Lung Cancer

What Is Lung Cancer?

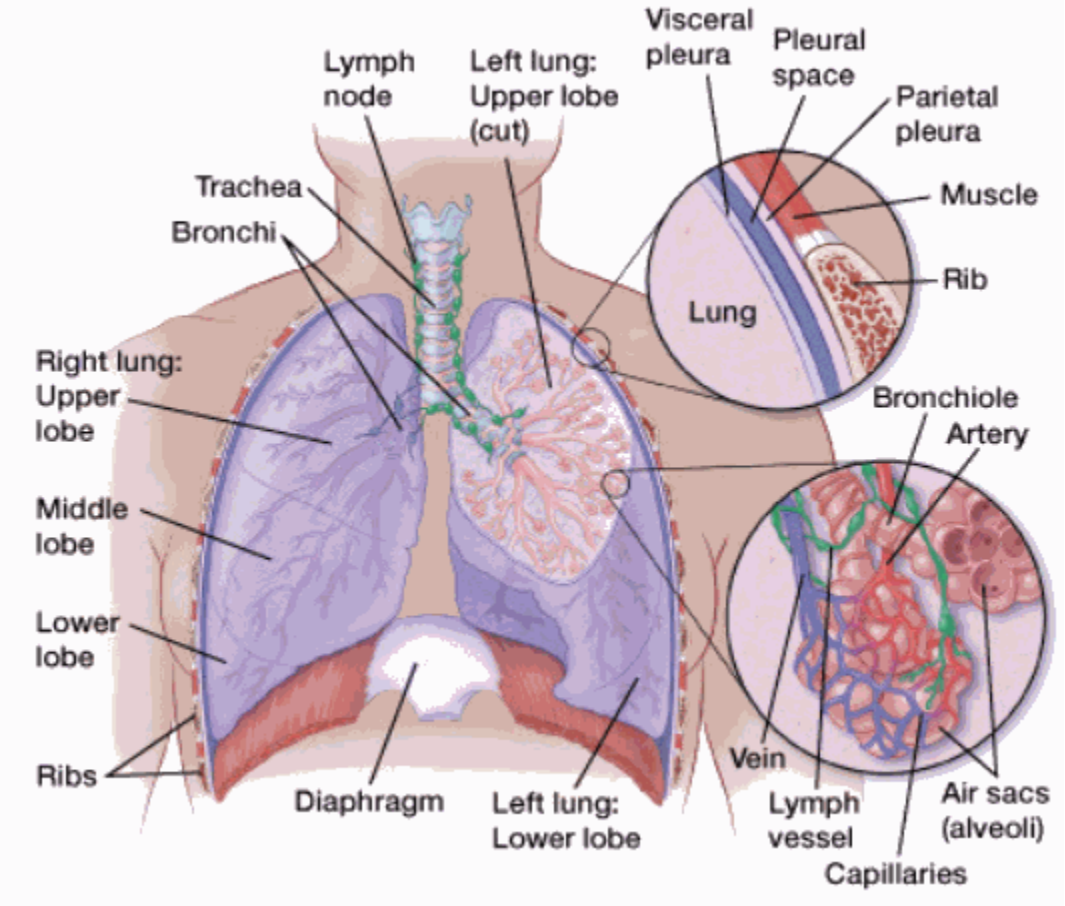
Lung cancer is a type of cancer that starts in the lungs.

Normal structure and function of the lungs

Your lungs are 2 sponge-like organs in your chest that are separated into sections called **lobes**. Your right lung has 3 **lobes**. Your left lung has 2 lobes. The left lung is smaller because the heart takes up more room on that side of the body.

When you inhale (breathe in), air enters through your mouth or nose and goes into your lungs through the **trachea** (windpipe). The trachea divides into tubes called **bronchi**, which enter the lungs and divide into smaller bronchi. These divide to form smaller branches called **bronchioles**. At the end of the bronchioles are tiny air sacs known as **alveoli**.

The alveoli absorb oxygen into your blood from the inhaled air and remove carbon dioxide from the blood when you exhale (breathe out). Taking in oxygen and getting rid of carbon dioxide are your lungs' main functions.



A thin lining layer called the **pleura** surrounds the lungs. The pleura protects your lungs and helps them slide back and forth against the chest wall as they expand and contract during breathing.

