

BIRDROCK LABORATORIES
BLOOD WELLNESS
CLINICAL BULLETINS

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***All reference ranges listed in this booklet are subject to change. Check www.birdrocktox.com for the most up to date information.

ALBUMIN

Albumin is a protein made by the liver that makes up 60% of the total protein in the blood. It is the major plasma protein responsible for regulating plasma osmotic pressure as well as providing transport for hormones, vitamins and drugs.

Elevated serum albumin levels are usually the result of dehydration. Decreased serum albumin levels are found in a number of conditions including kidney disease, liver disease, infections, severe burns and cancer.¹

Test Used:

To help evaluate overall health status, prior to a planned surgery, when patient shows symptoms of a liver disorder or kidney disease. Included in the Wellness Panel, Complete Metabolic Panel, Renal Function Panel and Liver Function Panel.

Birdrock Reference Ranges:²

3.5 – 5.7 g/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Friedman, R.B. and Young, D.S., Effects of Disease on Clinical Laboratory Tests, 3rd Edition, AACC Press, 1997
2. Albumin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

ALKALINE PHOSPHATASE (ALP)

Alkaline phosphatase (ALP) is an enzyme that is found primarily in liver, bone and biliary tract cells.

Elevated levels are most commonly caused by liver disease or bone disorders and may indicate injury to liver, biliary tract cells or bone.

Test Used:

To help evaluate overall health status or when patient shows symptoms of a liver or bone disorder. Included in the Wellness Panel, Complete Metabolic Panel and Liver Function Panel.

Birdrock Reference Ranges:¹

34 – 104 U/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Alkaline Phosphatase (ALP) [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

ALANINE AMINOTRANSFERASE (ALT)

Alanine aminotransferase (ALT) is an enzyme that is found primarily in the cells of the liver and kidney.

Elevated levels may be found in a variety of diseases which involve the liver such as hepatitis, mononucleosis and cirrhosis.

Test Used:

To help evaluate overall health status or when patient shows symptoms of a liver disorder or potential exposure to hepatitis virus. Included in the Wellness Panel, Complete Metabolic Panel and Liver Function Panel.

Birdrock Reference Ranges:¹

7 – 52 U/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Alanine Aminotransferase (ALT) [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

APOLIPOPROTEIN A-1

Apolipoprotein A-1 (Apo A) is a protein produced in both the liver and intestine. It provides structure to HDL particles as well as activates enzymes that add a fatty acid to cholesterol and allows it to enter the core of HDL.

Low level is associated with higher cardiovascular disease (CVD) risk¹, along with high concentrations of Apolipoprotein B. Elevated level is considered protective.

Test Used:

To assess risk of developing heart disease, when patient has family history of CVD, or monitoring effectiveness of lipid treatment and/or lifestyle changes. Included in the Cardiac Wellness Panel.

Birdrock Reference Ranges:²

100 – 200 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Ai M, Otokozawa S, Asztalos BF, Ito Y, Nakajima K, White CC, Cupples LA, Wilson PW, Schaefer EJ. Small dense low-density lipoprotein cholesterol and coronary heart disease: results from the Framingham Offspring Study. *Clin Chem*. 2010; 56(6):967-976.
2. Apolipoprotein A-1 [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

APOLIPOPROTEIN B

Apolipoprotein B (apoB) is a protein produced in the liver and intestine and is involved in the metabolism of lipids. It is also the main protein of very low-density lipoprotein (VLDL) and low-density lipoprotein (LDL).

Elevated levels of apolipoprotein B are significant predictors of heart disease and are a more significant indicator of cardiovascular disease (CVD) than LDL-C.¹

Test Used:

To assess risk of developing heart disease, when patient has family history of CVD, or monitoring effectiveness of high cholesterol treatment. Included in the Cardiac Wellness Panel.

Birdrock Reference Ranges:²

50 – 155 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Tsai MY, Steff en BT, Guan W, et al. New automated assay of small dense low-density lipoprotein cholesterol identifies risk of coronary heart disease: The Multi-Ethnic Study of Atherosclerosis. *Arterioscler Thromb Vasc Biol.* 2014;34(1):196-201.
2. Apolipoprotein B [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

ASPARTATE AMINOTRANSFERASE (AST)

Aspartate aminotransferase (AST) is an enzyme found mainly in hepatic, cardiac, muscle and kidney tissue.

Elevated serum levels indicate damage to the liver, cardiac, muscle and kidney tissues.

Test Used:

To help evaluate overall health status or when patient shows symptoms of a liver disorder or potential exposure to hepatitis virus. Included in the Wellness Panel, Complete Metabolic Panel, and Liver Function Panel.

Birdrock Reference Ranges:¹

13 – 39 U/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Aspartate Aminotransferase (AST) [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

VITAMIN B12

Vitamin B12 is required for proper red blood cell formation, neurological function and DNA synthesis. Vitamin B12 is not produced in the body and must be supplied by the diet.

Low levels indicate a deficiency and can be seen in vegans, diseases that cause malabsorption like pernicious anemia, celiac disease and inflammatory bowel disease, with the use of certain medications like proton pump inhibitors or metformin and in chronic alcoholism. Elevated levels can be caused by liver diseases like cirrhosis and hepatitis, and Myeloproliferative disorders and chronic myelogenous leukemia.

Test Used:

To help evaluate overall health status, when patient shows symptoms of anemia or neuropathy or when being treated for B12 deficiency. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

180 – 914 pg/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Vitamin B12 [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

BILIRUBIN (TOTAL)

Bilirubin is a waste product primarily produced by the breakdown of heme or red blood cells.

Elevated levels can indicate hepatitis, cirrhosis, neoplasm, alcoholism, hemolytic disease, biliary obstruction or anorexia.

Test Used:

To screen for or monitor liver disorders or hemolytic anemias and to monitor neonatal jaundice. Included in the Wellness Panel, Complete Metabolic Panel, and Liver Function Panel.

Birdrock Reference Ranges:¹

0.3 – 1.0 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Total Bilirubin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

BUN (BLOOD UREA NITROGEN)

Urea is a waste product formed in the liver when protein nitrogen is metabolized, and it is excreted by the kidneys.

Elevated levels of BUN can indicate renal damage or mechanical obstruction of urine excretion.

Test Used:

To help evaluate overall health status, or when patient shows symptoms that can be due to kidney disease or when being treated for a condition that may cause or be worsened by kidney dysfunction. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel and Renal Function Panel.

