

The background of the slide is a light gray color with a pattern of faint, semi-transparent chemical structures. These structures include various rings, lines, and dots representing atoms, typical of molecular diagrams. They are scattered across the entire page, creating a scientific and technical atmosphere.

Casual Friday Series

Functional Blood Chemistry Series

Pt. 11: Enzymes (I)

A Biogenetix Clinical Presentation

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Disclaimer

- *Information in this presentation is not intended to diagnose, treat, reverse, cure, or prevent any disease. While this presentation is based on medical literature, findings, and text, The following statements have not been evaluated by the FDA.*
- *The information provided in this presentation is for your consideration only as a practicing health care provider. Ultimately you are responsible for exercising professional judgment in the care of your own patients.*

Enzymes to note:

- Aspartate Aminotransferase
- Alanine Aminotransferase
- Lactate Dehydrogenase
- Gamma-glutamyl transferase
- Alkaline phosphatase



Aspartate Transferase (AST)

- Aspartate transferase (AST), previously known as Serum Glutamic-Oxalacetic Transaminase (SGOT), is an enzyme primarily found in the liver and heart, but is also found in skeletal muscle, the pancreas, kidneys and gonads.
- It is found in primarily in the cytosol of red blood cells and cardiac muscle, and in the mitochondria of hepatocytes.
- As with other transaminases, it transfers an amine group and thus is involved with amino acid synthesis and metabolism. All transaminase enzymes require vitamin B6 (pyridoxine) to carry out this task.



Aspartate Transferase (AST)

- As an intracellular enzyme, AST will likely be elevated in blood during active tissue and cellular destruction.
- In most types of liver diseases, ALT will be higher than AST and the AST/ALT ratio will be less than 1.
- Caveats to this are in alcoholic liver damage and cirrhosis, where AST will generally be higher.
- Has a half-life of 17 hours. (active damage)



Aspartate Transferase (AST)

Traditional Reference Range:

- 0-40 IU/L

Optimal Reference Range:

- Men: 12-25 IU/L
- Women: 10-22 IU/L



AST - Elevated

Cause	Reason	Additional Inquiry
Hepatitis	AST can be elevated in liver inflammation, though ALT will be higher. Will likely be over 100.	Evaluate ALT.
Liver cirrhosis or alcoholism	AST will be elevated and higher than ALT.	Client history. Evaluate ALT.
Hypothyroidism	Possibly due to hepatocellular injury secondary to hypoxia created by low thyroid hormone.	Evaluate thyroid markers.



AST - Decreased

Cause	Reason	Additional Inquiry
Vitamin B6 deficiency	AST is a transaminase enzyme, which requires vitamin B6 for proper function.	Diet journal and client symptoms.
Azotemia (high nitrogen in the serum)	Nitrogen-containing compounds include urea, uric acid, creatinine, etc. If these are elevated, it may cause low AST levels.	Evaluate nitrogen containing compounds in the blood.



Alanine Aminotransferase (ALT)

- Alanine Aminotransferase, previously known as Serum Glutamic-Pyruvic Transaminase (SGPT), is found in highest concentration in the liver. It is also found in the heart, muscle and kidney but in lower concentrations.
- Has a half-life of 47 hours.
- Interesting to note:
 - One study showed a decrease in ALT in magnesium deficient individuals when magnesium supplementation was given
 - High-normal (optimal range) ALT is associated with metabolic obesity and atherosclerosis.
 - Mild ALT elevations can indicate early fatty liver disease



Alanine Aminotransferase (ALT)

Traditional Reference Range:

- 0-40 IU/L

Optimal Reference Range:

- Women: 10-19 IU/L
- Men: 13-22 IU/L



ALT - Elevated

Cause	Reason	Additional Inquiry
Hepatocellular disease	Relatively high levels of ALT due to hepatocellular injury.	
Biliary issues	May be a mild increase in ALT. Other markers can help identify if it is related to biliary function.	Evaluate alkaline phosphatase and GGT.
Pancreatitis	Mild elevations in ALT may occur.	Evaluate symptoms. Serum amylase and lipase could be of value.



ALT - Decreased

Cause	Reason	Additional Inquiry
Vitamin B6 deficiency	AST is a transaminase enzyme, which requires vitamin B6 for proper function.	Diet journal and client symptoms.
Azotemia (high nitrogen in the serum)	Nitrogen-containing compounds include urea, uric acid, creatinine, etc. If these are elevated, it may cause low AST levels. (grass?)	Evaluate nitrogen containing compounds in the blood.



