



**{LAB WORK}**  
**EDUCATIONAL**  
**REFERENCE GUIDE**

**EDUCATE. EQUIP. EMPOWER.**

*[www.plantricianproject.org](http://www.plantricianproject.org)*

## Welcome to The Plantrician Project's Lab Work Educational Reference Guide!

This Plantrician Project Lab Work Educational Reference Guide was created by our physicians as an educational guide to help your patients gain a better understanding of their lab work, and the relationship between their results and diet and lifestyle. When appropriate, you will also find notation of optimal lab values that represent the potential of a whole food plant-based diet over time to assist the body in restoring and regenerating systems that were compromised by an unhealthy diet.

We hope this educational resource is beneficial to you and your patients and inspires greater motivation for choosing a whole food plant based diet.

Best in Health,



Dr. Scott Stoll



## {LAB WORK}

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**Disclaimer:**

*The content herein is not intended to cure, prevent, diagnose or treat any disease. Please consult with your patients / healthcare provider or specialist regarding any health related decisions. Please contact your health insurance carrier or your provider to get a personalized estimate for costs or out-of-pocket expenses.*

## COMPLETE BLOOD COUNT ("CBC")

This test tells us how well your bone marrow is creating red blood cells (RBC's) that carry oxygen, white blood cells (WBC's) that fight infection and platelets that help clot your blood.

Range of Normal values:

RBC's - 3.8 to 5.69 million/mm<sup>3</sup>

WBC's - 3.8 to 10.4 thousand/mm<sup>3</sup>

Platelets - 100 - 300 thousand/mm<sup>3</sup>

## IRON TESTS

### Hemoglobin, Hematocrit, Ferritin and TIBC

These tests indicate how well you are absorbing and transporting iron and how much stored iron you have in your tissues.

Range of Normal values:

#### Hemoglobin

Hemoglobin enables red blood cells to transport oxygen to tissues and carbon dioxide back to the lungs.

Male - 13.8-17.2 g/dL or 138-172 g/L

Female - 12.1-15.1 g/dL or 121-151g/L

#### Hematocrit

Hematocrit is the percentage of red blood cells by volume in your blood.

Male - 41% - 50%

Female - 36% - 48%

#### Total Iron Binding Capacity ("TIBC" = transport protein made by liver)

300 to 360 mcg/dL, which is 20% to 50% saturated with iron. Foods like lentils, beans, soy foods, seeds and nuts, black strap molasses, and leafy greens are excellent sources of iron. Adding vitamin C foods like citrus, cruciferous, and bell peppers enhance iron absorption.

#### Ferritin (Stored Iron)

40 to 200 ng/mm



## COMPREHENSIVE METABOLIC PROFILE ("CMP")

This commonly ordered battery of tests evaluates 14 different measurements to give insight into the function of vital organs, such as the kidneys (BUN, creatinine, eGFR and mineral electrolytes, namely, potassium, sodium, chloride, and bicarbonate), the pancreas (glucose), and liver (albumin, bilirubin, and liver enzymes, AST, ALT, alkaline phosphatase). Here are specifics about the individual tests.

*{The following test grouping in the CMP reflect KIDNEY function}*

### BUN (Blood Urea Nitrogen)

After you eat, your digestive system breaks down the proteins in your diet to the constituent amino acids, each containing an ammonia group (NH<sub>3</sub>). The liver then removes the ammonia groups from the amino acids, and packages it as urea for the kidneys to excrete in the urine. The amount of urea nitrogen in the blood indicates how well the kidneys are working, higher BUN levels indicate kidney failure. However, dehydration may also contribute to elevated BUN levels. As kidneys fail (for any reason), elevation of BUN levels in the blood are seen.

Range of Normal values:

5 - 20 mg/dL

### CREATININE

Creatinine is a byproduct of normal muscle activity. It is a waste product that is normally filtered and removed from the blood by the kidneys. Dehydration can cause elevated creatinine levels and the eGFR levels to fall. As kidneys fail (for any reason), elevation of creatinine levels in the blood are seen.

Range of Normal values:

0.6 - 1.2 mg/dL

### eGFR (estimated Glomerular Filtration Rate)

eGFR is a calculation of the amount of blood the kidneys filter every minute, based upon the creatinine levels.