Birdrock Reference Ranges:¹

7 – 25 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Urea Nitrogen [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CALCIUM

Calcium is an important mineral needed for blood clotting, bone health and many cell functions.

Elevated levels can indicate dehydration, hyperparathyroidism, kidney disease, bone cancer, or high Vitamin D, Vitamin A or Calcium intake. Low levels can indicate hypo-parathyroid gland problems, intestinal absorption problems and kidney failure.

Test Used:

To help evaluate overall health status, when patient has symptoms of a disorder affecting kidneys, bones, thyroid, parathyroid or nerves, when patient is critically ill or to evaluate effectiveness of treatment for abnormal calcium levels. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel and Renal Function Panel.

Birdrock Reference Ranges:¹

8.4 – 10.2 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Calcium [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CARBON DIOXIDE

Carbon dioxide (CO₂) is an electrolyte used by the body to maintain the acid-base (pH) balance. Measures the most prevalent form of total carbon dioxide in the blood which is bicarbonate (HCO₃⁻).

Elevated levels of CO₂ can indicate chronic obstructive pulmonary disease, emphysema, or pneumonia, hypertension, metabolic alkalosis.

Test Used:

To evaluate overall health status or when acidosis or alkalosis is suspected. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

21 – 31 mmol/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Bicarbonate [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

COMPLETE BLOOD COUNT (CBC) W/ DIFFERENTIAL

White Blood Cell (WBC): White blood cells, or leukocytes, function as phagocytes of bacteria, fungi and viruses. A low white blood cell count may result from bone marrow disorders, lymphoma and HIV. A high white blood cell count may result from infections, inflammation, leukemia, myeloproliferative neoplasms and allergic responses.

Red Blood Cell (RBC): Red blood cells, also called erythrocytes, are cells that circulate in the blood and carry oxygen throughout the body. A relatively stable number of red blood cells are maintained in the circulation by increasing or decreasing the rate of production by the bone marrow. Low levels of RBC may be seen in anemias, hemoglobinopathy, iron, vitamin B12 or folate deficiencies, bone marrow damage or disorders, chronic inflammatory diseases and kidney failure. Elevated RBC may be associated with dehydration, pulmonary disease, congenital heart disease, smoking, and polycythemia vera.

Hemoglobin: Hemoglobin is the iron-containing protein found in all red blood cells that enables them to bind to oxygen in the lungs and carry it to tissues and organs throughout the body. The hemoglobin test is often used to check for anemia, usually along with a hematocrit or as part of a complete blood count. Low hemoglobin level may be due blood loss, chronic kidney disease, bone marrow disorders or iron, folate, vitamin B12, and vitamin B6 deficiencies. A high hemoglobin level is most often caused by hypoxia, polycythemia vera, dehydration and smoking.

Hematocrit: Hematocrit is a measurement of the proportion of the blood that is made up of red blood cells and is dependent on the number of and size of the red blood cells. The hematocrit test is often used to check for anemia, usually along with a hemoglobin or as part of a complete blood count. Low hemoglobin level may be due blood loss, chronic kidney disease, bone marrow disorders or iron, folate, vitamin B12, and vitamin B6 deficiencies. A high hemoglobin level is most often caused by hypoxia, polycythemia vera, dehydration and smoking.

MCV: The mean red blood cell volume, mean corpuscular volume or MCV, is an evaluation of the average size of each red blood cell. A low MCV indicates microcytic RBCs which may be due to iron deficiency anemia or thalassemias. An elevated MCV indicates macrocytic RBCs which may be seen in anemia caused by vitamin B12 or folate deficiency, myelodysplasia, liver disease and hypothyroidism.

MCH: Mean corpuscular hemoglobin (MCH) is a calculation of the average amount of hemoglobin inside a single red blood cell. Mirrors MCV results.

MCHC: Mean corpuscular hemoglobin concentration (MCHC) is a calculation of the average amount of hemoglobin in the RBCs compared to the average size of the RBCs. May be low when MCV is low; decreased MCHC values are seen in conditions such as iron deficiency anemia and thalassemia. Increased MCHC values are seen in autoimmune hemolytic anemia, in burn patients, and hereditary spherocytosis.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

RDW: Red blood cell distribution width (RDW) is a numerical measure of the size variability of circulating red blood cells. Increased RDW is believed to be closely associated with the risk of cardiovascular morbidity and mortality in patients with previous myocardial infarction. A low value indicates uniformity in size of RBCs. A high value indicates a mixed population of small and large RBC which can signify iron deficiency anemia or pernicious anemia.

Platelets: Platelets are very small cells found in the blood and are essential for normal blood clotting. A platelet count is part of a complete blood count and may be used to screen for or diagnose various diseases and conditions that can cause problems with clot formation. A low platelet count may be a result of bone marrow disorders. A high platelet count may be caused by cancer, anemia, chronic inflammatory diseases, oral contraceptives, myeloproliferative disorders.

Differential includes:

Neutrophils: Measures the number of neutrophils which are the most abundant white blood cell in healthy adults and are the body's main defense against bacterial, viral and fungal infections. High levels of neutrophils can be caused by acute bacterial, viral or fungal infections, inflammatory diseases, physiological stress, rigorous exercise, smoking, and chronic leukemia. Low levels of neutrophils can be caused by myelodysplastic syndrome, medications, autoimmune disorders, cancers, and aplastic anemia.

Lymphocytes: Measures the number of lymphocytes, which are white blood cells that include B-cells, T-cells, and natural killer cells. High levels of lymphocytes may be seen in acute viral infections and certain bacterial infections. Low levels can be seen in autoimmune disorders, bone marrow damage, and immune deficiency.

Monocytes: Measures the number of monocytes which are white blood cells that engulf bacteria and other foreign particles. High levels of monocytes, monocytosis, can be caused by chronic infections, autoimmune diseases, monocytic leukemia, and chronic myelomonocytic leukemia. Low levels of monocytes, monocytopenia, can be caused by bone marrow damage or failure or hairy-cell leukemia.

Eosinophils: Measures the number of eosinophils which are white blood cells that respond to infections caused by parasites, play a role in allergic reactions, and control the extent of immune responses and inflammation. High levels of eosinophils, eosinophilia, can be caused by asthma, allergies, drug reactions, eczema, dermatitis, parasitic infections, inflammatory disorders, and certain cancers. High levels of eosinophils, eosinopenia, on one or just occasionally is usually not medically significant.

