Blood Chemistry Manual

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Blood tests primarily show patterns. Your clients will often bring a copy of their blood tests and on occasion you may suggest they get one. This manual is a compilation from several sources to help determine which organs and/or systems may need support. The Optimal Range may be higher or lower than the Pathological (Lab) Range. If you see number values that are considerably different from the Optimal Range listed in this manual they may be using a different unit of measure. Milligrams per deciliter, mg/dL, is a unit of measure that shows the concentration of a substance in a specific amount of fluid. In the United States, blood glucose test results are reported as mg/dL.

There are many limitations in blood testing so don't use most of your client's time studying the results. Look for border-line numbers and the obvious highs and lows which will be tagged by the laboratory. For the natural health professional, blood values help determine if the body is struggling to maintain homeostasis. Garrett Smith NMD CSCS BS gives a great statement on the limitations - NMD is a naturopathic MEDICAL doctor degree:

"The problem is, testing the blood for that "snapshot" is very dependent on many things, including but not limited to the day of the month, the dawn phenomenon, time of day, (intermittent) fasting, and hydration. Then, the body does its best to maintain the main electrolyte mineral (calcium, magnesium, sodium, potassium) levels in the blood, or else the heart rhythm is very quickly affected in negative ways. So…we're left looking at a set of numbers we get from a "tissue" that is on one hand very labile and changing all the time, while on the other hand it is giving its best poker face. Does it make sense to use this for long-term ***nutritional*** monitoring of any sort? Do you think that movie posters tell you all about what's in a movie? No, I'd say not."

In addition to the body's driving force to keep the blood in a state of homeostasis the tests do not reflect levels in the cells or tissues outside the blood. An example would be great calcium levels in the blood but the bones and tissues are starving for calcium. The same applies to potassium which is often the cause of "irregular heartbeats" and muscle cramps (calcium, magnesium, sodium, and potassium need to be in balance).

COMPONENT	HIGH	LOW
GLUCOSE **Optimal Range 80-100 mg/dL** The level of sugar (glucose) in the bloodstream is primarily controlled by the liver (gluconeogenesis), adrenal glands (cortisol), and the pancreas (insulin).	• Insulin resistance • Cortisol resistance • Hyper-Thyroid • Liver congestion/fatty liver • Diet changes needed • Diabetes (hyperglycemic) • Low chromium, zinc, magnesium, potassium • Low B6, B-complex • Low vitamin D	• Hypoglycemic • Liver glycogen dysfunction • Hyper-Insulin • Hypo-Adrenal/Adrenal Fatigue • Hypo-Thyroid • Diet changes needed • Low chromium • Low B-complex • Low Tyrosine production

All of our cells use glucose to make energy in the form of ATP. For the brain and nerves, glucose is the only source of fuel. This is why a drop in blood sugar leads to the feelings of fatigue and weakness. High blood sugar causes fatigue by increasing inflammation and slowing circulation which decreases oxygen and nutrients needed by the cells.

Insulin is a hormone secreted by the pancreas that helps move sugar from the blood and into the cells of the body. Insulin resistance is a condition where the cells are unable to take in the needed blood sugar.

Nutritional factors that influence cellular resistance include B vitamins, chromium, zinc, magnesium, vitamin D, omega-3 fatty acids, adequate protein, and vitamin C. Toxicity resulting from heavy metals, chemicals from food, water, or the workplace, viruses within the liver, and overgrowth of bowel pathogens should also be considered

When a person experiences episodes of hypoglycemia special attention must also be given to nutrients needed for the adrenals, pituitary, thyroid, and hypothalamus. Hypoglycemia commonly occurs during adrenal fatigue. Low levels of the adrenal hormones epinephrine, norepinephrine and cortisol may fail to raise blood glucose. When the cells do not get the glucose and other nutrients they require the person often craves sugar, and feels tired, shaky and weak.

According to Dicken Weatherby, N.D. “individuals progress through several stages of insulin resistance and glucose intolerance before becoming a classic type II diabetic. The stages include: Normal glucose tolerance > hypoglycemia (often due to hyperinsulinemia) > insulin insensitivity/resistance > eventually overt type II diabetes.” (1)

HEMOGLOBIN A1C
Optimal Range 4.1 - 5.7%

This test is primarily used to monitor long-term blood glucose control. It is a reflection of the average glucose levels for the previous 1-3 months. Values are increased when the person is not adequately controlling their long-term glucose levels very well. High levels also indicate a possible insulin resistance/pre-diabetic stage.

COMPONENT	HIGH	LOW
TRIGLYCERIDES **Optimal Range 70-110 mg/dL** Serum triglyceride levels are influenced by dietary fat consumption. Non-fasting samples are often the source of elevated levels.	• Insulin resistance/Diabetes • Bile/gallbladder dysfunction • Liver congestion/fatty liver • Poor fat metabolism • Gout • Pancreas dysfunction • Hypo-Adrenal, Thyroid, or Anterior Pituitary • B-12 Anemia • Omega-3 deficiency • Food sensitivities or allergies	• Liver congestion • Bile/gallbladder dysfunction • Hyper-Adrenal • Hyper-Thyroid • Hyper-Parathyroid • Autoimmune processes • Malnourishment • Malabsorption • Endurance exercise • Excessive oxidative stress • Food sensitivities or allergies

"Triglycerides are a type of fat that plays a major role as an energy source when they are metabolized in the human body. They are very rich in energy, containing double the energy of either carbohydrates or proteins that can also be used to supply energy to the body. As a normal component of the vascular system, triglycerides are continually in circulation ready to be metabolized to provide a source of energy. When present in excess, triglycerides can be stored in fatty deposits, which may lead to obesity and related health conditions if it extends over time." - http://www.news-medical.net/health/Triglycerides-What-do-they-do.aspx

When a gall bladder is removed the bile produced in the liver is released directly into the small intestine but, it is NOT released in response to food. This may lead to fat-soluble vitamin deficiencies and an insufficient surface area for the action of lipase. Lipase enzymes produced by the pancreas break down the triglycerides into fatty acids. Free fatty acids are used as an energy source by the heart and skeletal muscles.

According to Dicken Weatherby a person correctly metabolizing fats and carbohydrates tend to have a triglyceride level that is about one-half of the total cholesterol level. If the total cholesterol is 200 then the ideal triglyceride level should be 100. (1)

"Bile acids have long been known to facilitate digestion and absorption of lipids in the small intestine as well as regulate cholesterol homeostasis. Over the last decade, however, it has become clear that bile acids are not simply digestive detergents and the primary route governing cholesterol catabolism. Bile acids are now recognized as hormones involved in the regulation of various metabolic processes. Through activation of various signaling pathways, bile acids regulate not only their own synthesis and enterohepatic circulation, but also triglyceride, cholesterol, glucose, and energy homeostasis." - PHD and Vivian A. Fonseca, MD, http://care.diabetesjournals.org/content/32/suppl_2/S237.full

COMPONENT	HIGH	LOW
CHOLESTEROL **Optimal Range 150-220 mg/dL** Cholesterol is a fatty steroid hormone found in every cell of the body and plasma. It is essential for the membrane structure of cells. All steroid hormones (sex hormones, adrenal hormones, vitamin D…) are synthesized from cholesterol.	• Hypo-Thyroid. • Adrenal dysfunction. • Pre-diabetic/Diabetes • Liver/Gallbladder dysfunction • If total cholesterol is above 220, LDL is above 120, and triglycerides are above 110 with a decreased HDL (below 55) suspect fatty liver.	• Cholesterol lowering drugs • Low Folic acid, B6, B12 • Hyper-Adrenal • Malnutrition/Malabsorption • Liver/Bile/Gallbladder dysfunction • Heavy metals • Autoimmune response or endocrine dysfunction if triglycerides are also decreased

Most of our cholesterol is synthesized by the liver and dietary cholesterol does little to contribute to the levels. Cholesterol production requires enzyme actions with acetyl-CoA and the enzymes require B6, B12, and folate. Lipoproteins are responsible for transporting cholesterol within the body. LDL (low density lipoprotein), HDL (high density lipoprotein), and VLDL (very low density lipoprotein) levels are often part of laboratory testing.

