Blood Chemistry Terms

Alanine Aminotransferase (ALT)

Alanine Aminotransferase (ALT) The enzyme alanine aminotransferase (ALT) is present in significant quantities in the hepatocytic cytoplasm of dogs, cats, and primates. ALT catalyzes a reaction that transfers an amino group from an amino acid to a keto acid, providing a nitrogen source for the urea cycle.

Albumin

Albumin makes up 35-50% of the total serum protein in most animals. Synthesized by the liver, albumin is catabolized by all metabolically active tissues. Albumin is the primary protein affecting the colloid osmotic activity of plasma and a major transport protein for plasma constituents. Toxic materials in the body may be detoxified and inactivated through albumin binding.

Alkaline Phosphatase (ALP)

Alkaline phosphatases are a group of nonspecific enzymes that hydrolyze many types of monophosphate esters in most cells. The natural substrate(s) of ALP is currently unknown. High concentrations of alkaline phosphatases are found in osteoblasts, intestinal mucosa, renal tubule cells, liver, and placenta. Each tissue has its own ALP isoform.

Amylase

Alpha-amylases are enzymes that catalyze the hydrolysis of complex carbohydrates into maltose and residual glucose. Amylase is primarily synthesized in acinar cells of the pancreas and is secreted into the pancreatic duct system, where it is transported to the intestinal tract. Additional amylase activity is found in the intestines, kidneys, and uterus.

Anemia

Anemia with reticulocytosis or polychromasia is described as regenerative or responsive. This type of anemia occurs when the bone marrow is actively producing RBCs. Findings that indicate regenerative anemia include polychromasia, reticulocytosis, and hypercellular bone marrow with a low myeloid:erythroid ratio. The presence of regeneration suggests blood loss or RBC destruction. Regenerative anemia also denotes that sufficient time has elapsed for regeneration to occur (2-3 days), that there are adequate blood-forming elements (iron, appropriate vitamins, protein) for regeneration, that there are enough erythrocytic colonies in the bone marrow, and that there is adequate kidney function to form erythropoietin.

Anemia, Macrocytic Hypochromic

Macrocytic, hypochromic anemia is characterized by abnormally large RBCs containing subnormal amounts of hemoglobin. It is seen after acute blood loss or hemolysis. This type of anemia indicates marked RBC regeneration, but several days must elapse before this response is noted. Production of reticulocytes in response to anemia contributes to the pallor, increased MCV and decreased MCHC.

Anemia, Microcytic Hypochromic

Microcytic, hypochromic anemia is characterized by abnormally small RBCs containing subnormal amounts of hemoglobin. It is caused by iron deficiency, impaired iron metabolism, or iron depletion from chronic blood loss. Rarely, portosystemic shunts and chronic inflammation cause this type of anemia.

Anemia, Nonregenerative

Anemia without reticulocytosis or polychromasia is described as nonregenerative. During the first 2-3 days after hemorrhage or hemolysis, anemia may be nonregenerative. The slight anemias of disease may be nonregenerative. When no response is seen for several days, it indicates a primary or a secondary bone marrow disorder.

Anisocytosis

Anisocytosis is a variation in RBC size without a change in cell shape. Slight anisocytosis occurs normally in cats and dogs, and by itself is not diagnostic. In moderate to marked anisocytosis, RBCs may be macrocytic or microcytic. Microcytic RBCs occur in immune-mediated hemolytic anemia, microvascular constriction, early Heinz-body anemia and iron-deficiency anemia. Macrocytic RBCs occur with regenerative anemia and rarely with erythrocytic leukemia. Usually macrocytes raise the MCV. If microcytic anemia is also a regenerative anemia, such as occurs with Heinz-body anemia, the MCV is normal but the smear shows marked anisocytosis.

Aspartate Aminotransferase

The enzyme aspartate aminotransferase (AST) catalyzes a reaction that transfers an amino group from an amino acid to a keto acid, providing a nitrogen source for the urea cycle. AST is present in many tissues and is a good indicator of soft tissue damage. The largest sources of AST in the dog and cat are heart, liver, skeletal muscle, kidneys, brain, and plasma.

