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# Blood Markers'

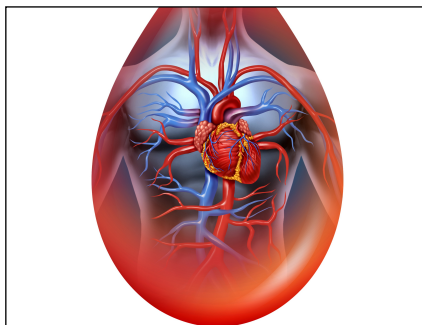
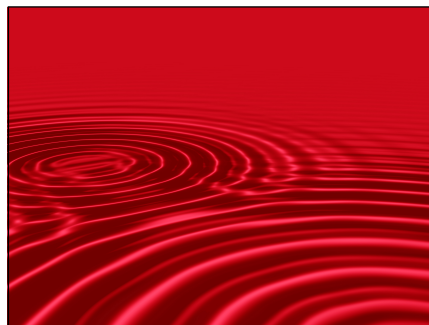
## CLINICAL SIGNIFICANCE



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## INTRODUCTION

The following summaries provide an overview of the clinical significance of the various tests our labs make available. Peer guidance regarding each of these tests has been developed by our team of physician advisors and may be provided with patient results as an element of the laboratory report. Moreover, peer consultation with our physician advisors is available to discuss these markers and other relevant matters in person.



### **Complete Blood Count**

The complete blood count provides the following individual tests: red blood cell count (RBC), hemoglobin A1C (Hgb), hematocrit (Hct), red blood cell indices, MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration), red blood cell distribution, white blood cell count (WBC), differential count (Diff), platelet count (Plt). The results provided by these tests are used to diagnose and treat a wide range of medical conditions. The CBC is one of the most important testing procedures to evaluate a patient's general health status.

### **Complete Metabolic Panel**

The complete metabolic panel includes the following individual tests: alanine aminotransferase, alkaline phosphatase, aspartate aminotransferase (AST), bilirubin level, blood creatinine/creatinine clearance, blood glucose, blood urea nitrogen (BUN), BUN-to-creatinine ratio, total calcium, carbon dioxide (bicarbonate), chloride, potassium, total serum protein and sodium. The results provided by these tests are used to diagnose and treat a wide range of medical conditions. The CMP is one of the most important testing procedures to evaluate a patient's general health status.

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### **Cortisol, Total**

Cortisol is the primary adrenal steroid hormone, released in quantity as a part of the body's response to stress. It is governed by the pituitary gland and the hypothalamus. In addition to its role in stress management, Cortisol is essential for proper metabolism, helping the body use glucose and fat for energy. It is also an important component of the skeletal system, the circulatory system, the immune response system and the nervous system.

Chronic stress can disrupt the adrenal gland's normal production of cortisol. This can produce weight gain, fatigue, depression, anxiety and insomnia. Major life stressors that may play a role in cortisol production include divorce, death of a family member, prolonged illness, poverty and unhappiness in the workplace. Acute, daily life stressors may also play a role in cortisol production.

### **C-Reactive Protein**

CRP is a protein found in blood plasma; its levels rise in response to systemic inflammation. Its physiological role is to bind to the surface of dead or dying cells in order to activate the complement system as part of the innate immune system.

Many physicians believe that inflammation plays an important role in a range of chronic and age-related conditions. In particular, clinicians are evaluating the potential use of CRP as a marker for cardiovascular disease, coronary heart disease, fibrosis, inflammatory disease and certain cancers. Measuring and charting CRP values may provide helpful information regarding disease progress or treatment efficacy for various conditions and therapies.

### **Dehydroepiandrosterone Sulfate (DHEA-S)**

DHEA is the most abundant circulating steroid hormone in the human body. It is produced in the adrenal gland, the gonads and the brain and is a precursor for the sex hormones, including estrogen and testosterone.

Low levels of DHEA have been associated in certain studies with chronic fatigue, increased risk of diabetes and heart disease, increased likelihood of complex illness and greater likelihood of insulin resistance. A 2008 study also found that low levels of DHEA-S showed a significant association with shorter life span and that higher levels strongly predicted longevity (Journal of the American Geriatrics Society 56(6):994. doi:10.1111/j.1532-5415.2008.01692.x.).