Range of Normal values:

Greater than 60 milliliters blood per minute

## SODIUM

A mineral (and electrolyte) that promotes healthy acid-base balance, fluid balance, normal nerve conduction, cellular pumps, and muscle function. Sodium comes from the diet and is tightly regulated by the kidneys. Low levels can be due to excessive water consumption, medications, chronic or severe vomiting and diarrhea, heart failure, kidney and liver disease, conditions like SIADH (Syndrome of Inappropriate Antidiuretic Hormone) and Addison's disease. Elevated levels usually indicate dehydration.

### Range of Normal values:

135 to 145 milliequivalents per liter (mEq/L)

## CHLORIDE

Another electrolyte that functions along with sodium, potassium, and bicarbonate to maintain electrical function of the tissues. It is important in fluid balance, regulating the pH of the body along with blood pressure, nerve, and muscle function. Imbalances can be caused by vomiting and diarrhea, medications like corticosteroids and diuretics, conditions like SIADH, respiratory acidosis, kidney disease, and chemotherapy.

### Range of Normal values:

95 to 106 milliequivalents per liter (mEq/L)

## CALCIUM

A critical mineral that maintains bone density along with proper functioning of the muscles, heart, and nervous system. Blood calcium levels do not fluctuate normally based on diet; instead, a low blood calcium level prompts the secretion of parathyroid hormone which lets the body draw calcium stored in the bones as a reserve to maintain normal blood levels. A well-planned whole food, plant-based diet, rich in dark leafy green vegetables, seeds, fruits and, often, calcium-fortified juices and plant-milks, provides sufficient calcium to maintain bone density - along with weight-bearing exercise and a healthy lifestyle.

### Range of Normal values:

8.5 - 10.5 dL

## POTASSIUM

A mineral electrolyte, rich in most whole plant foods, is critical to cell function and metabolism; it aids in the transport of glucose into cells, the movement of waste products out of cells and it helps to maintain the pH of the body. Potassium is essential for muscle function and the transmission of nerve signals. Because the blood concentration of this mineral is quite low, small changes can have significant impacts on health.

Range of Normal values:

3.5 - 5.5 mEq/dL

## BICARBONATE

An electrolyte that helps to maintain pH balance and reflects the total amount of carbon dioxide and acid load in the blood. Any disease that affects the lungs, kidneys, or metabolism can cause the bicarbonate levels to change.

Range of Normal values:

23 - 29 mEq/dL

*{The following test in the CMP reflect PANCREAS function}*

## GLUCOSE

A type of sugar that is the primary energy source of the brain and body. Also referred to as “blood sugar,” its levels can be elevated in common conditions like Type 2 diabetes when the body develops insulin resistance due to fat accumulation in the liver and muscle tissue and from inflammation. Type 1 diabetes, where the insulin-secreting cells in the pancreas have been destroyed, can also lead to elevated glucose levels.

Range of Normal values:

70 - 100 mg/dL



## HEMOGLOBIN A1c (HbA1c)

Although not part of the standard CMP, the HbA1c is the percent of hemoglobin in the blood that is “sticky” with glucose (glycosylated). It reflects average blood glucose over the preceding 8-12 weeks and elevated levels often indicate presence of insulin resistance or type 2 diabetes. Inflammation and fatty accumulation in the muscle, known as intramyocellular fat, and liver disrupt insulin signaling.

Range of Normal values:

<5.0 Optimal

< 5.7% = normal risk

5.8% - 6.4% = pre-diabetes

> 6.5% = diabetes

*{The following test grouping within the CMP reflect LIVER function}*

## TOTAL PROTEIN

Total Protein measures the total amount of protein in your blood with two main types of blood proteins: globulins and albumin. High or low levels are not always indicative of chronic disease and can be affected by intense exercise, diet, stress, age, pregnancy, surgery, hydration, and birth control pills.

Range of Normal values:

Normal range is 6.0 to 8.3 grams per deciliter (g/dL) or 60 to 83 g/L and vary slightly from lab to lab.

## ALBUMIN

Albumin makes up half of the total protein in the serum and helps keep blood from leaking out of blood vessels. It also helps move hormones, medicines, vitamins, and other important substances throughout the body. Additionally, albumin neutralizes metabolic acids, and osmotically prevents fluid from leaking out of blood vessels into the surrounding tissues. It reflects the ability of the liver to synthesize protein and normal albumin levels usually indicate healthy liver function.