Band Cells (stab cells)

The band cell (also called a stab cell) is an immature neutrophil occasionally found circulating in peripheral blood. An increase in the absolute number of bands indicates increased demand due to inflammation. Increased numbers are termed a ³left shift.² Slight increases in bands (300-1,000/ml) may occur in nonsuppurative diseases, such as hemorrhagic or granulomatous disease. Bands in excess of 1,000/ml indicate an intense purulent exudative process. Human labs often refer to band cells as ³stab² cells and often misdiagnose canine neutrophils as band cells because the canine neutrophil is less lobulated than the human neutrophil.

Basophils

Basophils and tissue mast cells contain granules of histamine and heparin. These substances initiate inflammation, prevent coagulation and activate lipoprotein lipase. Basophils may be seen with a variety of diseases, while the presence of many mast cells on a blood smear signifies mast-cell neoplasia. Mast cells and basophils are similar in appearance because both contain purple metachromatic granules. Mast-cell granules usually stain intensely and are often numerous enough to obscure the nucleus. Canine and feline basophils contain fewer dark granules. The granules in feline basophils stain light blue and are often missing from the cytoplasm, making them difficult to identify on blood films. Basophils have a tri-lobed nucleus, similar to that of neutrophils; mast cells have a single, round nucleus.

Blood Indices

Anemia occurs when the number of circulating RBCs is below the normal level for the age, sex and breed of the species concerned. The laboratory identifies anemia by low values for the PCV, hemoglobin and RBC count. We classify anemias by response, cause and cell characteristics such as cell size, shape and hemoglobin concentration. The red blood cell indices consist of the mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC). They are used to determine the type of anemia present in the patient.

Red cell indices are estimations of the size and cellular hemoglobin concentration of a population of RBCs. Determining the type of anemia may help select appropriate therapy and monitor the progress of therapy. Automated blood analyzers often have a built-in function that determines one or more of the indices; the remaining indices are then calculated from determined values. The values can be calculated by knowing the PCV, hemoglobin level and RBC count. The MCHC and MCH are high at birth but decrease to adult values in 2 months.

Calcium

Calcium is important in both extracellular and intracellular functions. Although approximately 99% of the body's calcium is contained in teeth and bone, calcium ions are also required for muscle contraction, blood coagulation, enzyme activation, nerve impulse transmission, and changes in cell membrane and capillary permeability.

Chloride

Chloride is an electrolyte. When combined with sodium it is mostly found in nature as "salt." Chloride is important in maintaining the normal acid-base balance of the body and, along with sodium, in keeping normal levels of water in the body. Chloride generally increases or decreases in direct relationship to sodium, but may change without any change in sodium when there are problems with too much acid or base in your body. For example, the stomach produces large amounts of hydrochloric acid, which contains chloride; vomiting expels both acid and chloride. Chloride is taken into the body through food. Most of the chloride is absorbed by the gastrointestinal tract, and the excess is excreted in urine. The normal blood level remains steady, with a slight drop after meals (because the stomach produces acid after eating, using chloride from blood).

Cholesterol

Cholesterol is a major precursor of cholesterol ester, bile acids, and steroid hormones and is a component of plasma membranes. The rate of cholesterol biosynthesis in the liver is indirectly proportional to dietary intake. Levels of cholesterol in the body are indirectly controlled by thyroid hormone, which stimulates bile acid production. Since bile acids are synthesized from cholesterol, cholesterol concentrations vary inversely with thyroid hormone activity.

Creatine Kinase

Creatine Kinase is an enzyme found in the heart, brain, and skeletal muscle. Enzymes are proteins that help cells perform their normal functions. In muscle, for example, CK helps cells make the energy needed to move. CK occurs in three major forms, called isoenzymes: CK-MB (found mostly in your heart muscle), CK-BB (found mostly in your brain), CK-MM (found in your heart and other muscles). CK in the blood comes mainly from your muscles. The CK in your brain almost never gets into the blood.