Increased LDL readings are associated with oxidative stress and and an immune response to infections. Low vitamin C, D, and E intake increases oxidation which increases inflammation. Low levels of selenium, CoQ10, folic Acid, B6 and B12 are also implicated in increased oxidation of LDL and inflammation. Oxidation of cholesterol is damaging to all cells but particularly our heart and blood vessels. Unoxidized cholesterol is a free radical scavenger and protects our cell membranes. Low levels of cholesterol increase a person's risk for low hormone levels (progesterone, estrogen, vitamin D, testosterone…) depression, brain dysfunction, lowered bile acid production, and death.

Low HDL levels are often the result of low omega 3 consumption or improper fat metabolism (liver, bile, gallbladder). HDL cholesterol is considered "good" cholesterol because it helps remove LDL cholesterol from the arteries. The function of LDL is to deliver cholesterol to cells, where it is used in membranes and for the synthesis of steroid hormones.

CoQ10 is a compound that is crucial for mitochondrial function. The statin cholesterol lowering medications result in lower CoQ10 levels because they inhibit the production of mevalonate, a precursor of both CoQ10 and cholesterol. Deficiencies of CoQ10 may result in many neurologic and myopathic syndromes. At least 20% of patients are statin intolerant. Common statin side effects include: Headache; Difficulty sleeping; Muscle aches, tenderness, or weakness (myalgia); Drowsiness; Dizziness; Nausea; Abdominal pain; Bloating or gas; Diarrhea; Constipation; and Rash. Statins also carry warnings that memory loss, mental confusion, high blood sugar, and type 2 diabetes are possible side effects. - http://www.webmd.com/cholesterol-management/side-effects-of-statin-drugs?page=2

COMPONENT	HIGH	LOW
BUN/Blood Urea Nitrogen **Optimal Range 12-20 mg/dL** The BUN is a test that is used primarily to measure kidney function. Urea circulates in the blood and is excreted by the kidneys. Ammonia generated by protein metabolism is converted to urea. This conversion involves a series of enzyme reactions. If the enzyme systems are impaired, ammonia and urea may increase beyond what the kidneys can process. (3)	• Kidney/Renal disease or insufficiency • Dehydration • Excessive protein intake • Anterior pituitary dysfunction • Hyper-Adrenal • Edema • Congestive heart disease • Diabetes • Body building/Strenuous exercise • Low potassium • Low magnesium • Low vitamin C levels	• Acidosis • Liver dysfunction • Malnutrition/Malabsorption • Low protein diet • Pancreatic enzyme deficiency • Posterior pituitary dysfunction when BUN/ Creatine ratio is below 10 • Dysbiosis • Pregnancy • Low B vitamins Falsely decreased levels of BUN may be due to small muscle mass (e.g. women and children). (1)
CREATININE **Optimal Range 0.8-1.1 mg/dL** Muscles use the energy molecule ATP to function but they have a limited supply. The muscles are able to regenerate ATP using the stored molecule creatine phosphate. Creatinine is a waste product of muscle metabolism.	• Kidney/renal obstruction • Prostatitis/Prostate issues • UTI • Uterine hypertrophy • Diabetes • Gout • Body building • Dehydration • Low vitamin C • Low fatty acids	• Prolonged muscle atrophy • Malnutrition/Malabsorption • Low protein diet (Creatine is produced in the liver and requires L-arginine, glycine, and L-methionine.) • Pancreatic enzyme deficiency • Liver disease • Low vitamin E and C
“The degradation of creatine is of particular clinical interest. The only end product of creatine degradation is creatinine, which diffuses into the bloodstream from the muscle. Upon entry into the renal parenchyma, creatinine is filtered in the glomerulus and excreted in the urine. Therefore, the clinician must be weary when interpreting the basic metabolic panel from an individual with large amounts of muscle mass, or in patients supplementing their diets with creatine. Such patients will exhibit elevated creatinine levels in the blood, and therefore, their blood creatinine levels may not be accurate indicators of renal function.” (4)		
BUN/CREATININE RATIO: OPTIMAL RANGE IS 10-16 An increased ratio happens when there is a decrease in creatinine or an increased BUN level. A decreased ratio is when BUN is decreased with a creatinine increase OR a normal BUN with a greatly increased creatinine. (1)		

COMPONENT	HIGH	LOW
URIC ACID **Optimal Range 3.5-5.9 mg/dL** Uric acid is the end product of purine, nucleic acid, and nucleoprotein metabolism. Levels represent the end product of protein utilization and deamination in the liver. Uric acid is used to bind iron, mercury, and other heavy metals if other measures have failed (glutathione activity, good bowel action, adequate protein…) (1) Uric acid is commonly deposited in the ankle, hand, knees, tendons, and kidneys. Sub-acute gout is often mistaken for arthritis or fibromyalgia.	• Gout • Atherosclerosis • Oxidative stress • Kidney disease • Circulatory disorders • Leaky gut syndrome • Diabetes with acidosis • Excessive polyunsaturated fatty acids • Excessive alcohol • Excessive red meat • B-vitamin deficiency • B-vitamin metabolism issues • Arthritis, Rheumatoid arthritis • Low vitamin C • Low magnesium In the absence of kidney or liver problems suspect alkaline mineral deficiency.	• Molybdenum deficiency, especially if chemical sensitivity is present • Anemia - folate/B12/B6 deficiency • Copper deficiency • Liver dysfunction • Pernicious anemia • Heavy metals • Steroid/corticosteroid use • Low protein intake “Our results indicate that UA could play a beneficial role against HgCl(2) toxicity by preventing systemic and renal oxidative stress and tissue damage.” (5) “Using asparagus instead of red meat is the “safest and most direct dietary approach” (2)

ANION GAP/ELECTROLYTES

Electrolytes are minerals that carry an electric charge. They help transmit electrical impulses for proper nerve, heart, and muscle function. The primary electrolytes in the body are cations (of calcium, potassium, sodium, and magnesium) and anions (of chloride, carbonates, phosphates, and iodide).

Cations (+/positive ions) and Anions (-/negative ions) are supposed to be equal. Anything that upsets this balance can have life-threatening consequences.

The anion gap is the difference between primary measured cations (sodium Na+ and potassium K+) and the primary measured anions (chloride Cl- and bicarbonate HCO3-) in serum.

The Anion Gap = Na+ - (Cl- + HCO3-) Chloride and bicarbonate are subtracted from sodium. The difference should be equal to or less than 12. When the anion gap is above 12 it indicates excess acidity. Low B-complex vitamins, especially thiamine may also increase the anion gap.

COMPONENT	HIGH	LOW
CALCIUM Ca **Optimal Range 9.5-10.2 mg/dL** Calcium is strictly controlled in the blood so serum calcium is not an accurate measure of calcium in the bones and tissues. Serum calcium levels	• Hyper-Parathyroid • Hypo-Thyroid • Kidney disease • Overuse of calcium supplements (especially calcium carbonate) • Thiazide diuretics • Aluminum-induced bone disease (7)	• Hyper-Parathyroid • Calcium deficiency • Low stomach acid • Malnutrition • High grains, sugars, soda/ pop • Magnesium deficiency • Metabolic Acidosis • Celiac and bowel inflammation

Low blood calcium levels are uncommon because the bones act as a reservoir for this electrolyte. Normal serum calcium does not reflect calcium levels in the bones or tissues. Intestinal absorption of calcium requires sufficient stomach acid and vitamin D.

