Blood Cells & Complete Blood Counts (CBC) in Animals

Drs. Foster & Smith Educational Staff

Whether it is a human, dog, cat, or even bird or ferret, when sick, their doctors typically draw a blood sample and perform some tests to help determine a diagnosis. These tests are generally one of two types. The first type is the complete blood count (CBC), which determines the number and types of blood cells present. The science concerned with this cellular portion of the blood is called hematology. The second type of test is a blood chemistry panel that measures the quantities of various electrolytes, enzymes, or chemical compounds in the liquid portion of the sample. Sometimes these tests yield little information about the case, but more typically, they are the fastest and best diagnostic tool available to the doctor.

> A complete blood count is a count of the total number of cells in a given amount of blood, including the red and white blood cells; often referred to as a CBC, it is one of the most common tests done to check for abnormalities of the blood.

Components of Blood

Blood is made up of a liquid portion plus all the various blood cells. It functions to transport nutrients and oxygen to the cells; wastes and carbon dioxide to the organs responsible for their removal or breakdown; and also to defend the body against bacteria, viruses, and other organisms.

The liquid portion of blood is referred to as plasma, if the blood was not allowed to clot, and serum, if it was. This liquid portion, without the cells, is generally a straw or light yellow color. The liquid portion of the blood is used in the chemistry tests.

Every drop of blood literally contains millions of blood cells. Although the sample drawn for a CBC may seem small, it contains such huge numbers of cells that it is an excellent and accurate portrayal of the total numbers of these cells found in the bloodstream. The CBC is concerned with the quantities and types of red blood cells, white blood cells, and platelets.

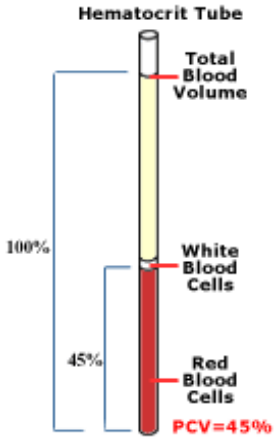
Red Blood Cells

First, let us look at the red blood cells (RBC's). These are the tiny workhorses that are responsible for carrying oxygen to the body's tissue. RBC's contain the molecule hemoglobin. Oxygen that is taken into our bodies attaches to the hemoglobin as the RBC's pass through the lungs. The RBC's then deliver the oxygen to all the other cells in the body and take the carbon dioxide back to the lungs.

RBC's are formed in the bone marrow. The bone marrow constantly produces new RBC's, since the life span of an RBC is only about 120 days. The body can respond quickly to maintain the number of RBC's present in the blood vessels. The body measures their numbers simply by evaluating the quantity of oxygen being supplied to its tissues. If not enough oxygen is available, then the body sees that as a need for more working RBC's.

If more RBC's are needed quickly, then more immature cells (called reticulocytes) are released into the circulation from the bone marrow. However, if there are adequate cells present, it slows down the release of new ones.

Hematocrit: In the CBC, we determine the number of RBC's in several different ways. The quickest and easiest is called the hematocrit, also referred to as the packed cell volume (PCV). A blood sample is placed in a tiny glass tube and spun in a centrifuge. This device spins the tube round and round at several thousand revolutions per minute. The cells are heavier than the plasma and are compacted at one end of the tube. After the tube is spun, it is examined and the PCV is determined as the percentage of the cellular portion relative to the total amount of blood in the tube (i.e., remainder being the plasma). The normal for dogs is 40-59 and cats is 29-50.



If the PCV is low, there are fewer red cells in the body than we would expect. This condition is referred to as anemia. In severe cases of anemia, the animal would probably have pale membranes in its mouth and seem weak and tired, since its body would be getting less oxygen than needed. Anemias are further classified as either regenerative or nonregenerative. In the former, even though the number of red blood cells is lower than normal, the body is responding by releasing new reticulocytes into the circulation. In the nonregenerative anemia, there are no or very few immature RBC's in the sample and the body continues to lose red blood cells, but no new ones are produced. A nonregenerative anemia is very, very serious and will quickly become life-threatening.

When the PCV is greater than 55, it is said to be elevated. This is seen in dehydrated animals as their blood is becoming more concentrated. It is noted in other conditions, such as some cases of shock, response to high altitudes (the air is 'thinner,' therefore there is less oxygen, so more RBC's are put into circulation), diseases of the lungs, etc. Remember, anything that decreases the amount of oxygen reaching the tissues of the body will cause higher numbers of red blood cells to be found in the CBC.