Basophils: Measures that number of basophils which are white blood cells that are involved in allergic reactions. High levels of basophils, basophilia, can be caused by allergic reactions, food allergies, autoimmune diseases and chronic myeloid leukemia. Low levels of basophils, basopenia, is usually not medically significant.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

Differential also includes the following (if identified):

Immature granulocytes, Atypical lymphocytes, Bands, Metamyelocytes, Myelocytes, Promyelocytes, Bands, Plasmacytes, Nucleated RBC, RBC Morphology, Smear Review

Test Used:

To evaluate overall health status or when patient has symptoms related to condition that affects blood cells. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

Red Blood Cell (RBC):	White Blood Cell (WBC):
Male: 4.5 – 6.5 x 10 ¹² /L	4.0 – 10.0 x 10 ⁹ /L
Female: 3.8 – 5.8 x 10 ¹² /L	
Hemoglobin:	Hematocrit:
Male: 13.0 – 17.0 g/dL	Male: 40.0% – 54.0%
Female: 11.5 – 16.0 g/dL	Female: 37.0% - 47.0%
MCV:	MCH:
80.0 – 100.0 fL	27.0 – 32.0 pg
MCHC:	RDW:
32.0 – 36.0 g/dL	11.0% – 16.0%
Platelets:	Neutrophils:
150 – 500 x 10 ⁹ /L	40.0% – 75.0%
Lymphocytes:	Monocytes:
20.0% – 50.0%	2.0% – 10.0%
Eosinophils:	Basophils:
0% - 5.0%	0% - 2.0%

Preferred Specimen:

1.0 mL whole blood collected in EDTA tube (Lavender Top).

CBC with differential: Sample must be received within **1 day** of collection.

CBC with platelets: Sample must be received within **2 days** of collection.

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Horiba. ABX Pentra XL 80: User Manual. France: Horiba ABX SAS; 2017.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CHLORIDE

Chloride is a negatively charged electrolyte used by the body to maintain the acid-base (pH) balance and regulate the amount of fluid in the body.

Elevated levels can indicate dehydration, high sodium or kidney disease, or Cushing's syndrome. Low levels can indicate low sodium, emphysema, chronic lung disease, congestive heart failure or Addison disease.

Test Used:

To evaluate overall health status or when an electrolyte balance is suspected. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

98 – 107 mmol/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. ISE [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CHOLESTEROL (TOTAL)

Cholesterol is essential for life: it forms membranes for cells in all organs and tissues in the body, it is used to make hormones. Total cholesterol is a measure of the amount of cholesterol circulating in the blood in lipoproteins.

Test Used:

To evaluate overall health status or when monitoring treatment of patients with unhealthy lipid levels or risk factors. Included in the Wellness Panel or Lipid Panel.

Birdrock Reference Ranges:¹

<200 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Cholesterol [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CORTISOL

Cortisol is a steroid hormone produced and secreted by the adrenal glands. It is involved in regulating blood sugar, blood pressure and inflammation. Testing is used to help diagnose problems with the pituitary or adrenal glands, to diagnose Cushing syndrome or conditions associated with cortisol deficiencies.

Elevated levels can have adverse effects on the immune system, memory and sugar metabolism. The level of cortisol rises and falls in a diurnal variation, it peaks early in the morning then declines throughout the day and reaches its lowest level around midnight.

Test Used:

To evaluate overall health status or when excess or deficient levels are suspected. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

6.7 – 22.6 mcg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Cortisol [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CREATINE KINASE (CK)

Creatine kinase is an enzyme found in muscle, heart and brain tissues. Increased amounts of CK are released into the blood when there is muscle damage.

Elevated levels are found in skeletal muscle diseases, myocardial infarction, and cerebral ischemia/injury.

Test Used:

To evaluate overall health status or when muscle weakness or muscle damage is suspected.

Birdrock Reference Ranges:¹

30 – 223 U/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Creatine Kinase [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

CREATININE

Creatinine is the byproduct of muscle breakdown and is consistently produced. Creatinine is filtered by the kidneys and is not re-absorbed to any significant extent. It is used to evaluate renal function and monitor renal dialysis.

Elevated levels may indicate kidney dysfunction.

Test Used:

To evaluate overall health status or when patient has symptoms of kidney disease or damage. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

Male: 0.7 – 1.3 mg/dL

Female: 0.6 – 1.2 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Creatinine [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

HIGH SENSITIVITY C-REACTIVE PROTEIN (hs-CRP)

CRP is an acute phase inflammatory plasma protein synthesized by the liver. The hs-CRP test detects very low levels of CRP that may be seen with vascular and/or systemic inflammation.

Elevated levels of hs-CRP can also predict cardiovascular events and may be useful in determining how well a patient is responding to lifestyle change and statin treatment.¹

Test Used:

To evaluate assess risk of heart disease. Included in the Wellness Panel.

Birdrock Reference Ranges:²

Adults: 0.2 – 3.0 mg/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Ridker PM, Danielson E, Fonseca FA, et al. JUPITER Trial Study Group. Reduction in C-reactive protein and LDL cholesterol and cardiovascular event rates after initiation of rosuvastatin: a prospective study of the JUPITER trial. *Lancet*. 2009;373(9670):1175-1182.
2. CRP Latex [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

DHEA-S

DHEA-S is a sex hormone found in both men and women and is the major androgen precursor in females.

Elevated levels can aid in the diagnosis of hirsutism and virilism. They may also be useful for the diagnosis of:¹⁻⁴ all forms of excess androgen, hyperprolactinemia, polycystic ovarian syndrome, exclusion of an androgen producing tumor of the adrenal cortex, genetic enzyme defects of the adrenal cortex, hyperplasia of the adrenal cortex as well as androgen producing tumors.

Test Used:

To evaluate overall health status or evaluate adrenal gland function. Included in the Wellness Panel.

