**What are tumor markers?**

Tumor markers are substances that are produced by cancer or by other cells of the body in response to cancer or certain benign (noncancerous) conditions. Most tumor markers are made by normal cells as well as by cancer cells; however, they are produced at much higher levels in cancerous conditions. These substances can be found in the blood, urine, stool, tumor tissue, or other tissues or bodily fluids of some patients with cancer. Most tumor markers are proteins. However, more recently, patterns of [gene expression](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000537335&version=Patient&language=English) and changes to DNA have also begun to be used as tumor markers.

Many different tumor markers have been characterized and are in clinical use. Some are associated with only one type of cancer, whereas others are associated with two or more cancer types. No “universal” tumor marker that can detect any type of cancer has been found.

There are some limitations to the use of tumor markers. Sometimes, noncancerous conditions can cause the levels of certain tumor markers to increase. In addition, not everyone with a particular type of cancer will have a higher level of a tumor marker associated with that cancer. Moreover, tumor markers have not been identified for every type of cancer.

**How are tumor markers used in cancer care?**

Tumor markers are used to help detect, diagnose, and manage some types of cancer. Although an elevated level of a tumor marker may suggest the presence of cancer, this alone is not enough to diagnose cancer. Therefore, measurements of tumor markers are usually combined with other tests, such as [biopsies](http://www.cancer.gov/about-cancer/Common/PopUps/popDefinition.aspx?id=CDR0000045164&version=Patient&language=English), to diagnose cancer.

Tumor marker levels may be measured before treatment to help doctors plan the appropriate therapy. In some types of cancer, the level of a tumor marker reflects the stage (extent) of the disease and/or the patient’s prognosis (likely outcome or course of disease).

Tumor markers may also be measured periodically during cancer therapy. A decrease in the level of a tumor marker or a return to the marker’s normal level may indicate that the cancer is responding to treatment, whereas no change or an increase may indicate that the cancer is not responding.

Tumor markers may also be measured after treatment has ended to check for recurrence (the return of cancer).

**How are tumor markers measured?**

A doctor takes a sample of tumor tissue or bodily fluid and sends it to a laboratory, where various methods are used to measure the level of the tumor marker.

If the tumor marker is being used to determine whether treatment is working or whether there is a [recurrence](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045861&version=Patient&language=English), the marker’s level will be measured in multiple samples taken over time. Usually these “serial measurements,” which show whether the level of a marker is increasing, staying the same, or decreasing, are more meaningful than a single measurement.

**What tumor markers are currently being used, and for which cancer types?**

A number of tumor markers are currently being used for a wide range of cancer types. Although most of these can be tested in laboratories that meet standards set by the Clinical Laboratory Improvement Amendments, some cannot be and may therefore be considered experimental. Tumor markers that are currently in common use are listed below.

[Alpha-fetoprotein](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046208&version=Patient&language=English) (AFP)

* Cancer types: Liver cancer and [germ cell tumors](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045695&version=Patient&language=English)
* Tissue analyzed: Blood
* How used: To help diagnose liver cancer and follow response to treatment; to assess stage, prognosis, and response to treatment of germ cell tumors

[Beta-2-microglobulin](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000411372&version=Patient&language=English) (B2M)

* Cancer types: [Multiple myeloma](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045793&version=Patient&language=English), [chronic lymphocytic leukemia](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044846&version=Patient&language=English), and some lymphomas
* Tissue analyzed: Blood, urine, or [cerebrospinal fluid](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046483&version=Patient&language=English)
* How used: To determine prognosis and follow response to treatment

[Beta-human chorionic gonadotropin](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000354453&version=Patient&language=English) (Beta-hCG)

* Cancer types: [Choriocarcinoma](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046753&version=Patient&language=English) and germ cell tumors
* Tissue analyzed: Urine or blood
* How used: To assess stage, prognosis, and response to treatment

[*BRCA1*](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046047&version=Patient&language=English) and [*BRCA2*](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046742&version=Patient&language=English) gene mutations

* Cancer type: Ovarian cancer
* Tissue analyzed: Blood
* How used: To determine whether treatment with a particular type of [targeted therapy](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000270742&version=Patient&language=English)is appropriate

[BCR-ABL fusion gene](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000561237&version=Patient&language=English) ([Philadelphia chromosome](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044179&version=Patient&language=English))

* Cancer type: [Chronic myeloid leukemia](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046755&version=Patient&language=English), [acute lymphoblastic leukemia](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045586&version=Patient&language=English), and [acute myelogenous leukemia](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046757&version=Patient&language=English)
* Tissue analyzed: Blood and/or bone marrow
* How used: To confirm diagnosis, predict response to targeted therapy, and monitor disease status

CA15-3/CA27.29

* Cancer type: Breast cancer
* Tissue analyzed: Blood
* How used: To assess whether treatment is working or disease has recurred

CA19-9

* Cancer types: Pancreatic cancer, gallbladder cancer, [bile duct cancer](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000527370&version=Patient&language=English), and gastric cancer
* Tissue analyzed: Blood
* How used: To assess whether treatment is working

[CA-125](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046490&version=Patient&language=English)