Below the lungs, a thin, dome-shaped muscle called the **diaphragm** separates the chest from the abdomen. When you breathe, the diaphragm moves up and down, forcing air in and out of the lungs.

Types of lung cancer

The main types of lung cancer are: non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC).

Non-small cell lung cancer (NSCLC)

About 80% to 85% of lung cancers are NSCLC. The main subtypes of NSCLC are adenocarcinoma, squamous cell carcinoma, and large cell carcinoma. These subtypes, which start from different types of lung cells, are grouped together as NSCLC because their treatment and prognoses (outlooks) are often similar.

Adenocarcinoma: Lung adenocarcinoma starts in cells in the lung that make mucus, called epithelial cells. Epithelial cells line the surface of the lungs. Adenocarcinoma is the most common type of non-small cell lung cancer

Lung adenocarcinoma occurs mainly in people who smoke or used to smoke, but it is also the most common type of lung cancer seen in people who don't smoke. It is more common in women than in men, and it is more likely to occur in younger people than other types of lung cancer.

Squamous cell carcinoma: Squamous cell carcinoma starts in squamous cells, which are flat cells that line the inside of the airways in the lungs. They are often linked to a history of smoking and tend to be found in the central part of the lungs, near a main airway (bronchus).

Large cell (undifferentiated) carcinoma: Large cell carcinoma can appear in any part of the lung. It tends to grow and spread quickly, which can make it harder to treat. A subtype of large cell carcinoma, known as **large cell neuroendocrine carcinoma (LCNEC)**, is a fast-growing cancer that is very similar to small cell lung cancer.

Other subtypes: A few other subtypes of NSCLC, such as adenosquamous carcinoma and sarcomatoid carcinoma, are much less common.

Small cell lung cancer (SCLC)

About 10% to 15% of all lung cancers are SCLC.

This type of lung cancer tends to grow and spread faster than NSCLC. In most people with SCLC, the cancer has already spread beyond the lungs at the time it is diagnosed. Since this cancer grows quickly, it tends to respond well to chemotherapy and radiation therapy. Unfortunately, for most people the cancer will return at some point.

Other types of lung tumors

Along with the main types of lung cancer, other tumors can develop in the lungs.

Lung carcinoid tumors: Carcinoid tumors of the lung account for fewer than 5% of lung tumors. Most of these grow slowly. For more information about these tumors, see Lung Carcinoid Tumor.

Other lung tumors: Other types of lung cancer, such as adenoid cystic carcinomas, lymphomas, and sarcomas, as well as benign lung tumors such as hamartomas, are rare. These are treated differently from the more common lung cancers and are not discussed here.

Cancers that spread to the lungs: Cancers that start in other organs (such as the breast, pancreas, kidney, or skin) can sometimes spread (metastasize) to the lungs,

but these are not lung cancers. For example, cancer that starts in the breast and spreads to the lungs is still breast cancer, not lung cancer. Treatment for metastatic cancer to the lungs is based on where it started (the primary cancer site).

Lung Cancer Risk Factors

A risk factor is anything that increases a person's chance of getting a disease such as cancer.

Factors that may affect lung cancer risk

Different cancers have different risk factors. Some risk factors, like smoking, can be changed. Others, like a person's age or family history, can't be changed.

But having a risk factor, or even several, does not mean that you will get the disease. And some people who get the disease may have few or no known risk factors.

Several risk factors can make you more likely to develop lung cancer. These factors are related to the risk of lung cancer in general.

Risk factors you can change

Tobacco smoke

Smoking is by far the leading risk factor for lung cancer. About 80% of lung cancer deaths are thought to result from smoking, and this number is probably even higher for small cell lung cancer (SCLC). It's rare for someone who has never smoked to have SCLC.

The risk of lung cancer for people who smoke is many times higher than for people who don't smoke. The longer you smoke and the more packs a day you smoke, the greater your risk.

Cigar smoking, pipe smoking, and menthol cigarette smoking are almost as likely to cause lung cancer as cigarette smoking. Smoking low-tar or "light" cigarettes increases lung cancer risk as much as regular cigarettes.

Secondhand smoke

If you don't smoke, breathing in the smoke of others (called secondhand smoke or environmental tobacco smoke) can increase your risk of developing lung cancer. Secondhand smoke is the third most common cause of lung cancer in the United States.