“Ionic or free calcium is not the only biological active form of calcium, but reflects the amount of albumin and the the blood pH. In academia, calcium becomes ionized and liberated from serum proteins. In alkalemia, more calcium is bound to proteins. This may lead to extra-osseous deposition or kidney stones. Serum calcium can not be properly interpreted without serum albumin level.” (7)

Metabolic alkalosis develops when your body loses too much acid or gains too much base. Common causes include

- Loss of electrolytes, especially potassium and sodium from vomiting, diuretics, or excessive sweating
- Adrenal disease
- Antacids and Laxatives
- Ingestion of too much bicarbonate found in baking soda
- Alcohol abuse

“*Calcium and phosphorus.* These two electrolytes are inversely related in the blood: When calcium levels are high, phosphorus levels are low, and vice versa.
Calcium is a cation with multiple functions, including transmitting nerve impulses, maintaining cell wall permeability, and activating the body's clotting mechanism. It's also involved in contracting cardiac and smooth muscle, generating cardiac impulses, mediating cardiac pacemaker function, and forming bones and teeth.
Phosphorus, the major intracellular anion, also plays a major role in bone formation. It's necessary for energy production in the cells and for carbohydrate, protein, and fat metabolism, as well. Phosphorous also helps maintain acid-base balance by buffering hydrogen ions.” http://www.modernmedicine.com/modern-medicine/content/restoring-electrolyte-balance

“Ideal Calcium/Phosphorus ratio is 10 parts calcium to 4 parts phosphorus, creating a 2.5 ratio.” (7)

COMPONENT	HIGH	LOW
CHLORIDE / Cl **Optimal Range 100 - 106 mEq/L** Helps regulate the cellular osmotic pressure. Chlorides, along with sodium, potassium, and CO2, form the basis for pH.	• Hyper-Adrenal • Metabolic acidosis • Dehydration • CO2 deficient (acidosis) • Bowel dysfunction • Kidney dysfunction • Loss of sodium bicarbonate • Diabetes • Excessive salicylates (nonsteroidal anti-inflammatory drugs)	• Hypo-Adrenal • Metabolic alkalosis • Diarrhea • Low stomach acid • Pneumonia • Edema • Insufficient salt intake • Excessive bromide • Congestive heart failure • Low B vitamins • Low magnesium

Chloride is primarily found in extracellular spaces in the form of sodium chloride or hydrochloric acid. Many of the same conditions that affect sodium will affect chloride. If serum sodium is decreased a decrease in chloride is expected, a reciprocal relationship. Hyper-adrenal function increases aldosterone production. Aldosterone in turn increases the reabsorption of sodium which also increases chloride levels.

Chloride has an inverse relationship with carbon dioxide (CO2). Metabolic acidosis is likely when CO2 is decreased while chloride is increased.

Chloride is necessary for the production of HCL (hydrochloric acid/stomach acid). Having enough HCL is critical for digestion.The HCL activates the chief cells in the middle portion of the stomach to start secreting a protein-digesting enzyme known as pepsinogen. Pepsinogen requires the presence of hydrochloric acid in order to begin digesting protein.

The secretion of hydrochloric acid by the stomach plays also plays an important role in protecting the body against pathogens ingested with food or water. A gastric fluid pH of 1 to 2 is lethal for many microbial pathogens. Escherichia coli, Salmonella Typhimurium, and H. pylori, have mechanisms that allow them to survive in acid environments.

Most of the sodium and chloride in the diet comes from salt. It has been estimated that 75% of the salt intake in the US comes from the salt added during food processing or manufacturing. Only 25% of the salt is added at the table or during cooking.

“Adrenal hypofunction, sometimes referred to as adrenal burnout, can result in chronic fatigue, exhaustion after exercise, abnormal fluid dynamics, low blood pressure and hypothyroid function. On a blood test, adrenal hypofunction is indicated by the following: potassium levels greater than 4.5, sodium less than 136 and chloride values 101 or less. Because there is excess potassium and decreased sodium, this is a major marker for metabolic alkalosis. It is wrong to assume that only acidosis is pathological. Alkalosis is just as common as acidosis, if not more so.” - http://metabolichealing.com/electrolytes-the-adrenals/

COMPONENT	HIGH	LOW
MAGNESIUM / Mg+ **Optimal Range 3.2 - 4.0 mg/dL** Most of the magnesium in the body is found in the bones and inside the cells. Only a tiny amount of magnesium is normally present in the blood.	• Kidney dysfunction • Hypo-Thyroid • Hypo-Pituitary • Excessive Mg supplements or antacids • Dehydration • Increased albumin	• Epilepsy • Hyper-Adrenal • Hepatitis • Inflammation (anywhere) • Kidney dysfunction • Decreased albumin • Consuming calcium gluconate with 24 hours of testing (1)

"Assessing magnesium status is difficult because most magnesium is inside cells or in bone . The most commonly used and readily available method for assessing magnesium status is measurement of serum magnesium concentration, even though serum levels have little correlation with total body magnesium levels or concentrations in specific tissues. Other methods for assessing magnesium status include measuring magnesium concentrations in erythrocytes, saliva, and urine; measuring ionized magnesium concentrations in blood, plasma, or serum; and conducting a magnesium-loading (or "tolerance") test. No single method is considered satisfactory." - https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/

Magnesium in the form of aspartate, citrate, lactate, and chloride are better absorbed and more bioavailable than magnesium oxide and magnesium sulfate.

"Magnesium is one of the most essential mineral in the human body, connected with brain biochemistry and the fluidity of neuronal membrane. A variety of neuromuscular and psychiatric symptoms, including different types of depression, was observed in magnesium deficiency. Plasma/serum magnesium levels do not seem to be the appropriate indicators of depressive disorders, since ambiguous outcomes, depending on the study, were obtained. The emergence of a new approach to magnesium compounds in medical practice has been seen. Apart from being administered as components of dietary supplements, they are also perceived as the effective agents in treatment of migraine, alcoholism, asthma, heart diseases, arrhythmias, renal calcium stones, premenstrual tension syndrome etc. Magnesium preparations have an essential place in homeopathy as a remedy for a range of mental health problems. Mechanisms of antidepressant action of magnesium are not fully understood yet. Most probably, magnesium influences several systems associated with development of depression. The first information on the beneficial effect of magnesium sulfate given hypodermically to patients with agitated depression was published almost 100 years ago. Numerous pre-clinical and clinical studies confirmed the initial observations as well as demonstrated the beneficial safety profile of magnesium supplementation. Thus, magnesium preparations seem to be a valuable addition to the pharmacological armamentarium for management of depression." (8)

COMPONENT	HIGH	LOW
PHOSPHORUS **Optimal Range 3.2 - 4.2 mg/dL** Phosphorus is the second most abundant mineral in the body and is found in every cell of the body.	• Hypo-Parathyroid • Magnesium deficiency • High calcium levels • Excessive soda/pop • Kidney dysfunction • Diabetes • Liver dysfunction • Excessive vitamin D	• Hyper-Parathyroid • Hypochlorhydria (low stomach acid) • Hyperinsulinism • Diet high in refined carbohydrates • Low protein in diet

Phosphorus is primarily stored in the bones (85%) and is essential for bone matrix and hydroxyapatite metabolism. It is hydroxyapatite that gives bones and teeth their rigidity. Phosphorus and calcium have an inverse relationship when taking supplements. When calcium levels increase the phosphorus levels will decrease. When phosphorus is ingested from whole foods it is “naturally buffered with minerals and vitamins that act as synergistic co-factors to increase calcium metabolism”. (1)

Seeds have the highest level of whole-food phosphorous. Pumpkin and squash seeds have 345mg (35% DV) per ounce, sunflower seeds (32% DV), chia seeds (24% DV), sesame seeds (22% DV), and flaxseeds (18% DV). DV=Daily Value

> “While various studies have been done on soft drink consumption and bone health in children and adolescents, this study looked adults, said Katherine Tucker, PhD, associate professor of nutritional epidemiology at Tufts University.
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> In other studies, there has been an assumption that increased soft drink consumption meant lower intake of dairy and other calcium sources.
> But in this cohort, "we looked at total calcium, and that was similar across the groups we studied. **[Decreased bone density] wasn't because of lower calcium,"** she told Medscape in an interview. Dr. Tucker presented her findings here at the 25th annual meeting of the American Society for Bone and Mineral Research.
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> **The problem appears to be increased levels of phosphoric acid, which can interfere with bone absorption.** A typical can of cola contains 44 to 62 mg of phosphoric acid per 12 ounce serving, and diet cola contains 27 to 39 mg.” - http://www.medscape.com/viewarticle/461898

Phosphorus is essential for all body tissues. It is needed for the formation of muscles, red blood cells, ATP (Adenosine Tri-Phosphate), pH balance, the nervous system, and metabolism of carbohydrates, protein and fat.(7) Like calcium, phosphorus levels are regulated by the parathyroid hormone (PTH).

