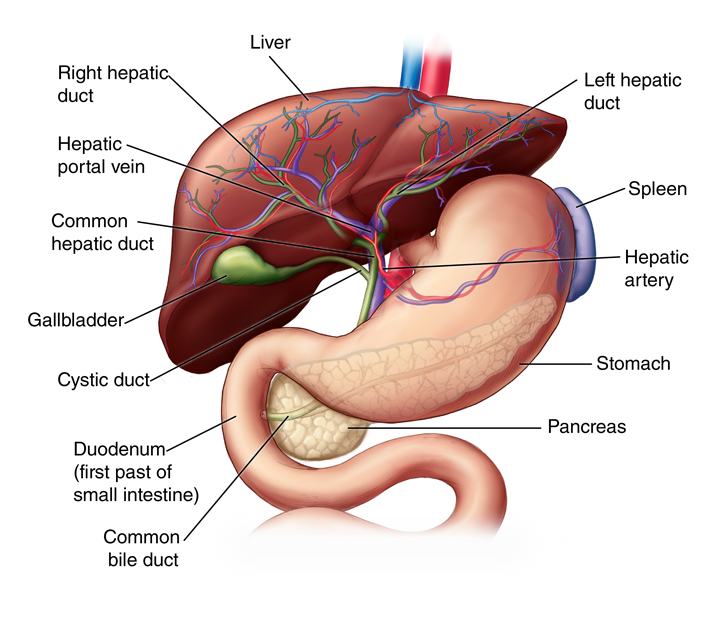
**Liver Disease and its identification**



The liver is located in the upper right-hand portion of the abdominal cavity, beneath the diaphragm, and on top of the stomach, right kidney, and intestines.

Shaped like a cone, the liver is a dark reddish-brown organ that weighs about 3 pounds.

There are 2 distinct sources that supply blood to the liver, including the following:

* Oxygenated blood flows in from the hepatic artery
* Nutrient-rich blood flows in from the hepatic portal vein

The liver holds about one pint (13%) of the body's blood supply at any given moment. The liver consists of 2 main lobes. Both are made up of 8 segments that consist of 1,000 lobules (small lobes). These lobules are connected to small ducts (tubes) that connect with larger ducts to form the common hepatic duct. The common hepatic duct transports the bile made by the liver cells to the gallbladder and duodenum (the first part of the small intestine) via the common bile duct.

Functions of the liver

The liver regulates most chemical levels in the blood and excretes a product called bile. This helps carry away waste products from the liver. All the blood leaving the stomach and intestines passes through the liver. The liver processes this blood and breaks down, balances, and creates the nutrients and also metabolizes drugs into forms that are easier to use for the rest of the body or that are nontoxic. More than 500 vital functions have been identified with the liver. Some of the more well-known functions include the following:

* Production of bile, which helps carry away waste and break down fats in the small intestine during digestion
* Production of certain proteins for blood plasma
* Production of cholesterol and special proteins to help carry fats through the body
* Conversion of excess glucose into glycogen for storage (glycogen can later be converted back to glucose for energy) and to balance and make glucose as needed
* Regulation of blood levels of amino acids, which form the building blocks of proteins
* Processing of hemoglobin for use of its iron content (the liver stores iron)
* Conversion of poisonous ammonia to urea (urea is an end product of protein metabolism and is excreted in the urine)
* Clearing the blood of drugs and other poisonous substances
* Regulating blood clotting
* Resisting infections by making immune factors and removing bacteria from the bloodstream
* *Clearance of bilirubin, also from red blood cells. If there is an accumulation of bilirubin, the skin and eyes turn yellow.*

When the liver has broken down harmful substances, its by-products are excreted into the bile or blood. Bile by-products enter the intestine and leave the body in the form of feces. Blood by-products are filtered out by the kidneys, and leave the body in the form of urine.

What is Heme?

If you’re a fan of the Impossible Burger, you may have heard about the magical ingredient that helps the plant-based patty taste so similar to beef: heme. The topic can be a bit confusing, since heme is not usually something, we see on ingredient lists — though if you eat meat, you’ve eaten your fair share of heme. Not to mention, your body produces its own heme. Heck, it might even be producing heme right now!

*Heme is an essential molecule that contains iron, that is naturally found in fairly high concentrations in the blood of humans and other animals, and in much lower concentrations in plants. Heme is also what makes blood red, makes meat pink, and gives blood a subtle metallic flavor (which you can taste when eating meat, or if you’ve ever tasted your own blood, perhaps after accidentally biting your tongue). But most importantly, heme is “what makes meat taste like meat.”*

Where does heme come from?

