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# Understanding Lab and Imaging Tests



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## A Message from Louis J. DeGennaro, PhD

President and CEO of The Leukemia & Lymphoma Society

The Leukemia & Lymphoma Society (LLS) is the world's largest voluntary health organization dedicated to finding cures for blood cancer patients. Our research grants have funded many of today's most promising advances; we are the leading source of free blood cancer information, education and support; and we advocate for blood cancer patients and their families, helping to ensure they have access to quality, affordable and coordinated care.

Since 1954, we have been a driving force behind nearly every treatment breakthrough for blood cancer patients. We have invested more than \$1 billion in research to advance therapies and save lives. Thanks to research and access to better treatments, survival rates for many blood cancer patients have doubled, tripled and even quadrupled.

Yet we are far from done.

Until there is a cure for cancer, we will continue to work hard—to fund new research, to create new patient programs and services, and to share information and resources about blood cancer.

Our vision is that, one day, all people with blood cancers will either be cured or will be able to manage their disease so that they can experience a better quality of life. Today, we hope our expertise, knowledge and resources will make a difference in your journey.

A handwritten signature in black ink, appearing to read 'Louis J. DeGennaro', with a long horizontal flourish extending to the right.

**Louis J. DeGennaro, PhD**

*President and Chief Executive Office  
The Leukemia & Lymphoma Society*

(Letter updated March 2015)

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This publication is designed to provide accurate and authoritative information. It is distributed as a public service by The Leukemia & Lymphoma Society (LLS), with the understanding that LLS is not engaged in rendering medical or other professional services.

# How to Use This Booklet

*Understanding Lab and Imaging Tests* is intended for anyone interested in learning more about how these types of tests are used to help detect (diagnose) and treat blood cancers (types of leukemia, lymphoma, myeloma, myelodysplastic syndromes and myeloproliferative neoplasms). This booklet describes a number of diagnostic and monitoring tests and what to expect. It also includes tips to help keep track of test results, questions to ask your healthcare provider and information about how The Leukemia & Lymphoma Society (LLS) can help.

**Part 1** provides general information about blood, marrow and imaging tests. Other tests, including urinalysis, lymph node biopsy and spinal tap, are discussed later in the booklet in the detailed test descriptions.

**Part 2** describes different types of lab and imaging tests, including

- Examples of why a certain test is ordered
- How it's done
- What the results might mean.

The tests in **Part 2** are listed in alphabetical order starting on page 15. There are symbols next to each test name that give some information about the test.



This symbol is for laboratory tests that are done by analyzing either a sample of blood, urine, marrow, spinal fluid or tissue from your body.



This symbol is for tests that provide an image of what's going on inside your body.



This symbol indicates tests for which patients may have either sedation medication or anesthesia. If applicable, check with your healthcare provider about driving after this procedure.

- If you have an outpatient test that requires sedation medication or anesthesia, you may need to ask a friend or family member to pick you up and take you home.
- You may want to have someone come with you for any test—to listen, help ask questions, take notes and provide emotional support.

**Part 2** of this booklet also includes tips to keep track of test results on page 34.

Several words in the booklet may be new to you or different than the terms your doctor has used. Check Medical Terms in **Part 3** or call our Information Specialists at (800) 955-4572 for more information.

**Part 3** includes suggested questions to ask your healthcare provider.

Please note that this booklet provides general information about the tests. It is not intended to replace the specific information that you will need to get from your healthcare provider.

**Want more information?**



You can view, print or order free LLS publications about leukemia, lymphoma, myeloma, myelodysplastic syndromes and myeloproliferative neoplasms and the free LLS publication *Financial Health Matters*, which can help you plan and organize the process of paying for your healthcare and meeting other financial obligations, at [www.LLS.org/resourcecenter](http://www.LLS.org/resourcecenter) or contact our Information Specialists for copies.

## Here to Help

This booklet offers information about tests you may have to undergo. It also suggests questions you can ask your doctor. We encourage you to take the lead in asking questions and discussing your fears and concerns. When you raise issues that are important to you, members of your healthcare team can answer your questions, extend emotional support and provide any needed referrals.

A blood cancer diagnosis is often a shock to the patient, family members and friends. Denial, depression, hopelessness and fear are some of the reactions people may have. Keep in mind that

- Many people are better able to cope once they begin treatment and can look forward to recovery.
- The outlook for people with blood cancers continues to improve. New approaches to therapy are being studied in clinical trials for patients of all ages and at every stage of treatment.

**LLS Has Ways to Help.** Your treatment may affect your daily life, at least for a time. You may have questions about your treatment and want to have friends, family members or caregivers help you get information.

Making treatment choices, paying for medical care, communicating with healthcare providers, family members and friends—these are some of the stresses that go along with a cancer diagnosis. LLS offers free information and patient services for individuals and families touched by blood cancers.

**Speak to an Information Specialist.** Information Specialists are master's level oncology professionals. They provide accurate, up-to-date disease and treatment information and are available to speak with callers Monday through Friday, from 9 a.m. to 9 p.m. ET at (800) 955-4572. You can email [infocenter@LLS.org](mailto:infocenter@LLS.org) or chat live with a Specialist at [www.LLS.org](http://www.LLS.org).

**Clinical Trials.** New treatments for patients are under way. Patients can learn about clinical trials and how to access them. For more information, please call (800) 955-4572 to speak with an LLS Information Specialist who can help conduct clinical-trial searches. When appropriate, personalized clinical trial navigation by trained nurses, is also available.

**Advocacy and Public Policy.** The LLS Office of Public Policy (OPP) enlists volunteers to help advocate for policies and laws to speed the development of new treatments and improve access to quality medical care. Visit [www.LLS.org/advocacy](http://www.LLS.org/advocacy) to find out more or get involved.

**Co-Pay Assistance Program.** This program offers assistance for financially eligible patients with certain blood cancer diagnoses to help pay for private or public health insurance premiums and/or co-pay costs for prescription medications. Check [www.LLS.org/copay](http://www.LLS.org/copay) or call (877) 557-2672 to speak to a *Co-Pay Assistance Program* specialist for more eligibility information.

**Language Services.** Free language services are available when you speak with an Information Specialist. Let your doctor know if you want a professional healthcare interpreter who speaks your native language or uses sign language to be present during your visit. Many times, this is a free service.

**Información en Español.** LLS has a number of resources available in Spanish for patients, caregivers and healthcare professionals. You can read and download these resources online at [www.LLS.org/espanol](http://www.LLS.org/espanol) or order printed copies by mail or by phone.

**Free Materials.** LLS publishes many free education and support materials for patients and healthcare professionals. PDF files can be either read online or downloaded. Free print versions can be ordered. Visit [www.LLS.org/resourcecenter](http://www.LLS.org/resourcecenter).

**Chapter Programs and Services.** LLS chapter offices around the United States and Canada offer support and education. Your chapter can arrange for peer-to-peer support through the *Patti Robinson Kaufmann First Connection Program*. Find your chapter by calling (800) 955-4572 or by visiting [www.LLS.org/chapterfind](http://www.LLS.org/chapterfind).

**Other Helpful Organizations.** Our website, [www.LLS.org/resourcedirectory](http://www.LLS.org/resourcedirectory), offers an extensive list of resources for patients and families about financial assistance, counseling, transportation, summer camps and other needs.

**Telephone/Web Education Programs.** LLS provides a number of free, live telephone and web education programs presented by experts for patients, caregivers and healthcare professionals. For more information, visit [www.LLS.org/programs](http://www.LLS.org/programs).