Higher levels of DHEA have also been found in men to be associated with decreased libido, increased fatigue and increased likelihood of prostate cancer. In women, excess DHEA has been associated with acne and facial hair growth.

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## **ESR Sedimentation Rate**

The ESR Sedimentation Rate test measures the millimeters of plasma (clear fluid) present at the top portion of the specimen tube after the specimen has rested for one hour (mm/hr). The ESR Sed Rate test is used to evaluate the nonspecific activity of infections, inflammatory states, autoimmune disorders and plasma cell dyscrasias. It is frequently used to assess and monitor the severity of the clinical activity of rheumatic diseases, particularly rheumatoid arthritis.

## **Estradiol**

Estradiol is one of the three most important estrogen hormones, the other two being estriol and estrone. Estradiol is the most frequently measured form of estrogen for women who are not pregnant. Prior to menopause, a woman's estradiol level will vary through her menstrual cycle. Post-menopause, women produce a significantly lower, but constant amount of estradiol.

Estradiol testing is often performed to evaluate ovarian function. Clinicians frequently use estradiol levels in the process of diagnosing and developing treatment for infertility, menstrual irregularities and early sexual development in females.

Elevated levels of estradiol may also be caused by polycystic ovary syndrome, ovarian tumors or adrenal tumors. Lower levels of estradiol may be associated with ovarian failure, hypogonadism (failure of gonadal function) and Turner syndrome. In men, estradiol testing may be used in the diagnostic process for patients who display feminized sexual characteristics, including enlarged breasts and high pitched voice.

## **Ferritin**

Ferritin is a protein found in the liver, spleen, skeletal muscles and bone marrow. Its function is to store iron in a non-toxic form, transport it as needed and deposit it safely for use in metabolic processes. It is a useful marker to identify such conditions as anemia and excess iron (hemochromatosis).

Lower levels of ferritin are often associated with iron deficiency anemia. Other sources of iron deficiency include chronic blood loss from heavy menstrual bleeding, pregnancy, dietary iron deficiency and intestinal bleeding from ulcers, colorectal polyps, hemorrhoids, colon cancer or other conditions.

Elevated levels of ferritin are often associated with hemochromatosis, an excessive buildup of iron. Hemochromatosis may be genetic in origin, or it may be caused by such diseases as alcoholism, thalassemia (a blood disorder that interferes with the body's normal production of hemoglobin) and certain forms of anemia. High ferritin levels may also indicate the presence of Hodgkin's

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disease, leukemia, infection, inflammatory conditions like arthritis or lupus, or a nutritional excess of iron.

### **Folate**

Folate-also known as folic acid-is a B vitamin that is essential for a number of bodily functions. Humans do not synthesize folate and must take it in through diet and/or supplementation. Folate is used to synthesize and repair DNA, and it serves as a co-factor in a variety of biological reactions. It is instrumental in the process of cell division and growth, particularly during infancy and pregnancy, and it is necessary for the healthy production of healthy red blood cells and the prevention of anemia.

The measurement of folate may be useful in detecting certain anemias, including the vitamin B12 deficiency anemia. It may also be useful in the diagnosis of dementia or other CNS symptoms. Folic acid deficiency is frequently seen in pregnant women, alcoholics, patients whose diets do not include raw fruits and vegetables and people with damage to the structure of the small intestine.

### **FSH: Follicle Stimulating Hormone**

Follicle stimulating hormone (FSH) is a glycoprotein produced and secreted by the gonadotrophs of the anterior pituitary gland. In women, FSH helps regulate the menstrual cycle and production of eggs, while in men, FSH helps regulate the production of sperm. FSH works in coordination with other hormones-particularly luteinizing hormone-in the reproductive process, and the hormones are frequently tested to identify and diagnose fertility issues and reproductive organ function.

High serum concentration of FSH in women is often associated with menopause; when the normal gonadal restricting feedback is absent in menopausal women, there can be unrestricted pituitary FSH production in response. High FSH levels in either women or men may also be associated with such conditions as premature menopause, premature ovarian aging, gonadal dysgenesis/Turner syndrome, Swyer syndrome, castration, congenital adrenal hyperplasia, testicular failure and Klinefelter syndrome.