Red Blood Cell Count: We can also measure the actual number of RBC's in a given quantity of blood. This is called the 'red count,' and is more difficult to perform than a hematocrit. The red blood cell count is not measured as a percentage of

*Unauthorized use of any images, thumbnails, illustrations, descriptions, article content, or registered trademarks of **Foster & Smith, Inc.** is strictly prohibited under copyright law. Site content, including photography, descriptions, pricing, promotions, and availability are subject to change without notice. These restrictions are necessary in order to protect not only our copyrighted intellectual property, but also the health of pets, since articles or images that are altered or edited after download could result in misinformation that may harm companion animals, aquatic life, or native species.*

anything, but rather the actual number of cells found in a microliter (µ l). To put things into perspective for those of us who do not relish the metric system, a liter is just a little larger than a quart, and a microliter is one millionth of a liter. Each laboratory has their own set of 'normal' ranges for a RBC count, but the average is 5.6-8.7 x 10^6 RBC's per microliter for dogs, and 6.1-11.9 x 10^6/µ l for cats.

Hemoglobin: A final way we can evaluate the RBC's is by quantifying the amount of hemoglobin present. In some anemias, the actual number of RBC's may not be real low, but if the cells contain less than the normal amount of hemoglobin, the signs of anemia could be quite severe. The normal hemoglobin level for a dog is 14-20 grams/deciliter, and 9-15.6 g/dl for cats.

White Blood Cells

The other major type of blood cells are the white blood cells (WBC's), which are also referred to as leukocytes. There are many more RBC's than there are WBC's. For every leukocyte present in a sample there will normally be 600 to 700 RBC's. The major role of the white blood cells is to defend the body against invading organisms such as bacteria, viruses, and fungi. There are different types of leukocytes, and a white blood count (WBC) is a total of all the various kinds. The normal range for a WBC count in the dog would be between 6,000 and 17,000 per microliter, and in the cat, 4,900-20,000/µ l. The number of WBC's is typically elevated when the body is fighting a severe infection or stressed by metabolic toxins (a patient that was in acute kidney failure with waste products building up in its body would normally have an elevated WBC). In addition, when extremely excited (if we overly excite or frighten the animal when drawing the blood sample) white blood cells will be released into the blood and the levels will rise. The WBC count will be lower than normal, if an animal has been weakened from a prolonged, debilitating disease and in some viral infections.

WBC's are divided into two groups depending on how they react to the stains that are used to better observe them under a microscope. There are granulocytes (they are WBC's with granules that absorb the stain) and the agranulocytes (those that do not absorb the stain). The granulocytes include the neutrophils, eosinophils, and the basophils, while the agranulocytes are the lymphocytes and monocytes.

Neutrophils: Neutrophils are also formed in the bone marrow. Mature cells have a multi-lobed nucleus and are referred to as 'segmented cells' (sometimes called 'segs'), while the immature ones have a single-lobed nucleus and are referred to as 'bands.' The bands are younger than the segs - when first released from the marrow neutrophils are bands, and after spending time in the circulating blood they mature into segs. These cells function by actually engulfing disease-causing bacteria and other small particles. In the presence of a bacterial infection, their number in the peripheral blood increases, the bone marrow releases more of the young cells into the circulation, and the percentage of bands increases in relation to the segmented ones. The normal range for mature neutrophils is between 3,000 to 12,000/µ l. The normal for the bands is approximately 100 to 300 per microliter.

When total neutrophil numbers are increased, it is usually a sign of a bacterial infection or some form of extreme stress. If the number of bands increases dramatically in relation to the number of segs, it is thought to be a more severe reaction, since the body is releasing more and more immature cells into the circulation to defend itself against the infection. In most viral infections, the total number of neutrophils decreases.

Eosinophils: Eosinophils are normally seen in fewer numbers than neutrophils. They are also produced in the bone marrow and their normal range is about 100 to 1200 per microliter. They also have the ability to eat up or engulf foreign particles into their bodies. Their quantities increase in the circulating blood when the animal is suffering from an infection with parasites, or has allergies. In conditions that cause extreme or prolonged stress to the dog or cat, eosinophil numbers decrease.

Basophils: The last of the granulocytes is the basophil. These are the least common of all the WBC's. In many samples, none are present. Their function is unknown, but they are also produced with the bone marrow.

