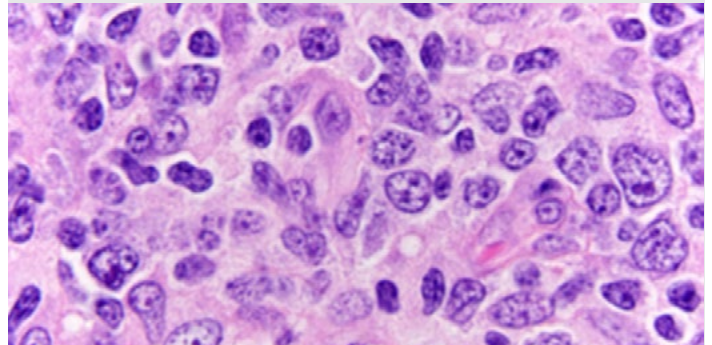


LAB TESTS RELATED TO LYMPHOMA

WHAT IS LYMPHOMA?

Lymphoma is a cancer that develops in white blood cells in the lymphatic system. The purpose of the lymphatic system is to take excess fluid from tissue, filter it through lymph nodes rich in infection-fighting white blood cells, and transport the fluid back into the blood. In the lymph nodes or tissue which comprise the lymphatic system, some white blood cells, lymphocytes, may experience a gene mutation and develop the cancer lymphoma. When lymphocytes develop lymphoma, the cancerous cells replicate faster than normal and crowd out healthy blood cells. This can inhibit the body's immune response because the cancerous cells do not function normally and inhibit the function of normal cells. There are also types of lymphoma that develop outside of lymph nodes, often related to chronic inflammation or infections. Lymphoma can be divided into two broad categories which require different treatment: Hodgkin lymphoma and Non-Hodgkin lymphoma. Hodgkin lymphoma is characterized by the presence of giant cancer cells known as Reed-Sternberg cells. Non-Hodgkin Lymphoma constitutes all other types of lymphoma and has many different subclassifications, but it can be basically separated into B-cell lymphoma and T-cell lymphoma, depending on the characteristics of the lymphocytes forming the tumor. Lab testing is essential in diagnosing lymphoma and creating an effective treatment plan for each specific case.

UNDER THE MICROSCOPE



Picture Legend: This image features a typical image of large B-cell lymphoma, which is more aggressive, shown with variation in size, shape, and coloration of the cells including very large cells. Large B-cell lymphoma is a type of non-Hodgkin lymphoma. It is an aggressive cancer that can develop in lymph nodes, areas outside of the lymph nodes (such as testes, thyroid, breast, bone) or any organ of the body. It is possible to cure large B-cell lymphoma.

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LABORATORY TESTS RELATED TO LYMPHOMA

There are numerous laboratory tests used every day in patients with or suspected to have lymphoma. Some of those tests, like a complete blood count test (CBC), are common in diagnosing and monitoring many different types of cancer. A CBC offers an overview of the composition of a sample of blood and is useful in determining if there are any abnormalities. Others are more specific to lymphoma, like a tissue biopsy. A biopsy is the removal of tissue for analysis in the laboratory. Since lymphoma is a tumor of clonal cells (millions of single cells that are copies of each other), a pathologist or laboratory professional can determine a lot about each individual case of lymphoma from their biopsy. This information is used by physicians to determine the most effective treatment for each specific case of lymphoma. Some of the most common lab tests are described here, but there are many other tests that are not covered.

THE MOST COMMON LABORATORY TESTS RELATED TO LYMPHOMA:

Complete Blood Count (CBC): This series of laboratory tests measures the prevalence of red blood cells, white blood cells, and platelets in a unit of blood. The results of this test are compared against the normal ranges of a healthy individual to identify any abnormalities. Lymphoma may not change a person's CBC results, but it can be used to determine that the individual does not have leukemia which more directly affects CBC results. A complete blood count is a ubiquitous and useful test in identifying irregularities in a patient's blood, but cannot be used to diagnose lymphoma.

Blood Smear: This test involves analyzing a sample of blood under a microscope to calculate the number of each type of blood cell present and determine if the cells are immature or abnormal in size and shape.

Bone Marrow Biopsy and Aspiration: This test involves removing a small sample of bone (biopsy) and a small amount of liquid bone marrow (aspiration) for analysis under a microscope. This procedure is performed in patients with high suspicion of bone marrow abnormalities, either from specific symptoms or a complete blood count result. This test is important because it identifies abnormalities in the ratio of blood cells present and the size and shape of those blood cells. This test can determine the stage and severity of lymphoma present in the samples.