Low FSH levels may be associated with such conditions as hypogonadism (failure of gonadal function), which may manifest itself in females as the cessation of menstrual cycles and in males as reduced sperm production. Low FSH levels in either women or men may also be associated with such conditions as polycystic ovarian syndrome, Kallmann syndrome, hypothalamic suppression, hypopituitarism, hyperprolactinemia or gonadotropin deficiency.

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Low levels may also be the result of medications associated with gonadal suppression therapy.

### **Hemoglobin A1C**

Also known as glycated hemoglobin, the Hemoglobin A1C test measures an average of the patient's blood sugar over the previous 60 – 90 days. It is used in conjunction with home blood sugar monitoring to assess a patient's control of diabetes and to adjust diabetes medication.

Many physicians recommend that those with diabetes should have this test performed approximately every three months to ensure they are maintaining adequate control of their blood sugar level. In patients with well-controlled diabetes, testing may be performed less frequently.

Patients with anemia and other conditions that affect hemoglobin may get abnormal results, as may patients who are taking supplements such as Vitamin C and E or those with high cholesterol levels, kidney disease and liver disease.

### **Homocysteine, Cardio**

High levels of the amino acid homocysteine in the blood may make a patient more susceptible to endothelial cell injury, which may lead to vascular inflammation and, subsequently, atherogenesis and ischemic injury. As a result, hyperhomocysteinemia may be considered a potential risk factor for coronary artery disease.

A number of researchers have also suggested that hyperhomocysteinemia is a notable risk factor for a number of diseases including thrombosis, neuropsychiatric illness, and fractures, along with microalbuminuria, which is strongly associated with the risk of future cardiovascular disease and renal dysfunction.

In addition to evaluating a patient's possible elevated risk for cardiac conditions, the test for homocysteine may be used to help identify a possible deficiency of either vitamin B12 or folic acid. It may also help identify a possible cause for blood clots and may be used in the diagnosis of homocystinuria, a rare disease that may cause the deficiency in a number of enzymes necessary for digestion.

### **Human Growth Hormone**

Human growth hormone (hGH) is produced by the pituitary gland and is essential for appropriate growth and physiological development. It plays an important role in the body's metabolism and stimulates growth, cell reproduction and cell regeneration.

High concentrations of human growth hormone may indicate gigantism (growth to abnormal height) or acromegaly (abnormally large growth of facial bones, the jaw, hands and feet), both of which may be caused by benign pituitary tumors. Other conditions which may be indicated by high growth hormone values



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include diabetes, kidney disease or severe caloric restriction. Low concentrations of human growth hormone in childhood can produce growth failure and short stature as well as delayed sexual maturity. Adults with growth hormone deficiency may have greater fat mass, decreased muscle mass, decreased energy and reduced quality of life when compared to normal adults.

### **Insulin-like Growth Factor-1**

Insulin-like growth factor-1 (IGF-1) is a protein produced primarily in the liver as an endocrine hormone. It is a primary mediator of the effects of growth hormone. When growth hormone is released from the anterior pituitary gland into the bloodstream, it stimulates the liver to produce IGF-1, which then stimulates systemic growth. IGF-1 has growth-promoting effects on almost the entire body, including muscle, cartilage, bone, liver, kidney, nerve, lung and skin cells, among others. IGF-1 can regulate cell growth, particularly in nerve cells, and it plays a role in cellular DNA synthesis.

Low IGF-1 may indicate a growth hormone deficiency or insensitivity to growth hormone. In children, this may be manifested by short stature and/or delayed development. Age-related decreased production of IGF-1 may be noted in many adults, but abnormally low concentrations may indicate a growth hormone deficiency or insensitivity.

Lower IGF-1 production may be associated with decreased pituitary function, either due to disease, damage or inherited defects. In particular, it may be associated with inflammation, infection and trauma. Nutritional deficiencies, chronic kidney and liver disease and high doses of estrogen may also produce low results.

An elevated level of IGF-1 is often associated with an increased production of growth hormone. Higher levels are normal during puberty and pregnancy, but are otherwise often associated with pituitary tumors. Physicians may assess IGF-1 levels in older patients to evaluate the body's ability to repair and regenerate tissue.

