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Determining if Something Is a Carcinogen

What is a carcinogen?

Substances and exposures that can lead to cancer are called **carcinogens**.

In general, the American Cancer Society does not determine if something causes cancer (that is, if it is a carcinogen), but we do look to other respected organizations for help with this.

When a substance or exposure has been labeled a carcinogen, it means it has been studied extensively by researchers, and one or more agencies have evaluated the evidence and determined it to be a cause of cancer.

Carcinogens and the cancer connection

Cancer is the result of changes in a cell's DNA – its genetic “blueprint.” Some of these changes may be inherited from our parents. Others may be caused by outside exposures, which are often referred to as *environmental factors*.

Environmental factors can include a wide range of exposures, such as:

- Lifestyle factors (nutrition, tobacco and alcohol use, physical inactivity, etc.)
- Naturally occurring exposures (ultraviolet light, radon gas, infectious agents, etc.)
- Medical treatments (radiation and medicines including chemotherapy, hormone drugs, drugs that suppress the immune system, etc.)
- Workplace exposures
- Household exposures
- Pollution

Some carcinogens cause cancer by changing a cell's DNA. Others do not affect DNA directly, but lead to cancer in other ways. For example, they may cause cells to divide at a faster than normal rate, which could increase the chances that DNA changes will occur.

Carcinogens do not cause cancer in every case, all the time. Some clearly raise a person's risk of one or more types of cancer. But **even the strongest carcinogens don't raise the risk of all types of cancer.**

Substances labeled as carcinogens can have different levels of cancer-causing potential. Some might increase cancer risk after only a short exposure, but others might only cause cancer after prolonged, high levels of exposure. And for any particular person, the risk of developing cancer depends on many factors, including how they are exposed to a carcinogen, the length and intensity of the exposure, and the person's genetic makeup.

How do researchers determine if something is a carcinogen?

Testing to see if something can cause cancer is often difficult. It isn't ethical to test a substance by exposing people to it and seeing if they get cancer from it. Instead, scientists must use other types of tests, such as lab tests on cell cultures and animals, or epidemiology studies, which look at human populations. These types of tests might not always give clear answers.

Deciding what substances to test

There are far too many substances (both natural and man-made) to test each one, so scientists use what is already known about chemical structures, results from other types of lab tests, the extent of human exposure, and other factors to select chemicals for testing. For example, they can often get an idea about whether a substance might cause a problem by comparing it to similar chemicals that have already been studied.

What lab studies can show

Scientists get much of their data about whether something might cause cancer from lab studies of cell cultures and animals.

Lab studies alone can't always predict if a substance will cause cancer in people.

However, almost all carcinogens are first tested on and found to cause cancer in lab animals then are later found to cause cancer in people.

Most studies of potential carcinogens expose the lab animals to doses that are much higher than common human exposures. This is so that cancer risk can be detected in relatively small groups of animals. It isn't always clear if the results from animal studies will be the same for people when they are normally exposed to a substance. For example, the effects seen in lab studies with very high doses of a substance may not be the same at much lower doses, or the effects of a substance when it is inhaled may not be the same as if it is applied to the skin. Also, the bodies of lab animals and humans don't always process substances in the same way.

But for safety reasons, it's usually assumed that exposures that cause cancer at larger doses in animals may also cause cancer in people. It isn't always possible to know how the exposure dose might affect risk, but it is reasonable for public health purposes to assume that lowering human exposure will reduce risk.

What epidemiology studies (studies in people) can show

Another important way to identify carcinogens is through **epidemiology studies**, which look at different groups of people to determine which factors might be linked to cancer. These studies also provide useful information, but they have their limits. Humans don't live in a controlled environment. People are exposed to all kinds of substances at any given time, including those they encounter at work, school, or home; in the food they eat; and in the air they breathe. What's more, these can change over time. This can make it very hard to determine which of these factors might be linked to cancer.

By combining data from both types of studies, scientists do their best to make an educated assessment of whether something can cause cancer.

- When the evidence is conclusive, the exposure or substance is labeled as a *carcinogen*.
- When the available evidence is compelling but not felt to be conclusive, the exposure or substance may be labeled as a *probable carcinogen*.
- When there is limited evidence that is far from being conclusive, the exposure or substance may be labeled as a *possible carcinogen*.

But in some cases there simply isn't enough information to be certain one way or the other.

Who determines how carcinogens are classified?

Several national and international agencies review the available evidence to try to

determine the cancer-causing potential of different substances.

International Agency for Research on Cancer (IARC)

The International Agency for Research on Cancer (IARC) is part of the World Health Organization (WHO). One of its major goals is to identify causes of cancer. The most widely used system for classifying carcinogens comes from the IARC. Over the past several decades, the IARC has evaluated the cancer-causing potential of more than 1,000 likely candidates, placing them into one of the following groups:

- Group 1: Carcinogenic to humans
- Group 2A: Probably carcinogenic to humans
- Group 2B: Possibly carcinogenic to humans
- Group 3: Not classifiable as to its carcinogenicity in humans

Perhaps not surprisingly, based on how hard it can be to test possible carcinogens, most are listed as being of probable, possible, or unknown risk. Only a little over 100 are classified in Group 1, as “carcinogenic to humans.”

The IARC publishes its findings, including the detailed evidence to support them, in volumes known as *monographs*. While the exposures considered by the IARC to be carcinogens or probable carcinogens are listed [here](#)¹, the full lists of IARC classifications can be found online at <https://monographs.iarc.fr/agents-classified-by-the-iarc/>². The full monographs are available on the site as well, at <https://monographs.iarc.fr/monographs-and-supplements-available-online/>³.

