



Lab Test Results Review Guide

Overview

Laboratory tests are essential tools in evaluating your health status. Laboratory tests can help you learn more about your body and detect potential problems in early stages when medical treatment or changes in personal habits can be most effective.

Some tests provide a simple yes or no (positive or negative, reactive or non-reactive) answer. Was the urine or blood pregnancy test positive for pregnancy (indicating the presence of a minimal level of a hormone called HCG) or negative (absence or very low level of HCG)? Did the test find antibodies to a virus or bacterium that indicates an infection – reactive or non-reactive?

More commonly, lab test results are reported as a number that is either within or outside the "normal or reference range." Is "out of the normal range" a cause for concern? The brief answer is that a result out of the normal range is a signal that further investigation – or at least an explanation – is needed.

[For detailed information about reference ranges, see this article.](#)

A lab test such as cholesterol, like any medical observation, must be considered in context. Otherwise, any observation or test result is meaningless. To understand what is normal for you, your doctor must know your age, sex and even when you last ate. Your results are then compared to a reference range taken from individuals similar to you in gender and age – comparing "apples to apples," so to speak.

Results falling outside the reference range – which may suggest better or worse than average health – can be due to such things as diet, age, sex, pregnancy, menstrual cycle, degree of physical activity, problems with collection and/or handling of the specimen, non-prescription and prescription drugs, alcohol intake and a number of non-illness-related factors. Any results not within the reference range should be discussed with your doctor, because some deviations might be significant while others are not. Typically, it is not possible to diagnose or treat any condition with a single blood test only. In addition, it is wise to verify significantly abnormal test results by repeating the test.

Here are the specific steps that you should take when reviewing your lab results:

Step 1: Verify that the results belong to you by checking that your name as well as other identifying data (like your date of birth, address, phone number, etc) are correct on the reporting form. Large national labs run thousands of tests each day and more than one person with your name could have been tested the same day.

Step 2: Verify that data pertinent to proper interpretation of results has been entered correctly – age, gender, fasting or non-fasting state, etc. Obvious and significant age and gender differences will dictate a different reference range based on age and gender. Similarly, whether you have eaten or not affects the expected results of several lab tests. For example, glucose has a different expected result range depending on whether one is fasting or has eaten recently.

Step 3: Look for results that are positive (reactive). This often indicates that the condition being tested for is present – for instance pregnancy. Of course, that can be good or bad based on your specific circumstances. Likewise, if you are testing for the presence of "hepatitis B antibody" to confirm that the vaccination that you took worked, then "positive" for this antibody is good. If you have never had the vaccination, then the test probably means that you have contracted hepatitis at some point in your life – that is not so good.

Step 4: Note if results are outside the reference range. If so, you will probably want to discuss the test results with your doctor if the cause is not apparent or expected.

Common lab tests and what they measure

The list that follows is a brief summary of commonly ordered lab tests and is not intended to be comprehensive or replace discussion of your results with your doctor.

- [Glucose](#)
- [Glycohemoglobin](#)
- [Electrolytes](#)
- [Waste products](#)
- [Enzymes](#)
- [Proteins](#)
- [Blood fats](#)
- [Cardiac risk factors](#)
- [Minerals](#)
- [Hormones](#)
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Glucose: This is a measure of the sugar (or glucose) level in your blood. High values are associated with eating before the test, and with diabetes.

The normal range for a fasting glucose is 60 -109 mg/dl. According to the 1999 ADA criteria, diabetes is diagnosed with a fasting plasma glucose of 126 or more. A precursor, Impaired Fasting Glucose (IFG), is defined as fasting glucose levels of 110 - 125. Sometimes a glucose tolerance test, which involves giving you a sugary drink followed by several blood glucose tests, is necessary to properly sort out normal from IFG from diabetes.

Be aware that individual labs have varying normal reference ranges. Also, Europeans tend to use a 2-hours-after-eating definition of diabetes rather than a fasting glucose, which tends to increase the number of people who are classified as having diabetes.

Glycohemoglobin: (Hemoglobin A1 or A1c, HbA1c): Glycohemoglobin measures the amount of glucose chemically attached to your red blood cells.