Heme is mostly found in human and animal blood, but many plants contain heme as well. One plant with a significant concentration of heme is the soybean, which contains leghemoglobin in its roots. For that reason, some chose soy (as well as yeast) to make its soy leghemoglobin, aka heme.

What is Bilirubin?

Bilirubin is a metabolite of heme, a compound that serves to coordinate iron in various proteins.

Very recently, bilirubin has been shown to possess important functions as an antioxidant, but it also serves simply as a means to excrete unwanted heme, derived from various heme-containing proteins such as hemoglobin, myoglobin, and various P450 enzymes.

Bilirubin and its metabolites are also notable for the fact that they provide color to the bile and stool, as well as, to a lesser extent, the urine.

Bilirubin derives from two main sources. The majority (80%) of the bilirubin formed in the body comes from the heme released from senescent red blood cells. The remainder originates from various heme-containing proteins found in other tissues, notably the liver and muscles.

Can excess of Bilirubin is harmful?

It is important for the body to be able to excrete bilirubin as it is potentially toxic. Excessive levels of bilirubin in the bloodstream can lead to accumulation of bilirubin in the brain due to its ability to cross the blood–brain barrier, a condition known as kernicterus (meaning “yellow-stained nucleus”) and cause certain diseases.

The development of this condition impairs brain function by mechanisms that are not well-understood, but it can be fatal if left untreated. Bilirubin is also notable for its yellow coloration.

Accumulation of this substance in the blood is the basis for jaundice, or a yellow discoloration of the skin and eyes which is a common symptom of liver diseases. Thus, measurement of bilirubin in the plasma can be a useful marker of such conditions.

Direct Bilirubin

**Does this test have other names?**

**Conjugated bilirubin**

**What is this test?**

This test looks for bilirubin in your blood or urine.

Bilirubin is a substance made when your body breaks down old red blood cells. This is a normal process. Bilirubin is also part of bile, which your liver makes to help digest the food you eat.

A small amount of bilirubin in your blood is normal. Healthy adults make 250 to 350 milligrams (mg) of bilirubin each day.

Bilirubin that is bound to a certain protein (albumin) in the blood is called unconjugated, or indirect, bilirubin. Conjugated, or direct, bilirubin travels from the liver into the small intestine. A very small amount passes into your kidneys and is excreted in your urine. This bilirubin also gives urine its distinctive yellow color.

This test is usually done to look for liver problems, such as hepatitis, or blockages, such as gallstones.

**Why do I need this test?**

You may need this test if your liver doesn't seem to be working the way it should. Signs and symptoms include:

* Jaundice, or yellowing of your skin and whites of your eyes
* Dark-colored urine
* Nausea
* Vomiting
* Fatigue
* Pain or swelling in the belly

You may also have this test if you drink a lot of alcohol on a regular basis. Drinking too much alcohol can damage the liver over time, so you may have this test to check for signs of possible liver damage.

You may also need this test if your healthcare provider suspects that you may have:

**Hepatitis**. Your liver can become inflamed for different reasons, including excessive drug or alcohol use and infection from hepatitis viruses. Inflammation of the liver is called hepatitis. When liver cells are damaged from hepatitis, the liver may release both indirect and direct bilirubin into the bloodstream. This causes higher levels.

**Gallstones**. The bile duct is a tube that carries bile to the small intestine. Bilirubin or cholesterol can form stones that block the duct. This causes bilirubin—mostly direct bilirubin—to rise in your bloodstream.

**Inflammation of the bile duct**. Higher levels of direct bilirubin in your bloodstream may stem from inflammation in the tube that carries bile to the small intestine.

**What other tests might I have along with this test?**

Your healthcare provider is likely to order this test as part of a liver panel, or group of related liver tests. When your liver is damaged, liver enzymes may leak into your blood. Your provider may order blood tests for these enzymes, such as:

Alkaline phosphatase, or ALP

Aspartate transaminase, or AST

Alanine transaminase, or ALT

Your healthcare provider may also order a test to check the levels of liver proteins like albumin.

**What do my test results mean?**

Test results may vary depending on your age, gender, health history, the method used for the test, and other things. Your test results may not mean you have a problem. Ask your healthcare provider what your test results mean for you.

***Results are given in milligrams per deciliter (mg/dL). Direct Bilirubin: Normal results of the blood test range from 0 to 0.3 mg/dL in adults. Total bilirubin: 0.1 to 1.2 mg/dL (1.71 to 20.5 µmol/L)***

If your results on the blood test are higher, bilirubin may also show up in your urine. Bilirubin is not present in the urine of normal, healthy individuals.

Results that are higher may mean that you have a liver problem, hepatitis, or gallstones.