If you or someone you care about needs help quitting, see How to Quit Using Tobacco or call the American Cancer Society at 1-800-227-2345

Exposure to radon

Radon is a naturally occurring radioactive gas that results from the breakdown of uranium in soil and rocks. You can't see, taste, or smell it. According to the US Environmental Protection Agency (EPA), radon is the second-leading cause of lung cancer in the United States, and it's the leading cause among people who don't smoke.

Outdoors, there is so little radon that it is not likely to be dangerous. But indoors, radon can be more concentrated. Breathing it in exposes your lungs to small amounts of radon. This may increase a person's risk of lung cancer.

Homes and other buildings in nearly any part of the country can have high indoor radon levels (especially in basements).

For more information, see Radon and Cancer.

Exposure to asbestos

People who work with asbestos (such as in mines, mills, textile plants, places where insulation is used, and shipyards) are several times more likely to die of lung cancer. Lung cancer risk is much greater in workers exposed to asbestos who also smoke. It's not clear how much low-level or short-term exposure to asbestos might raise lung cancer risk.

People exposed to large amounts of asbestos also have a greater risk of developing mesothelioma, a type of cancer that starts in the pleura (the lining surrounding the lungs). For more on this type of cancer, see Mesothelioma.

In recent years, government regulations have greatly reduced the use of asbestos in commercial and industrial products. It's still present in many homes and other older buildings, but it's not usually considered harmful as long as it's not released into the air by deterioration, demolition, or renovation. For more information, see Asbestos and Cancer Risk.

Exposure to other cancer-causing agents in the workplace

Other carcinogens (cancer-causing agents) found in some workplaces that can increase lung cancer risk include:

- Radioactive ores, such as uranium
- Inhaled chemicals, such as arsenic, beryllium, cadmium, silica, vinyl chloride, nickel compounds, chromium compounds, coal products, mustard gas, and chloromethyl ethers
- Diesel exhaust

The government and industry have taken steps in recent years to help protect workers from many of these exposures. But the dangers are still there, so if you work around these agents, be careful to limit your exposure whenever possible.

Taking certain dietary supplements

Studies looking at the possible role of vitamin supplements in reducing lung cancer risk have had disappointing results. In fact, multiple studies found that people who smoked and took beta-carotene supplements actually had an increased risk of lung cancer. The results of these studies suggest that people should avoid taking beta-carotene supplements.

Arsenic in drinking water

Studies of people in parts of Southeast Asia and South America with high levels of arsenic in their drinking water have found a higher risk of lung cancer. In most of these studies, the levels of arsenic in the water were many times higher than those typically seen in the United States, even areas where arsenic levels are above normal. For most Americans who are on public water systems, drinking water is not a major source of arsenic.

Risk factors you cannot change

Previous radiation therapy to the lungs

People who have had radiation therapy to the chest for other cancers are at higher risk for lung cancer, particularly if they smoke. Examples include people who have been treated for Hodgkin lymphoma or women who were treated with chest radiation for breast cancer.

Air pollution

In cities, air pollution, such as from diesel exhaust, appears to raise the risk of lung cancer slightly. This risk is far less than the risk caused by smoking, but about 1% to 2% of all deaths from lung cancer in the United States are thought to be due to outdoor air pollution.

Personal or family history of lung cancer

If you have had lung cancer, you have a higher risk of developing another lung cancer.

Brothers, sisters, and children of people who have had lung cancer may have a slightly higher risk of lung cancer themselves, especially if the relative was diagnosed at a younger age. It’s not clear how much of this risk might be due to shared genes among family members and how much might be from shared household exposures (such as tobacco smoke or radon).

Researchers have found that genetics do play a role in some families with a strong history of lung cancer. (To learn more, see What Causes Lung Cancer?)

Factors with uncertain or unproven effects on lung cancer risk

Smoking marijuana

There are reasons to think smoking marijuana might increase lung cancer risk.

- Marijuana smoke contains tar and many of the same cancer-causing substances that are in tobacco smoke. (Tar is the sticky, solid material that remains after burning, which is thought to contain most of the harmful substances in smoke.)
- Marijuana cigarettes (joints) are typically smoked all the way to the end, where tar content is the highest.
- Marijuana is inhaled very deeply, and the smoke is held in the lungs for a long time, which gives any cancer-causing substances more opportunity to deposit in the lungs.
- Because marijuana is still illegal in many places, it may not be possible to control what other substances it might contain.