National Toxicology Program

The National Toxicology Program (NTP) is formed from parts of several US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA). The NTP updates its *Report on Carcinogens* (RoC) every few years.

The *Report on Carcinogens* identifies 2 groups of agents:

- Known to be human carcinogens
- Reasonably anticipated to be human carcinogens

The current version of the RoC includes about 250 substances and exposures, which are listed [here](#)⁴.

The most recent RoC, which includes a summary profile for each listed substance, can be found online at <https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>⁵.

Other agencies and groups

Other federal agencies, such as the Environmental Protection Agency (EPA), the CDC's National Institute for Occupational Safety and Health (NIOSH), the Food and Drug Administration (FDA), and the National Cancer Institute (NCI) may comment on whether a substance or exposure may cause cancer and/or what levels of exposure to the substance might be considered acceptable.

Some state agencies also keep lists of known or probable carcinogens. For example, the California Environmental Protection Agency (CalEPA) maintains a list of "chemicals known to the state to cause cancer or reproductive toxicity." (Much of this list is based on the IARC and NTP lists below.)

The American Cancer Society's role

The American Cancer Society (ACS) contributes in many ways to evaluating how environmental factors affect a person's likelihood of developing cancer, including:

- Conducting epidemiologic research on the causes of cancer
- Funding laboratory and epidemiologic research at universities and other institutions that study environmental causes of cancer
- Advocating for environmental health on local, state, and federal levels
- Informing the public about environmental factors that affect cancer risk and how to lower their risk of developing cancer

In most cases, the ACS does not directly evaluate whether a certain substance or exposure causes cancer. Instead, the ACS looks to national and international organizations such as the NTP and IARC, whose mission is to evaluate environmental cancer risks based on evidence from laboratory and human research studies.

Hyperlinks

1. www.cancer.org/cancer/cancer-causes/general-info/known-and-probable-human-carcinogens.html
2. <https://monographs.iarc.fr/agents-classified-by-the-iarc/>
3. <https://monographs.iarc.fr/monographs-and-supplements-available-online/>
4. www.cancer.org/cancer/cancer-causes/general-info/known-and-probable-human-carcinogens.html

- [carcinogens.html](#)
5. <https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>
 6. <http://www.iarc.fr>
 7. <http://monographs.iarc.fr>
 8. <http://ntp.niehs.nih.gov>
 9. <http://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>
 10. <http://www.epa.gov>
 11. <http://www.epa.gov/iris>
 12. <http://www.fda.gov/>
 13. <http://www.cancer.gov/>
 14. <http://www.cancer.gov/cancertopics/causes>
 15. <http://www.cdc.gov/niosh>
 16. <http://www.cdc.gov/niosh/topics/cancer>
 17. <http://www.cdc.gov/niosh/topics/cancer/npotocca.html>
 18. <http://www.cancer.org>

Additional resources

Along with the American Cancer Society, other sources of information include:

International Agency for Research on Cancer (IARC) Website: ⁶www.iarc.fr
(<http://www.iarc.fr>)⁷ IARC Carcinogen Monographs: <http://monographs.iarc.fr>
(<http://monographs.iarc.fr>)⁸

National Toxicology Program (NTP) Website: <http://ntp.niehs.nih.gov>
(<http://ntp.niehs.nih.gov>)⁹ Report on Carcinogens:
<http://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>
(<http://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>)¹⁰

Environmental Protection Agency (EPA) Website: www.epa.gov
(<http://www.epa.gov>)¹¹ Integrated Risk Information System: www.epa.gov/iris
(<http://www.epa.gov/iris>)¹²

Food and Drug Administration (FDA) Website: www.fda.gov (<http://www.fda.gov>)¹³

National Cancer Institute Website: www.cancer.gov (<http://www.cancer.gov>)¹⁴ Cancer Causes and Risk Factors: www.cancer.gov/cancertopics/causes
(<http://www.cancer.gov/cancertopics/causes>)¹⁵

National Institute for Occupational Safety and Health (NIOSH)

Website: www.cdc.gov/niosh (<http://www.cdc.gov/niosh>)¹⁶ NIOSH Safety and Health

Topic – Occupational Cancer: www.cdc.gov/niosh/topics/cancer

(<http://www.cdc.gov/niosh/topics/cancer>)¹⁷ NIOSH Carcinogen

List: www.cdc.gov/niosh/topics/cancer/npotocca.html

(<http://www.cdc.gov/niosh/topics/cancer/npotocca.html>)¹⁸

**Inclusion on this list does not imply endorsement by the American Cancer Society.*

No matter who you are, we can help. Contact us anytime, day or night, for information and support. Call us at **1-800-227-2345** or visit www.cancer.org

(<http://www.cancer.org>)¹⁹.

References

International Agency for Research on Cancer (IARC). *Agents Classified by the IARC Monographs, Volumes 1–123*. 2019. Accessed at <https://monographs.iarc.fr/agents-classified-by-the-iarc/> on March 12, 2019.

International Agency for Research on Cancer (IARC). *Preamble to the IARC Monographs*. 2019. Accessed at <https://monographs.iarc.fr/preamble-to-the-iarc-monographs/> on March 12, 2019.

US Department of Health and Human Services. Public Health Service, National Toxicology Program. *Report on Carcinogens, Fourteenth Edition*. 2016. Accessed at <http://ntp.niehs.nih.gov/pubhealth/roc/index-1.html> on March 12, 2019.

Last Medical Review: May 17, 2019 Last Revised: May 17, 2019

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