Range of Normal values:

3.4 - 5.4 g/dL (34 to 54 g/L)

## GLOBULINS

Globulins help fight infection and move nutrients throughout the body. Some globulins are made by the liver. Others are made by the immune system. Foods that improve globulin are soy, hemp seeds, and green leafy vegetables.

### Range of Normal values:

2.0 to 3.5 grams per deciliter (g/dL) or 20 to 35 grams per liter (g/L)

IgM component: 75 to 300 milligrams per deciliter (mg/dL) or 750 to 3,000 milligrams per liter (mg/L)

## BILIRUBIN

Bilirubin is formed when red blood cells, specifically the heme component, are broken down and transported to the liver, gall bladder and digestive tract for removal. It can be elevated in conditions like gallstones, Gilberts syndrome (unable to process bilirubin), liver dysfunction and hepatitis, inflamed bile duct, and hemolytic anemia.

Normal Levels: 0.3 to 1.0 mg/dL.

Elevated: >1.2 mg/dL

## ALKALINE PHOSPHATASE (ALP)

Alkaline Phosphatase is an enzyme that is found in tissues throughout the body, but especially in liver and bone. Elevation of ALP in the blood can indicate damage to the liver, obstruction of bile flow or destruction of bone.

### Range of Normal values:

44 - 147 units/L

## ALANINE AMINOTRANSFERASE (ALT)

Alanine aminotransferase (ALT) is an enzyme that is primarily found in the liver. When the liver is damaged (alcohol, hepatitis, gallstones, NAFLD, etc.), ALT spills into the bloodstream, indicating damage to liver tissue. It is not uncommon for the liver tests to lag actual damage and inflammation of the liver from conditions like Non-Alcoholic Fatty Liver Disease (NAFLD).

### Range of Normal values:

7 - 55 units/L

## ASPARTATE AMINOTRANSFERASE (AST)

Aspartate Aminotransferase (AST) is an enzyme present mostly in the liver but also other tissues of the body, like brain, muscle, or pancreas. Elevations of AST in the blood can indicate damage to one of these tissues.

### Range of Normal values:

8 - 48 units/L

## CHOLESTEROL PANEL

Lipids (fats) are an important component of a healthy body. A vital lipid, cholesterol is made by the liver and is the “root” molecule in the production of hormones such as cortisol, vitamin D, testosterone, estrogen, and other steroid hormones. Comprising 30% of all cell membranes, it is important for intracellular nutrient transport and in bile production needed for fat absorption. People who eat completely whole food, plant-based diets occasionally have elevated cholesterol levels due to the liver’s meeting the needs for more hormone synthesis, bile production, etc. - but such an elevation in these people (in the absence of raised inflammatory markers) is believed to be a benign condition, not increasing the risk for atherosclerotic plaque formation in the arteries. It is important however to follow the trend and if cholesterol levels are consistently rising then diet, lifestyle, and stress factors need to be re-evaluated. Lifetime exposure to high cholesterol levels is the greatest risk factor for cardiovascular disease.

According to the CDC, 39% of people eating the Standard American Diet, laden with processed food, oils, refined sugars, and fried foods that repeatedly injure the artery walls, have elevated total cholesterol levels (>200 mg/dl). This measurement includes the LDL form of lipoprotein, which can be subdivided into large and small dense LDL. The small dense LDL is the most injurious to the artery walls and elevated values have been associated with an increased risk of atherosclerotic plaque formation, and, thus, heart attacks and strokes. There is a strong link between eating a plant-based diet and lower cholesterol. Cholesterol is only found in animal-based foods.

### **Lipid panel tests typically include:**

Total Cholesterol, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Very Low-Density Lipoprotein (VLDL), Triglycerides, and Cholesterol Ratio

## TOTAL CHOLESTEROL

Total Cholesterol is the measure of all cholesterol molecules.

Optimal: 125-145 mg/dL

Range of Normal values:

Less than 200 mg/dL (5.17 mmol/L)

## HIGH DENSITY LIPOPROTEIN (HDL)

HDL acts as a transport molecule to remove excess cholesterol and return it to the liver. HDL also contains an antioxidant and anti-inflammatory component that prevents LDL oxidation, and so is typically referred to as the “good” cholesterol.