It's been hard to study whether there is a link between marijuana and lung cancer because marijuana has been illegal in many places for so long, and it's not easy to gather information about the use of illegal drugs. Also, in studies that have looked at past marijuana use in people who had lung cancer, most of the people who smoked marijuana also smoked cigarettes. This can make it hard to know how much any increased risk is from tobacco and how much might be from marijuana. We do know that smoking marijuana will irritate your lungs and possibly increase your risk of getting more lung infections. More research is needed to know the cancer risks from smoking marijuana.

E-cigarettes

E-cigarettes are a type of electronic nicotine delivery system. Most e-cigarettes contain nicotine, so the Food and Drug Administration (FDA) classifies them as "tobacco products." The FDA states that e-cigarettes cause health risks, including lung damage. Furthermore, e-cigarettes have not been shown to improve your chances of quitting smoking. Whether e-cigarettes directly increase your risk of lung cancer is not yet known.

Signs and Symptoms of Lung Cancer

Most lung cancers do not cause any symptoms until they have spread, but some people with early lung cancer do have symptoms.

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The most common lung cancer symptoms

The most common symptoms of lung cancer are:

- A cough that does not go away or gets worse
- Coughing up blood or rust-colored sputum (spit or phlegm)
- Chest pain that is often worse with deep breathing, coughing, or laughing
- Hoarseness
- Loss of appetite
- Unexplained weight loss
- Shortness of breath
- Feeling tired or weak
- Infections such as bronchitis and pneumonia that don’t go away or keep coming back
- New onset of wheezing

Signs and symptoms of lung cancer that has spread

If lung cancer spreads to other parts of the body, it may cause:

- Bone pain (like pain in the back or hips)
- Nervous system changes (such as headache, weakness or numbness of an arm or leg, dizziness, balance problems, or seizures), from cancer spread to the brain
- Yellowing of the skin and eyes (jaundice), from cancer spread to the liver
- Swelling of lymph nodes (collection of immune system cells) such as those in the neck or above the collarbone

Syndromes caused by lung cancer

Some lung cancers can cause **syndromes**, which are groups of specific symptoms.

Horner syndrome

Cancers of the upper part of the lungs are sometimes called **Pancoast tumors**. These tumors are more likely to be non-small cell lung cancer (NSCLC) than small cell lung cancer (SCLC).

Pancoast tumors can affect certain nerves to the eye and part of the face, causing a group of symptoms called Horner syndrome:

- Drooping or weakness of one upper eyelid
- A smaller pupil (dark part in the center of the eye) on the same side of the face
- Little or no sweating on the same side of the face

Pancoast tumors can also sometimes cause severe shoulder pain.

Superior vena cava syndrome

The superior vena cava (SVC) is a large vein that carries blood from the head and arms down to the heart. It passes next to the upper part of the right lung and the lymph nodes inside the chest.

- Tumors in this area can press on the SVC, which can cause the blood to back up in the veins.
- This blood backup can lead to swelling in the face, neck, arms, and upper chest (sometimes with a bluish-red skin color), as well as trouble breathing.
- It can also cause headaches, dizziness, and a change in consciousness if it affects the brain.

While SVC syndrome can develop gradually over time, in some cases it can become life-threatening, and needs to be treated right away.

Paraneoplastic syndromes

Some lung cancers may cause problems in distant tissues and organs, even though the cancer has not spread to those places. These problems are called paraneoplastic syndromes. Paraneoplastic syndromes can affect your nervous system (paraneoplastic neurologic syndrome) or your endocrine system (paraneoplastic endocrine syndrome).Sometimes these syndromes may be the first symptoms of lung cancer. Because the symptoms affect other organs, a disease other than lung cancer may first be suspected as causing them.

Paraneoplastic syndromes can happen with any lung cancer but are more often associated with small cell lung cancer (SCLC).

In **paraneoplastic *endocrine* syndrome**, the lung tumor makes hormone-like substances that enter the bloodstream and affect distant organs. Examples include:

- **SIADH (syndrome of inappropriate anti-diuretic hormone):** There are many diseases that can cause SIADH. Cancer is one of them. In this condition, the cancer cells make ADH (anti-diuretic hormone), a hormone that causes the kidneys to keep too much water in the body. This lowers salt levels in the blood. Symptoms of SIADH can include fatigue, loss of appetite, muscle weakness or cramps, nausea, vomiting, restlessness, and confusion. Without treatment, severe cases may lead to seizures and coma.