### **Insulin-like Growth Factor Binding Protein-3**

Insulin-like growth factor binding protein-3 (IGFBP-3) is a protein that binds insulin-like growth factors 1 and 2 (IGF-1 and IGF-2) but that does not bind insulin. It is responsible for transporting approximately 95% of circulating IGF-1 and IGF-2. Insulin like growth factors are essential for a variety of physiological functions related to human growth and development.

IGFBP-3 is used as a biomarker for serum concentration of human growth hormone. Tests may be helpful for evaluating growth hormone activity and for

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differentiating between short stature that results from hormone deficiency and short stature that results from other causes.

Low IGFBP-3 results may indicate growth hormone deficiency or growth hormone resistance. Some of these results may be related to growth hormone receptor defects, pituitary or hypothalamic disease or tumors, or they may be related to radiation treatments.

High IGFBP-3 results may indicate overproduction of growth hormone or excessive treatment with recombinant human growth hormone.

Physicians may assess IGFBP-3 levels in older patients to evaluate the body's ability to repair and regenerate tissue. Adult growth hormone resistance may be related to pituitary tumors. Testing may also be used to assess nutritional status, because IGFBP-3 values are variable with caloric and protein restriction.

### **Intact PTH (Parathyroid Hormone)**

Parathyroid hormone is secreted by the parathyroid gland and acts to increase the amount of calcium in the blood and to regulate the amount of phosphorous in circulation. Measurement of PHT is used in the diagnosis of hyperparathyroidism, to identify a potential cause for abnormal levels of calcium and to evaluate the status of chronic kidney disease.

### **Interleukin-1 Beta**

IL-1B, or Interleukin-1 Beta, is one of 11 members of the interleukin-1 family of cytokines (secreted proteins and signaling molecules). It is an important mediator of the inflammatory response and is involved in a number of cellular activities, including cell proliferation, differentiation and apoptosis. It also plays a role in inflammatory pain hypersensitivity.

Elevated IL-1B production is associated with a number of autoinflammatory syndromes, including cryopyrin associated periodic syndrome. It has also been associated with such biological functions as bone formation, insulin secretion, appetite regulation, neuronal development and other conditions.

### **Interleukin-6**

Interleukin-6 is a member of a group of cytokines (secreted proteins and signaling molecules) secreted by T cells and macrophages to stimulate the immune response. IL-6 acts as both a pro-inflammatory cytokine and an anti-inflammatory myokine (a peptide that is generated by muscle fibers and that exhibits an autocrine, paracrine or endocrine effect).



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Elevated IL-6 concentrations are reported in a variety of autoimmune diseases such as rheumatoid arthritis, proliferative diseases such as mesangial proliferative glomerulonephritis, and malignancies such as leukemia and lymphoma. Many physicians believe that inflammation is an important marker for a number of illnesses and aging – related wellness concerns and use IL-6 to help identify excessive inflammation in patients.

### **Interleukin-8**

IL-8 is a chemokine – a small cytokine or signaling protein – that is an important mediator of the immune reaction in the innate immune system response. This test identifies elevated levels of interleukin-8.

IL-8 is frequently associated with inflammation, particularly as a pro-inflammatory mediator associated with localized inflammation, including gingivitis and psoriasis. It has been correlated with obesity and may play a role in colorectal cancer. Elevated levels of IL-8 in pregnant women has been associated with an increased risk of schizophrenia in her children. Elevated levels of IL-8 in schizophrenics have been associated with reduced positive response to antipsychotic medications.

### **Interleukin-10**

IL-10 is an anti-inflammatory cytokine (secreted proteins and signaling molecules) that has multiple, pleiotropic effect in human immunoregulation and inflammation. This test identifies elevated levels of interleukin-10.

IL-10 contributes to the regulation of immune response. It promotes the development of immunologic tolerance and suppresses the production of inflammatory cytokines. It also modulates acute graft-versus-host disease, GVHD, a complication associated with bone marrow transplants.

### **Iron/Total Iron Binding Capacity**

Iron is an essential component of the blood, necessary for the synthesis of red blood cells and hemoglobin. Approximately 70% of the body's iron is bound to hemoglobin in red blood cells. Much the remaining 30% is bound to proteins – either transferrin in blood or ferritin in bone marrow – though some iron is also found in tissue. TIBC, or total iron binding capacity, is the measurement of the amount of iron required to bind to all of the body's transferrin.