A decreased phosphorus level often results in joint stiffness (when arising or after sitting more than 30 minutes) that is improved with movement.

COMPONENT	HIGH	LOW
POTASSIUM **Optimal Range 4.0 - 4.7 mEq/L** Potassium is mainly found inside the cell (98%) and is necessary for pH balance throughout the body.	• Metabolic acidosis • Hypo-Adrenal • Tissue destruction • Acute Infections • Kidney dysfunction	• Hyper-Adrenal • Drug Diuretics • Anemia • High blood pressure • Low magnesium levels • Coticosteroids (prednisone or cortisone)

Potassium is vital for the proper functioning of nerves and muscles. Brain function relies on nerve impulses and electrical signaling so low potassium may cause fatigue, poor concentration, “brain fog”, trouble learning and remembering, as well as mood changes. Potassium plays a key role in smooth muscle contraction making it an important mineral for the digestive tract. Low potassium also contributes to bloating, constipation or abdominal pain.

The heart muscle is sensitive to both high and low levels of potassium. Low levels are known to cause abnormal heart rhythms and palpitations (feels like the heart skipped a beat). Low levels also lead to weakness and muscle cramps. Muscle cramps may also develop with low calcium or low magnesium.

Metabolic acidosis will drive potassium out of the cells and into the blood which may result in too much potassium in the blood if the kidneys are not able to excrete the excess. A diet high in processed foods with low vegetable intake induces a chronic, low-grade metabolic acidosis. Keeping the proper potassium balance in the body depends on the amount of sodium and magnesium in the blood. Too much sodium (processed foods) may increase the need for potassium.

> Dr. Josh Axe, DrAxe.com, simplifies a complex set of reactions with the following: “Potassium is needed to help protect bones from becoming weak and prone to breaks or fractures. In the body, potassium forms conjugate anions such as citrate that are converted to bicarbonate. Low potassium levels are associated with reduced bicarbonate precursors that are needed to neutralize acids that are present in commonly eaten foods, especially animal proteins.
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> Sulfuric acids enter the body in the form of the amino acids found in meat, poultry and other high-protein foods. Since low potassium means low levels of bicarbonate precursors, the bones are not properly buffered from the effects of sulfer-acids and can become demineralized, weak and porous when someone’s diet is lacking in potassium. This can increase the risk for osteoporosis and fractures.”

If the blood levels are high it usually indicates kidney issues or dehydration. Potassium is controlled by the kidneys and is greatly influenced by the adrenal hormone aldosterone. Acute infections, tissue destruction, and asthma will also lead to a release of potassium into the blood. Any value outside the expected range, high or low, requires attention. High levels may also develop with some cancer treatments. Cancer drugs that destroy cells (normal and cancer cells) will release potassium and electrolytes into the blood stream.

COMPONENT	HIGH	LOW
SODIUM / NA+ **Optimal Range 135 - 142 mEq/L** While potassium is found primarily inside the cell, sodium is primarily an extracellular (outside the cell) cation. Sodium is controlled by the kidneys and adrenal glands. Sodium levels affect blood pressure, blood volume, and it is needed for muscles and nerves to work properly.	• Hyper-Adrenal • Dehydration from vomiting, diarrhea, diuretics, excess sweating • Congestive heart disease • Diabetes/High blood sugar • Kidney dysfunction • Low vitamin A • Oxidative stress People with diabetes mellitus and high blood sugar levels may urinate excessive amounts, causing dehydration.	• Hypo-Adrenal • Edema • Drug diuretics • Kidney dysfunction • Heart dysfunction • Infections or Diarrhea • Acidosis • Insufficient salt intake “At first, people become sluggish and confused, and if hyponatremia worsens, they may have muscle twitches and seizures and become progressively unresponsive.”(6)

According to the Institute for Health Realities “A high serum sodium is associated with OXIDATIVE STRESS that is most likely to affect kidney function, bring on (and promote) high blood pressure, alter cell membrane function, and bring about FREE CALCIUM EXCESS coupled with tissue calcification.” And, “A low to low normal sodium is associated with the manifestation of the toxic effect of a wide variety of toxins.” (2)

The role of adrenal hormones should not be overlooked with high sodium levels. Aldosterone is the main mineralocorticoid secreted by the adrenal cortex which stimulates sodium absorption and potassium excretion. The following symptoms are common with low aldosterone levels and adrenal gland dysfunction:

- Craving salt
- Fluid retention in the arms and legs
- Pupils do not stay constricted when exposed to light
- Excessive urination – up to 15-20 times/day
- Excessive sweating even without activity.

To complicate matters, blood sugar is intricately related to adrenal gland function. Chronically elevated cortisol levels from adrenal stress will cause insulin receptor insensitivity/insulin resistance.

“There are two forms of Sodium - ionic as in earth and sea salt, and co-valent as is found in vegetables and fruit. Bothe forms affect the body, but it is the co-valent form that is required by the cells.”(3)

“Our bodies need far more potassium than sodium each day, but the typical US diet is just the opposite: Americans average about 3,300 milligrams of sodium per day, about 75 percent of which comes from processed foods, while only getting about 2,900 milligrams of potassium each day.” - http://www.hsph.harvard.edu/nutritionsource/salt-and-sodium/sodium-health-risks-and-disease

COMPONENT	HIGH	LOW
CO2 / CARBON DIOXIDE / BICARBONATE **Optimal Range 24-28 mEq/L** The primary bicarbonate buffering agent (alkaline reserve) for neutralization of metabolic and dietary acids - this function is regulated by the kidneys.	• Hyper-Adrenal • Respiratory acidosis • Metabolic alkalosis • Fevers • Mercury toxicity • Intestinal alkalosis/Low stomach acid • Excess bicarbonate/baking soda	• Metabolic acidosis • Respiratory alkalosis • Asthma • High Anion Gap • Thiamine deficiency • Kidney dysfunction • Toxic conditions • Aspirin use • Low alkaline minerals (acidosis)

"Carbon dioxide (CO2) is a gaseous waste product from metabolism. The blood carries carbon dioxide to your lungs, where it is exhaled. More than 90% of carbon dioxide in your blood exists in the form of bicarbonate (HCO3). The rest of the carbon dioxide is either dissolved carbon dioxide gas (CO2) or carbonic acid (H2CO3). Your kidneys and lungs balance the levels of carbon dioxide, bicarbonate, and carbonic acid in the blood." - http://www.webmd.com/a-to-z-guides/bicarbonate

The lungs, as a reaction to metabolic acidosis, will eliminate CO2+ and preserve bicarbonate. With alkalosis the lungs will decrease the loss of CO2 while the kidneys excrete bicarbonate.