Creatinine

Creatinine is the end product of creatine catabolism. Creatine is formed from arginine and glycine in a two-step process taking place in the pancreas, kidneys, and small intestine (first step) and the liver (second step). Creatine circulates in the blood and is taken up by the muscle where it stores energy and becomes phosphocreatine. Creatinine is formed during the breakdown of phosphocreatine and is found throughout the body water. In addition to endogenous creatinine, a small quantity of creatinine is consumed by eating animal tissues. The major route of creatinine excretion is through the kidneys, with some creatinine excreted through the gastrointestinal tract.

Differential White Blood Cell Count

In a differential WBC count, the number of each leukocytic cell type is reported as a percentage of the total WBC count. To determine absolute numbers of each cell type, individual (100-200) WBCs are identified and reported as a percentage of the total WBC count. This percentage is then multiplied by the total WBC count to obtain absolute numbers of each cell type. The 5-part traditional system classifies the cells into neutrophils, lymphocytes, monocytes, eosinophils and basophils. Immature forms are classified separately. The VetScan HMT gives a 3 part differential count. It groups all the granulocytes (neutrophils, eosinophils & basophils), but differentiates the lymphocytes and monocytes. A Percent Differential reports each cell type and a percent of the total count. An absolute differential count multiplies the percent count by the number of total WBCs. A good hand count evaluates 100-200 cells. A machine count does many more. An absolute count gives a more accurate representation of the circulating cells. It is determined by multiplying the percent of each cell by the total white blood cell count. The differential count is used to disclose inflammatory and hormonal responses.

Direct Bilirubin

Bilirubin is an orange-yellow pigment found in bile. It is formed when hemoglobin, the red-colored pigment of red blood cells that carries oxygen to tissues, breaks down. Small amounts of bilirubin are present in blood from damaged or old red cells that have died. In general, bilirubin can be combined or conjugated to a protein called albumin, in which case, conjugated bilirubin is often referred to as direct bilirubin. Bilirubin that is not attached to the protein is called indirect bilirubin. Each type of bilirubin can give a better picture of the present disease. Direct bilirubin usually indicates that there is a blockage from the liver into the bile duct. Indirect bilirubin indicates that the liver cannot process the bilirubin or there may be a rupture in a large number of red blood cells and the resultant release of bilirubin overwhelms the liver.

Eosinophils

Eosinophils are WBCs with numerous functions. They are parasiticidal, help regulate allergic and inflammatory responses by inhibiting mast cell release of histamine and serotonin, detoxify histamine at the site of antigen-antibody reactions, regulate the intensity of IgE reactions, and have some phagocytic activity against invading bacteria. Their granules contain potent cytotoxic proteins and lipids that are active in almost all types of inflammation and tissue injury. Eosinophils are easily recognized on stained blood smears by their large yellow-orange granules. They normally occur in small numbers in peripheral blood.

Fibrin

Fibrin is a filamentous protein that is formed as the blood clots. It is deposited in filaments that entangle with blood cells and platelets to form a clot.

Gamma Glutamyl Transferase

The physiological functions of gamma glutamyl transferase (GGT) are thought to be glutathione metabolism, amino acid membrane transport, and foreign compound detoxification. Concentrations of GGT are found in the kidneys, pancreas, liver, gallbladder, and intestines. The highest concentrations of GGT are found in the kidneys and pancreas; however, GGT in the blood is believed to be primarily from the liver.

Globulin

In the late nineteenth century, it was discovered that there were two different proteins in serum. These proteins were named albumin and globulin. Since then the use of electrophoresis has aided in the identification of over 22 individual plasma proteins, many of which are subsets of globulin. As a result of the pre-dominance of these two protein types among total protein, an approximation of the globulin concentration can be easily determined by subtracting the albumin concentration from the total protein concentration. Globulin synthesis occurs in plasma cells, lymphocytes, and the liver. The major fractions of globulin are termed alpha, beta, and gamma. Alpha and beta globulins mainly carry various lipids, lipid-soluble hormones and vitamins, and other lipid-like substances in the plasma. Two other alpha globulins, ceruloplasmin and haptoglobin, are carriers of copper and hemoglobin, respectively. A beta globulin, transferrin, is an iron carrier. The gamma globulins consist primarily of the immunoglobulins.