- **Cushing syndrome:** There are many reasons why a person may develop Cushing syndrome. Cancer is one of them and is called ectopic Cushing syndrome. In this condition, the cancer cells make ACTH (adrenocorticotropic hormone), a hormone that causes the adrenal glands to make cortisol. This can lead to symptoms that include weight gain, easy bruising, weakness, drowsiness, and fluid retention. Cushing syndrome can also cause high blood pressure, high blood sugar levels, or even diabetes.

- **Hypercalcemia:** The tumor can make a hormone called parathyroid hormone-related peptide (PTHrP) that acts on the bones and kidney to increase the level of calcium in the blood. High levels of calcium in the blood (hypercalcemia can cause frequent urination, thirst, constipation, nausea, vomiting, belly pain, weakness, fatigue, dizziness, and confusion.

In **paraneoplastic *neurologic* syndrome**, the tumor can cause the body's immune system to mistakenly attack parts of the nervous system (brain, spinal cord, nerves), rather than the cancer cells. Examples include:

- **Lambert-Eaton syndrome:** In this syndrome, the tumor may cause the immune system to attack the neuromuscular junction, which is the place where nerves communicate with muscle. This can lead to muscle weakness and issues with walking, speaking, and swallowing. One of the first signs may be trouble getting up from a sitting position. Later, muscles around the shoulder may become weak.

- **Paraneoplastic cerebellar degeneration:** This disease can be caused by many different cancers, including small cell lung cancer. The immune system makes antibodies meant to attack the tumor, but instead mistakenly attacks an area of the brain called the cerebellum. This can lead to loss of balance and unsteadiness in arm and leg movement, trouble speaking, trouble swallowing, and changes in vision.
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- **Paraneoplastic limbic encephalitis:** The limbic system is a part of the brain that is in charge of storing memory, and controlling emotions and behavior, as well as blood pressure and heart rate. The tumor may cause the immune system to damage the limbic system. This can lead to memory loss, personality changes, mood changes, sleep issues, and seizures.

Many of these symptoms are more likely to be caused by something other than lung cancer. Still, if you have any of these problems, it's important to see your doctor right away so the cause can be found and treated, if needed.

Tests for Lung Cancer

Some lung cancers can be found by screening, but most lung cancers are found because they are causing problems. The actual diagnosis of lung cancer is made by looking at a sample of lung cells in the lab. If you have possible signs or symptoms of lung cancer, see your doctor.

Medical history and physical exam

Your doctor will ask about your medical history to learn about your symptoms and possible risk factors. They will also examine you to look for signs of lung cancer or other health problems.

If the results of your history and physical exam suggest you might have lung cancer, more tests will be done. These could include imaging tests and/or biopsies of the lung.

Imaging tests to look for lung cancer

Imaging tests use x-rays, magnetic fields, sound waves, or radioactive substances to create pictures of the inside of your body. Imaging tests might be done for a number of reasons both before and after a diagnosis of lung cancer, including:

- To look at suspicious areas that might be cancer
- To learn how far cancer might have spread
- To help determine if treatment is working
- To look for possible signs of cancer coming back after treatment

Chest x-ray

A chest x-ray is often the first test your doctor will do to look for any abnormal areas in the lungs. If something suspicious is seen, your doctor may order more tests.

Computed tomography (CT) scan

A CT scan uses x-rays to make detailed cross-sectional images of your body. Instead of taking 1 or 2 pictures, like a regular x-ray, a CT scanner takes many pictures and a computer then combines them to show a slice of the part of your body being studied.

A CT scan is more likely to find lung tumors than routine chest x-rays. It can also show the size, shape, and position of any lung tumors and can help find enlarged lymph nodes that might contain cancer that has spread. This test can also be used to look for masses in other parts of the body that might be due to the lung cancer spread.

CT-guided needle biopsy: If a suspected area of cancer is deep within your body, a CT scan might be used to guide a biopsy needle into this area to get a tissue sample to check for cancer.

Magnetic resonance imaging (MRI) scan

Like CT scans, MRI scans show detailed images of soft tissues in the body. But MRI scans use radio waves and strong magnets instead of x-rays. MRI scans are most often used to look for possible spread of lung cancer to the brain, spinal cord, or liver.