TOTAL PROTEIN
Optimal Range 6.5 - 8.0 g/dL

The absorption of protein is affected by the stomach, pancreas, small intestine and the liver. Low stomach acid, insufficient protease enzymes, inflammation in the small intestine, and liver/gallbladder congestion or dysfunction interfere with the absorption and conversion of protein into amino acids.

"A normal total protein is possible even if the albumin or globulin levels are abnormal, for example a condition that causes a decreased albumin and an increased globulin level will result in a normal total serum protein."(1)

In the blood, proteins are in the form of albumin, globulin, and fibrinogen. Together they are "total protein". Albumin is the most plentiful protein circulating in the blood and it is produced primarily in the liver. Globulins are formed in the liver and/or the immune system. Fibrinogen is also produced by the liver and stops bleeding by helping blood clots to form.

COMPONENT	HIGH	LOW
ALBUMIN **Optimal Range 3.8 - 5.2 g/dL** Albumin is produced primarily in the liver and accounts for 2/3 of the total blood protein. It is a protein that helps maintain osmotic pressure, water distribution. It is also a transport protein for hormones, vitamins and minerals, and waste products.	• Dehydration • Excess protein in diet • Hypo-Adrenal • Lymphatic congestion Dehydration is the most common cause of high albumin levels.	• Liver dysfunction • Low insulin production • Gallbladder dysfunction • B12/Folate anemia • Low vitamin C • Oxidative stress • Intestinal inflammation • Low stomach acid • Low protein diet Low albumin will impair the calcium transport system.

In humans, albumin is the most abundant plasma protein, accounting for 55–60% of the measured serum protein. It is used by the body for growth and tissue repair. Low albumin concentrations in the elderly increases the risk of functional decline.

“Albumin also functions as a sink for xenobiotics, diminishing the binding of xenobiotics to hormone receptors and other cellular proteins. This protects animals from endocrine disruption by xenobiotics.” - http://joe.endocrinology-journals.org/content/175/1/121.full.pdf Albumin is protective against a wide range of chemicals and heavy metals.

“The rate of synthesis depends on nutritional intake, more so than for other hepatic proteins. Fasting reduces albumin production, but specifically omitting protein from the diet causes a greater reduction in synthesis. Early in protein deprivation, there is rapid disaggregation of free and bound polysomes, which can be reversed rapidly by refeeding the subject with amino acids. Two amino acids are particularly effective, tryptophan and ornithine.” - http://bja.oxfordjournals.org/content/85/4/599.full

Bilirubin production and excretion follows a specific pathway. When the reticuloendothelial system breaks down old red blood cells, bilirubin is one of the waste products. This "free bilirubin", is in a lipid-soluble form that must be made water-soluble to be excreted. The free, or unconjugated, **bilirubin is carried by albumin to the liver**, where it is converted or conjugated and made water soluble. Once it is conjugated into a water-soluble form, bilirubin can be excreted in the bile and the urine. Very high bilirubin levels cause jaundice, in which the skin and whites of the eyes turn yellow.

“Although long considered a toxic waste product of heme metabolism, the yellow pigment bilirubin is now recognized as an important vasoprotective molecule.” - www.diabetes.diabetesjournals.org/content/64/5/1506.full.pdf

COMPONENT	HIGH	LOW
GLOBULIN, Total **Optimal Range 2.4 - 3.2 g/dL** Globulins function in antibody formation, coagulation, and osmotic pressure of the blood.	• Liver cell damage • Oxidative stress • Heavy Metals • Parasites • Autoimmune diseases • Chronic infections • Low vitamin C • Low magnesium • Low vitamins A, D, E	• Digestive dysfunction • Low stomach acid • Intestinal Inflammation • Severe Anemia • Gallbladder dysfunction • Immune insufficiency and/ or poorly controlled autoimmune disease • Low B vitamins • Food sensitivities and/or parasites
Total serum globulin includes alpha 1, alpha 2, beta and gamma fractions. Globulins are proteins that include gamma globulins (antibodies) and a variety of enzymes and transport proteins (transports vitamins, hormones, amino acids, waste products, calcium, magnesium and more). Gamma globulins, antibodies, are the most abundant. “A high globulin accompanied by a hypersensitivity reaction (as determined by a rise in Eosinophils) is also a feature of people who are successfully dealing with exposure to mercury.” (2) “Along with albumin and fibrinogen, globulins are one of the major proteins in the blood. There are approximately sixty different types of globulins that help the body clot blood, fight infection, and carry other proteins in the body.” - http://www.newhealthguide.org/Globulin.html		
A/G (Albumin/Globulin) Ratio **Optimal Range 1.5 - 2.0** “If increased with a normal globulin level, check thyroid functions (TSH, FT4, FT3). If decreased with a normal globulin level, check liver enzymes (ALT, AST, GGTP) and blood clotting factors.” (7)	• Hypo-Thyroid • Hypo-Adrenal Falsely increased levels are usually due to dehydration.	• Liver dysfunction will cause a decreased albumin level and an increased globulin level resulting in a decreased ratio. • Immune Activation Low levels are normal during pregnancy.

COMPONENT	HIGH	LOW
ALT/SGPT **Optimal Range 8-35 U/L** Alanine aminotransferase is an enzyme found mainly in the liver, but also in smaller amounts in the kidneys, heart, muscles, and pancreas. ALT was formerly called serum glutamic pyruvic transaminase (SGPT)	• Liver dysfunction • Mononucleosis • Acute Hepatitis • Pancreatic dysfunction • Autoimmune diseases • Heart congestion or inflammation • Excessive muscle breakdown • Low vitamin A • Low magnesium	• Vitamin B6 deficiency, balance by using a B complex • Protein deficiency • Malabsorption • Low iron • Low copper
Salicylates (aspirin) may cause a falsely increased or decreased level. Vitamin B6, in its active form of pyridoxyl-5-phosphate, is required for the activity of the transferase enzymes. With a B6 deficiency it is common to also see a decreased MCV/ MCH level. (1)		
AST/SGOT **Optimal Range 10-30 U/L** Aspartate aminotransferase is an enzyme normally found in red blood cells, liver, heart, muscle tissue, pancreas, and kidneys. AST was formerly called serum glutamic oxaloacetic transaminase (SGOT).	• Liver dysfunction • Excessive muscle breakdown • Cardiovascular disease • Hepatitis, viral • Mononucleosis/Epstein Barr virus • Cytomegalovirus	Low levels of AST are normally found in the blood.
The AST/SGOT enzyme is found in highly metabolic tissues like muscles, kidneys, lungs, and the heart. In the event of cell damage or cell death the enzyme may be released into the blood. Metabolism is a term used to describe all of the chemical reactions required for cells to continue living. Metabolism is divided into two categories: Catabolism - the breakdown of molecules and release of energy and Anabolism - the synthesis of all compounds needed by the cells; requires energy. Metabolism is closely linked to nutrition and the availability of nutrients. The pathways of metabolism rely upon nutrients that they breakdown in order to produce energy. This energy in turn is required by the body to synthesize new proteins, nucleic acids (DNA, RNA), enzymes, etc. **The focus is on cellular damage.** “AST/SGOT is more specific for the detection of problems of cardiovascular origin than for biliary tree or liver problems.” (1)		