Birdrock Reference Ranges:⁵

Male: age 16-21: 24 – 537 mcg/dL	Female: age 16-21: 51 - 321 mcg/dL
Male: age 21-30: 85 – 690 mcg/dL	Female: age 21-30: 18 - 391 mcg/dL
Male: age 31–40: 106 – 464 mcg/dL	Female: age 31–40: 23 - 266 mcg/dL
Male: age 41-50: 70 – 495 mcg/dL	Female: age 41-50: 19 - 231 mcg/dL
Male: age 51-60: 38 – 313 mcg/dL	Female: age 51-60: 8 - 188 mcg/dL
Male: age 61-70: 24 – 244 mcg/dL	Female: age 61-70: 12 - 133 mcg/dL
Male: age 71+: 5 – 253 mcg/dL	Female: age 71+: 7 - 177 mcg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

References:

1. Bhasin S, Cunningham GR, Hayes FJ, et al. Testosterone therapy in men with androgen deficiency syndromes: Endocrine Society clinical practice guidelines. *J Clin Endocrinol Metab.* 2010;95(6):2536-2559.
2. Santen RJ, Allred DC, Ardoin SP, et al. Postmenopausal hormone therapy: an Endocrine Society scientific statement. *J Clin Endocrinol Metab.* 2010;95(7 Suppl 1):s1-s66.
3. Kopper NW, Gudeman J, Thompson DJ. Transdermal hormone therapy in postmenopausal women: a review of the metabolic effects and drug delivery technologies. *Drug Des Devel Ther.* 2008; 2:193-202.
4. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
5. DHEA-S [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

ESTRADIOL

Estradiol is the most potent naturally occurring estrogen. Estrogens are the female hormones produced by the ovaries, adrenal cortex, placenta and testes. Estrogens prepare the uterus for implantation of the fertilized ovum and promote the maturation and maintenance of female secondary sex characteristics and reproductive organs.

Estradiol in females is used in the assessment of menopausal status, fertility disorders, estrogen producing ovarian and hyperplasia of the adrenal cortex. It is also used for monitoring of fertility therapy and determining the time of ovulation for in vitro fertilization.

In men elevated levels can indicate testicular tumors, tumors of adrenal glands, gynecomastia or delayed puberty.

Test Used:

To evaluate overall health status, detect hormone imbalance, monitor infertility treatment or symptoms of menopause. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

Male: age: 12 – 18: <15 – 34.8 pg/mL

Male: age 19+: <15 – 31.5 pg/mL

Female: age 12 – 18: <15 – 196 pg/mL

Female: age 19 – 50: 22.4 – 517 pg/mL

Female: age 50+: <15 – 25.1 pg/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

1. Sensitive Estradiol [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

FERRITIN

Ferritin is a protein that contains iron. It is the primary form of iron stored inside of cells.

Decreased levels can be due to iron deficiency, chronic disease. Elevated levels are seen in those with hemolytic anemia, iron poisoning, hemochromatosis, inflammation, liver disease, chronic infection, autoimmune disorders and some types of cancer. Ferritin is not typically used to detect or monitor these conditions.

Test Used:

To evaluate determine body's total iron storage capacity or to help diagnose iron deficiency or overload. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

Male: 23.9 – 336.2 ng/mL

Female: 11.0 – 306.8 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Ferritin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

FOLATE

Folate is necessary for normal metabolism, DNA synthesis and red blood cell regeneration. Untreated deficiencies may lead to megaloblastic anemia. One of the most important folate-dependent reactions is the conversion of homocysteine to methionine.

Isolated folate deficiency is uncommon; it usually coexists with other nutrient deficiencies because of its strong association with poor diet, alcoholism, and, sometimes, malabsorptive disorders. Women with insufficient folate intakes are at increased risk of giving birth to infants with neural tube defects.

Test Used:

To evaluate overall health status, evaluate nutritional status or monitor effectiveness of folate deficiency treatment. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

5.9 – 24.8 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Folate [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

FOLLICLE STIMULATING HORMONE (FSH)

FSH is a hormone associated with reproduction and development of eggs in women and sperm in men.

FSH is used to assess for dysfunctions within the hypothalamic-pituitary-gonadal system.¹⁻⁴ It is also used in conjunction with LH to evaluate menopausal syndrome, polycystic ovarian syndrome, testosterone deficiency, amenorrhea causes and congenital diseases with chromosomal aberrations.¹⁻⁴

Test Used:

To evaluate fertility issues, function of male or female reproductive organs or pituitary function.
Included in the Wellness Panel.

Birdrock Reference Ranges:⁵

Male: 1.27 – 19.26 mIU/mL

Female: up to age 50: 1.79 – 22.51 mIU/mL

Female: age 50+: 16.74 – 113.59 mIU/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Bhasin S, Cunningham GR, Hayes FJ, et al. Testosterone therapy in men with androgen deficiency syndromes: Endocrine Society clinical practice guidelines. *J Clin Endocrinol Metab.* 2010;95(6):2536-2559.
2. Santen RJ, Allred DC, Ardoin SP, et al. Postmenopausal hormone therapy: an Endocrine Society scientific statement. *J Clin Endocrinol Metab.* 2010;95(7 Suppl 1):s1-s66.
3. Kopper NW, Gudeman J, Thompson DJ. Transdermal hormone therapy in postmenopausal women: a review of the metabolic effects and drug delivery technologies. *Drug Des Devel Ther.* 2008; 2:193-202.
4. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
5. hFSH [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

GLUCOSE

Glucose is the major short-term source of energy for the body, and is obtained from the diet, as well as being produced in the liver.

A fasting glucose level ≥ 125 mg/dL indicates the presence of diabetes mellitus, associated with a significantly increased risk of developing CVD, stroke, peripheral vascular disease, kidney failure, neuropathy, and retinopathy. The test needs to be confirmed by also having an elevated HbA1c level. Clinically significant hypoglycemia is defined as blood glucose <54 mg/dL.¹

Test Used:

To evaluate overall health status, determine if blood glucose level is within healthy range, to screen and diagnose diabetes and monitor high or low blood glucose. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:²

74 - 109 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. American Diabetes Association. Standards of medical care in diabetes. Diabetes Care-2018. Diabetes Care. 2018;41(Suppl 1): S55-S64.
2. Glucose [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

HEMOGLOBIN A1c (HbA1c)

This test measures the concentration of glucose attached to the hemoglobin in red blood cells. It assesses the average amount of glucose in the blood over the last two to three months.

This monitors the efficacy of diabetes treatment over time and identifies patients at risk of developing diabetes.¹ Increased risk 5.7 – 6.4% and Diabetes diagnosis >6.4%

Test Used:

To evaluate overall health status, determine if patient is at increased risk of developing diabetes or to diagnose diabetes and prediabetes. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

4.0% - 5.6%

Preferred Specimen:

1.0 mL whole blood collected in EDTA tube (Lavender Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. American Diabetes Association. Standards of medical care in diabetes. Diabetes Care-2013. Diabetes Care. 2013;36(Suppl 1):11-66.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

HDL CHOLESTEROL

HDL Cholesterol is a measure of high-density cholesterol particles. Higher levels of HDL are associated with reduced CVD risk, but not all HDL is good.