Association Between High–Normal Levels of Alanine Aminotransferase and Risk Factors for Atherogenesis

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Low-normal ALT: less than 19 IU/L in women and less than 31 IU/L in men
 High normal ALT: Between 19–40 IU/L in women and 31–40 IU/L in men
 Elevated ALT: Greater than 40 IU/L in either men or women

Level of ALT was associated with level of ApoB, concentration and particle size of very low-density lipoproteins (VLDL), concentration of LDL particles (LDL-P), and percentages of small dense LDL (sdLDL) and sdLDL-cholesterol (SdLDL-C) ($P < .0001$ for all). **High–normal level of ALT was associated with higher levels of LDL-cholesterol, LDL-P, sdLDL-C, and sdLDL particles ($P < .001$ for all).**

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AST and ALT

- If of hepatic origin, reflect active hepatocellular damage, not damage that occurred weeks or months ago.
- AST elevations without ALT elevations suggest damage outside of the liver.
- Severe liver disease can cause a decrease in AST and ALT.
- Elevated levels but less than 100 are likely not hepatitis, but can indicate fatty liver.
- A *vast* number of medications can increase AST and ALT. Thus if elevated be sure to check a client's medication history.



Gamma-Glutamyltransferase (GGT)

- Gamma-glutamyltransferase (GGT) is present primarily in the liver, kidney and pancreas.
- GGT is highly sensitive for biliary tree issues, and is often elevated in excess alcohol consumption
- GGT is present in cell membranes and is involved in the transfer of amino acids
- Historically used as an enzyme for liver and biliary dysfunction, and alcohol consumption, recently GGT has been identified as a marker of oxidative stress and predictive of future cardiovascular events.



Gamma-Glutamyltransferase (GGT)

Traditional Reference Range

- 0-65 IU/L

Optimal Reference Range

- 12-24 IU/L (Men)
- 10-22 IU/L (Women)



GGT - Elevated

Cause	Reason	Additional Inquiry
Biliary tree dysfunction (cholestasis)	GGT is found in high amounts in biliary epithelium. Thus in biliary tree dysfunction can increase GGT levels.	Gall bladder symptoms, alkaline phosphatase, bile acids.
Alcoholism	Alcohol seems to increase the activity of GGT, though the exact mechanism is unclear.	Client history.
Pancreatitis	Pancreatic inflammation can release enzymes normally found in that tissue. GGT is found in the pancreas and thus, can be elevated during pancreatic inflammation.	Consider running amylase and lipase.
Oxidative Stress	GGT, even when high-normal, may be an early and sensitive enzyme for oxidative stress.	Evaluate bilirubin (low) and uric acid (elevated).



GGT - Decreased

Cause	Reason	Additional Inquiry
Hypothyroidism	Observation	
Magnesium deficiency	Association. Inverse correlation between magnesium level and GGT levels.	Evaluate magnesium levels as well as signs and symptoms.



Jaundice



Jaundice



Lactate Dehydrogenase (LDH)

- Lactate dehydrogenase (LDH) is found in all cells, including anucleated red blood cells.
- Therefore when levels are elevated, it is difficult to ascertain what tissue is breaking down and is a non-specific marker for cellular damage.
 - If elevated beyond the laboratory range, LDH isoenzymes can be run, which can better help identify the tissue.



Lactate Dehydrogenase (LDH)

Traditional Reference Range

- 100-250 IU/L

Optimal Reference Range

- 140-180 IU/L



LDH - Elevated

- Liver diseases (cirrhosis, certain types of hepatitis)
- Hypothyroidism - (AI mechanism of cellular damage)
- Skeletal muscular damage, including intense exercise
- Certain types of anemia (hemolytic, pernicious)
- Fractures



LDH - Decreased

- **Poor carbohydrate entry into cells**
 - Reactive hypoglycemia (evaluate symptoms and glucose levels)
 - Insulin resistance
 - Ketosis



Lactate Dehydrogenase (LDH)

There are five types of LDH. They are known as isoenzymes. The five isoenzymes are found in different amounts in tissues throughout the body.

- LDH-1: found in heart and red blood cells
- LDH-2: found in white blood cells. It is also found in heart and red blood cells, but in lesser amounts than LDH-1.
- LDH-3: found in lung tissue
- LDH-4: found in white blood cells, kidney and pancreas cells, and lymph nodes
- LDH-5: found in the liver and muscles of skeleton



Alkaline Phosphatase

- An enzyme primarily found in the liver (biliary tree), bone, kidneys, small intestines and placenta
- As a phosphatase, it's responsible for removing phosphate from molecules and works well in an alkaline environment
- Elevated in bone and liver disease
- Intestinal alkaline phosphatase (IAP), has the ability to detoxify lipopolysaccharide and prevent bacterial invasion across the gut mucosal barrier