### **Suggestions From Other People Living With Cancer**

- Get information about choosing a cancer specialist or treatment center.
- Find out about financial matters: What does your insurance cover? What financial assistance is available to you?
- Learn about the most current tests and treatments for your type of blood cancer.
- Keep all appointments with the doctor and talk openly about your fears, concerns and/or any side effects that you experience.
- Talk with family and friends about how you feel and how they can help.
- Contact your doctor if you have fatigue, fever, pain or sleep problems so that any issues can be addressed early on.
- Get medical advice if you have experienced changes in mood, feelings of sadness or depression.

**Reach Out.** You and your loved ones can reach out for support in several ways.

- LLS offers online blood cancer discussion boards as well as online chats at [www.LLS.org/getinfo](http://www.LLS.org/getinfo).
- Local or Internet support groups and blogs can provide forums for support.
- Patients with cancer often become acquainted with one another, and these friendships provide support.

**Information for Veterans.** Veterans with certain blood cancer diagnoses who were exposed to Agent Orange while serving in Vietnam may be able to get help from the United States Department of Veterans Affairs. For more information call the Department of Veterans Affairs at (800) 749-8387 or visit [www.publichealth.va.gov/exposures/agentorange](http://www.publichealth.va.gov/exposures/agentorange).

**Information for World Trade Center Responders and Survivors.**

Responders, workers, and volunteers who helped with rescue, recovery, and cleanup at the World Trade Center and related sites in New York City; survivors who were in the New York City disaster area, lived, worked, or were in school in the area; and responders to the Pentagon and the Shanksville, PA crash who have been diagnosed with a blood cancer may be eligible for help from the World Trade Center Health Program. For more information, call the World Trade Center Health Program at (888) 982-4748 or visit [www.cdc.gov/wtc](http://www.cdc.gov/wtc).

**Depression.** Treatment for depression has proven benefits for people living with cancer. Depression is an illness that should be treated even when a person is undergoing cancer treatment. Seek medical advice if your mood does not improve over time—for example, if you feel depressed every day for a two-week period. Contact LLS or ask your healthcare team for guidance and referrals to other sources of help, such as counseling services or community programs. For more information you can contact the National Institute of Mental Health (NIMH) at [www.nimh.nih.gov](http://www.nimh.nih.gov) and enter “depression” in the search box at the top of the web page, or call the NIMH toll-free at (866) 615-6464.

**We’d Like to Hear From You.** We hope this booklet helps you. Please tell us what you think at [www.LLS.org/publicationfeedback](http://www.LLS.org/publicationfeedback). Click on “LLS Disease & Treatment Publications—Survey for Patients, Family and Friends.”

## Part 1

# About the Tests

Blood, bone marrow and imaging tests are important tools that help doctors diagnose, treat and manage blood cancers, as well as many other health conditions. Healthcare providers use these test results along with information from your physical examination and detailed medical history to

- Assess your health status
- Help guide treatment decisions
- Decide whether additional tests are needed
- Track your health during treatment and after treatment is completed.



Your doctor may also order additional tests if you have multiple medical conditions (called “comorbidities”) such as heart disease, kidney disease, diabetes or other illnesses that may affect the body’s ability to fight infection, tolerate therapy or that may complicate therapy.

Tests may be done in your doctor’s office, at an outpatient clinic, at a lab (for blood tests) or in the hospital. Check with your doctor about where you will be having your tests. He or she may want or require them to be done at the same place you will be receiving treatment. Insurance coverage may be determined based on where your testing is done. Always check with your doctor for specific pretest instructions. For example, you may need to fast (not eat or drink) for a specified number of hours before certain tests.

### **Lab and imaging tests are used to help the doctor**

- Confirm a blood cancer diagnosis: results from these tests can also guide treatment decisions by
  - Confirming the specific subtype of cancer
  - Identifying genetic or molecular markers associated with the disease
  - Staging the cancer (determine the extent of the disease)
  - Determining a patient’s risk and expected outcomes (prognosis).
- Observe a patient’s condition
- Measure the patient’s response to treatment during and after therapy to determine if more or different treatment is needed.

Researchers are learning more about the genetic and molecular features of a disease. A test called “gene expression profiling” is being used in research settings and may become a part of standard testing in the future. This test uses a method called “microarray analysis” to identify combinations of genes that are turned off or on in response to specific conditions. The information this analysis provides about the gene activity may allow for more accuracy classifying tumors and predict a patient’s response to treatment and outcome. As a result, treatments can be adapted and more precisely targeted; however, this type of testing may not be appropriate for every type of blood cancer.

### **Want more information?**



You can view, print or order the free LLS disease publications for additional information about risk-adapted therapies for each diagnosis. Visit [www.LLS.org/resourcecenter](http://www.LLS.org/resourcecenter) or call our Information Specialists at (800) 955-4572 for copies.

# About Blood Tests

When your doctor or another healthcare provider orders a blood test, he or she chooses a series of tests that can provide important clues about what's going on inside your body.

The most common blood test (called a “complete blood count” or “CBC”) measures the number of red blood cells, white blood cells and platelets in the blood. In addition to blood cell counts, tests to measure the values of many chemicals in the blood (such as a “metabolic panel”) can indicate how other parts of the body are functioning, including your liver, kidneys, heart and lungs. A metabolic panel is one test within a “chemistry panel” which are groups of tests that are ordered often to determine a person's general health status. The tests are done on a blood sample, usually from a vein in the arm. Blood cancers affect the body in different ways. If a doctor suspects a patient may have cancer, he or she may test the blood (or urine or tissues) for the presence of certain substances that could indicate cancer activity.

A number of factors can affect blood cell counts, including

- Illness or stress
- Medicines you take, especially chemotherapy agents
- Street drugs (for example marijuana or inhalants)
- Foods and beverages, including alcohol
- Intense exercise
- Smoking.

## How Blood Cancers Affect Blood Counts

Blood cancers can affect blood cell counts in a number of different ways. Measures may be lower or higher than usual depending on a number of factors. Be sure to talk with your doctor about your blood cell counts. If you are currently receiving cancer treatment, such as chemotherapy, drug therapy or radiation therapy, this will also affect your blood counts. Blood counts usually return to normal in between treatment cycles or after treatment is completed.

**Want more information?**



For more information about specific types of leukemia, lymphoma, myeloma, myelodysplastic syndromes and myeloproliferative neoplasms, please call our Information Specialists at (800) 955-4572 or visit [www.LLS.org](http://www.LLS.org).

# About Bone Marrow Tests

Blood cells (white blood cells, red blood cells, and platelets) are made in the marrow. Bone marrow tests allow doctors to look at the fluid (inner liquid part of the marrow also known as the spongy part of the bone) and tissue in the marrow to determine whether cancer or another disease is affecting blood cell production and/or the structure of the marrow. Marrow tests can help determine the type and extent of the disease. Certain changes to blood cells can be detected in marrow samples before they can be detected in blood samples.

Bone marrow aspiration (removal of the liquid part of the bone) and bone marrow biopsy are two tests that are usually done together. Samples of fluid, tissue and cells are examined under a microscope to look for chromosome changes (cytogenetic analysis) and other changes in the cells. These tests are also used to evaluate the response to cancer treatment by looking at whether marrow function is beginning to return to normal. Tests are often done in combination with another test, a white blood cell differential (also called “CBC plus differential” or “differential”).

Marrow samples may be used for immunophenotyping, a test that can be used to identify cells based on certain biomarkers on the cell’s surface. In some cases, blood samples are also used for cytogenetic testing, immunophenotyping and molecular testing. The test findings allow providers to further classify the type of abnormality, and monitor the patient's disease more sensitively for response to treatment.

# About Imaging Tests

Imaging or radiology tests create pictures of the chest, abdomen, head, neck and other parts of the body. These tests use different forms of energy (x-rays, sound waves, radioactive particles, or magnetic fields) that are passed through the body.

Examples of imaging tests include

- X-rays
- Ultrasound
- CT (computed tomography) scans
- MRI (magnetic resonance imaging)
- FDG-PET (fluorodeoxyglucose with positron emission tomography) scan.