Glucose

Glucose is normally the only sugar found in the blood. Blood glucose concentrations are kept within a relatively narrow range by such factors as hepatic and renal uptake and release, glucose removal by peripheral tissues, hormone influences on uptake and release, and intestinal absorption. The only endogenous sources of glucose are the liver and kidneys which convert glucose-6-phosphate to glucose. Insulin is the main hormone that affects glucose blood levels.

Granulocytes

Granulocytes are WBCs that contain cytoplasmic granules. These include neutrophils, eosinophils and basophils. These cells are produced in the bone marrow. When we count granulocytes we mainly estimate the neutrophil numbers and assume that an increased granulocyte count indicates a neutrophilia and a decreased count indicates a neutropenia.

HDL Cholesterol

HDL is one of the classes of lipoproteins that carry cholesterol in the blood. HDL is considered to be beneficial because it removes excess cholesterol and disposes of it. Hence HDL cholesterol is often termed "good" cholesterol. The test for HDL measures the amount of HDL-cholesterol in blood.

Hematocrit

The Hematocrit (HCT) and the Packed Cell Volume (PCV) indicate the percent of red blood cells in a unit of whole blood. They are equivalent measurements. The VetScan HMT calculates the HCT. It is equivalent to the manual centrifuge packing of red cells called the packed cell volume (PCV). When a blood sample is centrifuged (Spun Hematocrit), it separates into 3 layers: an upper layer of plasma; a middle layer of WBCs and thrombocytes (buffy coat); and a bottom layer of packed RBCs. Technically, the hematocrit is a measure of all the cellular elements of blood (WBCs, thrombocytes, RBCs). By common usage, however, it has become synonymous with packed cell volume (PCV). See also Packed Cell Volume.

Hemoglobin

Hemoglobin (Hb) is the oxygen-carrying pigment formed by developing RBCs in the bone marrow. The hemoglobin value of a blood sample is approximately one-third of the PCV. Variations from this indicate a laboratory error, hemolysis or abnormalities, such as Heinz bodies or lipemia. Altered hemoglobin may form Heinz bodies or crystals. Determination of hemoglobin provides no clinical advantage over measurement of the PCV other than allowing the determination of Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC).

Immature RBC

Immature RBCs include reticulocytes and nucleated red blood cells. Reticulocytes are indicated on the VetScan HMT by a high MCV and a high RDW. Occasionally immature cells retain their nuclei and are counted by the VetScan HMT as WBCs.

Left Shift

The term left shift indicates increased numbers of circulating immature neutrophils (band cells, metamyelocytes, myelocytes). These cells cannot be differentiated by automatic cell counters. A regenerative left shift is characterized by band cells and increased numbers of mature neutrophils. The number of immature neutrophils does not exceed 10% of the mature neutrophils, and no young cells, such as metamyelocytes, are present. A degenerative left shift is characterized by circulating band cells that exceed 10% of the segmented neutrophils, in conjunction with decreased numbers of neutrophils or the presence of very young cells, such as metamyelocytes or myelocytes. In a degenerative left shift, the total WBC count may vary from below normal to slightly elevated. A degenerative left shift is an unfavorable prognostic sign.

Leukocytes

Leukocytes are synonymous with "white blood cells" and may be classified as one of the following: neutrophils, eosinophils, monocytes,lymphocytes or basophils. These include both the granulocytes and the mononuclear cells of the lymphoid system. A total WBC count is the sum of all leukocytes.

Leukocytosis

Leukocytosis is an increased number of WBCs. It is usually caused by an increase in the number of circulating neutrophils (neutrophilia), though lymphocytosis (especially with leukemia) occasionally produces leukocytosis. Absolute values of individual WBC types provide much more diagnostic specificity than a simple WBC count. Exercise, fear and digestion cause physiologic leukocytosis. Infection, rapidly growing neoplasms, acute hemolysis, hemorrhage, intoxication, leukemia and trauma cause pathologic leukocytosis.