Low levels of iron may be indicative of iron deficiency anemia, which may result in fatigue, low energy, irritability, pale skin, muscle aches and headaches. High levels of iron may indicate hemochromatosis (excessive buildup of iron), along with liver disease, kidney disease and vitamin B6 deficiency. Iron testing may also be performed to identify, diagnose and monitor treatment for such

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conditions as cirrhosis, lead poisoning, rheumatoid arthritis and severe infection, among others.

### **Lipid Panel**

The Lipid Panel measures the following substances in blood: Total cholesterol, LDL, VLDL, HDL and triglycerides. It is an essential test for evaluating a patient's wellness.

### **Luteinizing Hormone (LH)**

Luteinizing Hormone is produced in the pituitary gland; in women, it helps regulate the menstrual cycle and the production of eggs. LH levels will vary with the patient's menstrual cycle, rising and falling symbiotically with levels of Follicle Stimulating Hormone (FSH). In particular, LH will increase rapidly prior to ovulation, about halfway through the menstrual cycle. In men, LH stimulates the production of testosterone.

### **Magnesium**

Magnesium is a mineral that plays an important role in muscle, nerve and enzyme function. It is an essential co-factor in a broad range of cellular enzymatic processes, contributes to healthy heart and cardiovascular function, supports the skeletal structure and plays a role in immune function.

High levels of magnesium may be a result of dehydration, adrenal diseases such as Addison's disease, an overactive parathyroid gland, an underactive thyroid gland and kidney failure. They may also be associated with the taking of certain medications, including antacids and laxatives. Low levels of magnesium may result from alcohol abuse, alcohol withdrawal, diabetic ketoacidosis, intestinal diseases, high blood calcium levels, pancreatitis, kidney disease, poor diet, mid-and late-term pregnancy and underactive parathyroid glands.

### **Osteocalcin**

Osteocalcin, also known as bone gamma-carboxyglutamic acid-containing protein (BGLAP) is the most abundant non-collagenous protein in bone matrix and dentin. It is a bone-specific, calcium-binding protein.

Osteocalcin levels are associated with the rate of bone turnover in certain disorders of bone metabolism, including osteoporosis, primary and secondary hyperparathyroidism and Paget's disease. It acts as a hormone, causing pancreatic beta cells to release insulin while directing fat cells to release adiponectin hormone, which increases insulin sensitivity. Osteocalcin also acts on certain cells in the testis to stimulate the biosynthesis of testosterone, potentially affecting male fertility.

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## **Progesterone**

Progesterone is a female steroid hormone produced by the ovaries during ovulation. It is involved in the female menstrual cycle, pregnancy and embryo formation.

In particular, progesterone aids in the preparation of the endometrium to receive a fertilized egg. Levels of progesterone will drop in the event that the egg is not fertilized. Beginning near the end of the first trimester of pregnancy, significant levels of progesterone will be produced by the placenta. These levels will remain elevated through birth. Progesterone levels in pregnancy are approximately 10 times higher than in a woman who is not pregnant.

Progesterone is also a metabolic intermediate in the production of sex hormones and corticosteroids, and as a neurosteroid, it is an important component of healthy brain function.

Men also produce progesterone and certain cancers may produce abnormal levels of progesterone in men as well as women.

## **Prolactin**

Prolactin is a hormone made by the pituitary gland; levels will vary throughout the day and are typically highest during sleep and shortly after awakening. Levels may also increase during periods of physical or emotional stress.

Women who are pregnant record higher levels of prolactin – as much as 10 to 20 times higher than when not pregnant. These levels support the creation of breast milk and will remain elevated while breast feeding – though they may return to normal after a number of months of breast feeding, even while nursing continues. In women who do not nurse, prolactin levels typically return to normal shortly after childbirth.

Certain medications may influence prolactin levels in pregnant and non-pregnant women, as can pituitary tumors or other damage to the pituitary gland.

## **Prostate-Specific Antigen (PSA), Total**

Prostate-Specific Antigen (PSA) is produced by the prostate gland and its concentration in serum has been used as a marker for the risk of prostate cancer and other prostate diseases.