* Cancer type: Ovarian cancer
* Tissue analyzed: Blood
* How used: To help in diagnosis, assessment of response to treatment, and evaluation of [recurrence](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045861&version=Patient&language=English)

[Calcitonin](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045207&version=Patient&language=English)

* Cancer type: [Medullary thyroid cancer](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044550&version=Patient&language=English)
* Tissue analyzed: Blood
* How used: To aid in diagnosis, check whether treatment is working, and assess recurrence

[Carcinoembryonic antigen](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000357558&version=Patient&language=English) (CEA)

* Cancer types: Colorectal cancer and some other cancers
* Tissue analyzed: Blood
* How used: To keep track of how well cancer treatments are working or check if cancer has come back

[CD20](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000721283&version=Patient&language=English)

* Cancer type: [Non-Hodgkin lymphoma](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045148&version=Patient&language=English)
* Tissue analyzed: Blood
* How used: To determine whether treatment with a targeted therapy is appropriate

[Chromogranin A](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000721302&version=Patient&language=English) (CgA)

* Cancer type: [Neuroendocrine tumors](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044904&version=Patient&language=English)
* Tissue analyzed: Blood
* How used: To help in diagnosis, assessment of treatment response, and evaluation of recurrence

[Estrogen receptor](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046409&version=Patient&language=English) (ER)/[progesterone receptor](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000423248&version=Patient&language=English) (PR)

* Cancer type: Breast cancer
* Tissue analyzed: Tumor
* How used: To determine whether treatment with [hormone therapy](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045110&version=Patient&language=English) and some targeted therapies is appropriate

[HER2/neu](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044945&version=Patient&language=English) [gene amplification](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000650175&version=Patient&language=English) or protein overexpression

* Cancer types: Breast cancer, gastric cancer, and [gastroesophageal junction](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000302458&version=Patient&language=English)[adenocarcinoma](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046216&version=Patient&language=English)
* Tissue analyzed: Tumor
* How used: To determine whether treatment with certain targeted therapies is appropriate

Immunoglobulins

* Cancer types: Multiple myeloma and [Waldenström macroglobulinemia](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044854&version=Patient&language=English)
* Tissue analyzed: Blood and urine
* How used: To help diagnose disease, assess response to treatment, and look for recurrence

[Lactate dehydrogenase](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000354462&version=Patient&language=English)

* Cancer types: Germ cell tumors, lymphoma, leukemia, melanoma, and [neuroblastoma](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000045418&version=Patient&language=English)
* Tissue analyzed: Blood
* How used: To assess stage, prognosis, and response to treatment

[Prostate-specific antigen](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046540&version=Patient&language=English) (PSA)

* Cancer type: Prostate cancer
* Tissue analyzed: Blood
* How used: To help in diagnosis, assess response to treatment, and look for recurrence

[Thyroglobulin](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044556&version=Patient&language=English)

* Cancer type: Thyroid cancer
* Tissue analyzed: Blood
* How used: To evaluate response to treatment and look for recurrence

**Can tumor markers be used in cancer screening?**

Because tumor markers can be used to assess the response of a tumor to treatment and for prognosis, researchers have hoped that they might also be useful in screening tests that aim to detect cancer early, before there are any symptoms. For a screening test to be useful, it should have very high sensitivity (ability to correctly identify people who have the disease) and specificity (ability to correctly identify people who do *not* have the disease). If a test is highly sensitive, it will identify most people with the disease—that is, it will result in very few false-negative results. If a test is highly specific, only a small number of people will test positive for the disease who do not have it—in other words, it will result in very few false-positive results.

Although tumor markers are extremely useful in determining whether a tumor is responding to treatment or assessing whether it has recurred, no tumor marker identified to date is sufficiently sensitive or specific to be used on its own to screen for cancer.

For example, the [prostate-specific antigen (PSA) test](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000322878&version=Patient&language=English), which measures the level of PSA in the blood, is often used to screen men for prostate cancer. However, an increased PSA level can be caused by benign prostate conditions as well as by prostate cancer, and most men with an elevated PSA level do not have prostate cancer. Initial results from two large randomized [controlled trials](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000044014&version=Patient&language=English), the NCI-sponsored Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial (PLCO), and the European Randomized Study of Screening for Prostate Cancer, showed that PSA testing at best leads to only a small reduction in the number of prostate cancer deaths. Moreover, it is not clear whether the benefits of PSA screening outweigh the harms of follow-up diagnostic tests and treatments for cancers that in many cases would never have threatened a man’s life.

Similarly, results from the PLCO trial showed that [CA-125](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046490&version=Patient&language=English), a tumor marker that is sometimes elevated in the blood of women with ovarian cancer but can also be elevated in women with benign conditions, is not sufficiently sensitive or specific to be used together with [transvaginal ultrasound](http://www.cancer.gov/Common/PopUps/popDefinition.aspx?id=CDR0000046633&version=Patient&language=English) to screen for ovarian cancer in women at average risk of the disease. An analysis of 28 potential markers for ovarian cancer in blood from women who later went on to develop ovarian cancer found that none of these markers performed even as well as CA-125 at detecting the disease in women at average risk.