Since blood cells live about 3 months, it tells us your average glucose for the last 6-8 weeks. A high level suggests poor diabetes control. Standardization for glycohemoglobin from lab to lab is poor, and you cannot compare tests from different labs unless you can verify the technique for measuring glycohemoglobin is the same. Our lab is standardized to the national DCCT referenced method. You can ask your lab (if comparing our result to a previous test result) if they use a DCCT referenced method.

Electrolytes: These are your potassium, sodium, chloride and CO₂ levels.

- *Potassium* is controlled very carefully by the kidneys. It is important for the proper functioning of the nerves and muscles, particularly the heart. Any value outside the expected range – high or low – requires medical evaluation. This is especially important if you are taking a diuretic (water pill) or heart pill (Digitalis, Lanoxin, Digoxin, etc.).
- *Sodium* is also regulated by the kidneys and adrenal glands. The most common causes of low sodium are diuretic usage, diabetes drugs like chlorpropamide, and excessive water intake in patients with heart or liver disease.
- *CO₂* reflects the acid status of your blood. Low CO₂ levels can be due to increased acidity from uncontrolled diabetes, kidney disease, or metabolic disorders, or to chronic hyperventilation.

Waste products:

- *Blood Urea Nitrogen (BUN)* is a waste product produced in the liver and excreted by the kidneys. High values may mean that the kidneys are not working as well as they should. BUN is also affected by high protein diets and/or strenuous exercise which raise levels, and by pregnancy which lowers it.

- *Creatinine* is a waste product largely from muscle breakdown. High values, especially with high BUN levels, may indicate problems with the kidneys.
- *Uric Acid* is normally excreted in urine. High values are associated with gout, arthritis, kidney problems and the use of some diuretics.

Enzymes:

AST, ALT, SGOT, SGPT, and GGT and Alkaline Phosphatase are proteins called enzymes which help all the chemical activities within cells to take place. Injury to cells releases these enzymes into the blood. They are found in muscles, the liver and heart. Damage from alcohol and a number of diseases is reflected in high values.

- *Alkaline phosphatase* is an enzyme found primarily in bones and the liver. Expected values are higher for those who are growing (children and pregnant women), when damage to bones or liver has occurred, or with gallstones. Low values are probably not significant.
- *GGT* is also elevated in liver disease, particularly with obstruction of bile ducts. Unlike the alkaline phosphatase, it is not elevated with bone growth or damage.
- *AST/SGOT and ALT/ SGPT* are also liver and muscle enzymes. They may be elevated from liver problems, hepatitis, excess alcohol ingestion, muscle injury or recent heart attack.
- *LDH* is the enzyme present in all the cells in the body. Anything which damages cells – including drawing blood – will raise amounts in the blood. If blood is not processed promptly and properly, high levels may occur. If all values except LDH are within expected ranges, it is probably a processing error and does not require further evaluation.
- *Bilirubin* is a pigment removed from the blood by the liver. Low values are of no concern. If slightly elevated above the expected ranges, but with all other enzymes (LDH, GOT, GPT, GGT) within expected values, it is probably a condition known as Gilbert's syndrome and is not significant.
- *CPK* is an enzyme which is very useful for diagnosing diseases of the heart and skeletal muscle. This enzyme is the first to be elevated after a heart attack (within 3-4 hours). If CPK is high in the absence of heart muscle injury, this is a strong indication of skeletal muscle disease.

Proteins:

Albumin and Globulin measure the amount and type of protein in your blood, which is a general index of overall health and nutrition. Globulin is the "antibody" protein important for fighting disease. A/G Ratio is the mathematical relationship between these two proteins.

Blood Fats:

Cholesterol is a fat-like substance in the blood which, if elevated, has been associated with heart disease.

- *Total Cholesterol*: A high cholesterol in the blood is a major risk factor for heart and blood vessel disease. Cholesterol in itself is not all bad; in fact, our bodies need a certain amount to function properly. However, when the level gets too high, it can result in vascular disease. A total cholesterol of less than 200, and an LDL Cholesterol of 100 or less is considered optimal by the National Heart, Lung and Blood Institute. The levels that your doctor will recommend depend upon whether you are at high risk for cardiovascular disease.