Imaging tests are generally used to look for signs of disease or to check if the cancer (tumors or masses of cells) has spread to other areas, such as the lymph nodes, chest or lungs. Your doctor may order an imaging test “**with contrast**” to make certain organs and tissues in the body easier to see. Contrast medium is an

iodine dye and it may be swallowed, put into a vein in your arm, or placed in other parts of the body such as a joint or the rectum. Contrast dye is ordered for certain CT imaging to make the structures and organs easier to see on the CT pictures; it may be used to assess blood flow, find tumors or look for other problems. Images may be taken before the dye is administered and after the dye is administered to compare. You will get specific pretest instructions from your healthcare provider. For example, it's important that you do not move during an imaging test so the resulting pictures are clear. Be sure to tell your doctor if you are or might be pregnant, because many imaging tests use small amounts of radiation.

## Preparing for Tests

Many people feel some stress or anxiety about having a test or getting test results. It's important to

- Discuss any concerns that you may have with your doctor.
- Ask questions so that you understand why a specific test is being ordered and what to expect.
- Write down or record the answers to your questions; you may want to bring a friend or family member with you to write down the information.

You may have concerns or questions about

- The safety of the test
- Your comfort during and after the test
- Whether you need to do anything beforehand to prepare for the test
- Whether you will need someone to pick you up after the test
- How long you'll have to wait for the test results
- Whether you need to call for the results or if someone from your doctor's office will call you
- When you'll be able to discuss the test results with your doctor.

Many people are uncomfortable about having their blood drawn, getting injections (shots) or being in an enclosed space (a part of certain imaging tests). Make sure you discuss any concerns with your doctor or mention them to the staff member when you schedule your appointment. Parents often have to calm their child's fears about tests. For guidance, see the free LLS publication *Coping with Childhood Leukemia and Lymphoma*.

See *Questions to Ask Your Healthcare Provider About Lab and Imaging Tests* on page 39.

# Who's Who in Giving You Care?

There are a number of healthcare professionals involved with ordering and interpreting tests and explaining the results.

Healthcare professionals who play a role in your care may include a

- **General Surgeon**—a doctor who performs surgery and may perform a lymph node biopsy or other tissue biopsy (for example, removing a lymph node, part of a lymph node or other tissue from another part of the body to determine whether cancer or other disease is present). The surgeon may also be required during treatment, for example if your spleen needed to be removed.
- **Hematology Oncologist**—a doctor who is specially trained to diagnose and treat patients who have blood cancers
- **Hematopathologist**—a doctor-pathologist, board-certified in both anatomical and clinical pathology, who looks at peripheral blood smears, bone marrow aspirate and biopsy samples, lymph node biopsy and other tissue biopsy samples. Findings help to diagnose diseases such as blood cancers.
- **Nurse Practitioner**—a registered nurse who has additional education and training in how to diagnose and treat disease and who is qualified to assess, diagnose, prescribe care, medication and treatment to promote overall wellness and comfort to patients and their families. Nurse practitioners are licensed at the state level and certified by national nursing organizations. In cancer care, a nurse practitioner may manage the primary care of patients and their families, based on a practice agreement with a doctor. A nurse practitioner is also called an "advanced practice nurse," APN, and NP.
- **Oncology Nurse**—a health professional trained to care for people who are diagnosed with cancer
- **Pathologist**—a doctor who identifies disease by studying cells and tissues under a microscope
- **Radiologist**—a doctor trained to read imaging studies (for example, a CT scan or an MRI scan) to help diagnose and treat diseases
- **Radiology or Lab Technician**—a healthcare professional with special training to take images of a patient's body or to withdraw blood, based on a doctor's orders

Your doctor may order additional tests that require input from other specialists. For example, a patient may need to consult with a gastroenterologist or a nephrologist for a more complete evaluation.

- **Gastroenterologist**—a doctor with dedicated training in the diagnosis and management of diseases of the digestive tract and liver

- **Nephrologist**—a doctor who has special training in kidney diseases, kidney transplantation and dialysis therapy.

If a patient has cancer, his or her oncologist will coordinate care with other members of the healthcare team, including the patient's primary care doctor, to

- Determine whether additional tests are needed
- Work together with the patient to determine the best treatment plan.

A radiation oncologist, social worker, psychologist and/or nutritionist may also be a member of the healthcare team, depending on the patient's needs.

# Index of Tests

The following pages describe a number of tests used to detect or monitor blood cancers. It's important to talk with your doctor about each test you need, why the test has been ordered and what your results mean.

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# The Tests: Details



## Blood chemistry (chemistry panels)

### Why is the test done?

There are a number of tests, called “chemistry panels,” that provide information about a person’s general health. Depending on the type of panel, these tests may measure the body’s electrolyte balance (for example, sodium or potassium), protein, blood glucose (sugar), cholesterol or chemicals that indicate liver and kidney function.

Higher levels of certain proteins in the blood, including

- Albumin
- Beta<sub>2</sub>-microglobulin
- Immunoglobulins (IgM, IgG and others)
- Lactate dehydrogenase (LDH)

can be signs of disease severity (for example, size and growth rate of tumors).

Measures of uric acid levels and erythrocyte sedimentation rate (ESR) may also be important for your doctor to note. For example, certain diseases or treatments increase uric acid levels. Medications are given to reduce high uric acid levels.

Other chemicals in the body that are measured include

- Antibodies, including those we develop from our vaccinations (such as poliovirus antibodies)
- Hormones (such as thyroid hormone)
- Minerals (such as iron, calcium or potassium)
- Vitamins (such as B<sub>12</sub> or folate).

### How is it done?

For a blood chemistry test, blood is drawn from a patient’s vein and placed in an empty tube and usually allowed to clot. The fluid portion of the blood after clotting, called the “serum”, is then used for the various chemical studies. You may be asked to fast (not eat or drink) before getting your blood test. Be sure to ask your healthcare provider for any special instructions.



Lab Test



Imaging Test



Sedation or Anesthesia

## What do the results mean?

The results will give your healthcare team information about your overall health and identify potential problems that may need treatment. Higher levels of certain blood proteins, combined with other information, can help doctors determine the extent of a patient's disease.



### Blood smear

(also called **peripheral blood smear**, **manual differential**)

## Why is the test done?

A blood smear may be done when CBC results are abnormal or unclear and your doctor wants to take a closer look at the cells, or when he or she thinks that a disorder or disease may be disrupting normal blood cell production. This test helps determine whether red cells, white cells and platelets are normal in appearance and number. It is also used to determine the proportion of each type of white cell relative to the total white cell count. The results also help a doctor monitor cell production and cell maturity before and during blood cancer therapy.

## How is it done?

A single drop of blood is spread on a glass slide, dried, and then stained with a special dye. The sample is then examined under the microscope to calculate the number of each type of blood cell. The doctor will also compare the size, shape and general appearance of the sampled cells to “normal” cells.

## What do the results mean?

If results fall within the normal range, it means the blood cells are normal in shape, size, color and number. This test may show the presence of abnormal or immature cells, which may indicate an underlying condition, provide information about its severity and suggest the need for further testing.



Lab Test



Imaging Test



Sedation or Anesthesia



## Bone marrow aspiration and biopsy

### Why is the test done?

These tests are often done together. They help doctors take a close look at cells in the marrow and assess whether the blood cell production is normal. Bone marrow tests can provide information to

- Confirm a blood cancer diagnosis or a bone marrow disorder
- Determine the cause of severe anemia or thrombocytopenia (low platelet count)
- Look for chromosome abnormalities to assess risk and plan treatment
- Evaluate the appropriateness of certain medications, drugs or other treatments for a patient
- Help track a patient's progress during treatment for certain blood cancers.