Range of Normal values:

Above 40 mg/dL

## LOW DENSITY LIPOPROTEIN (LDL)

LDL makes up most of your body’s cholesterol and elevated levels are strongly associated with heart disease. The subclass small dense LDL is the most atherogenic or disease-causing type of LDL.

Optimal: <70 mg/dL

Range of Normal Values:

<100 mg/dL (This is the goal for people with diabetes or heart disease.)

100 to 129 mg/dL = Near optimal

130 to 159 mg/dL = High



## VERY LOW-DENSITY LIPOPROTEIN (VLDL)

Produced in the liver, VLDL carries triglycerides to the tissues of the body and therefore is an indicator of increased risk of coronary heart disease. VLDL measurements are indirect, derived via a calculation, and if elevated, reflect high triglyceride levels.

### Range of Normal Values:

Between 2 and 30 mg/dL

## TRIGLYCERIDES

Elevated levels are due to excessive dietary consumption of sugars; they are the predominant component of body fat and elevated levels can increase the risk of heart disease. A diet high in sugar and processed food leads to increased triglyceride levels, as does moderate alcohol use.

Optimal: <50 mg/dL

### Range of Normal Values:

<150 milligrams per deciliter (mg/dL), or less than 1.7 millimoles per liter (mmol/L) = Low Risk

150 to 199 mg/dL (1.8 to 2.2 mmol/L) = Borderline High

200 to 499 mg/dL (2.3 to 5.6 mmol/L) = High

## CHOLESTEROL RATIO

Cholesterol ratio is a comparison of your total cholesterol to your HDL cholesterol. This ratio is a tool to predict your risk of heart disease. More recent studies have found that elevated cholesterol over time is the highest risk and greatest predictor of heart disease risk.

Normal: Value of 5 or less

Optimal: Value of 3 or less



## MARKERS OF INFLAMMATION

### CRP (C-REACTIVE PROTEIN)

CRP (C-reactive protein) is a protein produced by the liver in response to inflammation. Any condition that causes inflammation, such as the Standard American Diet, infections, injuries, autoimmune diseases, arthritis, lupus, inflammatory bowel disease, or surgeries, for example, can cause CRP to be elevated. Elevated CRP levels can also be seen in people who recently suffered a heart attack. CRP measures markedly high levels of inflammation.

Optimal: <1 mg/L

#### Range of Normal Values:

Less than 10 mg/L

### hsCRP (HIGH SENSITIVITY CRP)

hsCRP, in contrast, identifies lower levels of persistent inflammation that may be associated with atherosclerotic plaque formation and, thus, cardiovascular disease. Typically, the test will need to be repeated to confirm that an individual has persistent low levels of inflammation. The CDC and American Heart association recommend that levels greater than 10 mg/L be repeated twice, two weeks apart in people without infection, recent surgery, or acute illness. A whole food, plant-based diet dramatically reduces hsCRP within weeks.

#### Range of Normal Values for cardiac risk:

Low: < 1.0 mg/dL

Average: 1.0-3.0 mg/dL

High: > 3.0 mg/dL



## VITAMIN D

Naturally produced when UV light activates the production of vitamin D in the skin, vitamin D promotes calcium absorption in the gut and helps to maintain bone health and density. It also reduces inflammation, is involved in the growth of cells, supports immune function (reduces the risk of viral illnesses), is essential for neuromuscular function and it plays a key role in regulating insulin and glucose metabolism.

Vitamin D has two forms, D2 (ergocalciferol from plants and yeast) and D3 (cholecalciferol) traditionally made from animal products,) though there is now a vegan vitamin D3 produced from algae. Very few plant-based foods contain vitamin D, except for some mushrooms, but it is commonly found in fortified cereals, nut/seed milks and juices. Forty percent of people living in the US have low vitamin D levels and may be at risk for reduced bone density, pain in muscles and joints, low energy, anxiety, weight gain, hair loss, increased irritability, and depressed mood. Those at risk for low vitamin D levels include people who have limited sun exposure, like those who live in facilities like nursing homes, those who have darker skin, GI diseases like celiac disease, bariatric surgery, and, since vitamin D is activated in the kidneys and liver, chronic kidney and liver disease can also promote vitamin D deficiency.