COMPONENT	HIGH	LOW
GGTP/GGT **Optimal Range 10-30 U/L** Gamma Glutamyl Transpeptidase/Transferase is an enzyme found in the highest amounts within the liver. The GGTP is involved in amino acid and protein metabolism.	• Gallbladder dysfunction • Liver cell damage • Pancreas/enzyme dysfunction • Pancreas/insulin dysfunction • Viruses • Alcoholism • Exposure to toxins	• B6 deficiency • Zinc deficiency • Magnesium deficiency • Hypothalamic malfunction • Hypo-Thyroid
“Drugs that may cause an elevated GGT level include phenytoin, carbamazepine, and barbiturates such as phenobarbital. Use of many other prescription and non-prescription drugs, including nonsteroidal anti-inflammatory drugs (NSAIDs), lipid-lowering drugs, antibiotics, histamine receptor blockers (used to treat excess stomach acid production), antifungal agents, antidepressants, and hormones such as testosterone, can increase GGT levels. Clofibrate and oral contraceptives can decrease GGT levels. Levels of GGT increase with age in women, but not in men, and are always somewhat higher in men than in women.” - https://labtestsonline.org/understanding/analytes/ggt/tab/all/		
ALP/ALKALINE PHOSPHATASE **Optimal Range 50-75 U/L** ALP is an enzyme produced by a variety of cells in response to rapid cellular proliferation and repair. Phosphorus is essential for life. The backbone of DNA is based on a repeated pattern of a sugar group and a phosphate group. Adenosine Triphosphate (ATP) is the energy-bearing molecule found in all living cells. Most usable source of natural phosphorus comes from seeds like pumpkin, squash, flax, sunflower, chia, and sesame.	• Naturally elevated in growing children • Naturally elevated during bone repair from breakage • Other bone-related conditions include rickets, bone disease, Paget's disease, and osteomalacia (softening of bones) • Low vitamin D • Low Calcium • Low Magnesium • Low Omega-3 fatty acids • Acidic/Low minerals • Tumor growth • Liver Disease • Drug toxicity/Drug-induced liver damage	• Zinc deficiency • B6 deficiency Zinc and B6 are required for the formation of ALP. “The body needs phosphorus to build and repair bones and teeth, help nerves function, and make muscles contract. Most (about 85%) of the phosphorus contained in phosphate is found in bones. The rest of it is stored in tissues throughout the body.” - http://www.webmd.com/a-to-z-guides/phosphate-in-blood

COMPONENT	HIGH	LOW
BILIRUBIN, Total **Optimal Range 0.1 - 1.2 mg/dL** Bilirubin is formed from the breakdown of hemoglobin from red blood cells. Breakdown occurs in the spleen and bone marrow and is transported to the liver where it is made water soluble and excreted in the bile.	• Biliary obstruction • Excessive red blood cell destruction • Oxidative stress due to toxins or inflammation • Liver dysfunction • Thymus dysfunction (when combined with delayed healing time, frequent colds and other low immune responses)	• Spleen dysfunction • Iron deficiency • Impaired digestion of fats (bile insufficiency, removal of gallbladder, insufficient lipase production)
Symptoms associated with biliary stasis/cholestasis, is a condition where **bile** cannot flow from the liver to the duodenum, include: pain between shoulder blades, stomach upset by greasy foods, greasy or shiny stools, nausea, light colored stools, and gallbladder attacks. Jaundice occurs when the level of bilirubin is so high that the liver is unable to excrete enough. The excess results in a yellow discoloration of the skin and eyes. Indirect/unconjugated bilirubin is the term used when albumin is bound to bilirubin so it can be transported to the liver from the spleen or bone marrow. Direct/conjugated bilirubin is the form that is excreted in the bile.		
HCT/HEMATOCRIT **Optimal Range 40-45%** A high hematocrit suggests an excess of blood and an increased risk of thrombosis. Thrombosis is the formation of a blood clot inside a blood vessel.	• Low vitamin E • Hydrogenated oil use • High carbohydrate diet • Oxidative stress • Heart disease • Lung disease • Bone marrow disorders	• Anemia (B6, B12, Folic acid, iron) • Blood loss • Infection • Leukemia • Lymphoma • Low alkalizing minerals • Low fat soluble vitamins (A, C, D, E, K)
Hemoglobin is a <u>protein</u> present mainly in red blood cells. Hematocrit is a <u>measurement</u> related to total blood count. Both of these are used to diagnose anemia and are often mistaken to be the same thing. **HGB/HEMOGLOBIN** **Optimal Range 14 - 16 g/dL** Hemoglobin is responsible for the red color of red blood cells. The function of hemoglobin is to transport oxygen from the lungs to our tissues. From tissues, carbon dioxide is transported back to the lungs. Hemoglobin also has the ability to transport nitric oxide molecules which are important in cell signaling processes.		

COMPONENT	HIGH	LOW

IRON, TOTAL IRON-BINDING CAPACITY (TIBC), TRANSFERRIN, and FERRITIN
Optimal total serum iron is 70-150 µg/dL

In a healthy body, iron contained in blood serum is bound to the protein transferrin. Each transferrin molecule can transport two molecules of iron to areas of the body that need iron. Total iron binding capacity (TIBC) measurement indicates the potential capacity of transferrin molecules to bind with serum iron.

Ferritin is a protein found inside cells that stores iron so your body can use it later. Ferritin is found in the cells of the liver, spleen, skeletal muscles, and bone marrow. The body requires iron to make hemoglobin for blood and myoglobin for muscles. About 30% of the iron is stored in the ferritin protein but, this percentage can be significantly higher or lower in cases of iron overload or deficiency).

Myoglobin stores a small percentage of the iron. It is a protein in heart and skeletal muscles. When you exercise, your muscles use up available oxygen. Myoglobin has oxygen attached to it, which provides extra oxygen for the muscles to keep at a high level of activity for a longer period.

Most of the body's iron (about 60%) is found in hemoglobin. Hemoglobin is the protein molecule in red blood cells that carries oxygen from the lungs to the body's tissues and returns carbon dioxide from the tissues back to the lungs.

"Iron lost through unknown causes can signal disease processes that often lead to anemia. Most harmful bacteria, fungi, parasites and cancers need iron to grow. Viruses utilize iron to synthesize and spread viral particles. Iron deficiency can sometimes indicate these pathogens have successfully invaded and are competing with your body for iron to enable colonization, infection and disease progression. Fortunately, the body can normally sequester some potentially dangerous iron in ferritin molecules." - http://www.irondisorders.org/iron-tests/

Anemia is a condition in which you don't have enough healthy red blood cells to carry adequate oxygen to your tissues. Iron-deficiency anemia is assumed to be the most common. Vitamin-deficiency anemia occurs when levels of vitamin B6, vitamin B12, and folate are low. Acute or chronic blood loss through menstruation, child birth, ulcers, hemorrhoids, inflammation of the stomach, Chrohn's disease, celiac disease, and gastritis may also result in anemia. Vegetarians, vegans, and the standard American diet are common eating patterns that may lead to anemia.

The use of soy protein and soy milk: "However, even after removal of virtually all the phytic acid, iron absorption from the soy-protein meal was still only half that of the egg white control. It is concluded that phytic acid is a major inhibitory factor of iron absorption in soy-protein isolates but that other factors contribute to the poor bioavailability of iron from these products." - http://ajcn.nutrition.org/content/56/3/573.abstract

COMPONENT	HIGH	LOW
RBC/RED BLOOD CELL COUNT **Normal RBC range is:** Male: 4.7 to 6.1 million cells per microliter (cells/mcL) Female: 4.2 to 5.4 million cells/mcL	• Smoking • Dehydration • Respiratory: asthma, emphysema • Low vitamin C • Hyper-Adrenal	• Anemia from low iron, B6, B12, folate, or copper • Internal bleeding • Heavy menstrual bleeding • Liver dysfunction • Absorption int
Red blood cells circulate in the blood and transport oxygen, glucose, carbohydrates, lipids, and proteins throughout the body. The primary concern is the adequate delivery of oxygen to cells. RBC's are produced in the bone marrow and then released into the bloodstream as they mature. RBCs have a lifespan of about 120 days and are continuously renewed and replaced as they age and degrade or are lost through bleeding. **The RBC count may be used to detect a problem with red blood cell production and/or lifespan but it cannot determine the underlying cause.**		
RDW/RED CELL SIZE DISTRIBUTION WIDTH **Optimal: 13** RDW describes the size of the red blood cells. Newly-made red blood cells are called reticulocytes. Reticulocytes, B12 deficient, and folic acid-deficient cells are larger than iron-deficient red blood cells. (7) A high RDW is commonly associated with mycrocytic anemia. “Microcytic anemia is defined as the presence of small, often hypochromic (pale in color), red blood cells in a peripheral blood smear…” - http://www.ncbi.nlm.nih.gov/pubmed/1578956		
PLATELETS **Optimal: 150- 350 cu/mm; 150,000-350,000/mm3** Platelets play a critical role in the control of bleeding and repair of blood vessel walls. “Small red dots “petechiase” that do not blanch may appear on the lower legs when platelet counts are low.” (7)	• Oxidative stress • Chronic inflammation • Tissue damage • Acute blood loss • Infection • Obesity • Magnesium deficiency • Omega 3 fatty acid deficiency • Antioxidant deficiencies, especially vitamins A, C, and E	• Anemia • Radiation and chemotherapy drugs • Leukemia • Multiple myeloma • EBV/Mononucleosis • Low vitamin A,C,D,E, K • Low B12, B6, folic acid