Leukopenia

Leukopenia indicates a decreased total WBC count. It is usually characterized by decreased numbers of circulating neutrophils. The most common causes of leukopenia are excessive consumption in an inflammatory process and primary bone marrow disease. Persistent leukopenia is a poor prognostic sign.

Leukemia

Leukemia implies neoplastic cells in the peripheral blood. It may occur in myeloproliferative and lymphoproliferative diseases. In myeloproliferative diseases immature precursers of red blood cells, granulocytes, are seen on stained blood smears. In lymphoproliferative diseases, large numbers of immature lymphocytes are present in peripheral blood smears.

Lymphocytes

Lymphocytes in the blood are a mixed population of B-cells and T-cells. They are the major cellular component of immunity in the body. B-lymphocytes synthesize antibodies that are responsible for humoral immunity. T-lymphocytes are the principal component of cellular immunity. Lymphocytes also participate in immune regulation and surveillance, and some are cytotoxic.

Lymphocytosis

Lymphocytosis indicates increased numbers of circulating lymphocytes. Pathologic lymphocytosis occurs in chronic inflammation, recovery from acute infection, lymphocytic leukemia, and hypoadrenocorticism. Lymphocytosis usually indicates a strong immune stimulus of some chronic duration from a bacterial infection, viremia or immune-mediated disease. Lymphocytic leukemia may or may not be accompanied by lymphocytosis. Lymphocytosis not associated with disease occurs with physiologic leukocytosis, in healthy cats from excitement, immature age-related responses in young puppies and kittens, and sometimes following vaccination.

Lymphopenia

Lymphopenia indicates decreased numbers of circulating lymphocytes. It may occur with acute severe disease, some viral diseases (canine distemper, hepatitis, parvovirus and coronavirus infections, feline panleukopenia, FeLV infection), stress-related corticosteroid response, and loss of lymph into the gut (chylothorax, lymphangiectasia).

Mean Corpuscular Hemoglobin Concentration (MCHC)

MCHC measures the average concentration of hemoglobin in RBCs. Increases are usually caused by hemolysis. Decreases are termed hypochromasia and are seen in reticulocytosis and iron deficiency anemia.

Mean Corpuscular Hemoglobin (MCH)

The MCH is the average amount of hemoglobin in each RBC. This calculated index is increased with hemolysis. Decreases are termed hypochromasia and are seen with reticulocytosis and iron deficiency.

Mean Cell Volume (MCV)

The MCV is the average volume of a single RBC. It is determined by direct measurement with an electronic cell counter such as the VetScan HMT. Increases are usually due to reticulocytes and indicate a responsive anemia.

Mean Platelet Volume (MPV)

The MPV is a machine calculation of platelet size. In thrombocytopenic dogs, increased mean platelet volume gives indirect evidence of increased megakaryocyte response. High mean volume (>12 fl) indicates increased response but decreased volume (<12 fl) is not accurate in predicting lack of bone marrow megakaryocyte production.

Monocytes

Monocytes are the immature blood stage of tissue macrophages. Increased numbers occur in response to inflammation. Their main function is phagocytosis of foreign material, cellular debris and pathogens that are not effectively controlled by neutrophils. They engulf intracellular organisms and those causing a granulomatous inflammatory response. They are effective scavengers, removing tissue debris, cellular remnants and foreign material. Monocytes are also active in regulating the immune response, processing antigen, and activating killer cells and macrophages. Monocytes are the most commonly misidentified leukocyte in blood smears, often being placed into the lymphocyte category.

Monocytosis

Increased numbers of circulating monocytes (monocytosis) occur in chronic suppurative, pyogranulomatous, necrotic, malignant, hemolytic, hemorrhagic or immune-mediated diseases. Monocytosis also occurs in dogs as a corticosteroid-induced response from stress, adrenal hyperfunction or exogenous corticosteroids. Some animals with chronic disease have persistent monocytosis. Decreased numbers of circulating monocytes (monocytopenia) is rare and has no diagnostic significance.

