a concern</i>	Liver disease/damage Muscle injury Alcoholism
<b>Bilirubin</b>	Direct: 0.1-0.6 mg/dL Total: 0.2-1.3 mg/dL	<i>Uncommon and not a concern</i>	Liver disease Hemolytic or pernicious anemia

## Complete Blood Count (CBC)

The complete blood count does just that, it 'counts' how many blood cells and platelets are in your blood. Your bone marrow makes WBCs, RBCs, and platelets. Some treatments have a great effect on the bone marrow's ability to create new cells and platelets (*bone marrow suppression*). *It is very common for blood counts to drop during certain types of treatments.* There are medications available that can encourage your bone marrow to make more blood cells.

## White Blood Cell Count (WBC)

Substance Measured	Normal Range	Causes of a Low Result	Causes of a High Result
<b>WBC</b>	4.0-11.0 x10 <sup>9</sup> /L	Medications that suppress the bone marrow/ immune system Overwhelming infections	Infection Inflammation Medications (steroids) Immune system disorders Physical or emotional stress

## White Blood Cells - Differential

The automated analyzer at Roswell Park gives a WBC differential with every CBC result. The WBC differential measures the amount of every type of WBC in the blood. It can also reveal abnormal or immature cells. The 5 types of WBCs commonly found in blood are neutrophils, lymphocytes, monocytes, eosinophils, and basophils.

- Immature neutrophils, or neutrophils that have recently been released from the bone marrow, are *band neutrophils*.
- Mature neutrophils are *segmented neutrophils or segs*.

Substance Measured	Normal Range	Causes of a Low Result	Causes of a High Result
<b>Neutrophils</b>	40.0 - 79.0%	Bone marrow suppression Aplastic anemia Chemotherapy Medications Radiation therapy Infection	Smoking Bacterial infection Physical Stress Inflammatory response
<b>Band Neutrophils</b>	0-5 %		Infection
<b>Lymphocytes</b>	20.0 - 45.0 %	Bone marrow suppression Medications that suppress the immune system (steroids) Chemotherapy Radiation therapy Autoimmune disorders	Viral infections Lymphocytic leukemia
<b>Monocytes</b>	1.0 – 13.0 %		Chronic inflammatory disease Parasitic infection Tuberculosis Viral infections
<b>Eosinophils</b>	0.0 – 6.0 %	Alcohol intoxication Body overproducing steroids (cortisol)	Allergic reactions, Asthma Parasitic infection Drug reactions Inflammatory disorders
<b>Basophils</b>	0.0 – 2.0 %	Steroid medications Allergic reactions Acute infections	Change in bone marrow function

## Red Blood Cells (RBC)

The parameters measured for RBCs are:

- count
- the amount of oxygen-carrying protein (hemoglobin or HGB)
- the variation in size among the RBCs (red cell distribution width or RDW)

Parameters calculated from the measured RBC tests are:

- the percentage of RBCs in your blood (HCT -hematocrit)
- average size (MCV - mean corpuscular volume)
- the average amount of hemoglobin in a RBC (MCH - mean corpuscular hemoglobin)

Having too many RBCs circulating in your blood is a condition called *polycythemia*.

Substance Measured	Normal Range	Causes of a Low Result	Causes of a High Result
<b>Red Blood Cells (RBC)</b>	Males: 4.7-6.1 X10 <sup>12</sup> /L  Females: 4.2-5.4 X10 <sup>12</sup> /L	Bone marrow suppression Bleeding Chemotherapy Low RBCs Iron, Vitamin B12, or folate (B9) deficiency Kidney failure Anemia	Dehydration Smoking Lung disease Heart disease
<b>Hemoglobin (HGB)</b>	Males 13.5-17.5  Females 12.5-15.5 g/dL	Level usually mirrors the RBC level. Causes are the same as a decreased RBC.	Level usually mirrors the RBC level. Causes are the same as an increased RBC.
<b>Hematocrit (HCT)</b> Level usually mirrors the RBC level.	Males: 38.0 - 52.0 %  Females: 36-47%	Causes are the same as a decreased RBC.	Causes are the same as increased RBC – dehydration is the most common
<b>Mean Corpuscular Volume (MCV)</b>  <b>Mean Corpuscular Hemoglobin (MCH)</b>	76.0 -100.0 fL  27.0-34.0 pg/cell	Causes of smaller RBCs: Iron deficiency anemia	Causes of larger RBCs: Vitamin B12 or folate (B9) deficiency Alcoholism Hemolytic or pernicious anemia
<b>RBC Distribution Width (RDW)</b>	11.5 - 14.5 %	Low value indicates RBCs are uniform in size Macrocytic anemia	High value - mixed population of small and large RBCs Iron deficiency Pernicious anemia Transfusion

## Platelets (PLT)

Platelets are essential for normal blood clotting. The tests for PLTs include getting a count and tests to measure:

- the average size of platelets (mean platelet volume or MPV)
- variation in size of the platelets (platelet distribution width)

Having abnormally low platelets is called thrombocytopenia (THROM-bo-si-to-PE-ne-ah); having too many platelets is called thrombocytosis (THROM-bo-si-TO-sis).

Substance Measured	Normal Range	Causes of a Low Result	Causes of a High Result
Platelets (PLT)	150-450 x10 <sup>9</sup> /L	Bone marrow suppression Viral infection Medication (acetaminophen/ Tylenol®, sulfa) Myelodysplasia syndromes (MDS) Chemotherapy Radiation therapy Cirrhosis (scarring of liver) Autoimmune disorders	Anemia Bleeding (hemorrhage) Inflammation Cancer Myeloproliferative disorder (MPD or MPN -bone marrow makes too many platelets) Decreased spleen function
Mean Platelet Volume (MPV)	7.2-11.1 fL	Low result indicates platelets are small in size/older	High result indicates larger, younger platelets
Platelet Distribution Width (PDW)	25.0-65.0 %	Low value indicates PLTs are more uniform in size	High value indicates a wide variation in platelet size

## Clotting Studies: PT/INR and APTT

Coagulation is a series of reactions that occur in the blood. During this process, clotting factors are activated in order to form a clot.

There must be a sufficient amount of each clotting factor, working properly, for normal clotting to occur. Too little can lead to too much bleeding, and too many may lead to excessive clotting.

**PT** (prothrombin time) measures the overall ability to produce a clot in the blood and how long it takes a clot to form.

**INR** (International Normalized Ratio) allows comparison between different institutions for patients taking warfarin (Coumadin®). Together, the PT and INR levels monitor the effectiveness of warfarin therapy.

**APTT** (activated partial thromboplastin time) also evaluates the ability to form blood clots but it looks at different clotting factors than the PT test. It's used to monitor heparin therapy.

Substance Measured	Normal Range	Causes of Prolonged Result (longer time for blood to clot)	Factors Affecting Results
<b>PT</b>	11.6-13.7 seconds	Low vitamin K level Decreased or defective clotting factors (II, VII, IX, X) Anticoagulation drugs (warfarin) Liver disease	Alcohol Certain medications: aspirin, ibuprofen, estrogen (oral contraceptives) Foods/vitamins high in vitamin K**
<b>INR</b>	Therapeutic Range: 2.0-3.0		Foods high in vitamin K** Medications (aspirin, ibuprofen, estrogen)
<b>APTT</b>	23.0-36.0 seconds	Deficiency of clotting factor XIII or IX Severe liver disease Heparin therapy	High hematocrit High fat meals before blood draw Blood sample that is too small

\*\*Some foods high in vitamin K include broccoli, lettuce, spinach, soybean products, and kale