Alkaline Phosphatase

Traditional Reference Range

- 25-150 IU/L

Optimal Reference Range

- 65-90 IU/L



Alkaline Phosphatase - Increased

Cause	Reason	Additional Inquiry
Liver obstruction	Can cause damage to biliary cells releasing alkaline phosphatase into the blood.	Evaluate with bilirubin levels.
Liver or biliary cirrhosis	Same as above.	Evaluate with bilirubin levels.
Gastrointestinal issues (ulcerative colitis, peptic ulcer)	Damage to intestinal mucosa can release alkaline phosphatase into the blood stream.	Client history.
Hyperphosphatemia or high parathyroid hormone.	Association.	Evaluate phosphate and calcium level.



Phosphorus Content in Commonly Consumed Beverages

Erica Wickham, MS, RD, CDN

Patients with chronic kidney disease are likely to experience certain symptoms when their phosphorus gets too high. Individuals with diabetes may suffer from severe itching all over their body. In the dialysis population, elevated serum phosphorus levels are a constant struggle for the clinical team and the patient alike. As a dietitian, there is a constant search for a solution to help renal patients control their serum phosphorus and, in many cases, to remember to take their phosphate binders.

phosphorus is removed by the body. However, individuals with chronic kidney disease cannot adequately remove phosphorus and are at a higher risk of developing hyperphosphatemia.¹ This may ultimately result in elevated parathyroid hormone secretion, progressive deterioration of kidney function, renal bone disease, vascular calcification, increased risk of cardiovascular accidents, and higher mortality rates.^{2,4} Because elevated phosphorus affects bone and cardiovascular risk, the Kidney Disease Improving Global Outcomes guidelines refer to this condition as mineral bone disorder of chronic kidney disease.⁵

Patients with chronic kidney disease are likely to experience certain symptoms when their phosphorus gets too high. Individuals with diabetes may suffer from severe itching all over their body.¹ In the dialysis population, elevated

According to Kalantar-Zadeh and colleagues,² the amount of phosphorus absorbed from food additives is much higher (>90%) than that of natural sources, such as animal and plant proteins (40–60%).⁴ Several preservative and additive salts containing phosphorus are found in processed, convenience foods. These additives are useful in prolonging shelf life, enhancing flavor, retaining moisture, and improving the color of the food item.^{4,6} The form of phosphorus in additives is not bound to protein, but rather it is a salt that is readily absorbed in the intestinal tract. Table 1 illustrates the nutritional content, including the calorie, potassium, and phosphorus content found in commonly consumed beverages. It is of interest that most clear sodas are lower in phosphorus, but many still contain natural and added potassium (Gordon D. per



Canada Dry Ginger Ale	140	<1	<1
Diet Ginger Ale	<1	<1	<1
Cranberry Lime Seltzer	<1	<1	<1
Mandarin Orange Seltzer	<1	<1	<1
Raspberry Seltzer	<1	<1	<1
Lemon Lime Seltzer	<1	<1	<1
Tonic Water	135	<1	<1
Club Soda	<1	<1	<1
Coca-Cola	145	<1	58
Coca-Cola with Lime	146	51	56
Coke Zero	2	47	54
Diet Coke	2	18	27
Diet Coke with Lime	3	29	27
Cherry Coke	156	<1	56
Diet Cherry Coke	2	29	35
Cherry Coke Zero	2	50	56
Vanilla Coke	200	0	56
Vanilla Coke Zero	2	47	56
Mello Yellow	170	10	<1
Diet	<1	<1	<1
Mountain Dew	110	<1	<1
Diet Mountain Dew	<1	63	<1
Mountain Dew Coe Red	170	10	53
Mountain Dew Live Wire	170	5	<1
Mug Root Beer	170	15	<1
Diet Mug Root Beer	<1	10	<1
Mug Cream Soda	180	<1	<1
Diet Mug Cream Soda	<1	<1	<1
Nestea Lemon Sweet	129	<1	<1
Honey Lemon Green	120	35	<1
Raspberry	135	<1	<1
Sweetened	125	<1	32
Unsweetened	<1	<1	32
Orange Slice	180	<1	35
Cherry Slice	165	<1	35
Dr. Slice	180	<1	35
Pepsi	150	10	53
Diet Pepsi	<1	25	33
Pepsi Max	<1	20	42
Pepsi Next	35	15	33
Wild Cherry	160	10	53
Diet Pepsi Lime	<1	40	89
Diet Pepsi Vanilla	<1	45	89
Pibb Xtra	145	21	44
Pibb Zero	2	33	44
Schweppes Ginger Ale	180	<1	<1
Diet Ginger Ale	<1	<1	<1
Tonic Water	135	<1	<1
Club Soda	<1	<1	<1
Sierra Mist	90	35	<1
Diet Sierra Mist	<1	71	<1
Sierra Mist Cranberry Splash	160	50	<1
Diet Cranberry Splash	<1	37	<1
Sierra Mist Strawberry Kiwi	140	50	<1
Diet Strawberry Kiwi	5	137	<1
Sprite	144	<1	<1
Sprite Zero	3.6	110	<1