Higher levels may also mean that you have:

* Septicemia, an infection in the bloodstream commonly known as blood poisoning
* Sickle cell anemia
* Certain cancers or tumors
* Certain rare inherited diseases
* Scarring of the bile ducts

If your results show low levels of bilirubin, your healthcare provider usually will not monitor them.

What is the relationship between Heme, Total Bilirubin, Direct Bilirubin and Indirect Bilirubin?

Bilirubin is an orange-yellow pigment, a waste product primarily produced by the normal breakdown of heme. Heme is a component of hemoglobin, which is found in red blood cells (RBCs). Bilirubin is ultimately processed by the liver so that it can be removed from the body. This test measures the amount of bilirubin in the blood to evaluate a person's liver function or to help diagnose anemias caused by RBC destruction (hemolytic anemia).

RBCs normally degrade after about 120 days in circulation. Bilirubin is formed as the liver breaks down and recycles aged red blood cells.

Two forms of bilirubin can be measured or estimated by laboratory tests:

* **Unconjugated bilirubin** is formed when heme is released from hemoglobin. It is carried by proteins to the liver. In the liver, sugars are attached (conjugated) to bilirubin to form conjugated bilirubin.
* **Conjugated bilirubin** enters the bile and passes from the liver to the small intestines, where it is further broken down by bacteria and eventually eliminated in the stool. Thus, the breakdown products of bilirubin give stool its characteristic brown color. Normally, the level of conjugated bilirubin in the blood is very low.

The bilirubin test is included in the comprehensive metabolic panel (CMP) and the liver panel, which are often used as general health screenings.

Usually, an initial test measures the total bilirubin level (unconjugated plus conjugated bilirubin).

If the total bilirubin level is increased, the laboratory can use a second test to detect water-soluble forms of bilirubin, called "direct" bilirubin. The direct bilirubin test provides an estimate of the amount of conjugated bilirubin present.

**Subtracting the direct bilirubin level from the total bilirubin level helps estimate the "indirect" level of unconjugated bilirubin.**

*A small amount (approximately 250 to 350 milligrams, or about 4 milligrams per kilogram of body weight) of bilirubin is produced daily in a normal, healthy adult. Most bilirubin (70%-90%) comes from damaged or degraded RBCs, with the remaining amount coming from the bone marrow or liver. Normally, small amounts of unconjugated bilirubin are released into the blood, but almost no conjugated bilirubin is present.*

*If the bilirubin level increases in the blood, a person may appear jaundiced, with a yellowing of the skin and/or whites of the eyes. The pattern of bilirubin test results can give the healthcare practitioner information regarding the condition that may be present.*

***Adults and children***

*Total bilirubin that is mainly unconjugated (indirect) bilirubin may be increased when:*

*There is an unusual number of red blood cells (RBCs) being broken down and destroyed (e.g., hemolytic or pernicious anemia, blood transfusion reaction). The liver is unable to process bilirubin (i.e., with liver disease such as cirrhosis or inherited problems)*

*You have a relatively common inherited condition called Gilbert syndrome, due to low levels of the enzyme that produces conjugated bilirubin*

*If conjugated (direct) bilirubin is elevated more than unconjugated (indirect) bilirubin, there typically is a problem associated with decreased elimination of bilirubin by the liver cells. Some conditions that may cause this include:*

* *Viral hepatitis (hepatitis A, hepatitis B, hepatitis C)*
* *Drug reactions*
* *Alcoholic liver disease*

*Conjugated (direct) bilirubin is also elevated more than unconjugated (indirect) bilirubin when the liver is able to process bilirubin but there is blockage of the bile ducts. This may occur, for example, with:*

* *Gallstones present in the bile ducts*
* *Tumors*
* *Scarring of the bile ducts*

Rare inherited disorders that cause abnormal bilirubin metabolism such as Rotor, Dubin-Johnson, and Crigler-Najjar syndromes, may also cause increased levels of bilirubin.

*Low levels of bilirubin are generally not a concern and are not monitored.*

***Newborns***

Increased total and unconjugated bilirubin levels are relatively common in newborns in the first few days after birth. This finding is called "physiologic jaundice of the newborn" and occurs because the newborn's liver is not mature enough to process bilirubin yet. Usually, physiologic jaundice of the newborn is temporary and resolves within a few days to two weeks.

However, if the bilirubin level is critically high or increases rapidly, the healthcare practitioner will diagnose the cause so appropriate treatment can be started as soon as possible.

Increased bilirubin levels may result from the accelerated breakdown of red blood cells due to:

* Blood type incompatibility between the mother and her newborn, causing hemolytic disease of the newborn (HDN)
* Certain congenital infections
* Lack of oxygen (hypoxia)
* Diseases that can affect the liver

In most of these conditions, only unconjugated (indirect) bilirubin is increased.