Nucleated Red Blood Cells, (nRBC)

Nucleated RBCs (nRBCs) are larger and more immature than reticulocytes and mature RBCs. These immature, nucleated stages of the erythrocyte generally occur within the bone marrow, and are rarely observed in the peripheral blood of normal dogs and cats. They appear as metarubricytes in small numbers in response to acute blood loss or anemia. Nucleated RBCs without concurrent anemia or reticulocytosis are a sign of disease. They are found in splenic disease, extramedullary hemopoiesis, lead poisoning, hyperadrenocorticism, leukemia and bone marrow disease. Circulating nucleated RBCs can be metarubricytes or younger cells, such as rubricytes. RBCs of birds and reptiles are all nucleated and are counted as WBCs by automatic counters.

Neutrophils

Neutrophils phagocytize and kill microorganisms. They also initiate and modify the acute inflammatory process, cause tissue damage and are cytotoxic. Production and storage in the bone marrow, margination of cells in the capillary beds, and the demands of peripheral tissues affect the numbers of circulating neutrophils.

Neutropenia

Neutropenia indicates decreased numbers of circulating neutrophils. It may be due to insufficient production or increased destruction of neutrophils. Conditions that cause neutropenia include endotoxemia, viral infections, overwhelming bacterial infections, and administration of drugs that cause bone marrow suppression.

Neutrophilia

Neutrophilia indicates increased numbers of circulating neutrophils. It can be physiologically induced by exercise and corticosteroids, or pathologically induced by infections and tissue destruction. The primary differential diagnoses for neutrophilia are inflammation (both septic and non-septic), stress, exercise or excitement.

Packed Cell Volume (PCV)

The packed cell volume (PCV) or hematocrit (Hct) is a measure of RBC numbers, expressed as a percentage of the total volume of blood. The PCV, by common usage, has become synonymous with the Hct. Traditionally the PCV is obtained by centrifuging an anticoagulated blood sample (spun crit); with automated counters this value is calculated from the measured Mean Corpuscular Volume (MCV) and RBC count. This is the reason that laboratory values may differ slightly from in-clinic values. The column of packed RBCs (PCV) is measured in millimeters and expressed as a percentage of the total blood volume. Anemia exists when the PCV falls below the reference range for the species. Hemoconcentration may exist when the PCV exceeds the reference range. There is normally a 3:1 ratio of PCV to hemoglobin value.

Platelet clumping

Platelet clumping is an aggregation of thrombocytes that produces inaccurate counts with electronic counters. This is caused by activation of the platelets from poor collection but sometimes occurs spontaneously in cats. Storage in EDTA (lavender top tubes) may increase this tendency. Rapid processing with electronic counters decreases this tendency. The histogram may show an abnormal distribution of large cells indicating platelet clumping. Because of this clumping in samples the reference labs usually give only an estimation of platelet numbers as seen on blood smears. An adequate count of 8-10 platelets/100X objective field would suggest platelet numbers greater than 150,000. Thrombocytopenic slides show <7 per 100X objective indicating counts less than 100,000.

Platelet Count

Counts below 100,000/ml are significant. Platelets can be counted directly, or numbers can be estimated from the blood smear (>5 per oil-immersion field). Decreased platelet numbers (thrombocytopenia) occur with disseminated intravascular coagulation, bone marrow depression, autoimmune hemolytic anemia, systemic lupus erythematosus and severe hemorrhage. Thrombocytosis (increased platelet numbers) is caused by excess bleeding (from trauma, blood sucking parasites or neoplasia), iron deficinecy anemia and myeloproliferative syndromes.

Platelet Distribution Width (PDW)

Platelet distribution width (PDW) is a number that measures platelet anisocytosis (variation in size). A mixture of large and small platelets may give a normal Mean Platelet Volume (MPV) but a high PDW. This would be an indication of active platelet release.

Platelets (Thrombocytes)

Platelets or thrombocytes are small flat disks, which are produced by megakaryocytes. They adhere to exposed subendothelial collagen within seconds of injury to form a hemostatic plug. Low platelet counts predispose an animal to hemorrhage.