Low HDL-C is independently associated with CVD risk and it is also a characteristic of the metabolic syndrome and insulin resistance.¹

Test Used:

To evaluate overall health status or to determine risk of developing heart disease. Included in the Wellness Panel or Lipid Panel.

Birdrock Reference Ranges:²

> 40 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goff DC Jr, Lloyd-Jones DM, Bennett G, et al. 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129(25 Suppl 2): S49-73.
2. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Heart, Lung and Blood Institute. (2001). National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (NIH Publication No. 01-3670). Retrieved from <https://www.nhlbi.nih.gov/files/docs/guidelines/atp3xsum.pdf>

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

HOMOCYSTEINE

Homocysteine is an amino acid that is typically present in very small amounts in all cells of the body because the body converts homocysteine into other products quickly.

Elevated levels (>15 umol/L) have been associated with increased risk of cardiovascular disease.¹ Elevated levels are a risk factor for ischemic heart disease, fatal and non-fatal myocardial infarction, sudden cardiac death, premature coronary artery disease, extracranial carotid-artery stenosis, venous thrombosis, stroke and peripheral vascular disease.¹

Test Used:

To determine risk of heart attack or stroke, to monitor patients with heart disease, or determine if patients are vitamin B deficient. Included in the Cardiac Wellness Panel.

Birdrock Reference Ranges:²

3.0 – 15.0 umol/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Clarke R, Halsey J, Lewington S, et al. Effects of lowering homocysteine levels with B vitamins on cardiovascular disease, cancer, and cause-specific mortality. *Arch Intern Med.* 2010;170(18):1622-1630.
2. Homocysteine 2 Reagent Enzymatic Assay [package insert]. Poway, CA: Diazyme Laboratories; 2013.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

INSULIN

Insulin is a hormone responsible for the transportation and storage of glucose in cells, it regulates glucose levels in blood.

Presence of insulin resistance indicates higher risk to develop type 2 diabetes, hypertension, hyperlipidemia, or heart disease.¹

Test Used:

In conjunction with glucose to diagnose insulin resistance or insuloma, monitor amount of endogenous insulin production, or determine when a type 2 diabetic may need to start insulin therapy. Included in the Wellness Panel.

Birdrock Reference Ranges:²

1.9 – 23.0 uIU/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Haffner S. Relationship of Metabolic Risk Factors and Development of Cardiovascular Disease and Diabetes. *Obesity*. 2006;14(Suppl 3):121S-127S.
2. Ultrasensitive Insulin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

IRON

Iron is an important component of hemoglobin, the substance in red blood cells that carries oxygen from the lungs and transports it throughout the body. Hemoglobin represents about two-thirds of the body's iron. If there is not enough iron the body cannot make hemoglobin.

Test Used:

To evaluate overall health status or help diagnose iron deficiency anemia or iron overload. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

50 – 212 mcg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Iron [package insert]. Brea, CA: Beckman Coulter, Inc.; 2018.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

LDL CHOLESTEROL

LDL Cholesterol is a measure of low-density lipoproteins. LDL is often called “bad” cholesterol because it deposits excess cholesterol in blood vessel walls and contributes to hardened arteries and heart disease.

Elevated LDL cholesterol is a primary independent risk factor for cardiovascular disease.¹

Test Used:

To evaluate overall health status, determine risk of developing heart disease or monitor effectiveness of lipid-lowering therapy. Included in the Wellness Panel or Lipid Panel.

Birdrock Reference Ranges:²

Adults: < 100 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goff DC Jr, Lloyd-Jones DM, Bennett G, et al. 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129(25 Suppl 2): S49-73.
2. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Heart, Lung and Blood Institute. (2001). National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (NIH Publication No. 01-3670). Retrieved from <https://www.nhlbi.nih.gov/files/docs/guidelines/atp3xsum.pdf>

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

LUTEINIZING HORMONE (LH)

LH is a hormone associated with reproduction and stimulation of the release of an egg in women and testosterone production in men.

LH is used to assess for dysfunctions within the hypothalamic-pituitary-gonadal system.¹⁻⁴ It is also used in conjunction with FSH to evaluate menopausal syndrome, polycystic ovarian syndrome, testosterone deficiency, amenorrhea causes and congenital diseases with chromosomal aberrations.¹⁻⁴

Test Used:

To evaluate fertility issues, function of male or female reproductive organs, detect the release of an egg during ovulation or pituitary function. Included in the Wellness Panel.

Birdrock Reference Ranges:⁵

Male: 1.24 – 8.62 mIU/mL

Female: up to age 50: 1.20 – 103.03 mIU/mL

Female: age 50+: 10.87 – 58.64 mIU/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Bhasin S, Cunningham GR, Hayes FJ, et al. Testosterone therapy in men with androgen deficiency syndromes: Endocrine Society clinical practice guidelines. *J Clin Endocrinol Metab.* 2010;95(6):2536-2559.
2. Santen RJ, Allred DC, Ardoin SP, et al. Postmenopausal hormone therapy: An Endocrine Society scientific statement. *J Clin Endocrinol Metab.* 2010;95(7 Suppl 1): s1-s66.
3. Kopper NW, Gudeman J, Thompson DJ. Transdermal hormone therapy in postmenopausal women: a review of the metabolic effects and drug delivery technologies. *Drug Des Devel Ther.* 2008; 2:193-202.
4. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
5. Luteinizing Hormone [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

LIPASE

Lipase is an enzyme primarily produced by the pancreas to help digest dietary fats.

Elevated levels can occur when the pancreas is injured and occur in conditions such as acute pancreatitis or inflammation of the pancreas.

Test Used:

To diagnose and monitor acute pancreatitis, chronic pancreatitis or other pancreatic diseases.

Birdrock Reference Ranges:¹

11 – 82 U/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Lipase [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

LIPOPROTEIN (A)

Lipoprotein (a) is a type of lipoprotein that carries cholesterol in the blood. It is composed of an LDL-like particle and apolipoprotein (a).

Elevated levels are an independent risk factor for cardiovascular disease.¹⁻³

Test Used:

To evaluate risk of developing heart disease. Included in the Cardiac Wellness Panel.