A rare (about 1 in 12,000 births) but life-threatening congenital condition called biliary atresia can cause increased total and conjugated bilirubin levels in newborns. This condition must be quickly diagnosed and treated, usually with surgery, to prevent serious liver damage that may require liver transplantation within the first few years of life. Some children may require liver transplantation despite early surgical treatment.

Alkaline Phosphatase

Alkaline phosphatase (ALP) is an enzyme found in several tissues throughout the body. The ALP in blood samples of healthy adults comes mainly from the liver, with most of the rest coming from bones (skeleton). Elevated levels of ALP in the blood are most commonly caused by liver disease, bile duct obstruction, gallbladder disease, or bone disorders. This test measures the level of ALP in the blood.

In the liver, ALP is found on the edges of cells that join to form bile ducts, tiny tubes that drain bile from the liver to the bowels, where it is needed to help digest fat in the diet. ALP in bone is produced by special cells called osteoblasts that are involved in the formation of bone. Each of the various tissue types produces distinct forms of ALP called isoenzymes.

ALP blood levels can be greatly increased, for example, in cases where one or more bile ducts are blocked. This can occur as a result of inflammation of the gallbladder (cholecystitis) or gallstones. Smaller increases of blood ALP are seen in liver cancer and cirrhosis, with use of drugs toxic to the liver, and in hepatitis.

Any condition causing excessive bone formation, including bone disorders such as Paget's disease, can cause increased ALP levels. Children and adolescents typically have higher blood ALP levels because their bones are still growing. As a result, the ALP test must be interpreted with different reference (normal) values for children and for adults.

It is possible to distinguish between the different forms (isoenzymes) of ALP produced by different types of tissues in the body. If it is not apparent from clinical signs and symptoms whether the source of a high ALP test result is from liver or bone disease, then a test may be performed to determine which isoenzyme is increased in the blood.

*Slightly irregular ALP levels are usually no cause for concern. However, severely abnormal levels can signify a severe underlying medical condition, typically one relating to the liver, bones, or gallbladder.*

What is an ALP test?

*An ALP test is a simple procedure that measures the amount of ALP in the blood. ALP is an enzyme that is present in most parts of the body but is most abundant in the bones, liver, kidneys, gallbladder, and intestines.*

Researchers still do not understand the full range of ALP’s functions, but it seems to contribute to a wide range of processes, such as:

* transporting nutrients and other enzymes in the liver
* aiding the formation and growth of bones
* transporting fatty acids, phosphates, and calcium in the intestines
* digesting fat in the intestines
* regulating cell growth, death, and migration during fetal development

Doctors will often request that a routine blood test includes an ALP test if a person has symptoms that may indicate liver problems. These include:

* yellowing of the skin or eyes
* painful or swollen tummy
* feeling nauseous
* vomiting
* feeling tired or weak
* unexplained weight loss
* urine that is darker than usual

They will also specifically order an ALP test if they think a person has a condition affecting any of the following:

* bones
* gallbladder
* kidney
* intestines

What is a normal ALP level?

**The ALP level in healthy adults should be**[**20–140 units per liter (U/L)**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4062654/)**.**

*Children tend to have significantly higher levels of ALP than adults because their bones are still growing. A person recovering from a bone injury may also have a raised ALP level in the 3 months after the injury while their bone heals.*

*It is also common to have higher ALP levels than usual during the second and third trimesters of pregnancy. However, everyone’s natural ALP level will be a bit different. After an ALP test, a doctor will be able to explain what it means if the ALP level is higher or lower than they would expect*

What causes abnormal ALP levels?

As ALP is most abundant in the bones and liver, elevated ALP levels are generally a sign of a liver or bone condition. An obstruction of the liver or damage to it will cause ALP levels to rise. This will also occur if there is an increase in bone cell activity.

Abnormal ALP levels usually indicate one of the following conditions:

* gallstones
* cholecystitis — inflammation of the gallbladder
* liver cancer
* abnormal, noncancerous growths on the liver
* cirrhosis — scarring of the liver
* hepatitis — inflammation of the liver, often due to infection
* bile cancers
* overuse of medications harmful to the liver
* excessive consumption of alcohol
* malnutrition, especially deficiencies in vitamin D, calcium, protein, magnesium, and zinc
* bone cancers

Conditions that abnormal ALP levels may indicate less regularly include:

* rickets — a weakening of the bones in children, usually as a result of a vitamin D or calcium deficiency
* osteomalacia — a weakening of the bones in adults, usually relating to a vitamin deficiency
* Paget’s disease — a condition that causes significant bone deformity and problems with bone regeneration

Unusual ALP levels may also signify one of the following conditions, although this is rare:

* congestive heart failure
* anemia
* untreated celiac disease
* hyperparathyroidism
* Hodgkin’s lymphoma
* hypophosphatasia
* some bacterial infections
* ulcerative colitis
* Wilson’s disease
* breast cancer
* prostate cancer

What do the results mean?