Positron emission tomography (PET) scan

For a PET scan, a slightly radioactive form of sugar (known as fluorodeoxyglucose [FDG]) is injected into the blood and collects mainly in cancer cells. This is because cancer cells tend to take up more sugar (or glucose) than normal cells do.

PET/CT scan: Often a PET scan is combined with a CT scan using a special machine that can do both at the same time. This lets the doctor compare areas of higher radioactivity on the PET scan with a more detailed picture on the CT scan. This is the type of PET scan most often used in patients with cancer. PET/CT scans are used for cancer staging, which is to see if and where the cancer has spread. While they can be used to look at most organs in the body, they are not useful for looking at the brain or spinal cord.

Bone scan

For a bone scan, a small amount of low-level radioactive material is injected into the blood and collects mainly in abnormal areas of bone. It can help show if a cancer has spread to the bones.

Tests to diagnose lung cancer

Symptoms and the results of certain tests may strongly suggest that a person has lung cancer, but the actual diagnosis is made by looking at lung cells in the lab.

The cells can be taken from a suspicious area using a needle or surgery (needle biopsy), fluid removed from the area around the lung (thoracentesis), or lung secretions (mucus you cough up from the lungs). The choice of which test(s) to use depends on the situation.

Needle biopsy

Doctors often use a hollow needle to get a small sample from a suspicious area (mass). An advantage of needle biopsies is that they don't require an incision. The drawback is that they remove only a small amount of tissue, and in some cases, the amount of tissue removed might not be enough to both make a diagnosis and to perform more tests on the cancer cells that can help doctors choose anticancer drugs. The main types of needle biopsies are: fine needle aspiration (FNA) biopsy and core needle biopsy (CNB).

Fine needle aspiration (FNA) biopsy
A syringe with a very thin, hollow needle is used to withdraw (aspirate) cells and small fragments of tissue. FNA biopsy may be done to check for cancer in very small masses or in the lymph nodes located around the lungs. **Transtracheal FNA or transbronchial FNA** is done by passing the needle through the wall of the trachea (windpipe) or bronchi (the large airways leading into the lungs) during a bronchoscopy or endobronchial ultrasound (described below).

In some patients, an FNA biopsy is done during an endoscopic esophageal ultrasound (described below) by passing the needle through the wall of the esophagus.

Core biopsy
A larger needle is used to remove one or more small cores of tissue. Samples from core biopsies are often preferred because they are larger than FNA biopsies.

Core biopsies can be done during many lung procedures and/or surgeries. One example would be during a **Transthoracic needle biopsy**, where the biopsy needle is put through the skin on the chest wall. The doctor guides the needle into the area while looking at the lungs with either fluoroscopy, which is like an x-ray, or a CT scan. A possible complication of this procedure is that air may leak out of the lung at the biopsy site and into the space between the lung and the chest wall. This is called a ***pneumothorax***. It can cause part of the lung to collapse and sometimes cause trouble breathing. If the air leak is small, it often gets better without any treatment. Large air leaks are treated by inserting a chest tube (a small tube into the chest space), which sucks out the air over a day or two, after which it usually heals on its own.

Thoracentesis

If fluid has collected around the lungs (called a **pleural effusion**), doctors can remove some of the fluid to find out if it is caused by cancer spreading to the lining of the lungs (pleura). The buildup might also be caused by other conditions, such as heart failure or an infection.

For a thoracentesis, the skin is numbed and a hollow needle is inserted between the ribs to drain the fluid. The fluid is checked in the lab for cancer cells. Other tests of the fluid are also sometimes useful in telling a malignant (cancerous) pleural effusion from one that is not.

If a malignant pleural effusion has been diagnosed and is causing trouble breathing, a thoracentesis may be repeated to remove more fluid which may help a person breathe better.

Sputum cytology

A sample of sputum (mucus you cough up from the lungs) is looked at in the lab to see if it has cancer cells. The best way to do this is to get early-morning samples 3 days in a

row. This test is more likely to help find cancers that start in the major airways of the lung, such as squamous cell lung cancers. It might not be as helpful for finding other types of lung cancer. If your doctor suspects lung cancer, further testing will be done even if no cancer cells are found in the sputum. This form of testing is not usually used unless the other methods are felt to be too dangerous for the patient.