Birdrock Reference Ranges:⁴

<5.4 – 29.9 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Nordestgaard BG, Chapman MJ, Ray K, et al. Lipoprotein(a) as a cardiovascular risk factor: current status. *Eur Heart J*. 2010;31(23):2844–2853.
2. Hoff HF, Beck GJ, Skibinski CI, et al. Serum Lp(a) level as a predictor of vein graft stenosis after coronary artery bypass surgery in patients. *Circulation*. 1988;77(6):1238–1244.
3. Lamon-Fava S, Marcovina SM, Albers JJ, Kennedy H, Deluca C, White CC, Cupples LA, McNamara JR, Seman LJ, Bongard V, Schaefer EJ. Lipoprotein(a) levels, isoforms, and coronary heart disease risk in the Framingham Offspring Study. *J Lipid Res*. 2011;52(6):1181-1187
4. Diazyme Lipoprotein (a) Assay [package insert]. Poway, CA: Diazyme Laboratories; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

LP-PLA₂

Lp-PLA₂ is an enzyme that breaks down phospholipids. Increased levels of Lp-PLA₂ are associated with soft, active growing plaque. It predicts cardiovascular disease risk independent of LDL cholesterol and other inflammatory markers.¹ It is associated with 2-fold increased risk for coronary events and 2-fold increased risk for stroke.¹

Test Used:

To determine risk of developing cardiovascular disease and risk of coronary heart disease or stroke.

Birdrock Reference Ranges:²

0 - 225 nmol/min/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Davidson MH, Corson MA, Alberts MJ, et al. Consensus panel recommendation for incorporating lipoprotein-associated phospholipase A2 testing into cardiovascular disease risk assessment guidelines. *Am J Cardiol.* 2008;101(Suppl):51F-57F.
2. PLAC[®] Test for Lp-PLA₂ Activity [package insert]. Poway, CA: Diazyme Laboratories; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

MAGNESIUM

Magnesium is a mineral that is vital for energy production, muscle contraction, nerve function and maintenance of bone health.

Hypomagnesemia may result from insufficient intake, alcoholism, impaired gastrointestinal absorption, increased gastrointestinal, or urinary loss. Hypermagnesemia is rarely due to dietary sources but is usually the result of an excretion problem or excessive supplementation. Increased levels may be seen in kidney failure, hyperparathyroidism, hypothyroidism, dehydration, and with the use of magnesium-containing antacids or laxatives.

Test Used:

To evaluate overall health status or help determine cause of abnormal levels of magnesium, calcium and/or potassium. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

1.9 – 2.7 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Magnesium [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

PHOSPHOROUS

Phosphorous is a mineral that combines with other substances to form organic and inorganic phosphate compounds. Phosphates are vital for energy production, muscle and nerve function, and bone growth. Phosphates play an important role as a buffer, helping to maintain the body's acid-base balance.

Hypophosphatemia may be seen with malnutrition, malabsorption, acid-base imbalances, hypercalcemia, and with disorders that affect kidney function. Hyperphosphatemia may be seen with increased intake of the mineral, hypocalcemia, and with kidney dysfunction.

Test Used:

To evaluate overall health status, diagnose conditions known to cause abnormally high or low levels of phosphorous. Included in the Wellness Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

2.5 – 5.0 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Inorganic Phosphorous [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

POTASSIUM

Potassium is an electrolyte vital to cell metabolism. Potassium helps transport nutrients and remove waste products from cells, it is also important in muscle and nerve function.

Elevated levels could indicate excessive potassium intake, kidney disease, diabetes and dehydration. Low levels can indicate dehydration or acetaminophen overdose.

Test Used:

To diagnose and evaluate hypertension, diabetic ketoacidosis, kidney disease and used to monitor patient receiving dialysis, diuretics or IV therapy. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

3.5 – 5.1 mmol/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. ISE [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

PROGESTERONE

Progesterone is a steroid hormone that promotes normal sexual function and secondary sex characteristics in women, as well as prepares the uterus for implantation of the fertilized ovum and maintains pregnancy. In men, it is involved in the development of sperm.

Test Used:

To determine cause of infertility, track ovulation, monitor the health of a pregnancy or diagnose an ectopic pregnancy. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

Male: 0.14 – 2.06 ng/mL

Female: up to age 50: 0.31 – 18.56 ng/mL

Female: age 50+: 0.08 – 0.78 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Progesterone [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

PROLACTIN

Prolactin is a hormone that promotes lactation in females. It is typically elevated in women during pregnancy and after childbirth.

High levels can also be seen in prolactinomas, anorexia, underactive thyroid, polycystic ovary syndrome, diseases of the kidney, liver, hypothalamus, and pituitary.

Test Used:

To detect and monitor prolactinomas. In women, to help explain galactorrhea, abnormal nipple discharge, absence of menstrual period or infertility. In men, to help diagnose erectile dysfunction and decreased libido. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

Male: 2.64 – 13.13 ng/mL

Female: up to age 50: 3.34 – 26.72 ng/mL

Female: age 50+: 2.74 – 19.64 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Prolactin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

PROTEIN (TOTAL)

Protein (total) is the sum of all circulating proteins and is a major component of blood. Total protein is often used in conjunction with the A/G ratio.

Elevated levels could indicate dehydration or high levels of albumin and/or globulin as a result of chronic inflammation or infections such as viral hepatitis or HIV. Elevated levels may also be associated with bone marrow disorders such as multiple myeloma. Low total protein levels can indicate a liver or kidney disorder, malnutrition, malabsorption, celiac or inflammatory bowel disorder.

Test Used:

To evaluate overall health status, diagnose certain liver or kidney disorders or determine nutritional health. Included in the Wellness Panel, Complete Metabolic Panel, or Liver Function Panel.

Birdrock Reference Ranges:¹

6.4 – 8.9 g/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Total Protein [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

PSA (TOTAL)

PSA (prostate specific antigen) is primarily produced by cells in the prostate gland and is present in small quantities in the serum of men with healthy prostate glands. The total serum PSA assay is an excellent addition to a rectal examination for the diagnosis of prostate cancer, as well as for follow-up of patients with diagnosed prostate cancer.

Increased levels are associated with an increased risk of prostate cancer but may also be seen in subjects with benign prostatic hypertrophy.

Test Used:

To screen men for prostate cancer, help determine necessity to biopsy prostate, monitor effectiveness of treatment for prostate cancer or detect recurrence of prostate cancer. Included in the Male Wellness Panel.

Birdrock Reference Ranges:¹

≤ 4.0 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Prostate-Specific Antigen [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

SHBG

Sex Hormone Binding Globulin (SHBG) is a glycoprotein that binds to sex hormones, specifically testosterone and estradiol.