Results of the ALP test are typically interpreted along with gamma-glutamyl transferase (GGT) results and with other tests that may have been performed at the same time, such as a liver panel, as well as in the context of your medical history and physical exam.

High ALP usually means that either the liver has been damaged or a condition causing increased bone cell activity is present.

* If other liver tests such as bilirubin, aspartate aminotransferase (AST), or alanine aminotransferase (ALT) are also high, usually the increased ALP is caused by liver damage or disease. If GGT is also increased, then the high ALP is likely due to liver disease. Significantly elevated ALP, often more than 4 times what is normal, may indicate bile duct obstruction and/or gallbladder inflammation.
* If liver tests and GGT are normal, then the high ALP is likely caused by bone diseases. Likewise, if calcium and/or phosphorus measurements are abnormal, usually the ALP is coming from bone.

If it is not clear from signs and symptoms or from other routine tests whether the high ALP is from liver or bone, then a test for ALP isoenzymes may be necessary to distinguish between bone and liver ALP.

**ALP in liver disease**

ALP results are usually evaluated along with other tests for liver disease. In some forms of liver disease, such as hepatitis, ALP is usually much less elevated than AST and ALT. When the bile ducts are blocked (usually by gallstones, scars from previous gallstones or surgery, or by cancers), ALP and bilirubin may be increased much more than AST or ALT. ALP may also be increased in liver cancer.

**ALP in bone disease**

In some bone diseases, such as Paget disease, where bones become enlarged and deformed, or in certain cancers that spread to bone, ALP may be increased.

If you are being successfully treated for Paget disease, then ALP levels will decrease or return to normal over time. If you have bone or liver cancer that responds to treatment, ALP levels should decrease.

Moderately elevated ALP may result from other conditions, such as Hodgkin lymphoma, congestive heart failure, ulcerative colitis, and certain bacterial infections.

Low levels of ALP may be seen temporarily after blood transfusions or heart bypass surgery. A deficiency in zinc may cause decreased levels. A rare genetic disorder of bone metabolism called hypophosphatasia can cause severe, long-term low levels of ALP. Malnutrition may lower serum ALP activity.

**Some more facts**

Most people with abnormal ALP levels have high, rather than low, levels. The most common causes of high ALP levels include:

* liver conditions, often bile duct obstructions
* gallbladder conditions, usually gallstones
* bone conditions, such as abnormal growths and occasionally cancers
* pregnancy
* young age, as children who are still growing tend to have much higher ALP levels

*If related symptoms do not help the doctor reach a diagnosis, they may carry out further tests. These may include tests to determine which type of ALP enzyme is raised in the blood. Each part of the body makes a distinct type of ALP enzyme*.

*Further tests may also include the following liver tests:*

* *bilirubin test*
* *aspartate aminotransferase (AST) test*
* *alanine aminotransferase (ALT) test*

*If a person has raised ALP levels but the results of other liver tests are normal, the problem may not be with their liver. It may be that their bones are affected. The doctor may use imaging tests to diagnose bone disorders.*

Rarely, high ALP levels may indicate:

* bacterial infection
* cancer
* heart failure
* kidney failure

It is relatively rare for a person to have low ALP levels. These are most often the result of:

* severe or long-term vitamin and mineral deficiencies
* chronic conditions that can cause malnutrition, such as untreated celiac disease

ALT (Alanine Aminotransferase)

Alanine aminotransferase (ALT) is an enzyme found mostly in the cells of the liver and kidney. Much smaller amounts of it are also found in the heart and muscles.

Normally, ALT levels in blood are low, but when the liver is damaged, ALT is released into the blood and the level increases. This test measures the level of ALT in the blood and is useful for early detection of liver disease.

The ***function*** of ALT is to convert alanine, an amino acid found in proteins, into pyruvate, an important intermediate in cellular energy production. In healthy individuals, ALT levels in the blood are low. When the liver is damaged, ALT is released into the blood, usually before more obvious signs of liver damage occur, such as jaundice.

* The liver is a vital organ located in the upper right side of the abdomen, just beneath the rib cage. It is involved in many important functions in the body.
* The liver helps to process the body's nutrients, manufactures bile to help digest fats, produces many important proteins such as blood clotting factors and albumin, and breaks down potentially toxic substances into harmless ones that the body can use or eliminate.

A number of conditions can cause damage to liver cells, resulting in an increase in ALT. The test is most useful in detecting damage due to hepatitis (inflammation of the liver) or as a result of drugs or other substances that are toxic to the liver.