Tests to look for lung cancer

If lung cancer has been found, it's often important to know if it has spread to the lymph nodes in the space between the lungs (mediastinum) or other nearby areas. This is especially important for a person with early-stage lung cancer, and can affect their treatment options. Several types of tests can be used to look for this cancer spread.

Bronchoscopy

Bronchoscopy can help the doctor find tumors or blockages in the airways of the lungs, which can often be biopsied during the procedure.

Electromagnetic navigation bronchoscopy uses a bronchoscope to biopsy a tumor in the outer part of the lung. First, CT scans are used to create a virtual bronchoscopy. The abnormal area is identified, and a computer helps guide a bronchoscope to the area so that it can be biopsied. The bronchoscope used has some special attachments that allow it to reach farther than a regular bronchoscope. This takes special equipment and training.

Endobronchial ultrasound

An endobronchial ultrasound can be used to see the lymph nodes and other structures in the area between the lungs if biopsies need to be taken in those areas.

Endoscopic esophageal ultrasound

An endoscopic esophageal ultrasound goes down into the esophagus, where it can show the nearby lymph nodes which may contain lung cancer cells. Biopsies of the abnormal lymph nodes can be taken at the same time as the procedure.

Mediastinoscopy and mediastinotomy

These procedures may be done to look more directly at and get samples from the structures in the mediastinum (the area between the lungs). The main difference between the two is in the location and size of the incision.

A mediastinoscopy is a procedure that uses a lighted tube inserted behind the sternum (breast bone) and in front of the windpipe to look at and take tissue samples from the lymph nodes along the windpipe and the major bronchial tube areas. If some lymph nodes can't be reached by mediastinoscopy, a mediastinotomy may be done so the

surgeon can directly remove the biopsy sample. For this procedure, a slightly larger incision (usually about 2 inches long) between the left second and third ribs next to the breastbone is needed.

Thoracoscopy

Thoracoscopy can be done to find out if cancer has spread to the spaces between the lungs and the chest wall, or to the linings of these spaces. It can also be used to sample tumors on the outer parts of the lungs, as well as nearby lymph nodes and fluid, and to assess whether a tumor is growing into nearby tissues or organs. This procedure is not often done just to diagnose lung cancer, unless other tests such as needle biopsies are unable to get enough samples for the diagnosis. Thoracoscopy can also be used as part of the treatment to remove part of a lung in some early-stage lung cancers. This type of operation, known as **video-assisted thoracic surgery (VATS)**, is described in Surgery for Non-Small Cell Lung Cancer.

Lung function tests

Lung (or pulmonary) function tests (PFTs) are often done after lung cancer is diagnosed to see how well your lungs are working. This is especially important if surgery might be an option in treating the cancer. Surgery to remove lung cancer may mean removing part or most of a lung, so it's important to know how well your lungs are working beforehand. Some people with poor lung function (like those with lung damage from smoking) don't have enough healthy lung to withstand removing even part of a lung. These tests can give the surgeon an idea of whether surgery is a good option, and if so, how much lung can safely be removed.

There are different types of PFTs, but they all basically have you breathe in and out through a tube that is connected to a machine that measures airflow.

Sometimes PFTs are coupled with a test called an **arterial blood gas**. In this test, blood is removed from an artery (instead of from a vein, like most other blood tests) so the amount of oxygen and carbon dioxide can be measured.

Lab tests of biopsy and other samples

Samples that have been collected during biopsies or other tests are sent to a pathology lab. A pathologist will look at the samples and may do other special tests to diagnose and better classify the cancer. (Cancers from other organs also can spread to the lungs. It's very important to find out where the cancer started, because treatment is different depending on the origin of the cancer.)

The results of these tests are described in a pathology report, which is usually available within a week. If you have any questions about your pathology results or any diagnostic tests, talk to your doctor. If needed, you can get a second opinion of your pathology report by having your tissue samples sent to a pathologist at another lab.

For more information, see Understanding Your Pathology Report.