Elevated levels can be seen in elderly men, in patients with hyperthyroidism and cirrhosis of the liver, or when oral contraceptives or antiepileptic drugs are taken.¹⁻⁴ Markedly higher levels are seen in pregnant women due to their increased estrogen production.¹⁻⁴ Decreased concentrations are often seen with hypothyroidism, polycystic ovarian syndrome, obesity and elevated androgen levels.¹⁻⁴

Test Used:

To evaluate androgen deficiency in men or excess androgens in females. Included in the Wellness Panel.

Birdrock Reference Ranges:⁵

Male: 13.3 – 89.5 nmol/L

Female: up to age 47: 18.2 – 135.5 nmol/L

Female: age 47+: 16.8 – 125.2 nmol/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Bhasin S, Cunningham GR, Hayes FJ, et al. Testosterone therapy in men with androgen deficiency syndromes: Endocrine Society clinical practice guidelines. *J Clin Endocrinol Metab.* 2010;95(6):2536-2559.
2. Santen RJ, Allred DC, Ardoin SP, et al. Postmenopausal hormone therapy: An Endocrine Society scientific statement. *J Clin Endocrinol Metab.* 2010;95(7 Suppl 1): s1-s66.
3. Kopper NW, Gudeman J, Thompson DJ. Transdermal hormone therapy in postmenopausal women: a review of the metabolic effects and drug delivery technologies. *Drug Des Devel Ther.* 2008; 2:193-202.
4. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228
5. Sex Hormone-Binding Globulin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

SODIUM

Sodium is an electrolyte present in all body fluids and is vital to normal body function, including nerve and muscle function. It helps cells function normally and helps regulate the amount of fluid in the body.

Elevated levels of sodium can indicate hypernatremia or dehydration. Low levels can indicate hyponatremia, fluid retention or too much water intake.

Test Used:

To evaluate overall health status or detect the cause and help monitor treatment plan for patients with abnormal levels. Included in the Wellness Panel, Complete Metabolic Panel, Basic Metabolic Panel or Renal Function Panel.

Birdrock Reference Ranges:¹

136 - 145 mmol/L

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. ISE [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

FREE T3

Free T3 (free triiodothyronine) is the amount of T3 hormone that is freely circulating in the blood.

Low levels are consistent with hypothyroidism or inadequate thyroid hormone replacement.¹⁻³ High levels are consistent with hyperthyroidism or excess thyroid hormone replacement.¹⁻³

Test Used:

To evaluate thyroid gland function, diagnose thyroid disease or monitor effectiveness of treatment of a thyroid disorder.

Birdrock Reference Ranges:⁴

2.5 – 3.9 pg/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
2. Castro MR, Gharib H. Thyroid disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:43-80.
3. Garber JR, Cobin RH, Gharib H, et al. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American Association of Clinical Endocrinologists and the American Thyroid Association. Endocr Pract. 2012;18(6):988-1028.
4. Triiodothyronine, Free [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

T3 TOTAL

Total T3 (triiodothyronine) is a hormone generated by converting T4 to T3 in the body's tissue. T3 is the active thyroid hormone and is necessary for normal body metabolism.

Low levels are consistent with hypothyroidism or inadequate thyroid hormone replacement.¹⁻³ High levels are consistent with hyperthyroidism or excess thyroid hormone replacement.¹⁻³

Test Used:

To evaluate thyroid gland function, diagnose thyroid disease or monitor effectiveness of treatment of a thyroid disorder. Included in the Wellness Panel.

Birdrock Reference Ranges:⁴

0.87 – 1.78 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
2. Castro MR, Gharib H. Thyroid disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:43-80.
3. Garber JR, Cobin RH, Gharib H, et al. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American Association of Clinical Endocrinologists and the American Thyroid Association. *Endocr Pract.* 2012;18(6):988-1028.
4. Triiodothyronine [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

FREE T4

Free T4 (free thyroxine) is the amount of T4 hormone that is freely circulating in the blood.

Low levels of Free T4 are consistent with an underactive thyroid gland or inadequate thyroid hormone replacement.¹⁻³ High levels are consistent with either an overactive thyroid gland or excess thyroid hormone replacement.¹⁻³

Test Used:

To evaluate thyroid gland function, diagnose thyroid disease or monitor effectiveness of thyroid treatment. Included in the Wellness Panel.

Birdrock Reference Ranges:⁴

0.61 – 1.12 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
2. Castro MR, Gharib H. Thyroid disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:43-80.
3. Garber JR, Cobin RH, Gharib H, et al. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American Association of Clinical Endocrinologists and the American Thyroid Association. *Endocr Pract.* 2012;18(6):988-1028.
4. Thyroxine, Free [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

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T4 TOTAL

Total T4 (thyroxine) is a hormone produced by the thyroid gland and is converted in the body's tissue to the major active thyroid hormone T3.

Low levels of Total T4 are consistent with an underactive thyroid gland or inadequate thyroid hormone replacement.¹⁻³ High levels are consistent with either an overactive thyroid gland or excess thyroid hormone replacement.¹⁻³

Test Used:

To evaluate thyroid gland function, diagnose thyroid disease or monitor effectiveness of thyroid treatment.

Birdrock Reference Ranges:⁴

6.09 – 12.23 mcg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
2. Castro MR, Gharib H. Thyroid disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:43-80.
3. Garber JR, Cobin RH, Gharib H, et al. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American Association of Clinical Endocrinologists and the American Thyroid Association. *Endocr Pract.* 2012;18(6):988-1028.
4. Total Thyroxine [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

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TESTOSTERONE (TOTAL)

Total testosterone is a measurement of free and protein-bound testosterone and is the most potent naturally occurring sex hormone. It is produced in the testes in response to stimulation by luteinizing hormone (LH). Testosterone is also produced by the ovary and adrenal cortex in small amounts and is responsible for the regulation of gonadotropic secretion and spermatogenesis, as well as the development of male secondary sex characteristics.

Testosterone is used in the diagnosis and treatment of primary and secondary hypogonadism, delayed or precocious puberty, impotence in males, excessive hair and masculinization in females due to polycystic ovaries, tumors and adrenogenital syndromes.¹⁻⁴

Test Used:

To diagnose infertility or erectile dysfunction in males or when females have male traits, abnormal uterine bleeding, amenorrhea or infertility. Included in the Wellness Panel.