### Range of Normal Values:

Between 20 and 50 ng/mL

## OMEGA-3 FATS

Omega-3 Fats are essential polyunsaturated fats needed for cell membranes and for regulating inflammatory reactions throughout the body. There are three different types of omega-3 fats which are of particular importance – ALA, DHA, and EPA, (alpha-linolenic acid, docosahexaenoic acid, and eicosapentaenoic acid respectively). While the body can produce EPA and DHA from ALA, it cannot make its own ALA and this must therefore come from the food we eat, especially walnuts, seeds like flax, chia, and hemp, as well as dark green vegetables - foods which should be eaten almost daily. The US Dietary Guidelines Advisory Committee reported that a staggering 70% of Americans are deficient in omega-3s, so vegans and vegetarians should be vigilant to avoid a deficiency and check levels once a year to avoid deficiencies.

## OMEGA-3 FATS (cont.)

If you're purely relying on ALA to obtain EPA & DHA without supplements, the efficiency of your body's conversion from ALA to EPA & DHA can be assessed with an Omega-3 Index blood test. This test measures the quantity of EPA and DHA present in the membranes of the red blood cells. However, this test may not reflect DHA production within nerve, heart, and other cells, and while taking supplemental DHA and EPA can raise levels of these fats on the blood tests, it is unclear if such supplementation increases longevity or improves function of brain, heart or other vital organs. More research is needed to definitively answer this question.

### Range of Normal Values:

Omega-3 Index values less than 6-8 have been associated with increased risk of atherosclerosis in people eating the Standard American Diet and thus repeatedly injuring their artery walls but it is unknown if it has similar prognostic value in people eating completely whole food, plant-based diet (WFPBD). It is also unknown if people eating WFPBD with low Omega-3 index values are at higher risk for dementia, etc. The choice to supplement with EPA/DHA is up to the individual.

## VITAMIN B12

Vitamin B12 is an essential vitamin required for healthy function of the brain, central and peripheral nerves, and red blood cell formation. Made by microbes in soils, it can be commercially produced, harvested, and added to B12 supplements and fortified foods. Animal products containing B12 originate either in the soil when animals are grazing on grass or through supplements added to their food. Low levels can damage the brain leading to dementia, nerves, peripheral neuropathy, and anemia.

### Range of Normal Values:

Although "normal" levels are commonly listed as low as 200 pg/ml, people are often symptomatic with signs of nerve dysfunction at this level and many health authorities advise safer levels between 500 pg/ml and 900 pg/ml. Taking 500 - 1000 mcg of cyanocobalamin or methylcobalamin two to three times weekly is usually sufficient to avoid deficiency. It is recommended that you check your B12 levels at least once per year to avoid deficiencies and adjust supplements accordingly.

## HOMOCYSTEINE

Homocysteine is another molecular marker that requires folate and B12 for its metabolism; elevated levels of homocysteine can injure the artery walls and promote plaque formation and are associated with cardiovascular disease. An elevated homocysteine level issue would indicate either folic acid is low or not adequately metabolized. If both MMA and homocysteine are normal, a B12 deficiency is unlikely.

### Range of Normal Values:

5 to 15 micromoles per liter (mcmol/L)

## METHYLMALONIC ACID (MMA)

Methylmalonic Acid (MMA) is a metabolic waste product requiring vitamin B12 for its elimination; rising MMA levels are often useful to diagnose the early stages of a vitamin B12 deficiency in cells and tissues. It is a more sensitive measure of B12 deficiency.

### Range of Normal Values:

0.07 to 0.27 micromoles per liter

## IODINE

Iodine is a mineral found in food grown in healthy soils and in many sea vegetables. Essential for creating vital thyroid hormones, deficiency of iodine can result in a hypothyroidism and a large, swollen thyroid gland known as a goiter. When our iodine stores are replete, we excrete in the urine approximately 100 micrograms of iodine each day. Since blood levels of iodine can fluctuate during the day depending on when the blood is drawn, the most accurate test for iodine sufficiency is a 24-hour urine collection. It is essential for pregnant women to get sufficient iodine because it is vital for the baby's brain development. Iodine rich foods include potatoes, strawberries and cranberries, beans, spring greens, and dried sea vegetables.

### Range of Normal Values:

(Blood, in adults) 150–249 mcg/L

(Urine, in adults) 100–200 mg/L



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