REFERENCE RANGES OF BLOOD CELL COUNTS FOR HEALTHY ADULTS AND CHILDREN

	Red Cells per microliter (µL) of blood	White Cells per microliter (µL) of blood	Platelets per microliter (µL) of blood	Hematocrit ¹ % of blood composed of red cells	Hemoglobin ¹ Grams Per Deciliter (g/dL)
MEN	4.7 to 6.1 million	5,000 to 10,000	150,000 to 400,000	42 to 52	14 to 18
WOMEN	4.2 to 5.4 million	4,500 to 11,000	150,000 to 400,000	37 to 47	12 to 16
CHILDREN	4.0 to 5.5 million	5,000 to 10,000	150,000 to 400,000	32 to 44	9.5 to 15.5

*Table taken from [Leukemia and Lymphoma Society](#), can reproduce if interested

IMMUNOPHENOTYPING

Flow Cytometry: This test involves exposing a sample of blood or bone marrow to specifically-designed antibodies (bound to fluorescent markers) which bind to markers on the tumor cells and then analyzing them with a laser and computer. The antibodies used in a flow cytometry test are designed to strongly bind to certain proteins which are present in cancerous cells. The samples are then analyzed under a laser (which excites the fluorescent markers) to see if the antibodies are bound. This is a separately ordered test on blood or tissue.

Immunohistochemistry: This test involves exposing a tissue sample (such as bone marrow or lymph nodes) with specifically-designed antibodies which bind to markers on the tumor cells and then visualizing them with a microscope. The antibodies used in an immunohistochemistry test are designed to bind to certain proteins which are present in cancerous cells. The samples are then analyzed under a microscope to see if the antibodies are bound and are detected by colored dyes attached to the antibodies. This test is part of the reflex testing done by pathologists on a biopsy.

Lymphatic Tissue Biopsy and Aspiration: This test involves removing a small sample of tissue (biopsy) and a small amount of liquid (aspiration) for analysis under a microscope. The sample is analyzed in the laboratory for evidence of abnormalities in the size, shape, and ratio of those different cells. Flow Cytometry and Immunohistochemistry are add on tests to this procedure.

Molecular Tests: Analyzing chromosomes and genetic sequence is important in diagnosing and treating certain types of lymphoma, as chromosomal abnormalities can be the cause of the lymphoma.

Cytogenetic Analysis (Karyotyping): This test looks at the chromosomes to determine if there are genetic changes associated with lymphoma. Cytogenetic analysis can lead to a more accurate diagnosis and help determine the aggressiveness of the cancer if it has a chromosomal origin. Some specific cytogenetic anomalies indicate specific treatments that patients may undergo.



Fluorescent in situ Hybridization (FISH): This test involves taking a sample of cells and introducing a fluorescent dye which is designed to adhere to some genetic DNA abnormalities. The fluorescent dye of two different colors binds to specific regions of a chromosome that should either be naturally together or separated. When an abnormality is present, the markers are in the opposite orientation.

Polymerase Chain Reaction (PCR): This test involves replicating a small sample of genetic material in the laboratory to create a larger sample. This process allows for genetic abnormalities to be identified at a much lower threshold.

Spinal Tap (Lumbar Puncture): This test involves removing cerebrospinal fluid (CSF) from inside the spinal cord and analyzing it for signs of lymphoma. This test is likely to be ordered only if it is expected that lymphoma has spread to other parts of the body.

“Ultimately, trust your doctors and their treatments,” he says, “but do not be afraid to question them or ask for further testing if something health-related is not right.”

MEET BRIAN

Brian was building up a website design and computer repair company while also acting as the primary caregiver for his young daughter, and his stress levels were on the rise. At the same time, he could tell something wasn't right with his health, but he couldn't seem to get any answers from his doctors. But when doctors found a large mass in his chest via CT scan, he finally got the answers—though not the one he was looking for.

Brian was diagnosed with large B-cell lymphoma, a rare subtype of cancer. It is composed of abnormal B-cells, which are a type of white blood cells that produce antibodies. The cancer is aggressive, and Brian was diagnosed at stage 3, and the cancer had spread to some lymph nodes but thankfully hadn't spread to any other organs.

Having worked for a couple of years as a processor in a laboratory environment, Brian learned to advocate for himself. “I have learned that my doctors tend to disregard abnormal test results, especially if there are no symptoms and the test doesn't directly diagnose something,” he says. “If the numbers are slightly off, I usually have to request further testing.”

Brian has been in remission since 2016, and gets a CT scan every six months as part of his follow-up care. His wife and daughter, he says, have been essential to his recovery, along with his doctors, friends and family.



To learn more about Brian, go to www.ascp.org/patients