### How is it done?

First, the patient gets medication to numb the skin (local anesthetic) then the local anesthetic is applied to the top of the bone surface. Some patients have light sedation before the test (check with your doctor to see if sedation or premedications may be given at your clinic/hospital). Then a special (hollow) needle is inserted through the patient's hip bone into the marrow to remove a sample of cells (aspiration [liquid part of the marrow]) or a very small amount of bone filled with marrow cells (biopsy). The collected cells are viewed under a microscope to see the types of cells and any changes to the cells.

Some patients may experience slight bone pain or discomfort either during or for a few days after the procedure. Other risks associated with this procedure include bleeding, a small risk for infection at the incision site and a small risk for nerve injury due to the location of the biopsy.

### What do the results mean?

Results give doctors information about the

- Patient's immune system
- Presence and extent of cancer or other disease
- Possible need to modify treatment.

The sample of cells can also be used for more specialized testing, including immunophenotyping, cytogenetic analysis, polymerase chain reaction (PCR) and other tests.



Lab Test



Imaging Test



Sedation or Anesthesia



## Chest x-ray

### Why is the test done?

A chest x-ray provides images of the chest, lungs, heart, large arteries, ribs and diaphragm. Doctors can use this type of x-ray to look for signs of disease, including infection or tumors. An abnormal collection of fluid seen on an x-ray might be a sign of infection or tumor.

### How is it done?

You will be asked to undress and put on a gown and remove all jewelry. You will be positioned in front of the machine. Usually two pictures are taken, one from the back of the chest and another from the side. You must hold your breath when the x-ray is taken. The technician will give you detailed instructions.

### What do the results mean?

A chest x-ray can show evidence of an infection, such as pneumonia or tuberculosis, a tumor or enlarged lymph nodes that cannot be felt during a physical exam, or other signs of internal injury. If the findings on the chest x-ray film are abnormal your doctor may ask you to get a more sensitive imaging test, such as a CT or an MRI scan, to better view the chest.



## Complete blood count (CBC)

### Why is the test done?

The CBC is a very common test that gives a general picture of a patient's health. A CBC is done to count the number of red cells, the different types of white blood cells (neutrophils, eosinophils, basophils, monocytes and lymphocytes) and platelets in the blood, and to measure levels of hemoglobin and hematocrit. Many health conditions cause increases or decreases in blood counts. A doctor may order a CBC on a regular basis to monitor a patient's condition or to track the response to treatment, if needed.

### How is it done?

A needle is inserted into a vein (usually in the fold of your arm) and a sample of blood is withdrawn. You may feel a slight pinprick. The blood is placed in a tube containing an anticoagulant (to prevent clotting) and sent to a laboratory where it will be examined by a pathologist. A sample of blood can also be obtained by



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a simple finger stick, depending on how many other tests need to be done at the same time. Dyes are added to the sample of blood so that different types of blood cells can be identified. The slide with the sample of blood cells is examined under a microscope to count the number of cells and to see whether they are normal or, if abnormal, the nature of the changes (see also **Blood smear** on page 16).

### What do the results mean?

Normal ranges vary slightly among different labs, so ask your healthcare provider to review the results with you. Results that are above or below normal ranges may signal health problems. For example, if a patient has anemia, he or she will have fewer red cells and a lower hemoglobin level than normal. Anemia may explain changes in energy levels or an inability to carry out everyday tasks. Low red blood cell counts may also be due to vitamin deficiency (for example, not getting enough folic acid and/or B<sub>12</sub>). High white blood cell counts may indicate a bacterial infection. A very low white blood cell count may mean a person is at increased risk for infection. If the platelet count is very low, a person may bleed or bruise more easily. Your doctor may use the terms “cytopenia” or “pancytopenia” (a reduction in the number of all main cell types in the blood); “anemia” (a decrease below normal in the number of red cells); “leukopenia” (a decrease below normal in the concentration of white cells also known as “leukocytes”); or “thrombocytopenia” (a decrease below normal in the number of platelets) to explain the test results.

See Table 1—*What Are Normal Blood Cell Counts?* on page 31, Table 2—*White Blood Cell (WBC) Differential* on page 32 and Table 3—*Noncancerous Conditions and High or Low Blood Cell Counts* on page 33.



### Computed Tomography (CT) scan

#### Why is the test done?

This type of imaging test is used to show a cross-section of the body (similar to looking into a loaf of bread by cutting the loaf into thin slices). CT scans are different from standard x-rays because CT creates a series of pictures taken from different angles and produces much clearer images. A CT scan of the chest or abdomen can help the doctor to detect an enlarged lymph node or cancers in the liver, pancreas, lungs, bones and spleen.

#### How is it done?

You will first be asked to undress, put on a gown and remove any jewelry or metal objects. The technician will then take you to the exam room and position you



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on the CT exam table, usually lying flat on your back. The table is connected to a doughnut-shaped machine, which is the scanner. The table will move through the hole in the middle of the scanner quickly to determine the correct starting position. When the actual scan begins, the machine will rotate around you taking a series of images. You may be asked to hold and release your breath during the scan. It is important that you hold still during the exam. The technician may use pillows or straps to help you hold still. A CT scan usually takes between 10 and 30 minutes. You may be asked to wait while the radiologist looks to see whether more images are needed. In some cases, you may be asked not to eat or drink for several hours before the exam. If this exam is for the abdominal area, laxatives, enemas or suppositories or a temporary change in what you eat and drink may be prescribed to cleanse the bowel before the scan. Your doctor may order a CT scan with contrast. If your scan is ordered with contrast dye, the dye will usually be injected into a vein in your hand or arm. If you've had a reaction to contrast dye or iodine in the past, let your doctor or the technician know. (See page 9 for more information about contrast dye.) Also, tell your doctor or the technician if you are anxious about being strapped down or confined in a small space. Some patients may be given a mild sedative before the test to help them relax.

### What do the results mean?

A CT scan may reveal signs of masses (tumors) or injuries to the body. The test may be repeated over time so that doctors can see how a tumor is responding to therapy or detect a possible return of the cancer after treatment is completed.



### FDG-positron emission tomography (FDG-PET) scan

### Why is the test done?

Tumor cells require more glucose to survive and multiply. FDG-PET is an imaging test that uses a radioactive glucose (sugar) molecule to produce images that show the metabolic (functional) activity of tissues. Because tumor cells consume significantly larger amounts of the glucose compared to normal cells in surrounding tissue, FDG-PET is an effective tool for detecting lymphoma and other cancers. The presence of FDG can be detected by PET imaging in tumors as small as one centimeter.

### How is it done?

For this procedure, the patient is injected with FDG, a molecule very similar to glucose (a type of sugar), but with a radioactive tracer (F-18) attached to it. It takes 30 to 60 minutes for the radioactive glucose to travel through the body and be absorbed by the organ or tissue being studied. The technician will then help



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position you on the exam table and move you into the PET scanner, and the imaging will begin. A PET scanner is a large doughnut-shaped machine with a round hole in the middle, similar to a CT scanner. You will need to remain very still during the test. Once the scan is over (in about 45 minutes), you may be asked to wait until the technician checks the images to make sure additional images are not needed. Some patients may be given a mild sedative before the test to help them relax. This test is painless. You may feel a cold sensation move up your arm when the radioactive tracer is injected into your arm, but there are generally no side effects. The amount of exposure to radiation is small. You usually have to fast (not eat) before the test to make sure your blood sugar level is not high.

### What do the results mean?

This test provides a very sensitive and relatively rapid assessment of a patient's response to therapy.

It can also

- Help to detect cancer
- Determine the extent of cancer that has already been diagnosed.

The value of this test in determining if cancer has returned once treatment has been completed is under study.



### Fine-needle aspiration

### Why is the test done?

This is a test in which cells and/or tissue is removed from a lump or mass (such as a lymph node) to examine the types of cells present. A fine-needle aspiration biopsy is performed to classify the type of tissue in a new lump or mass, assess the effect of treatment or to obtain tissue for special studies being conducted.