Molecular testing (genomic testing) of lung tumor

In some cases, especially for non-small cell lung cancer (NSCLC), doctors may test for specific gene changes in the cancer cells, which could mean certain targeted drugs might help treat the cancer. For example:

- About 20% to 25% of NSCLCs have changes in the ***KRAS*** gene that cause them to make an abnormal KRAS protein, which helps the cancer cells grow and spread. NSCLCs with this mutation are often adenocarcinomas, resistant to other drugs such as EGFR inhibitors, and are most often found in people with a smoking history.
- **EGFR** is a protein that appears in high amounts on the surface of 10% to 20% of NSCLC cells and helps them grow. Some drugs that target EGFR can be used to treat NSCLC with changes in the *EGFR* gene, which are more common in certain groups, such as those who don't smoke, women, and Asians. But these drugs don't seem to be as helpful in patients whose cancer cells have changes in the *KRAS* gene.
- About 5% of NSCLCs have a change in the ***ALK*** gene. This change is most often seen in people who don't smoke (or who smoke lightly) and have the adenocarcinoma subtype of NSCLC. Doctors may test cancers for changes in the *ALK* gene to see if drugs that target this change may help them.
- About 1% to 2% of NSCLCs have a rearrangement in the ***ROS1*** gene, which might make the tumor respond to certain targeted drugs.
- A small percentage of NSCLCs have changes in the ***RET*** gene. Certain drugs that target cells with *RET* gene changes might be options for treating these tumors.
- About 5% of NSCLCs have changes in the ***BRAF*** gene. Certain drugs that target cells with *BRAF* gene changes might be an option for treating these tumors.
- A small percentage of NSCLCs have certain changes in the ***MET*** gene that make them more likely to respond to some targeted drugs.
- In a small percentage of NSCLCs, the cancer cells have certain changes in the ***HER2*** gene that make them more likely to respond to a targeted drug.
- A small number of NSCLCs have changes in one of the ***NTRK*** genes that make them more likely to respond to some targeted drugs.

These genetic tests can be done on tissue taken during a biopsy or surgery for lung cancer. If the biopsy sample is too small and all the studies cannot be done, the testing may also be done on blood that is taken from a vein just like a regular blood draw. This blood contains the DNA from dead tumor cells found in the bloodstream of people with advanced lung cancer. Obtaining the tumor DNA through a blood draw is called a **liquid biopsy. Liquid biopsies are done in cases where a tissue biopsy is not possible or if a tissue biopsy is felt to be too dangerous for the patient.**

PD-L1 testing on tumor cells

Patients diagnosed with non-small cell lung carcinoma (NSCLC) will have the lung tumor cells tested for PD-L1. PD-L1 is a protein (program death ligand 1) on cancer cells. A score is calculated depending on “if” and “how much” PD-L1 protein the tumor is making. This score will guide decisions about whether the patient would benefit from certain immunotherapy drugs.

Can Lung Cancer Be Prevented?
Not all lung cancers can be prevented, but you may be able to lower your risk for lung cancer by changing the risk factors that you can control.

Stay away from tobacco

The best way to reduce your risk of lung cancer is not to smoke and to avoid breathing in other people’s smoke.

If you stop smoking before a cancer develops, your damaged lung tissue gradually starts to repair itself. No matter what your age or how long you’ve smoked, quitting will lower your risk of lung cancer and help you live longer. If you would like help quitting smoking, see How to Quit Using Tobacco or call the American Cancer Society at 1-800-227-2345.

Avoid radon exposure

Radon is an important cause of lung cancer. You can reduce your exposure to radon by having your home tested and treated, if needed. For more information, see Radon and Cancer.

Avoid or limit exposure to cancer-causing agents

Avoiding exposure to known cancer-causing agents, in the workplace and elsewhere, may also be helpful (see Lung Cancer Risk Factors). When people work where these exposures are common, they should be kept to a minimum.

Eat a healthy diet

A healthy diet with lots of fruits and vegetables may also help reduce your risk of lung cancer. Some evidence suggests that a diet high in fruits and vegetables may help protect people who smoke and those who don’t against lung cancer. But any positive effect of fruits and vegetables on lung cancer risk would be much less than the increased risk from smoking.

Trying to reduce the risk of lung cancer in people who currently smoke or those who formerly smoked by giving them high doses of vitamins or vitamin-like drugs has not been successful so far. In fact, some studies have found that supplements of beta-carotene, a nutrient related to vitamin A, appear to increase the rate of lung cancer in these people.

Some people who get lung cancer do not have any clear risk factors. Although we know how to prevent most lung cancers, at this time we don’t know how to prevent all of them.