***ALT is commonly tested in conjunction with aspartate aminotransferase (AST), another liver enzyme, as part of a liver panel. Both ALT and AST levels usually rise whenever the liver is being damaged, although ALT is more specific for the liver and, in some cases, may be the only one of the two to be increased. An AST/ALT ratio may be calculated to aid in distinguishing between different causes and severity of liver injury and to help distinguish liver injury from damage to heart or muscles.***

What is an ALT test?

An alanine aminotransferase (ALT) test measures the level of ALT in your blood. ALT is an enzyme made by cells in your liver.

The liver is the body’s largest gland. It has several important functions, including:

* making proteins
* storing vitamins and iron
* removing toxins from your blood
* producing bile, which aids in digestion

Proteins called enzymes help the liver break down other proteins so your body can absorb them more easily. ALT is one of these enzymes. It plays a crucial role in metabolism, the process that turns food into energy.

ALT is normally found inside liver cells. However, when your liver is damaged or inflamed, ALT can be released into your bloodstream. This causes serum ALT levels to rise.

Measuring the level of ALT in a person’s blood can help doctors evaluate liver function or determine the underlying cause of a liver problem. The ALT test is often part of an initial screening for liver disease.

An ALT test is also known as a serum glutamic-pyruvic transaminase (SGPT) test or an alanine transaminase test.

Why is an ALT test done?

The ALT test is usually used to determine whether someone has liver injury or failure. Your doctor may order an ALT test if you’re having symptoms of liver disease, including:

* jaundice, which is yellowing of your eyes or skin
* dark urine
* nausea
* vomiting
* pain in the right upper quadrant of your abdomen

Liver damage generally causes an increase in ALT levels. The ALT test can evaluate the levels of ALT in your bloodstream, but it can’t show how much liver damage there is or how much fibrosis, or scarring, is present. The test also can’t predict how severe the liver damage will become.

An ALT test is often done with other liver enzyme tests. Checking ALT levels along with levels of other liver enzymes can provide your doctor with more specific information about a liver problem.

An ALT test may also be performed to:

* monitor the progression of liver diseases, such as hepatitis or liver failure
* assess whether treatment for liver disease should be started
* evaluate how well treatment is working

What do my ALT test results mean?

A low level of ALT in the blood is expected and is normal. Liver disease is the most common reason for higher than normal levels of ALT. Very high levels of ALT (more than 10 times normal) are usually due to acute hepatitis, sometimes due to a viral hepatitis infection. In acute hepatitis, ALT levels usually stay high for about 1-2 months but can take as long as 3-6 months to return to normal. Levels of ALT may also be markedly elevated (sometimes over 100 times normal) as a result of exposure to drugs or other substances that are toxic to the liver or in conditions that cause decreased blood flow to the liver.

ALT levels are usually not much elevated in chronic hepatitis, often less than 4 times normal. In this case, ALT levels often vary between normal and slightly increased, so the test may be ordered frequently to see if there is a pattern. Other causes of moderate increases in ALT include obstruction of bile ducts, cirrhosis (usually the result of chronic hepatitis or bile duct obstruction), heart damage, alcohol abuse, and with tumors in the liver.

***In certain types of liver diseases, the ALT level is higher than AST and the AST/ALT ratio will be low (less than 1). There are a few exceptions; the AST/ALT ratio is usually greater than 1 in alcoholic hepatitis, cirrhosis, and with heart or muscle injury and may be greater than 1 for a day or two after onset of acute hepatitis.***

Normal results

The normal value for ALT in blood ranges from 29 to 33 units per liter (IU/L) for males and 19 to 25 IU/L for females, but this value can vary depending on the hospital. This range can be affected by certain factors, including gender and age. It’s important to discuss your specific results with your doctor.

Abnormal results

Higher-than-normal levels of ALT can indicate liver damage. Increased levels of ALT may be a result of:

* hepatitis, which is an inflammatory condition of the liver
* cirrhosis, which is severe scarring of the liver
* death of liver tissue
* a tumor or cancer in the liver
* a lack of blood flow to the liver
* hemochromatosis, which is a disorder that causes iron to build up in the body
* mononucleosis, which is an infection usually caused by the Epstein-Barr virus
* pancreatitis, which is an inflammation of the pancreas
* diabetes

Lower-level ALT results indicate a healthy liver. However, studies have shown that lower-than-normal results have been related to increased long-term mortality. Discuss your numbers specifically with your doctor if you’re concerned about a low reading.

If your test results indicate liver damage or disease, you may need more testing to determine the underlying cause of the problem and the best way to treat it.