### How is it done?

The test is usually done in an operating room at a hospital or in an outpatient surgical facility. You will lie on the examination table. The skin over the biopsy site is cleansed, and a local anesthetic is injected (occasionally, a general anesthetic is given). You may also be given a mild sedative. To do the aspiration, the surgeon may use imaging equipment such as CT (computed tomography) and/or ultrasound to locate the precise area to be sampled. During this procedure, a very thin needle will be used to remove cells/tissue from the mass being biopsied. You will notice that the needles may



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be inserted and withdrawn several times. There are many reasons for this:

- One needle may be used as a guide, with the other needles placed along it to achieve a more precise position.
- Sometimes several passes may be needed to obtain enough cells for the intricate tests performed by the cytopathologists (pathologists who study and diagnose diseases on the cellular level).
- When the mass is small, several passes may be necessary to properly position the needle tip.

### **What do the results mean?**

The examination of the cells and tissue may show cancerous or noncancerous tumors, it may also show the presence of inflammation or infection.



### **FISH (fluorescence in situ hybridization)**

#### **Why is the test done?**

Cytogenetic analysis by FISH is a highly sensitive lab test used to check for chromosome changes in blood cancer cells that are associated with specific blood cancers and genetic disorders. If abnormal cytogenetics are detected, your doctor may use this test to monitor for residual disease and to see if the treatment is working. This is done by measuring the number of cells with abnormal chromosomes that remain following treatment (cytogenetic response). FISH can provide doctors with more information than they can obtain from looking at single cells under a microscope.

#### **How is it done?**

Blood or marrow may be used for FISH testing. Samples are collected through blood or bone marrow tests. Usually, FISH testing is done every three to six months, but testing frequency may decrease when a complete cytogenetic response occurs.

#### **What do the results mean?**

FISH helps provide more information about different blood cancers that may have different genetic abnormalities and, therefore, may require different treatment. After treatment begins, this test can be used to measure treatment response and monitor for residual disease.



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## Flow cytometry

### Why is the test done?

This test is a method of measuring the number of cells in a sample, the percentage of cells in a sample and certain characteristics of cells, such as size, shape and the presence of biomarkers on the cell surface. The cells are stained with a light-sensitive dye, placed in a fluid stream and passed through a laser or other type of light. The measurements are based on how the light-sensitive dye reacts to the light.

Flow cytometry is used to find out if a high lymphocyte count is the result of a blood cancer. If leukemia, lymphoma or myeloma cells are present, this test can be used to obtain specific information about the type of cell that is present. Each disease subtype has a specific pattern of biomarkers on the cell surface. Collected cells are tagged with an antibody that is specific for a site on the cell surface. Then the cells can be detected when they flow through the instrument (called a “flow cytometer”). The cells light up when they pass through a laser beam. For example, myeloid leukemia cells can be distinguished from lymphocytic leukemia cells. Normal lymphocytes can be distinguished from abnormal lymphocytes.

Flow cytometry can also detect residual levels of disease after treatment. This helps doctors to identify disease relapse and restart treatment as needed.

### How is it done?

Blood or marrow samples are obtained and then examined to see how fast the tumor cells are reproducing and whether the tumor cells contain a normal or an abnormal amount of DNA. Cells carrying their array of antigens and tagged with specific antibodies can be identified as they pass through the flow cytometer.

### What do the results mean?

Flow cytometry is used to find out if cancer is causing a high white blood cell (lymphocyte) count. Additional lab tests are done after a flow cytometry test shows that the patient has cancer. This approach allows doctors to subclassify cell types; that classification may, in turn, help the doctor to decide on the best treatment to apply in a particular type and subtype of blood cancer.



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## Karyotype test

### Why is the test done?

A karyotype test is used to identify and evaluate any changes to the expected arrangement, size, shape and number of chromosomes in a sample of cells. This test provides a map of the 46 human chromosomes of a cell in 22 matched pairs (maternal and paternal member of each pair) by length from longest to shortest and other features. These 22 pairs are referred to as “autosomes.” The sex chromosomes are shown as a separate pair (either XX or XY). In some cases, a dye called “Giemsa” may be used as a stain to make the banding pattern of chromosome pairs easier to see. This is also referred to as “G-banding.”

### How is it done?

Usually a blood sample taken from a vein is used for the test, but a marrow sample can also be used. Test results are usually available within one to two weeks. See **Complete blood count (CBC)** on page 18 and **Bone marrow aspiration and biopsy** on page 17 for more information.

### What do the results mean?

Having more or fewer than 46 chromosomes, changes in the size or shape of chromosomes or broken pairs of chromosomes may be insignificant or these findings may signal a positive or negative risk in the context of a diagnosis. That information may help the doctor develop a more specific treatment plan.



## Lymph node biopsy

### Why is the test done?

This is a test in which all or part of a lymph node is removed to see whether cancer cells are present. If they are, a precise diagnosis is needed because treatment differs for various types of blood cancers. Surgery is used to obtain the lymph node sample because it gives the pathologist or hematopathologist more tissue to look at. A pathologist or hematopathologist examines the lymph node tissue to determine if there are abnormalities and to determine the type(s) of cells present in the sample. A second opinion from another pathologist or hematopathologist may be necessary to make an accurate diagnosis. For example, a biopsy of an involved lymph node (or sometimes another tumor site) is used to make a diagnosis of various types of lymphoma.



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## How is it done?

The test is usually done in an operating room at a hospital or in an outpatient surgical facility. You will lie on the examination table. The skin over the biopsy site is cleansed, and a local anesthetic is injected (occasionally, a general anesthetic is given). You may also be given a mild sedative. To do the biopsy, the surgeon makes a small incision to remove part or all of the enlarged lymph node. Once the sample of tissue is removed, the surgeon will close the opening with stitches. There is usually limited or no scarring.

## What do the results mean?

The examination of the tissue may show cancerous or noncancerous tumors, or the presence of infection.



## Magnetic resonance imaging (MRI)

## Why is the test done?

An MRI provides detailed pictures of internal organs, soft tissues, blood vessels and bones. Pictures from an MRI scan can show signs of disease (tumors and masses of cells). An MRI can also detect bone changes that characterize some forms of cancer (for example, myeloma) earlier than conventional x-ray studies.

The MRI machine is shaped like a tunnel and produces images of the body using

- A large magnet
- Radio waves
- A computer.

## How is it done?

An MRI may be contraindicated in certain individuals. If you are claustrophobic, unable to lie flat on your back for two hours, or if you have any internal surgical devices such as implants or metal hardware from past surgical procedures, talk with your doctor.

You will be asked to leave jewelry and other accessories at home, if possible, or remove them prior to the MRI scan, as they can interfere with the test. In the exam room you will lie on a table. This table slides into the MRI machine. As with other imaging tests, you will need to stay very still. An MRI may be done either with or without contrast dye depending on the type of imaging needed. If your scan is ordered with contrast dye, the dye will usually be injected into a vein in your hand or arm. If you've had a reaction to contrast dye or iodine in the past,



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let your doctor or the technician know. (See page 9 for more information about contrast dye.) The technician will position you in the machine. Multiple images will be taken, and you will hear a series of loud knocking sounds. The MRI usually takes between 15 and 45 minutes, depending on the area being scanned. Some patients may be given a mild sedative before the test to help them relax. Having the test with an open MRI machine may be another option.

### What do the results mean?

Images can reveal tumors or masses of cells.



### Polymerase chain reaction (PCR)

#### Why is the test done?

PCR is a very sensitive test that can measure the presence of certain biomarkers in blood or marrow cells. It is used to measure any remaining blood cancer cells that are not found by cytogenetic methods (for example, FISH). PCR is used to diagnose and check a patient's molecular response to treatment.