Elevated levels of PSA may be used to aid in the diagnosis of prostate cancer, benign prostatic hypertrophy and other prostate-specific inflammatory conditions. The presence of elevated PSA concentrations only suggest the potential for an increased risk of cancer – prostate cancer can occur at any level. Clinicians report that men with a PSA reading of less than 4 have a 15%

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chance of having prostate cancer, increasing to 25% when readings are between 4 and 10 and to 67% when the reading is greater than 10.

### **Rheumatoid Factor**

Rheumatoid Factor is an autoantibody directed against Immunoglobulin G and is a member of a class of proteins that are elevated in patients experiencing inflammatory states. This test identifies the patient's level of RF antibodies.

Measurement of a patient's RH factor is used to monitor inflammation associated with such collagen vascular diseases as rheumatoid arthritis, lupus, Sjogren's syndrome and scleroderma, along with such other conditions as tuberculosis, thyroid disease, certain malignancies, leprosy and syphilis. It is also often measured in a large percentage of otherwise normal elderly patients.

### **SHBG: Sex Hormone Binding Globulin**

Sex hormone binding globulin is produced largely in the liver and serves as the primary binding mechanism for circulating testosterone and estradiol. SHBG inhibits the activity of the hormones it binds with, only approximately 1% – 2% of the hormones remain unbound and available for bioactivity.

High concentrations of SHBG may be associated with pregnancy, hyperthyroidism (overactive thyroid), cirrhosis and certain drugs or medications that patients may be taking, including oral estrogen.

Low concentrations of SHBG may be associated with hypothyroidism (underactive thyroid), Cushing's syndrome (overproduction of the hormone ACTH by the pituitary gland), acromegaly (abnormally large growth of facial bones, the jaw, hands and feet) and obesity.

Imbalances of SHBG may also play a role in certain cancers, type 2 diabetes, metabolic syndrome and sleep apnea.

### **T3, Free**

This test measures the amount of the thyroid hormone T3 in serum that is not bound to thyroxine-binding globulin. As the active form of thyroid hormone, T3 plays an important role in metabolism, governing many daily cellular functions, including those related to growth, body temperature and heart rate.

T3 is often used to aid in the diagnosis of thyroid disorders such as overactive thyroid (hyperthyroidism) and underactive thyroid (hypothyroidism). In the case of hyperthyroidism, cellular dysfunction and metabolic breakdown may occur. Symptoms may include weight gain, constipation, dry skin and hair loss. Low T3

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may also contribute to such chronic diseases as heart disease and diabetes. Elevated T3 may cause anxiety, insomnia, heart palpitations and digestive distress.

#### **T4, Free**

Thyroxine, also known as T4, is a prohormone produced in the thyroid gland. In human tissue, T4 converts to a more active hormone called T3, or tri-iodothyronine, an important hormone for a number of physiological functions, including growth and metabolism. This test measures the amount of the T4 in serum that is not bound to a protein called thyroxine-binding globulin.

Excess T4 (hyperthyroidism) is associated with symptoms that include increased heart rate, anxiety, weight loss, insomnia, diarrhea, tremors in the hands, weakness, light sensitivity and visual disturbances.

Low levels of T4 (hypothyroidism) are associated with weight gain, dry skin, constipation, cold intolerance, hair loss and fatigue.

#### **Testosterone, Free**

Free testosterone testing measures the amount of testosterone in serum that is not bound to albumin and/or sex hormone binding globulin (SHBG). Testosterone is a steroid hormone from the androgen group. Testosterone is secreted primarily in the testicles of males and ovaries of females, although small amounts are also secreted by the adrenal glands. It plays an essential role in metabolism and in repairing and regeneration of tissue.

In men, testosterone is fundamental both for the development of reproductive tissue as well as the expression of secondary sexual characteristics, including increased muscle mass and hair growth. In women, testosterone is also important for the development of reproductive tissue and it plays a role in sexual arousal. Testosterone also influences many behavioral characteristics and may play a role in decision making and aggressive behavior.

Low testosterone in males has been associated with low sex drive, erectile dysfunction, fatigue, reduced energy levels, reduced sense of well-being, difficulty concentrating, depression, irritability, increased risk of certain cancers, low sperm counts, low muscle mass, reduced strength and decreased bone density.