As the level of blood cholesterol increases, so does the possibility of plugging the arteries due to cholesterol plaque build-up. Such a disease process is called "hardening of the arteries" or atherosclerosis. When the arteries feeding the heart become plugged, a heart attack may occur. If the arteries that go to the brain are affected, then the result is a stroke.

There are three major kinds of cholesterol: High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), and Very Low Density Lipoprotein (VLDL).

- *LDL Cholesterol* is considered "bad cholesterol" because cholesterol deposits form in the arteries when LDL levels are high. An LDL level of less than 130 is recommended, 100 is optimal, and values greater than 160 are considered high risk and should be followed up by your physician. Those persons with established coronary or vascular disease may be instructed by their doctor to get their LDL Cholesterol well below 100. You should ask your doctor which LDL target is best for you.

There are two ways to report LDL. The most common is simply an estimate calculated from the Total Cholesterol, HDL, and triglycerides results. This may say "LDL Calc." A directly measured LDL Cholesterol is usually more accurate but more expensive, and may require that your doctor specify the direct LDL.

- *Triglyceride* is fat in the blood which, if elevated, has been associated with heart disease, especially if over 500 mg. High triglycerides are also associated with pancreatitis. Triglyceride levels over 150 mg/dl may be associated with problems other than heart disease.
 - Ways to lower triglycerides:
 1. Lose weight
 2. Reduce animal fats in the diet: eat more fish
 3. Take prescription medication
 4. Get regular aerobic exercise
 5. Decrease alcohol and sugar consumption. While alcohol and sugar are not fats, the body can convert them into fats then dump those fats into your blood stream.

6. Restrict calories. The body converts carbohydrates into triglycerides when eaten to excess.
 - o *HDL cholesterol* is a "good cholesterol" because it protects against heart disease by helping remove excess cholesterol deposited in the arteries. High levels seem to be associated with low incidence of coronary heart disease.
 - o *VLDL (very low density lipoprotein)* is another carrier of fat in the blood.

Cardiac Risk Factors:

- *C Reactive Protein (CRP)*: This is a marker for inflammation. Traditionally it has been used to assess inflammation in response to infection. However, Private MD uses a highly sensitive C Reactive Protein to predict vascular disease, heart attack or stroke. The best treatment for a high C Reactive Protein level has not yet been defined; however, taking statin drugs and/or niacin, losing weight, quitting smoking, and exercising all appear to improve C- Reactive Protein levels.
- *Homocysteine*: This amino acid is normally found in small amounts in the blood, where higher levels are associated with increased risk of heart attack and other vascular diseases. Homocysteine levels may be high due to a deficiency of folic acid or Vitamin B12, due to heredity, older age, kidney disease, or certain medications. Men tend to have higher levels. Our lab normals are 4 - 15 micromole/l, but if you have had previous vascular disease, we may recommend medications to reduce it below 10. You can reduce your homocysteine level by eating more leafy green vegetables and fortified grain products or cereals. The usual treatment is folic acid with or without Vitamin B-12.
- *Lipoprotein (a) or Lp(a)*: Elevated concentrations are associated with premature coronary heart disease (CHD). The exact mechanism is not yet clear, but it appears that there is a strong genetic component to elevated Lp(a) levels that correlates with coronary disease. Those with diabetes and a high Lp(a) level appear to be at increased risk of asymptomatic coronary disease.

Note that a few insurance companies refuse to pay for cardiac risk factor testing. As of this writing (in early 2008), Aetna stands out as a company that refuses to cover testing for homocysteine or Lp(a) on the basis that it is "experimental" or "investigational." Private MD has requested a comprehensive review of their policy since it deviates from the norm.

Minerals:

- *Calcium* is controlled in the blood by the parathyroid glands and the kidneys. Calcium is found mostly in bone and is important for proper blood clotting, nerve and cell activity. An elevated calcium can be due to medications such as thiazide type diuretics, inherited disorders of calcium handling in the kidneys,

or excess parathyroid gland activity or vitamin D. Low calcium can be due to certain metabolic disorders such as insufficient parathyroid hormone, or drugs like Fosamax or diuretics (furosemide type).

Calcium is bound to albumin in the blood, so a low albumin level will cause the total calcium level in the blood to drop. Your doctor can easily determine if this is significant or not.