PCR is used for patients with blood cancers that have a specific DNA abnormality or marker that can be detected by PCR (dependent on the availability of a specific DNA-probe). PCR tests are done in cases of acute promyelocytic leukemia [to detect PML-RARA t(15;17)] and in cases of chronic myeloid leukemia (CML) [to detect (BCR-ABL t(9;22)], for example.

Interest in using a standardized scale for PCR in CML patients is increasing, but using this scale is not yet in common practice in the United States. Since labs still do not use a standard scale, it is important for testing to be done at the same lab over time since each lab may be using a different standard to evaluate a patient's *bcr/abl*.

#### How is it done?

Blood or marrow may be used for PCR testing. Samples are collected through blood or bone marrow tests.

#### What do the results mean?

PCR allows more sensitive follow-up of patients who are in remission and can help determine whether additional treatment is necessary.



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## Protein Electrophoresis

### Why is the test done?

Serum Protein Electrophoresis (SPEP) and Urine Protein Electrophoresis (UPEP) are tests used to identify the presence of abnormal proteins or the absence of normal proteins and to determine increases and decreases of different groups of proteins in blood or urine. These tests can detect and identify excessive production of specific proteins (immunoglobulins), including IgG, IgA, IgM, IgE, or IgD. If present, an excessive production of a monoclonal immunoglobulin may be shown on lab results as a spike on a graph. Protein electrophoresis may be ordered to help in the diagnosis of a disease or to monitor treatment.

### How is it done?

For a SPEP test, blood is drawn from a patient's vein and placed in an empty tube. For a UPEP test, a 24-hour urine collection is used. You may be asked not to eat or drink for 12 hours before an electrophoresis test. Your health care provider may ask you to stop taking drugs that could affect the test. Do not stop taking any medications without first talking to your healthcare provider.

### What do the results mean?

Protein electrophoresis tests give your doctor rough estimates of the amount of specific proteins present and whether any abnormal proteins are present. Certain conditions or diseases may be associated with decreases or increases in various proteins.

These tests may be repeated at regular intervals to monitor the course of the disease and measure the effectiveness of certain disease-specific treatments.



## Spinal tap (also called lumbar puncture)

### Why is the test done?

This procedure is used to collect and look at the cerebrospinal fluid (CSF) surrounding the brain and spinal cord to check for the presence of disease or injury. In particular, a spinal tap can tell doctors whether there are blood cancer cells in the CSF, if there is abnormal protein or glucose, and if there are bacteria or viruses in the CSF. The pressure in the fluid surrounding the brain and spinal cord also can be measured, providing important information in some cases.



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## How is it done?

During a spinal tap (lumbar puncture) you will generally be asked to lie on your side with your knees pulled up toward your chest. It's important to stay in this position and to avoid moving. A special needle is then carefully inserted between two vertebrae in the lower back and then into the spinal canal. The area will be numbed with a local anesthetic, but you may feel some pressure. Once the needle is properly positioned, spinal fluid pressure is measured, and fluid is collected. It usually takes several minutes to get the sample of fluid. Once the needle is removed, a bandage will be placed on the site. The fluid is then sent to the lab for analysis. Sometimes special x-rays are used to help guide the needle into the proper position. This is called "fluoroscopy." Most spinal taps are done without any problem. In rare instances, patients report experiencing headaches, infection or bleeding after the procedure.

## What do the results mean?

A spinal tap may provide evidence of blood cancer cells or infection.



## Ultrasound (also called sonography)

## Why is the test done?

This imaging test uses high-frequency sound waves to create rather precise images of internal organs, tissue and blood flow in the body. Unlike other imaging tests (x-ray, CT), ultrasound does not use radiation. Ultrasound can be used to look for cysts, tumors, organ damage following illness and other problems. It helps doctors evaluate symptoms such as

- Pain
- Swelling
- Infection.

## How is it done?

A lubricant (jelly) is applied to the area being studied to help the technician slide the handheld instrument across the skin. This instrument transmits sound waves to create pictures. Ultrasound is commonly used by an obstetrician who wants to look at a pregnant woman's developing baby or when a cardiologist (heart specialist) wants to look at the heart pumping.

The technician will move the device around the area being studied while viewing and capturing different images on the screen. For some scans your doctor may ask you not to eat or drink for up to 12 hours before the test. For others you may



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be asked to drink up to eight glasses of water one to two hours before the exam and not to urinate, so that your bladder is full for the scan.

### What do the results mean?

The radiologist will look for signs of abnormalities, especially lumps or thickening tissue, in the area(s) being studied.



### Urine test (also called **urinalysis**)

#### Why is the test done?

A urine test is used to measure levels of proteins, blood cells and chemicals that may be found in the urine. This test can provide information about how your body is functioning and is often used to help diagnose kidney and bladder infections and other diseases. Urine is a filtrate of the blood. In other words, your kidneys filter the blood in your body and produce urine. As a result, many things that show up in the blood are seen in your urine as well.

#### How is it done?

You will be asked to urinate into a sterile container. The urine sample is either tested in the doctor's office using chemically treated paper or sent to a laboratory for analysis.

#### What do the results mean?

High levels of calcium in the urine may mean low blood calcium levels, which can contribute to weakness, loss of appetite, nausea, confusion, lethargy and other symptoms. Abnormal proteins in the urine may indicate a number of disease states. Discuss your specific results with your doctor.



### White blood cell differential (also called **CBC plus differential**, or **differential**)

#### Why is the test done?

The body produces different types of white cells. A white blood cell differential is often included as part of the CBC, to measure the amount of each type of white cell (also called "leukocyte") in the blood. This test helps determine the body's ability to react to and fight infection. It can also identify various types and stages of blood cancers, detect the existence and severity of infections and measure a patient's response to chemotherapy.



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**How is it done?**

This test is done by determining the percentage of the different types of white cells from a sample obtained from a blood draw and seen on a stained blood slide. The pathologist is also able to tell whether the white cells in the blood are normal in appearance.

**What do the results mean?**

The results indicate the percentage of each type of white cell that is present. Abnormal patterns of white cells may point to infections, leukemia, immune disorders, inflammation and other problems. The doctor may mention the absolute neutrophil count (ANC), which is the number of neutrophils (a type of white cell) a person has in his or her blood that will fight an infection.

See Table 1—*What Are Normal Blood Cell Counts?* on page 31 and Table 2—*White Blood Cell (WBC) Differential* on page 32.



# Table 1—What Are Normal Blood Cell Counts?

Blood counts should fall within an established range of normal in healthy men and women. The cell counts are compared to those of healthy individuals of similar age and sex. Nearly all lab reports make it easier to understand test results by including a “normal” range or high and low “values.” If a certain cell count is either higher or lower than normal, your doctor will try to determine the reason(s).

The approximate normal ranges of blood cell counts for healthy adults are as follows:

Blood Cell Counts				
Red Blood Cells (per microliter [μL] of blood)	White Blood Cells (per microliter [μL] of blood)	Platelets (per microliter [μL] of blood)	Hematocrit (% of blood composed of red cells)	Hemoglobin (substance in red blood cells that carries oxygen) (grams per deciliter [g/dL])
Men				
4.7–6.1 million	5,000–10,000	150,000–400,000	42%–52%	14–18
Women (who are not pregnant)				
4.2–5.4 million	4,500–11,000	150,000–400,000	37%–47%	12–16
Children*				
4.0–5.5 million	5,000–10,000	150,000–400,000	32%–44%	9.5–15.5

\*These ranges are for children from infancy to adolescence, so be sure to speak with your doctor to find out specific values for infants and young children.

Note: The ratio of hematocrit to hemoglobin is about 3 to 1.

# Table 2—White Blood Cell (WBC) Differential

This test can be used to look for diseases that affect the white cells, such as blood cancers.