Aspartate aminotransferase (AST)

Aspartate aminotransferase (AST) is an enzyme found in cells throughout the body but mostly in the heart and liver and, to a lesser extent, in the kidneys and muscles. In healthy individuals, levels of AST in the blood are low. When liver or muscle cells are injured, they release AST into the blood. This makes AST a useful test for detecting or monitoring liver damage.

The liver is a vital organ located in the upper right-hand side of the abdominal area just beneath the rib cage. It is involved in many important functions in the body. The liver helps to process the body's nutrients, manufactures bile to help digest fats, produces many important proteins such as blood clotting factors, and breaks down potentially toxic substances into harmless ones that the body can use or excrete.

A number of conditions can cause injury to liver cells and may cause increases in AST. The test is most useful in detecting liver damage due to hepatitis, drugs toxic to the liver, cirrhosis, or alcoholism. AST, however, is not specific for the liver and may be increased in conditions affecting other parts of the body.

An AST test is often performed along with an alanine aminotransferase (ALT) test. Both are enzymes found in the liver that become elevated in the blood when the liver is damaged. A calculated AST/ALT ratio is useful for differentiating between different causes of liver injury and in recognizing when the increased levels may be coming from another source, such as heart or muscle injury.

What does the test result mean?

Low levels of AST in the blood are expected and are normal.

Very high levels of AST (more than 10 times normal) are usually due to acute hepatitis, sometimes due to a viral infection. With acute hepatitis, AST levels usually stay high for about 1-2 months but can take as long as 3-6 months to return to normal. Levels of AST may also be markedly elevated (often over 100 times normal) as a result of exposure to drugs or other substances that are toxic to the liver as well as in conditions that cause decreased blood flow (ischemia) to the liver.

With chronic hepatitis, AST levels are usually not as high, often less than 4 times normal, and are more likely to be normal than are ALT levels. AST often varies between normal and slightly increased with chronic hepatitis, so the test may be ordered frequently to determine the pattern. Such moderate increases may also be seen in other diseases of the liver, especially when the bile ducts are blocked, or with cirrhosis or certain cancers of the liver. AST may also increase after heart attacks and with muscle injury, usually to a much greater degree than ALT.

AST is often performed together with the ALT test or as part of a liver panel. For more about AST results in relation to other liver tests, see the Liver Panel article.

***In most types of liver disease, the ALT level is higher than AST and the AST/ALT ratio will be low (less than 1). There are a few exceptions; the AST/ALT ratio is usually increased in alcoholic hepatitis, cirrhosis, hepatitis C virus-related chronic liver disease, and in the first day or two of acute hepatitis or injury from bile duct obstruction. With heart or muscle injury, AST is often much higher than ALT (often 3-5 times as high) and levels tend to stay higher than ALT for longer than with liver injury.***

Albumin

Albumin is a protein made by the liver. It makes up about 60% of the total protein in the blood and plays many roles. This test measures the level of albumin in the blood.

Albumin keeps fluid from leaking out of blood vessels, nourishes tissues, and transports hormones, vitamins, drugs, and substances like calcium throughout the body. Levels of albumin may decrease, to a greater or lesser degree, when conditions interfere with its production by the liver, increase protein breakdown, increase protein loss via the kidneys, and/or expand the volume of plasma, the liquid portion of blood (diluting the blood).

Two important causes of low blood albumin include:

* **Severe liver disease**—since albumin is produced by the liver, its level can decrease with loss of liver function; however, this typically occurs only when the liver has been severely affected.
* **Kidney disease**—one of the many functions of the kidneys is to conserve plasma proteins such as albumin so that they are not released along with waste products when urine is produced. Albumin is present in high concentrations in the blood, and when the kidneys are functioning properly, virtually no albumin is lost in the urine. However, if a person's kidneys become damaged or diseased, they begin to lose their ability to conserve albumin and other proteins. This is frequently seen in chronic diseases, such as diabetes and hypertension. In nephrotic syndrome, very high amounts of albumin are lost through the kidneys.

[What does the test result mean?](https://labtestsonline.org/tests/albumin)

Results of albumin testing are evaluated along with those from other tests done at the same time, such as the tests included in a CMP, basic metabolic panel (BMP), liver panel, or renal panel.

A low albumin level may be an indication that further investigation may be warranted. A low albumin may reflect a temporary condition that will resolve itself or may suggest an acute or chronic condition that requires treatment.

Levels of albumin may decrease, to a greater or lesser degree, when conditions interfere with its production, increase protein breakdown, increase protein loss, and/or expand plasma volume (diluting the blood). Depending on your medical history, signs and symptoms, and physical exam, additional testing may be done to investigate a low result.