Alkaline Phosphatase - Decreased

Cause	Reason	Additional Inquiry
Zinc deficiency	Alk Phos is a zinc dependent enzyme. If zinc is low, alkaline phosphatase may be decreased.	Diet journal. Zinc deficiency symptoms.
Vitamin C deficiency.	Alk phos is low in individuals with scurvy.	Diet journal. Evaluate vitamin C deficiency symptoms.
Magnesium deficiency	Alk Phos also requires magnesium for proper function.	Evaluate GGT and serum magnesium.

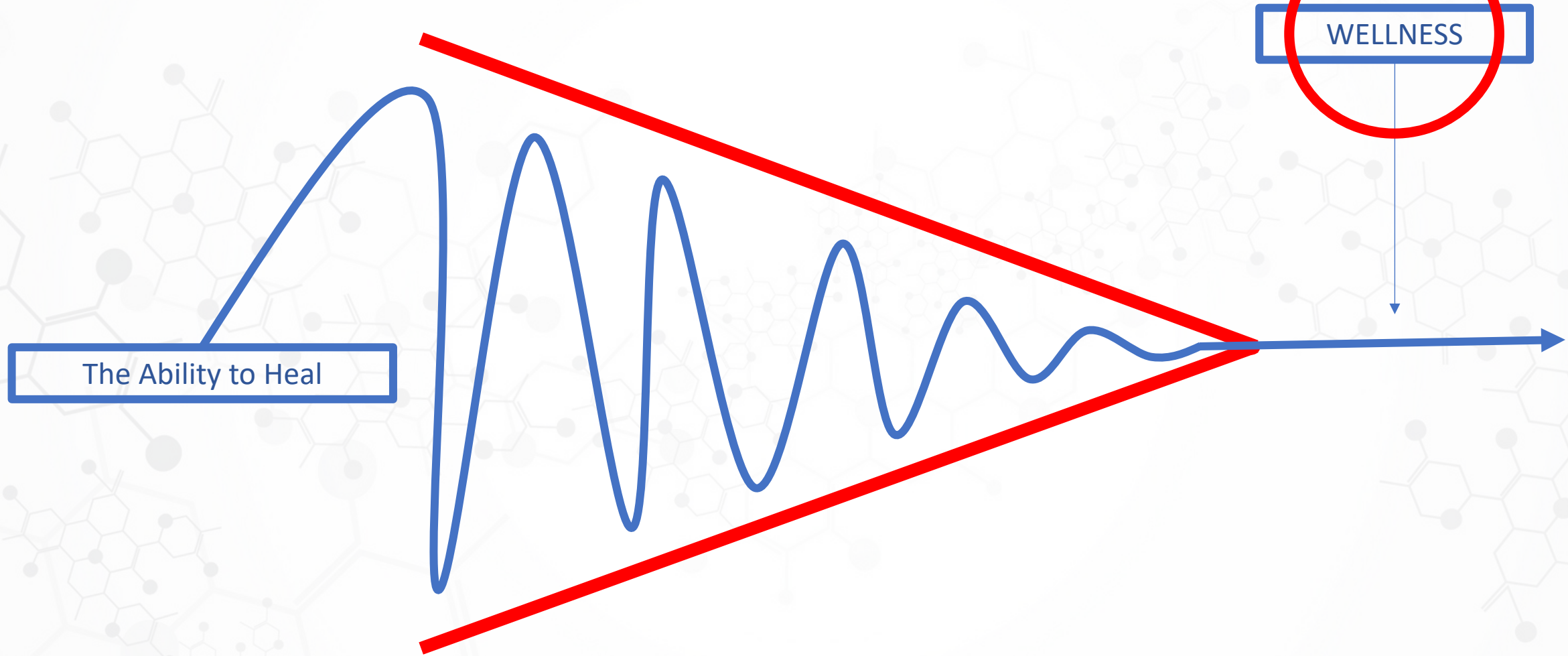


Alk. Phos. Isoenzymes

- Liver Isoenzyme a2
- Liver Isoenzyme a1
- Bone Isoenzyme
- Intestinal Isoenzyme
- Placental Isoenzyme



The Wedge Protocol



The Ability to Heal

WELLNESS