Elevated testosterone in males has been associated with hypertension, increased risk for cardiovascular disease and cardiac failure, acne, aggressive behavior and hair loss.

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Low testosterone in women has been associated with osteoporosis, low sex drive, fatigue, reduced energy levels, depression, irritability, reduced sense of well-being, increased risk of certain cancers and decreased bone density. Elevated testosterone in women has been associated with hypertension, increased risk for cardiovascular disease and cardiac failure, acne and the development of facial hair.

### **Testosterone, Total**

Total testosterone testing measures the total amount of testosterone in serum, including free testosterone and testosterone that is bound to albumin and/or sex hormone binding globulin (SHBG). Testosterone is a steroid hormone from the androgen group. Testosterone is secreted primarily in the testicles of males and ovaries of females, although small amounts are also secreted by the adrenal glands. It plays an essential role in metabolism and in repairing and regeneration of tissue.

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Elevated testosterone in males has been associated with hypertension, increased risk for cardiovascular disease and cardiac failure, acne, aggressive behavior and hair loss.

Low testosterone in women has been associated with osteoporosis, low sex drive, fatigue, reduced energy levels, depression, irritability, reduced sense of well-being, increased risk of certain cancers and decreased bone density. Elevated testosterone in women has been associated with hypertension, increased risk for cardiovascular disease and cardiac failure, acne and the development of facial hair.

### **Thyroid Stimulating Hormone**

Thyroid stimulating hormone (TSH) is produced in the pituitary gland, stimulating the thyroid gland to produce the hormone triiodothyronine (T3) and



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prohormone thyroxine (T4). Together, T3 and T4 affect almost every human physiological process, including metabolism, heart rate, body temperature, growth and development.

TSH testing is often used as a front line method to assess thyroid condition. Tracking of TSH results may be used to monitor disease progression and to evaluate treatment. Elevated TSH often indicates an underactive thyroid gland that is not responding adequately to the stimulation of TSH as a result of some form of acute or chronic thyroid dysfunction. Low TSH can indicate an overactive thyroid gland (hyperthyroidism) or excessive amount of thyroid hormone medication in those who are being treated for an underactive or removed thyroid gland.

### **Tumor Necrosis Factor-A**

TNF-A is a member of a class of cytokines (secreted proteins and signaling molecules) that cause cell death. It is involved in systemic inflammation that makes up the acute phase reaction. This test identifies the patient's TNF-A concentration.

The primary role of TNF-A in the body is in the regulation of immune cells. TNF-A has the ability to induce fever, apoptotic cell death, cachexia and inflammation. It may also inhibit tumorigenesis and viral replication, among other biological activities. Elevated levels of TNF may promote an inflammatory response, which may contribute to certain clinical problems associated with such autoimmune disorders as rheumatoid arthritis, inflammatory bowel disease, ankylosing spondylitis, psoriasis, refractory asthma and others. Inhibition of TNF may be achieved through the use of certain monoclonal antibodies such as infliximab or adalimumab, or with a circulating receptor fusion protein such as etanercept.

### **Vitamin B12**

Vitamin B12 plays an important role in many basic physiological functions, including brain health, blood cell production and proper nerve function. Nursing mothers must maintain adequate B12 levels to help prevent putting their children at risk for neurological damage and developmental problems.

### **Vitamin D, 25-Hydroxy**

Vitamin D helps the body absorb calcium, essential to maintenance of the skeletal system. Vitamin D2 and D3 are derived from dietary intake, particularly fish, eggs and fortified dairy products. Serum cholesterol is converted by sunlight to provide additional Vitamin D3.

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There is no single number range that indicates Vitamin D deficiency; rather, patient age, gender and other variables are used to determine appropriate levels. Vitamin D deficiency is often the result of poor eating habits, poor absorption of vitamin D or lack of sun exposure. Deficiency can contribute to such conditions as osteoporosis, rickets and atypical metabolism of calcium. There is also some evidence that a deficiency may indicate that the patient is at a higher risk of certain cancers, immune diseases and cardiovascular disease.

Elevated levels of vitamin D may result from taking too many vitamins and/or nutritional supplements. Elevated vitamin D may result in hypervitaminosis D, a rare but serious condition that may cause liver or kidney damage.