A low albumin can suggest liver disease. Liver enzyme tests or a liver panel may be ordered to determine exactly which type of liver disease may be present. A person may, however, have normal or near normal albumin levels with liver disease until the condition has reached an advanced stage. For example, in people with cirrhosis, albumin is typically (but not always) low whereas in most chronic liver diseases that have not progressed to cirrhosis, albumin is usually normal.

Low albumin levels can reflect kidney diseases in which the kidneys cannot prevent albumin from leaking from the blood into the urine and being lost. In this case, the amount of albumin or protein in the urine also may be measured (see Urine Albumin) or tests for creatinine and BUN or a renal panel may be ordered.

Low albumin levels can also be seen in inflammation, shock, and malnutrition. They may be seen with conditions in which the body does not properly absorb and digest protein, such as Crohn disease or celiac disease, or in which large volumes of protein are lost from the intestines.

A low albumin may also be seen in several other conditions, such as:

• Infection

• Burns

• Surgery

• Chronic illness

• Cancer

• Diabetes

• Underactive thyroid (hypothyroidism)

• Carcinoid syndrome

• Increase in blood volume due to congestive heart failure, sometimes pregnancy

High albumin levels can be seen with dehydration, although the test is not typically used to monitor or detect this condition.

Total Protein, Albumin-Globulin (A/G) Ratio

Proteins are important building blocks of all cells and tissues. They are important for body growth, development, and health. They form the structural part of most organs and make up enzymes and hormones that regulate body functions. This test measures the amount of protein in your blood.

***Two classes of proteins are found in the blood, albumin and globulin.***

1. **Albumin** is made by the liver and makes up about 60% of the total protein. Albumin keeps fluid from leaking out of blood vessels, nourishes tissues, and transports hormones, vitamins, drugs, and substances like calcium throughout the body.
2. **Globulins** make up the remaining 40% of proteins in the blood. The globulins are a varied group of proteins, some produced by the liver and some by the immune system. They help fight infection and transport nutrients.

The test also compares the amount of albumin with globulin and calculates what is called the A/G ratio. A change in this ratio can provide your healthcare practitioner with a clue as to the cause of the change in protein levels. Total protein levels in the blood may increase or decrease, to a greater or lesser degree, with various conditions.

Total protein levels may decrease in conditions that:

* Interfere with production of albumin or globulin proteins, such as malnutrition or severe liver disease
* Increase the breakdown or loss of protein, such as kidney disease (nephrotic syndrome)
* Increase or expand the volume of plasma, the liquid part of blood (diluting the blood), such as congestive heart failure

Total protein levels may increase with conditions that cause:

* Abnormally high production of protein (e.g., inflammatory disorders, multiple myeloma)
* Dehydration

Flow Diagram

**BONE MARROW**

10%-20%

80%-90%

**HEME**

**1.** Bilirubin is produced when the liver breaks down the old RBC’s or recycled the aged RBC’s.

**2.** It is a yellow color waste product of this breakdown process & needs to be removed from the body.

**Indirect Bilirubin\***

**1.** Sugar attached bilirubin forms the direct bilirubin.

**Direct Bilirubin\*\***

**1.** Very small amount of indirect bilirubin release into the blood but almost no direct bilirubin is present.

**2.** If bilirubin level increases in the blood then person may appear with a yellowish skin and/ or white eyes.

*\* Indirect or unconjugated bilirubin*

*\*\* Direct or conjugated bilirubin*

**Total Bilirubin**

Reference Links:

<https://www.hopkinsmedicine.org/health/conditions-and-diseases/liver-anatomy-and-functions#:~:text=All%20the%20blood%20leaving%20the,body%20or%20that%20are%20nontoxic.>

<https://www.greenmatters.com/p/what-is-heme-impossible-foods>

<http://accessmedicine.mhmedical.com/content.aspx?bookid=691&sectionid=45431414>

<https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=167&contentid=bilirubin_direct#:~:text=Bilirubin%20that%20is%20bound%20to,is%20excreted%20in%20your%20urine.>

<https://labtestsonline.org/tests/bilirubin#:~:text=Usually%2C%20an%20initial%20test%20measures,%2C%20called%20%22direct%22%20bilirubin.>

<https://www.medicalnewstoday.com/articles/321984>

<https://www.healthline.com/health/alt#purpose>

<https://labtestsonline.org/tests/alanine-aminotransferase-alt#:~:text=A%20low%20level%20of%20ALT,to%20a%20viral%20hepatitis%20infection.>

<https://labtestsonline.org/tests/alkaline-phosphatase-alp>

<https://labtestsonline.org/tests/aspartate-aminotransferase-ast>

<https://labtestsonline.org/tests/liver-panel>

<https://labtestsonline.org/tests/gamma-glutamyl-transferase-ggt>

<https://labtestsonline.org/tests/albumin>