- *Phosphorus* is also largely stored in the bone. It is regulated by the kidneys, and high levels may be due to kidney disease. When low levels are seen with high calcium levels, it suggests parathyroid disease; however, there are other causes. A low phosphorus, in combination with a high calcium, may suggest an overactive parathyroid gland.

Hormones:

- *Thyroid*: There are 2 types of thyroid hormones easily measurable in the blood: thyroxine (T4) and triiodothyronine (T3). For technical reasons, it is easier and less expensive to measure the T4 level, so T3 is usually not measured on screening tests. **In particular, the "Total T3," "Free T3" and "T3 Uptake tests" are very confusing to interpret and are not the same test.**
 - *Thyroxine (T4)*: This shows the total amount of T4. High levels may be due to hyperthyroidism; however, technical artifact occurs when estrogen levels are higher from pregnancy, birth control pills or estrogen replacement therapy. A Free T4 test (see below) can avoid this interference.
 - *T3 Resin Uptake or Thyroid Uptake*: This is a test that confuses doctors, nurses and patients. First, this is not a thyroid test, but a test on the proteins that carry thyroid around in your blood stream. Not only that, a high test number may indicate a low level of the protein. The method of reporting varies from lab to lab. The proper use of the test is to compute the free thyroxine index.
 - *Free Thyroxine Index (FTI or T7)*: A mathematical computation allows the lab to estimate the free thyroxine index from the T4 and T3 Uptake tests. The results tell us how much thyroid hormone is free in the blood stream to work on the body. Unlike the T4 alone, it is not affected by estrogen levels.
 - *Free T4*: This test directly measures the free T4 in the blood rather than estimating it like the FTI. While it is a more reliable test, it is also a little more expensive. Some labs now do the Free T4 routinely rather than the Total T4.
 - *Total T3*: This is usually not ordered as a screening test, but rather when thyroid disease is being evaluated. T3 is the more potent and shorter lived version of thyroid hormone. Some people with high thyroid levels secrete

more T3 than T4. In these (overactive) hyperthyroid cases, the T4 can be normal, the T3 high, and the TSH low. The Total T3 reports the total amount of T3 in the bloodstream, including T3 bound to carrier proteins plus freely circulating T3.

- *Free T3*: This test measures only the portion of thyroid hormone T3 that is "free," that is, not bound to carrier proteins.
- *Thyroid Stimulating Hormone (TSH)*: This protein hormone is secreted by the pituitary gland and regulates the thyroid gland. A high level suggests your thyroid is underactive, and a low level suggests your thyroid is overactive.
- *Insulin*: Insulin is secreted by the pancreas in response to eating or elevated blood sugar. It is deficient in persons with type 1 diabetes, and present at insufficient levels in persons with type 2 diabetes. The natural evolution of type 2 diabetes causes insulin levels to fall from high levels to low levels over a course of years. Thus, insulin levels in persons with type 1 and type 2 diabetes overlap significantly, and insulin levels are not very useful in determining type 1 vs. type 2.

Insulin levels vary widely from person to person, depending upon an individual's insulin sensitivity or insulin resistance. Insulin levels also vary widely according to your most recent meal.

Because insulin resistance is a risk factor for coronary disease, assessing an individual's insulin resistance may have some value using the HOMA-IR calculation. Insulin levels are also elevated in patients with true hypoglycemia; however the interpretation of these levels is difficult. Insulin level, when measured by itself at a random time, is rarely useful.

- *C-peptide*: This is a fragment cleaved off of the precursor of endogenously (inside the body) produced insulin. However, it is not present with exogenously (outside the body) produced insulin. C-peptide levels correlate with the insulin levels, except when people take insulin injections. When a patient is hypoglycemic, this test may be useful to determine whether high insulin levels are due to excessive pancreatic release of insulin, or from an injection of insulin. Consequently, this test has value in certain CSI-type testing or when a patient may be suffering from associated psychiatric illness leading to self-induced hypoglycemia from exogenous insulin.
- *Estradiol*: This is the most commonly measured type of estrogen. In women, it varies by age, as well as normal menstrual cycles. Hormone levels also change when taking birth control pills or estrogen replacement.
- *Testosterone*: This is the male hormone most frequently measured in men and women, although normal ranges are significantly different for gender and age.