Birdrock Reference Ranges:⁵

Female: <10 - 75 ng/dL

Male: age 16 – 30: 259 – 816 ng/dL

Male: age 31 – 44: 198 – 679 ng/dL

Male: age 45+: 150 – 684 ng/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

References:

1. Bhasin S, Cunningham GR, Hayes FJ, et al. Testosterone therapy in men with androgen deficiency syndromes: Endocrine Society clinical practice guidelines. *J Clin Endocrinol Metab.* 2010;95(6):2536-2559.
2. Santen RJ, Allred DC, Ardoin SP, et al. Postmenopausal hormone therapy: an Endocrine Society scientific statement. *J Clin Endocrinol Metab.* 2010;95(7 Suppl 1):s1-s66.
3. Kopper NW, Gudeman J, Thompson DJ. Transdermal hormone therapy in postmenopausal women: a review of the metabolic effects and drug delivery technologies. *Drug Des Devel Ther.* 2008; 2:193-202.
4. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228
5. Testosterone, Total [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

TPO

Thyroid peroxidase antibody (TPO) is an enzyme expressed mainly in the thyroid involved in the production of thyroid hormones T3 and T4.

Elevated levels can indicate autoimmune damage to the thyroid due to disorders like Hashimoto thyroiditis and Graves disease.

Test Used:

To diagnose an autoimmune thyroid disease and to distinguish it from other forms of thyroid dysfunction.

Birdrock Reference Ranges:¹

< 9.0 IU/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Thyroperoxidase Antibody [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

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TRIGLYCERIDES

Triglycerides are composed of three fatty acids attached to glycerol that function as fat storage (adipose tissue) or may be used for energy. Triglycerides are the primary lipid component in chylomicrons and very low-density lipoproteins but are also found in other lipoproteins.

Elevated triglycerides are a secondary risk factor for CVD.¹⁻² Elevated levels increase CVD risk by altering lipoprotein metabolism. Elevated levels can enhance the formation of small dense LDL particles or contribute to low levels of large HDL particles.¹⁻²

Test Used:

To evaluate risk of developing heart disease or monitor effectiveness of lipid-lowering therapy. Included in the Wellness Panel or Lipid Panel.

Birdrock Reference Ranges:³

< 150 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goff DC Jr, Lloyd-Jones DM, Bennett G, et al. 2013 ACC/AHA Guideline on the Assessment of Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129(25 Suppl 2):S49-73.
2. Stone NJ, Robinson J, Lichtenstein AH, et al. 2013 ACC/AHA Guideline on the Treatment of Blood Cholesterol to Reduce Atherosclerotic Cardiovascular Risk in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2014;129(25 Suppl 2): S49-73.
3. Triglyceride [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

THYROID STIMULATING HORMONE (TSH)

Thyroid Stimulating Hormone (TSH) is a peptide hormone synthesized and secreted by the anterior pituitary gland. TSH regulates thyroid gland function.

Test Used:

To diagnose primary, secondary and tertiary hypothyroidism, to screen for hyperthyroidism, or to allow adjustment of thyroid replacement in hypothyroid patients.¹⁻³

Birdrock Reference Ranges:⁴

0.45 – 5.33 uIU/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
2. Castro MR, Gharib H. Thyroid disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. Evidence-Based Endocrinology. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:43-80.
3. Garber JR, Cobin RH, Gharib H, et al. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American Association of Clinical Endocrinologists and the American Thyroid Association. *Endocr Pract.* 2012;18(6):988-1028.
4. TSH (3rd Gen) Thyrotropin [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

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URIC ACID

Uric acid is produced by the breakdown of purines. Purines are nitrogen containing compounds found in the cells of the body, including DNA.

Elevated uric acid elevations are seen in renal disorders, gout, leukemia, psoriasis, starvation, and patients receiving cytotoxic drugs.

Test Used:

To diagnose gout or kidney stones and the monitor uric acid levels when undergoing chemotherapy or radiation treatment. Included in the Wellness Panel.

Birdrock Reference Ranges:¹

Male: 4.4 – 7.6 mg/dL

Female: 2.3 – 6.6 mg/dL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Uric Acid [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

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VITAMIN D 25-OH

25-hydroxy vitamin D is a hormone precursor that promotes bone, calcium and phosphorus metabolism. Vitamin D comes from two sources: endogenous- produced in the skin on exposure to sunlight and exogenous- ingested in foods and supplements.

Vitamin D insufficiency is associated with secondary hyperparathyroidism, muscle weakness with increased fall risk, and myalgias.¹ Vitamin D insufficiency may be associated with deleterious effects on cardiovascular system, impaired pancreatic function, and increased mortality.²⁻⁴

Test Used:

To determine vitamin D deficiency. Included in the Wellness Panel.

Birdrock Reference Ranges:⁵

30 - 100 ng/mL

Preferred Specimen:

1.0 mL serum collected in serum separator tube (SST - Gold Top)

Transport Temperature:

Refrigerated – ship in insulated envelope with frozen cold pack

References:

1. Muscogiuri G, Sorcie GP, Ajjan R, et al. Can vitamin D deficiency cause diabetes and cardiovascular diseases? Present evidence and future perspectives. *Nutr Metab Cardiovasc Dis.* 2012;22(2):81-7.
2. Goodman N, Cobin RH. Reproductive disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:190-228.
3. Castro MR, Gharib H. Thyroid disorders. In: Camacho PM, Gharib H, Sizemore GW, eds. *Evidence-Based Endocrinology.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins. 2012:43-80.
4. Garber JR, Cobin RH, Gharib H, et al. Clinical practice guidelines for hypothyroidism in adults: cosponsored by the American Association of Clinical Endocrinologists and the American Thyroid Association. *Endocr Pract.* 2012;18(6):988-1028
5. 25(OH) Vitamin D [package insert]. Brea, CA: Beckman Coulter, Inc.; 2019.

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

COMMON CAUSES OF REJECTION

1. Improper packaging (i.e. not received with cold pack inside insulated envelope)
2. Specimen not received within manufacturer recommended stability window
3. Clotted specimen
4. Hemolysis
5. Lipemia
6. SST tube not spun
7. Specimen drawn in incorrect tube
8. Tube not filled with minimum volume
9. Improper labeling
10. Specimen diluted or contaminated with IV fluid

Please call (858) 217-5918 where a Clinical Laboratory Scientist can assist with further review of results.

REFERENCES

1. Boston Heart Test Menu. Boston Heart, <https://bostonheartdiagnostics.com/boston-heart-test-menu/>.
2. Lab Tests Online. Patient Education on Blood, Urine, and Other Lab Tests, AACC, <https://labtestsonline.org/>.

***All reference ranges listed in this booklet are subject to change. Check www.birdrocktox.com for the most up to date information.