COMPONENT	HIGH	LOW
WBC/White Blood Cell Count/Leukocytes **Normal range: 4,500-10,000 cells per mcL**	• Bacterial or Viral infection • A drug reaction (corticosteroids and epinephrine) • A bone marrow disease (leukemia, tumors…) • Asthma or Allergies • Parasites • Bowel inflammation • Arthritis	• Viral infections Autoimmune disorders • Vitamin and mineral deficiencies, especially A,C,D,E, K, zinc, magnesium and iron • Anemia • Leukemia • Parasites • Drugs, Chemo, Radiation • HIV/AIDS

There are five major types of white blood cells/leukocytes:

1. Basophils
2. Eosinophils
3. Lymphocytes (T cells and B cells and NK cells)
4. Monocytes
5. Neutrophils

The five major types form two groups:

1. Granulocytes are formed in the bone marrow and have granules in the cytoplasm: neutrophils, basophils, and eosinophils
2. Agranulocytes do not have granules in the cytoplasm: monocytes (formed in the bone marrow) and lymphocytes (formed within the spleen, lymph glands, tonsils, thymus, and appendix)

LOW WBC COUNT - below 4,500

A low number of WBCs is called LEUKOPENIA. **Several drugs may lower WBC count:** Antibiotics, Anticonvulsants, Anti-thyroid drugs, Arsenicals, Captopril, Chemotherapy drugs, Chlorpromazine, Clozapine, Diuretics, Histamine-2 blockers, Sulfonamides, Quinidine, Terbinafine, Ticlopidine

“Our immune system is composed of white blood cells including phagocyte cells that are carried in the blood system. If there is an infection or cancer or some foreign agent, these phagocytes will go to that area and start engulfing and destroying this bad agent whether it is a cancer cell or a bacterium or virus. It engulfs it in a little pocket called a *lysosome* which squirts enzymes and breaks down the bad agent into little pieces. They have other things called peroxisomes which burn that agent with free radicals and either destroy it or use it for building new and healthy cells. These phagocytes will actually eat up bacteria or viruses, and toxic substances are just thrown off. Studies from the University of Glasgow show that fluoride inhibits these white blood cells.” - http://www.consumerhealth.org/articles/display.cfm?ID=19990303222823

COMPONENT	HIGH	LOW
BASOPHILS **Optimal: 0-2% of white blood cells** Basophils are mostly found in the skin and mucosa tissues, which are the tissues lining the openings in the body.	• Increased estrogen • Hypo-Thyroid • Parasites • Food allergies • Candida or Fungus • Environmental allergies • "Leaky gut" syndrome	
The physiologic role of basophils remains unknown, although they are thought to play a role in host defense, particularly against parasites. A role for basophils in innate immunity is suggested by their expression of a functional TLR2 receptor, as well as their non-IgE-dependent activation by multiple proteases, including *Der p 1* and hookworm. Basophils are the predominant source of IL-4 in allergen- and helminth parasite-activated PBMCs, as well as in corresponding mouse models. Basophils have been identified in cutaneous and pulmonary late-phase allergic responses and are found in increased numbers in the lungs of patients who die of asthma._- http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2847274/ Basophils activated by IgE and antigen can help to induce the development of acute allergic reactions, such as anaphylaxis to bee stings or peanut products, and also chronic allergic reactions, such as in asthma or atopic dermatitis. - http://www.els.net/WileyCDA/ElsArticle/refId-a0001120.html Following their release from the bone marrow, basophils migrate to the skin and mucosa tissues. When the IgE antibodies bind to basophils, the cells release the inflammatory chemicals histamine, serotonin, and leukotrienes. These chemicals cause: • Constriction of the smooth muscles leading to breathing difficulty • Dilation of blood vessels which causes skin flushing and hives • Increased vascular permeability which results in swelling and a decrease in blood pressure. "With inflammation, basophils deliver heparin to the affected tissue to prevent clotting." (1)		
EOSINOPHILS **Optimal: 0-4% of white blood cells**	• Parasites • Fungal infections • Food allergies • Environmental allergies • Asthma	• Stress/Increased adrenal steroid production • Over consumption of alcohol

COMPONENT	HIGH	LOW
LYMPHOCYTES **Optimal: 60-65% of white blood cells** Lymphocytes are part of our immune defense. They recognize antigens, produce antibodies, and destroy cells that could cause damage.	• Viral infections • Bacterial infections • Systemic toxicity • Poor Detoxification • Parasites • Inflammation • Hypo-Thryroid • Low A, C, D, and E • Low zinc	• Acute bacterial infections • Low A, C, D, and E • Low zinc • Anemia • Chemotherapy • Radiation
Lymphocytes are the cells that determine the specificity of the immune response to infectious microorganisms and other foreign substances. They are found in the blood, spleen, tonsils, and lymph nodes. Lymphocytes are also used by the body to destroy and dispose of the toxic by-products of protein metabolism. The three primary types of lymphocytes are B lymphocytes (B cells) T lymphocytes (T cells), and Natural Killer cells. B cells and T cells originate from stem cells in the bone marrow. Some lymphocytes migrate to the thymus, where they mature into T cells; others remain in the bone marrow, where they develop into B cells. Most lymphocytes only live for a week to a few months but a few live for years. It is the long-lived T and B cells that provide immunologic “memory,” to provide a fast response to a second encounter with the same antigen/infectious agent/foreign substance. Natural killer (NK) cells are a frontline defense system. They do not attack invading organisms directly, they destroy the body’s own cells that have either become cancerous or are infected with a virus. “It is generally accepted that NK cells develop primarily in the bone marrow, similar to B cells and myeloid origin cells. However, recent studies have shown that NK cells can also develop in lymph nodes and liver.” - http://www.sciencedirect.com/science/article/pii/S1658387614001083		
MONOCYTES **Optimal: 4-10 % of white blood cells** Monocytes are the body's second line of defense against infection. They are phagocytic cells the remove dead cells, microorganisms, and other matter in the blood.	• Liver dysfunction • Parasites • Urinary tract congestion • Benign Prostate Hypertrophy (BPH)	• Corticosteroids

COMPONENT	HIGH	LOW
NEUTROPHILS **Optimal: 60-65% of white blood cells** This type of white blood cell is important for fighting infections. Neutrophils release a lysozyme able to dissolve bacterial walls. For serious infections they require the support of monocytes, macrophages, antibodies, etc.	• Bacterial infections • Acute inflammation • Spirochetes (Syphilis, Borrelia) • Gout • Fungal infections • Parasites • Leukemia and other bone marrow disorders • Carcinoma of lung, stomach, breast, or liver • Low A, C, D levels • Emotional stress/adrenals	• Viral infections • Heavy metals • Chronic viral infections • Parasites • Food allergies • Exposure to cancer-causing agets • Low C, B6, B12, folate, and iron An adult with fewer than 1700 neutrophils in a microliter of blood has a low white blood cell count.