Poikilocytes

Poikilocytes are abnormally shaped RBCs. Poikilocyte is a general term that encompasses all categories of abnormal RBC shapes, including more specific terms, such as echinocyte, acanthocyte, schizocyte and crenation. RBC distortion may occur with improperly prepared blood films and should not be confused with poikilocytosis. Poikilocytosis is a nonspecific change seen in chronic blood loss, iron-deficiency anemia, diseases characterized by RBC fragmentation, and chronic lead poisoning. A stained blood smear will show the abnormally shaped RBCs.

Polycythemia

Polycythemia is an increase in the red cell mass of the blood. This is seen as an increase in PCV, hemoglobin concentration and RBC count. Absolute polycythemia results from increased bone marrow production of RBCs and may be primary, as with polycythemia vera or myeloproliferative disease, or secondary to hypoxia and renal disease. Absolute polycythemia must be distinguished from relative polycythemia that occurs with dehydration (high plasma protein), hypovolemia (low plasma protein), shock or splenic contraction (normal plasma protein).

Potassium

Potassium and sodium are the two cations mainly responsible for the osmotic pressures of intracellular and extracellular fluid (ICF and ECF, respectively). Sodium, found primarily in ECF, is actively moved from ICF to ECF by sodium-potassium pumps in the cells. The ICF is the principal location of potassium, where it can not be clinically measured. The movement of potassium across the cell membrane is crucial to cardiac and neuromuscular excitability. Membrane potential is altered by changing the ratio of ICF potassium to ECF potassium. Homeostasis of potassium is controlled by the ICF : ECF potassium ratio and by body intake and output. The ICF : ECF ratio is affected by acid-base balance, glucose and insulin administration, exercise, and catecholamine release.

Red Blood Cells (RBC)

Red blood cells (RBCs) transport oxygen from the lungs to body tissues. Their production is stimulated by erythropoietin, secretion of which is controlled by the blood oxygen tension. Erythropoietin stimulates maturation of RBC precursors in bone marrow into mature RBCs. Blood loss, parasitism, renal failure, RBC damage, chronic inflammatory disease, hematopoietic malignancies and insufficient dietary iron, copper or vitamin B12 cause a deficiency of RBCs (anemia). Shock, fluid loss or increased RBC production can cause increased RBC numbers (polycythemia). Dehydration or protein fluid extravasation causes a relative decrease in the fluid portion of the blood and a relative increase in the cellular portion. Carbon monoxide, lung disease, heart disease and high altitude cause excessive RBC production by stimulating erythropoietin secretion. Erythrocytic malignancies and polycythemia vera cause excessive RBC production without normal stimulation.

Red Cell Distribution Width (RDW)

The red cell distribution width is an electronic measure of anisocytosis (variation of cell size). It increases where the degree of anisocytosis is increased. In regenerative anemia, it increases when large cells are produced even before the MCV exceeds the reference range. It also increases when small cells are produced as with iron deficiency anemia.

Reticulocytes

Reticulocytes are immature RBCs without a nucleus. They retain a fine network of endoplasmic reticulum that stains with reticulocyte stains. These immature cells are slightly larger than mature RBCs and normally circulate in small numbers. Elevated numbers of circulating reticulocytes (reticulocytosis) occur in chronic hemorrhagic or hemolytic anemia with increased erythropoiesis. A lack of circulating reticulocytes in chronic anemia indicates bone marrow depression. Reticulocytosis without evidence of anemia may indicate reduced oxygenation of blood. This leads to increased erythropoietin levels, which in turn stimulate erythropoiesis and release of reticulocytes from the bone marrow. Reticulocytes are not counted by the VetScan HMT but are suggested by a high MCV. When present they indicate the animal is responding to blood loss by red cell regeneration.

Right Shift

The term right shift indicates increased numbers of circulating hypermature neutrophils in neutrophilic blood samples. These are cells showing hypersegmentation. This is usually seen in noninfectious inflammatory processes such as inflammation secondary to a malignancy.

The 3X Rule

Hemoglobin x 3 = Hematocrit (± 2%)
In normal blood samples, the hemoglobin is approximately one third the hematocrit. This relationship can be used to cross check the accuracy of the blood counts. If abnormal, the sample should be checked for hemolysis or Heinze bodies.