Type of White Blood Cell Measured	Blood Contains What %?
Neutrophils	55%–70%
Band neutrophils	0%–3%
Lymphocytes*	20%–40%
Monocytes	2%–8%
Eosinophils	1%–4%
Basophils	0.5%–1%

\*Until children are over 4 years of age, they have a higher percentage of lymphocytes in their blood than adults.

# Table 3—Noncancerous Conditions and High or Low Blood Cell Counts

Many symptoms of cancer are also symptoms of other common and often more benign diseases. Here are some other examples of noncancerous conditions that might cause high or low red cell, white cell or platelet counts. Treatment with chemotherapy and/or radiation therapy for cancer can also affect blood counts. These usually return to normal in between treatments or once treatment is completed.

	High Counts	Low Counts
Red Cells	Smoking, exposure to carbon monoxide, long-term lung disease, kidney disease, certain forms of heart disease, alcoholism, liver disease or conditions that affect the body's fluid level	Anemia, due to too little iron, folic acid or vitamin B <sub>12</sub> ; bleeding; inflammatory bowel disease; other diseases that might cause malnutrition; certain medicines
White Cells	Infection, inflammation, severe physical or emotional stress (such as a fever, injury, or surgery), burns, kidney failure, lupus, rheumatoid arthritis, malnutrition, thyroid problems, certain medicines	Infection, chemotherapy and other medicines, malaria, alcoholism, AIDS, lupus, enlarged spleen
Platelets	Bleeding, mild to moderate iron deficiency, problems with bone marrow function	Pregnancy, idiopathic thrombocytopenic purpura, other autoimmune diseases, thrombotic thrombocytopenic purpura, hemolytic uremic syndrome

# Keeping Track of Test Results

Needing tests and waiting for test results can cause anxiety for most people. Remember, many of the tests described in this booklet are also used to identify and track other more common conditions. And no single test result provides all the answers. Most results need to be considered along with other reports and within the context of your overall health. If someone has a blood cancer, the lab and imaging tests are important tools that help the members of the healthcare team identify problems early and, if needed, direct treatment decisions for individual patients.

Here are some helpful tips to get organized and manage your health:

- Ask your doctor why certain tests are being done and what to expect.
- Discuss test results with your healthcare provider. Understanding these results can help you be an active partner in your care. For blood tests, ask your nurse or doctor to review your measures and how they compare to the lab's normal ranges.
- Find out whether additional follow-up tests are needed and when. Follow-up tests and appointments are sometimes needed to make sure health problems are identified early on and to make sure a patient is responding to treatment. These appointments also provide an opportunity to talk with your providers about any health concerns or questions you may have.
- Depending on the type of test and why it has been ordered, you may want to bring someone with you to listen, help ask questions and take notes. He or she can also provide emotional support.
- Ask for and keep copies of lab reports from your healthcare providers. You might consider creating your own file folder or three-ring binder. Some people prefer to use online or mobile tracking tools. Choose a system that works best for you. Be sure to organize test reports chronologically (by date) so they are easy to find. Starting a folder or binder will help you
  - Keep all of your test results and health information in one place
  - Compile information from different doctor's offices
  - Play an active (and more informed) role in your care
  - Refer to reports when talking with members of your healthcare team or caregivers
  - Track trends or changes over time. For example, decreasing levels of B<sub>12</sub>, iron or folate can play a role in anemia (low red blood cell production).

As you organize your health records, you'll save time and feel more knowledgeable about your health.

# Medical Terms

**Absolute neutrophil count (ANC).** The number of neutrophils (a type of white cell) that a person has to fight infection. It is calculated by multiplying the total number of white blood cells by the percentage of neutrophils.

**Albumin.** A protein made in the liver. Low levels of albumin can signal illness, including liver or kidney disease.

**Anemia.** Decrease in the hematocrit concentration and hemoglobin levels in the blood.

**Basophil.** A type of white cell that participates in certain allergic reactions.

**Beta<sub>2</sub>-microglobulin.** A cell protein found in the blood. A high level of beta<sub>2</sub>-microglobulin may be a sign of faster-growing disease.

**Biomarkers (cancer cell markers, tumor markers).** Chemicals or structures present either on the surface of or within cells or in the serum. They may aid doctors in determining when treatment (and which type of treatment) is needed by identifying disease that will progress more rapidly and/or have a better or worse response to certain treatments. Examples of biomarkers are gene expression, serum protein levels and chromosome abnormalities in cancer cells. No single feature can accurately predict disease progression in a patient; therefore, doctors use a combination of factors to make a diagnosis and a treatment plan.

**Central line.** A special tube inserted into a large vein in the upper chest. The central line, sometimes referred to as an “indwelling catheter,” is tunneled under the skin of the chest to keep it firmly in place. The external end of the catheter can be used to administer medications, fluids or blood products or to withdraw blood samples. With meticulous care, central lines can remain in place for long periods of time (many months) if necessary. They can be capped and remain in place in patients after they leave the hospital, and be used for outpatient chemotherapy or blood product administration. Several types of catheters (for example, Groshong®, Hickman®, and Broviac®) can be used for patients receiving intensive chemotherapy or nutritional support.

**Chemotherapy.** Treatment with drugs or medicines that kill or damage cancer cells.

**Chromosomes.** Parts of each cell that carry genes. Genes give instructions that tell each cell what to do.

**Clinical trials.** Carefully planned and monitored research studies, conducted by doctors. The goal of clinical trials for blood cancers is to improve treatment and quality of life and to increase survival. A treatment that is proven safe and effective in a clinical trial is often approved by the U.S. Food and Drug Administration (FDA) for use as a standard treatment if it is more effective or has fewer side effects than the current standard treatment.

**Complete cytogenetic response.** A response to treatment in which there are no cancer cells in the marrow that can be detected by FISH.

**Complete hematologic response.** A response to treatment in which the number of cancer cells is decreased, immature cancer cells are mostly eliminated from the blood and the hemoglobin concentration, white blood cell counts and platelet counts are at either normal or near-normal values.

**Complete molecular response.** A response to treatment in which polymerase chain reaction (PCR) testing reveals no evidence of cells containing cancer genes (oncogenes).

**Contrast dye.** A substance used during certain types of imaging tests to help distinguish between different body tissues and to clarify test findings. It is usually injected into a vein or given by mouth before the test. Contrast dyes are also called “contrast agents.”

**Cytogenetic analysis.** The examination of the chromosomes of cancer cells to give doctors information about how to treat patients. Cell samples may be taken from blood or marrow.

**Eosinophil.** A type of white cell that participates in allergic reactions and helps fight certain parasitic infections.

**Erythrocyte sedimentation rate (ESR).** See Sedimentation rate.

**Fluorodeoxyglucose (FDG).** A substance that is similar to glucose (a type of sugar) with a radioactive tracer (F-18) attached to it. FDG is injected into a patient’s blood, and its activity in the body is traced using a PET scan. Because tumor cells consume significantly larger amounts of glucose than normal cells in surrounding tissue do, FDG-PET is an effective tool for detecting lymphoma and other cancers.

**Gene expression profiling.** A test that can help identify cancer subtypes and risk factors to predict treatment response and increased risk for relapsed disease. See Microarray.

**Hematocrit.** The amount of blood that is occupied by red cells.

**Hemoglobin.** A protein that carries oxygen inside the red cells to other tissues and cells in the body.

**Immune system.** Cells and proteins that defend the body against infection. Lymphocytes, lymph nodes and the spleen are parts of the body’s immune system.

**Immunity.** The ability to resist infection.

**Immunoglobulins.** Proteins that help the body fight infection. Low levels of immunoglobulins, which are also called “gamma globulins” or abbreviated as “Ig,” may be a cause of repeated infections in some patients (for example, those with chronic lymphocytic leukemia). The major classes of immunoglobulins are IgG, IgA, IgM and IgE.