Lymphocytes: Of the agranulocytes, the most abundant is the lymphocyte. There are normally 500-4,800 of these in a microliter of dog's blood, and 1,500-7,000/µ l in a cat's. They are formed and released from lymphoid tissue such as lymph nodes, spleen, etc. They are unable to eat or engulf organisms, but fulfill their function of defending the body in other ways. The lymphocytes can be divided into two major types by their functions - B cells and T cells, but these cannot be distinguished from each other through looking at them under a microscope. The B cells produce antibodies, which are protein molecules that attach to and thereby destroy invading organisms or other foreign materials and particles. The T cells activate and help other cells destroy viruses and other foreign material. When lymphocytes numbers decrease it is referred to as a lymphopenia, and is frequently noted in the initial stages of infections (a common example would be parvovirus) or following the use of corticosteroids like prednisone. There are other situations that bring about reduced lymphocyte numbers, but they are fairly uncommon. An increase in the number of lymphocytes does not happen as consistently as might be expected, but is noted in prolonged illnesses. Examples of this would be when bacterial or viral infections have gone on for a long time or in certain autoimmune diseases. A common cause of increased lymphocytes is leukemia, which is a cancer of blood cell production that is usually fatal.

Monocytes: Monocytes develop and are stored in the spleen and bone marrow. Normally, there are only 100 to 1800 of these per each microliter of dog's blood, and 0-850/µ l in a cat. They also have the ability to eat or engulf foreign material, such as infectious organisms. Additionally, they secrete various protein molecules that help in the clean up of inflamed and irritated tissue. Their numbers do not vary greatly unless there is a cancerous leukemia condition affecting their cell lines.

Platelets

*Unauthorized use of any images, thumbnails, illustrations, descriptions, article content, or registered trademarks of **Foster & Smith, Inc.** is strictly prohibited under copyright law. Site content, including photography, descriptions, pricing, promotions, and availability are subject to change without notice. These restrictions are necessary in order to protect not only our copyrighted intellectual property, but also the health of pets, since articles or images that are altered or edited after download could result in misinformation that may harm companion animals, aquatic life, or native species.*

The final component that we study when interpreting the CBC, are the platelets. They serve a vital function in the formation of clots. To recognize their importance, think of having a large cut and how it would be possible to bleed to death, if normal clotting did not occur. In actuality, we are bleeding all the time. Microscopically small vessels often break within our bodies, but we do not notice it, since a clot forms within seconds and the amount of blood lost is insignificant. The platelets and a protein called fibrinogen are responsible for the repair of all damaged blood vessels. Even if there was never a cut on the outside of our bodies, without platelets and fibrinogen working together, we would bleed to death internally within a matter of days. If the platelet numbers are decreased, it may mean that the body has either used up a large quantity of the available cells in clot formation, or that their number may be low and the animal is at great risk, if bleeding should commence in the future.

Cell Morphology

A top quality laboratory that performs a CBC reports not only the quantities of the different cell types, but also supplies a description of their size and shape. We refer to this as the cell morphology. Abnormalities are often seen that are very specific for certain diseases. An example would be in certain cancers that affected the blood cells themselves, as is the case in many different forms of leukemia.

Many times, the results of the CBC when combined with a good physical exam and history, make diagnosis easy. A female dog was in heat 2 to 3 months previously, her water consumption is elevated, and she seems weak in the rear quarters. The veterinarian is thinking she may have a severe uterine disorder called pyometra. The CBC comes back with a grossly elevated WBC count of 45,000 and the diagnosis is virtually confirmed.

When the results of the CBC are available to us, we are better equipped to determine the overall health of the animal. It will help us determine if an infection is present and to differentiate if it is viral, bacterial, or parasitic. A CBC can diagnose or help confirm other disorders such as allergies, autoimmune diseases, anemia, leukemia, and many others.

Normal Hematology Values for Dogs and Cats*

	Unit	Canine	Feline
Hematocrit (PCV)	%	40-59	29-50
Hemoglobin	g/dl	14-20	9-15.6
Red Blood Cell Count	$x10^6/\mu l$	5.6-8.7	6.1-11.9
White Blood Cell Count	/µl	6,000-17,000	4,900-20,000
Neutrophils	/µl	3,000-12,000	2,500-12,500
Lymphocytes	/µl	530-4,800	1,500-7,000
Monocytes	/µl	100-1800	0-850
Eosinophils	/µl	0-1,900	0-1,500
Basophils	/µl		
Platelets	/µl	145-440	190-800

* normal values may differ from laboratory to laboratory.

*Unauthorized use of any images, thumbnails, illustrations, descriptions, article content, or registered trademarks of **Foster & Smith, Inc.** is strictly prohibited under copyright law. Site content, including photography, descriptions, pricing, promotions, and availability are subject to change without notice. These restrictions are necessary in order to protect not only our copyrighted intellectual property, but also the health of pets, since articles or images that are altered or edited after download could result in misinformation that may harm companion animals, aquatic life, or native species.*