



**Medical Laboratory Techniques Department**

**Practical Biochemistry**

**SECOND STAGE \ SECOND COURSE**

**Lab 7-8**

## **Enzymology**

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The study of enzymes is called enzymology. Enzymes are biological catalysts that increase the speed of chemical reactions by reducing the activation energy that occurs inside living cells, whether plant or animal, without changing during these reactions. Most enzymes are proteins consisting of amino acids formed by living cells and can function independently outside living cells after the appropriate conditions are provided for them. The reactant in enzymatic reactions is called the substrate, which is the substance on which the enzyme works

## Enzymes functions

1. Maintaining the balance of the body by controlling chemical reactions
2. Enzymes reduce the amount of energy needed to start a chemical reaction, and this helps protect them from exposure to high temperatures that lead to denaturation and the dismantling of protein synthesis in the body.

## Alkaline Phosphatase (ALP)

Alkaline phosphatase (ALP) is an enzyme found in several tissues throughout the body. The highest concentrations of ALP are present in the cells that comprise bone and the liver. Elevated levels of ALP in the blood are most commonly caused by liver 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.

Any condition that affects bone growth or causes increased activity of bone cells can affect ALP levels in the blood. An ALP test may be used, for example, to detect cancers that have spread to the bones or to help diagnose Paget's disease, a condition that causes malformed bones. This test may also sometimes be used to monitor treatment of Paget's disease or other bone conditions, such as vitamin D deficiency.

If ALP results are increased but it is not clear whether this is due to liver or bone disease, tests for ALP isoenzyme may be done to determine the cause. A GGT test and/or a test for 5'-nucleotidase may also be done to differentiate between liver and bone disease. GGT and 5'-nucleotidase levels are increased in liver disease but not in bone disorders.

### **When is it ordered?**

An ALP test may be ordered as part of routine laboratory testing, often with a group of other tests called a liver panel. It is also usually ordered along with several other tests when a person has symptoms of a liver or bone disorder.

### **Signs and symptoms of liver involvement may include:**

Weakness, fatigue

Loss of appetite

Nausea, vomiting

Abdominal swelling and/or pain

Jaundice

Dark urine, light-colored stool

Itching (pruritus)

## **Some examples of the signs and symptoms suggesting a bone disorder include:**

Bone and/or joint pain

Increased frequency of fractures

Deformed bones

## **What does the test result mean?**

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 coming from the liver. If GGT or 5'-nucleotidase is also increased, then the high ALP is likely due to liver disease. If either of these two tests is normal, then the high ALP is likely due to a bone condition. 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's disease, where bones become enlarged and deformed, or in certain cancers that spread to bone, ALP may be increased.

If a person is being successfully treated for Paget's disease, then ALP levels will decrease or return to normal over time. If someone with bone or liver cancer responds to treatment, ALP levels should decrease.

Moderately elevated ALP may result from other conditions, such as Hodgkin's 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, protracted low levels of ALP. Malnutrition or protein deficiency as well as Wilson disease could also be possible causes for lowered ALP.

**Notes:**

- Pregnancy can increase ALP levels. Temporary elevations are also seen with healing fractures.
- Children and adolescents normally have higher ALP levels than adults because their bones are growing, and ALP is often very high during a growth spurt, which occurs at different ages in boys and girls.
- Some drugs may affect ALP levels. For example, oral contraceptives may decrease levels while anti-epileptics may increase levels.