Thyroxine

Thyroxine is a hormone synthesized in and secreted by the thyroid gland. The primary secretory form of the thyroid hormone is tetraiodothyronine (T4), although some triiodothyronine (T3) is also secreted into the blood. The ratio of T4 to T3 is 25:1 in canine plasma. Once in the blood, T4 and T3 are bound by transport proteins. The primary binding protein is thyroxine-binding globulin (TBG) in the dog and albumin in the cat. Upon delivery to the target cell, T4 is deiodinated to T3 at the cell surface. T3 is the biologically active form of the thyroid hormone and more readily enters the target cell.

Total Bilirubin

Bilirubin is an orange-yellow pigment found in bile. It is formed when hemoglobin, the red-colored pigment of red blood cells that carries oxygen to tissues, breaks down. Small amounts of bilirubin are present in blood from damaged or old red cells that have died. In general, bilirubin can be combined or conjugated to a protein called albumin, in which case, conjugated bilirubin is often referred to as direct bilirubin. Bilirubin that is not attached to the protein is called indirect bilirubin.

Total Cholesterol/HDL ratio

Cholesterol is a structural component in cell membranes as well as in plasma lipoproteins. It is also used to form steroid hormones, bile acid and glucocorticoids. Typically, the body synthesizes most of the cholesterol the body needs. The cholesterol in our diet can increase the levels in our body. Too much cholesterol, however, is implicated in coronary artery diseases, which can lead to heart attacks. HDL is one of the classes of lipoproteins that carry cholesterol in the blood. HDL is considered to be beneficial because it removes excess cholesterol and disposes of it. Hence HDL cholesterol is often termed "good" cholesterol. The combination of total cholesterol and HDL ratio is used to determine the risk of developing coronary artery disease.

Total Protein

A total protein assay measures the amount of proteins found in the plasma. The two major protein components are albumin and globulins. Plasma proteins play a major role in maintaining colloid osmotic pressure, and are a source of amino acids. They also bind and transport a variety of substances including lipids, fatty acids, lipid-like substances, copper, iron, and hemoglobin.

Triglycerides

Triglyceride testing measures the amount of triglycerides in your blood. Triglycerides are the body's storage form for fat. Most triglycerides are found in adipose (fat) tissue. Some triglycerides circulate in the blood to provide fuel for muscles to work. Extra triglycerides are found in the blood after eating a meal‹when fat is being sent from the gut to adipose tissue for storage. The test for triglycerides should be done when you are fasting and no extra triglycerides from a recent meal are present.

Urea Nitrogen (BUN)

Urea is one of three end products of nitrogen metabolism. Blood levels of urea are typically low and relatively constant since the primary mode of urea excretion is through the kidneys. The action of antidiuretic hormone on the permeability of the medullary collecting duct allows urea to diffuse into the medullary interstitium. The presence of both urea and sodium in the interstitium increases the osmotic gradient for water reabsorption and increases the concentration of the urine.

Uric Acid

Uric acid is a product of the metabolism (breakdown) of purines. Purines are chemicals that come from both the breakdown of foods and nucleic acids (DNA) in the body. If uric acid levels in the body are low, there are no symptoms. Doctors don’t need to test for low levels of uric acid.

White Blood Cell Count (WBC)

The total WBC count combines circulating numbers of neutrophils, lymphocytes, monocytes, eosinophils and basophils. Because neutrophils are the predominant leukocytic cell type, a high total WBC count (leukocytosis) is generally due to an increase in this cell line. However, absolute values of individual leukocytic cell lines (found by performing a differential count and multiplying each cell line percentage by the total WBC count) often provides more diagnostic specificity. Leukopenia (decreased WBCs) is generally evident only with a decrease in neutrophils. Leukocytosis and leukopenia occur with a variety of diseases. Normal ranges for total WBC counts are printed by the VetScan HMT and should be similar to textbook ranges. Differential counts may differ from textbooks and reference labs because the VetScan HMT groups neutrophils, eosinophils and basophils into one category (Granulocytes). Lymphocyte and monocyte values should be similar to textbook values.