Complete Blood Count (CBC):

The CBC typically has several parameters that are created from an automated cell counter. These are the most relevant:

- *White Blood Count (WBC)* is the number of white cells. High WBC can be a sign of infection, or certain types of leukemia. Low white counts can be a sign of bone marrow diseases or an enlarged spleen and, in some cases, is also found in HIV infection. (Note: The vast majority of low WBC counts in our population is **NOT** HIV-related.)
- *Hemoglobin (Hgb) and Hematocrit (Hct)* : The hemoglobin is the amount of oxygen-carrying protein contained within the red blood cells. The hematocrit is the percentage of the blood volume occupied by red blood cells. In most labs, the Hgb is actually measured, while the Hct is computed using the RBC measurement and the MCV measurement. Thus the Hgb measurement is generally more reliable. Low Hgb or Hct suggest an anemia, which can be due to nutritional deficiencies, blood loss, destruction of blood cells internally, or failure to produce blood in the bone marrow. High Hgb can occur due to lung disease, living at high altitude, or excessive bone marrow production of blood cells.
- *Mean Corpuscular Volume (MCV)*: This helps diagnose the cause of an anemia. Low values suggest iron deficiency; high values suggest either deficiencies of B12 or Folate, ineffective production in the bone marrow, or recent blood loss with replacement by newer (and larger) cells from the bone marrow.
- *Platelet Count (PLT)*: This is the number of cells that plug up holes in your blood vessels and prevent bleeding. High values can occur with bleeding, cigarette smoking or excess production by the bone marrow. Low values can occur from premature destruction states such as Immune Thrombocytopenia (ITP), acute blood loss, drug effects (such as heparin), infections with sepsis, entrapment of platelets in an enlarged spleen, or bone marrow failure from diseases such as myelofibrosis or leukemia. Low platelets also can occur from clumping of the platelets in a lavender-colored tube. In that case, you may need to repeat the test using a green-top tube.

Urinalysis:

Urine tests are typically evaluated with a reagent strip that is briefly dipped into your urine sample. The technician reads the colors of each test and compares them with a reference chart. These tests are semi-quantitative; there can be some variation from one sample to another on how the tests are scored.

- *pH*: This is a measure of acidity for your urine.
- *Specific Gravity (SG)*: This measures how dilute your urine is. Water would have a SG of 1.000. Most urine is around 1.010, but it can vary greatly, depending on when you drank fluids last, or if you are dehydrated.
- *Glucose*: Normally there is no glucose in urine. A positive glucose occurs in diabetes. A small number of people have glucose in their urine with normal blood glucose levels; however, any glucose in the urine would raise the possibility of diabetes or glucose intolerance.
- *Protein*: Normally there is no protein detectable on a urinalysis strip. Protein can indicate kidney damage, blood in the urine, or an infection. Up to 10% of children can have protein in their urine. Certain diseases require the use of a special, more sensitive (and more expensive) test for protein called a

microalbumin test, which screens for early damage to the kidneys from diabetes, for instance.

- *Blood*: Normally there is no blood in the urine. Blood can indicate an infection, kidney stones, trauma, or bleeding from a bladder or kidney tumor. The technician may indicate whether it is hemolyzed (dissolved blood) or non-hemolyzed (intact red blood cells). Rarely, muscle injury can cause myoglobin to appear in the urine, which also causes the reagent pad to falsely indicate blood.
- *Bilirubin*: Normally there is no bilirubin or urobilinogen in the urine, because these pigments are cleared by the liver. Their presence can indicate liver or gallbladder disease.
- *Nitrate*: Normally negative, this usually indicates a urinary tract infection.
- *Leukocyte esterase*: Normally negative. Leukocytes are the white blood cells (or pus cells). This looks for white blood cells by reacting with an enzyme in the white cells. White blood cells in the urine suggests a urinary tract infection.
- *Sediment*: Here the lab tech looks under a microscope at a portion of your urine that has been spun in a centrifuge. Items such as mucous and squamous cells are commonly seen. Abnormal findings would include more than 0-2 red blood cells, more than 0-2 white blood cells, crystals, casts, renal tubular cells or bacteria (if there was contamination at the time of collection).

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