I AM INCLUDING A THYROID ARTICLE AFTER THE REFERENCES.

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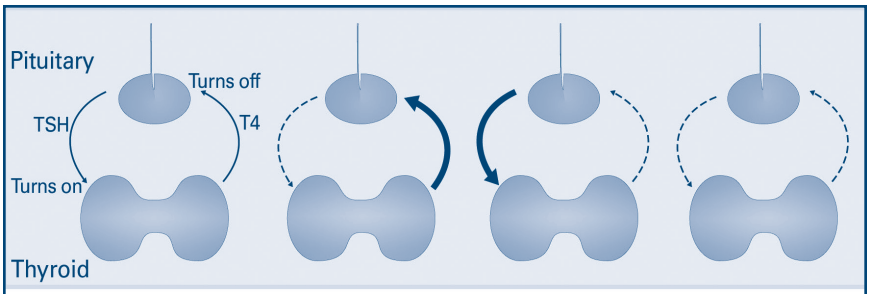
Thyroid Function Tests

WHAT IS THE THYROID GLAND?

The thyroid gland is a butterfly-shaped endocrine gland that is normally located in the lower front of the neck. The thyroid's job is to make thyroid hormones, which are secreted into the blood and then carried to every tissue in the body. Thyroid hormone helps the body use energy, stay warm and keep the brain, heart, muscles, and other organs working as they should.

FUNCTION

HOW DOES THE THYROID GLAND FUNCTION?
The major thyroid hormone secreted by the thyroid gland is thyroxine, also called T4 because it contains four iodine atoms. To exert its effects, T4 is converted to triiodothyronine (T3) by the removal of an iodine atom. This occurs mainly in the liver and in certain tissues where T3 acts, such as in the brain. The amount of T4 produced by the thyroid gland is controlled by another hormone, which is made in the pituitary gland located at the base of the brain, called thyroid stimulating hormone (abbreviated TSH). The amount of TSH that the pituitary sends into the blood stream depends on the amount of T4 that the pituitary sees. If the pituitary sees very little T4, then it produces more TSH to tell the thyroid gland to produce more T4. Once the T4 in the blood stream goes above a certain level, the pituitary's production of TSH is shut off. In fact, the thyroid and pituitary act in many ways like a heater and a thermostat. When the heater is off and it becomes cold, the thermostat reads the temperature and turns on the heater. When the heat rises to an appropriate level, the thermostat senses this and turns off the heater. Thus, the thyroid and the pituitary, like a heater and thermostat, turn on and off. This is illustrated in the figure below:



CONDITION:	Normal	Hyperthyroidism	Hypothyroidism Primary	Hypothyroidism Secondary
TSH	Normal	Low	High	Low
T4	Normal	High	Low	Low

T4 and T3 circulate almost entirely bound to specific transport proteins, and there are some situations which these proteins could change their level in the blood, producing also changes in the T4 and T3 levels (it happens frequently during pregnancy, women who take control birth pills, etc)

Another measurement done to assess the thyroid status of patients is the Free T4 measurement. The Free T4 avoids any change the proteins could have, giving us a more accurate value for the T4 level (see below).

TESTS

Blood tests to measure TSH, T4, T3 and Free T4 are readily available and widely used.

Tests to evaluate thyroid function include the following:

TSH TESTS

The best way to initially test thyroid function is to measure the TSH level in a blood sample. A high TSH level indicates that the thyroid gland is failing because of a problem that is directly affecting the thyroid (primary hypothyroidism). The opposite situation, in which the TSH level is low, usually indicates that the person has an overactive thyroid that is producing too much thyroid hormone (hyperthyroidism). Occasionally, a low TSH may result from an abnormality in the pituitary gland, which prevents it from making enough TSH to stimulate the thyroid (secondary hypothyroidism). In most healthy individuals, a normal TSH value means that the thyroid is functioning normally.

T4 TESTS

T4 circulates in the blood in two forms:

1) T4 bound to proteins that prevent the T4 from entering the various tissues that need thyroid hormone.

2) Free T4, which does enter the various target tissues to exert its effects. The free T4 fraction is the most important to determine how the thyroid is functioning, and tests to measure this are called the Free T4 (FT4) and the Free T4 Index (FT4I or FTI). Individuals who have hyperthyroidism will have an elevated FT4 or FTI, whereas patients with hypothyroidism will have a low level of FT4 or FTI.

Thyroid Function Tests

Combining the TSH test with the FT4 or FTI accurately determines how the thyroid gland is functioning.

The finding of an elevated TSH and low FT4 or FTI indicates primary hypothyroidism due to disease in the thyroid gland. A low TSH and low FT4 or FTI indicates hypothyroidism due to a problem involving the pituitary gland. A low TSH with an elevated FT4 or FTI is found in individuals who have hyperthyroidism.

T3 TESTS

T3 tests are often useful to diagnosis hyperthyroidism or to determine the severity of the hyperthyroidism. Patients who are hyperthyroid will have an elevated T3 level. In some individuals with a low TSH, only the T3 is elevated and the FT4 or FTI is normal. T3 testing rarely is helpful in the hypothyroid patient, since it is the last test to become abnormal. Patients can be severely hypothyroid with a high TSH and low FT4 or FTI, but have a normal T3. In some situations, such as during pregnancy or while taking birth control pills, high levels of total T4 and T3 can exist. This is because the estrogens increase the level of the binding proteins. In these situations, it is better to ask both for TSH and free T4 for thyroid evaluation.

THYROID ANTIBODY TESTS

The immune system of the body normally protects us from foreign invaders such as bacteria and viruses by destroying these invaders with substances called antibodies produced by blood cells known as lymphocytes. In many patients with hypothyroidism or hyperthyroidism, lymphocytes make antibodies against their thyroid that either stimulate or damage the gland. Two common antibodies that cause thyroid problems are directed against thyroid cell proteins: thyroid peroxidase and thyroglobulin. Measuring levels of thyroid antibodies may help diagnose the cause of the thyroid problems. For example, positive anti-thyroid peroxidase and/or anti-thyroglobulin antibodies in a patient with hypothyroidism make a diagnosis of Hashimoto's thyroiditis. If the antibodies are positive in a hyperthyroid patient, the most likely diagnosis is autoimmune thyroid disease.

THYROGLOBULIN

Thyroglobulin (Tg) is a protein produced by normal thyroid cells and also thyroid cancer cells. It is not a measure of thyroid function and it does not diagnose thyroid cancer when the thyroid gland is still present. It is used most often in patients who have had surgery for thyroid cancer in order to monitor them after treatment. Tg is included in this brochure of thyroid function tests to communicate that, although measured frequently in certain scenarios and individuals, Tg is not a primary measure of thyroid hormone function.

NON-BLOOD TESTS

RADIOACTIVE IODINE UPTAKE

Because T4 contains much iodine, the thyroid gland must pull a large amount of iodine out from the blood stream in order for the gland to make an appropriate amount of T4. The thyroid has developed a very active mechanism for doing this. Therefore, this activity can be measured by having an individual swallow a small amount of iodine, which is radioactive. The radioactivity allows the doctor to track where the iodine molecules go. By measuring the amount of radioactivity that is taken up by the thyroid gland (radioactive iodine uptake, RAIU), doctors may determine whether the gland is functioning normally. A very high RAIU is seen in individuals whose thyroid gland is overactive (hyperthyroidism), while a low RAIU is seen when the thyroid gland is underactive (hypothyroidism). In addition to the radioactive iodine uptake, a thyroid scan may be obtained, which shows a picture of the thyroid gland (see *Thyroid Nodules brochure*).

FURTHER INFORMATION

Further details on this and other thyroid-related topics are available in the patient information section on the American Thyroid Association® website at ***www.thyroid.org***.