**Immunophenotyping.** A lab test that can determine the specific type of cell in a sample of blood cells, marrow cells or lymph node cells. For example, immunophenotyping can be used to find out if the patient’s lymphocytic leukemia cells are B cells or T cells.

**Lactate dehydrogenase (LDH or LD).** A protein found in tissue cells that is released into the bloodstream when cells are damaged or destroyed. High levels of LDH may be a sign of tissue damage and some cancers and other diseases.

**Lymph nodes.** Small bean-shaped organs around the body that are part of the body’s immune system.

**Leukocytes.** See White cells.

**Lymphocyte.** A type of white blood cell. There are three major types of lymphocytes: T cells, B cells and natural killer cells. These cells help fight infection.

**Macrophage.** See Monocyte.

**Marrow.** The spongy material in the center of bones where blood cells are made.

**Microarray.** A two-dimensional grid of molecules (often but not always DNA genes or gene fragment spots), usually arranged on a glass slide or silicone wafer. A typical microarray, also called “DNA-gene chip,” contains 10,000 to 200,000 microscopic DNA spots. A microarray is used by scientists to study gene expression and to learn which genes are expressed and not expressed under given circumstances. See Gene expression profiling.

**Microliter (μL) of blood.** A measurement used for some blood test results. One μL is about one-millionth of a quart of blood.

**Monocyte (macrophage).** A type of white blood cell that represents about 5 to 10 percent of the cells in normal human blood. The monocyte and the neutrophil are the two major microbe-eating and microbe-killing cells in the blood. When monocytes leave the blood and enter the tissue, they are converted to macrophages. The macrophage is the monocyte-in-action, and it can combat infection in the tissues, ingest dead cells (in this function it is called a “scavenger cell”) and assist lymphocytes in their immune functions.

**Neutrophil.** The principal phagocyte (microbe-eating cell) in the blood. This blood cell is the main cell that combats infection. Often, it is not present in sufficient numbers in patients with myelodysplastic syndromes or after chemotherapy, thus

increasing the patient's susceptibility to infection. A neutrophil may be called a "poly" (for "polymorphonuclear") or "seg" (for "segmented nucleus").

**Platelets.** Small cells (about one-tenth the volume of red cells) that stick to the site of blood vessel injury, aggregate with each other and seal off the injured blood vessel to stop bleeding.

**Polymerase chain reaction (PCR).** A sensitive lab test that can measure the presence of certain types of biomarkers in the blood or marrow. PCR is used to detect remaining cancer cells that cannot be detected by other tests.

**Port.** A small device that is used with a central line to access a vein. The port is placed under the skin of the chest. To take blood samples (or to give medicines or nutrition) the doctor or nurse puts a needle through the skin into the port. A numbing cream can be put on the skin before the port is used.

**Radiation oncologist.** A doctor who is specially trained to use radiation to treat various types of cancer.

**Red cells.** Blood cells (erythrocytes) that carry hemoglobin, which binds oxygen and carries it to the tissues of the body. The red cells make up about 40 to 45 percent of the volume of the blood in healthy individuals.

**Relapse (recurrence).** A return of the disease after it has been in remission following treatment.

**Remission.** No sign of the disease and/or a long time span when the disease is not causing any health problems for the patient.

**Sedimentation rate.** A blood test that measures how quickly red cells (erythrocytes) settle in a test tube in one hour. A sedimentation rate test is done to find out if inflammation is present in the body, check on the progress of a disease or see how well a treatment is working. This test is also called a "sed rate" or an "erythrocyte sedimentation rate (ESR)."

**Serum.** The portion of blood without cells.

**Thrombocytopenia.** A decrease below normal in the concentration of blood platelets.

**Watch and wait (watchful waiting).** A treatment plan for patients with certain blood cancers that are either not growing or slow-growing and who have no symptoms of their blood cancer. Patients in watch and wait need periodic medical exams and tests to monitor their disease. They may not need treatment for a long time after diagnosis.

**White cells.** A synonym for leukocytes. There are five major types of white cells in the blood: neutrophils, eosinophils, basophils, monocytes and lymphocytes.



# Questions to Ask Your Healthcare Provider About Lab and Imaging Tests

Asking your healthcare provider questions can help you understand why a certain test is being done and will help you take an active role in managing your (or your child's) care. If you do not understand any part of the information your healthcare provider gives you, ask him or her to explain it in another way. Bring these questions with you to your healthcare appointment or have them on hand if you are speaking to your healthcare provider by phone.

Doctor's name \_\_\_\_\_

Date of appointment or call \_\_\_\_\_

1. Why is the test being done? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

2. How and where is the test done? Is it painful? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

3. Will I be able to go back to work (go to school) after the test? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

4. Do I need to bring someone with me? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

5. How do I contact you if I have questions before/after the test? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

6. I/my child gets nervous about having blood drawn or getting a needle. Is there anything you can suggest to help ease this anxiety? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

7. I/my child gets nervous about being in enclosed spaces. Is there anything you can suggest to help ease this anxiety? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
8. Are there any potential side effects from the test? Are there things I can do to make sure I/my child is comfortable and properly protected during the test?  
\_\_\_\_\_  
\_\_\_\_\_
9. How accurate is the test? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
10. Will the cost of this test be covered by my healthcare plan? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
11. How soon will I get the results? Will you contact me? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
12. What do my/my child's results show? How do these results compare to "normal?" \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
13. Will these results affect my/my child's treatment? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
14. Are there additional tests that will be needed before starting therapy?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

15. Where and when will these tests need to be repeated? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
16. Will I/my child need additional tests or special monitoring for other medical conditions that might complicate treatment? (Examples are diabetes, high blood pressure, previous history of cancer.) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
17. Can I have a copy of the test results? Will you send copies of your notes and the test results to my family doctor (pediatrician)? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
18. How will I know when I/my child has a complete response to treatment? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
19. What type of follow-up tests will be needed? Will your office send me reminders for follow-up visits and tests? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
20. How often will I/my child need to get blood and/or marrow tests after treatment? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
21. Are there specific tests that you recommend after treatment is completed to check for any long-term and late effects of my/my child's treatment? When and how often are these tests needed? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

To print additional copies of *Questions to Ask Your Healthcare Provider About Lab and Imaging Tests* or to print other question guides, visit [www.LLS.org/whattoask](http://www.LLS.org/whattoask).



## Notes

## Notes



**someday  
is today®**

## REACH OUT TO OUR **INFORMATION SPECIALISTS**

**The Leukemia & Lymphoma Society's (LLS) Information Specialists provide patients, families and healthcare professionals with the latest information on leukemia, lymphoma and myeloma.**

Our team consists of master's level oncology social workers, nurses and health educators who are available by phone Monday through Friday, 9 am to 9 pm (ET).

### **Co-Pay Assistance**

LLS's Co-Pay Assistance Program helps blood cancer patients cover the costs of private and public health insurance premiums, including Medicare and Medicaid, and co-pay obligations. Support for this program is based on the availability of funds by disease.

**For more information,  
call 877.557.2672 or  
visit [www.LLS.org/copay](http://www.LLS.org/copay).**



**For a complete directory of our patient services programs, contact us at**

**800.955.4572 or [www.LLS.org](http://www.LLS.org)**

*(Callers may request a language interpreter.)*



For more information, please  
contact our Information Specialists  
800.955.4572 (Language interpreters  
available upon request)  
[www.LLS.org](http://www.LLS.org)

or:

**National Office**

3 International Drive, Suite 200  
Rye Brook, NY 10573

**Our Mission:**

Cure leukemia, lymphoma, Hodgkin's disease and myeloma, and improve the quality of life of patients and their families.

LLS is a nonprofit organization that relies on the generosity of individual, foundation and corporate contributions to advance its mission.