

Environmental Toxins and Human Cancer

Kyaw Myint Oo

Professor, Rector (Retired), University of Dagon

Member of the Executive Committee, Myanmar Academy of Arts and Science

Ministry of Education, Yangon

1. Introduction

Cancer is caused by changes to certain genes that alter the way our cells function. Some of these genetic changes occur naturally when DNA is replicated during the process of cell division. But others are the result of environmental exposures that damage DNA. One research study concludes that as many as 35% of all cancers are driven by Environmental toxins. A British Government White Paper concluded that across 4000 common compounds used in-home, two thirds were toxic, and one third were probably carcinogenic.

Many well-known scientists, public health officials and physicians have been sounding alarms about the links between environmental toxins and human cancer for years now. The incidence of certain cancers, particularly thyroid cancer and leukemia, may very well rise in the Japanese population most heavily exposed to radiation from the Fukushima accident. Environmental toxins pose potentially grave threats to our health, and accidents only compound these threats both locally and for people all over the world who breathe air, eat food, and drink water. People can avoid some cancer-causing exposures, such as tobacco smoke and the sun's rays. But others are harder to avoid, especially if they are in the air we breathe, the water we drink, the food we eat, or the materials we use to do our jobs.

Scientists are studying which exposures may cause or contribute to the development of cancer. Understanding which exposures are harmful, and where they are found, may help people to avoid them. The chemicals in our water, air, and food, the materials in our home, and non ionizing radiation present cancer risks. But that doesn't mean that we are defenseless. Researchers have identified several mechanisms by which most cancer-producing toxins disrupt our body's defense systems. Compelling evidence reveals how we can defend against these carcinogenic mechanisms.

2. Sources of Cancer-Inducing and Cancer-Promoting Toxins

While it is impossible to avoid all cancer-causing environmental toxins, it is important to be aware of some of the most prominent sources. Researchers have compiled a list of common toxins broken down by their environmental sources. As you'll see from this list, these can be found in sources we interact with on a daily basis, including our food, water, plastic, cell phones, and even sunlight (Table 1).

- **Aflatoxins** are toxic chemicals produced by *Aspergillus* fungi growing on grains and peanuts, particularly those stored improperly. Chronic exposure induces cancer by multiple mechanisms.
- **Polycyclic aromatic hydrocarbons** are chemical structures composed of carbon, hydrogen, and occasionally other atoms. They are products of fossil fuel combustion, particularly

petrochemicals, and are a major source of cancer-causing chemicals in polluted air. Air pollutants (polycyclic aromatic hydrocarbons, tobacco smoke).

- **Bisphenol A (BPA)** is one of the highest-volume toxic chemicals found worldwide. It is used in making all kinds of plastics and resins, including water bottles and food containers.
- **Arsenic.** People are exposed to elevated levels of inorganic arsenic through drinking contaminated water, using contaminated water in food preparation and irrigation of food crops, industrial processes, eating contaminated food and smoking tobacco. Long-term exposure to arsenic in drinking water can cause cancer in the skin, lungs, bladder and kidney. It can also cause other skin changes such as thickening and pigmentation.
- **PCBs** are fat-soluble substances to which everyone is exposed through ingesting animal fats, inhalation, or dermal contact. Exposure to PCBs is associated with an increased risk of certain cancers of the digestive tract, liver and skin. PCB exposure is also associated with reproductive deficiencies, such as reduced growth rates, retarded development, and certain neurological effects which may or may not persist beyond infancy.
- **Heavy metals** (including cadmium, arsenic, nickel, lead, and mercury) are naturally occurring components of the earth's crust. Human exposure results from mining, smelting, and petroleum manufacturing, all of which release heavy metals into the air, water, and soil.
- **Pesticides and herbicides**, especially those containing organic chemicals bonded to chlorine or bromine, are found in agricultural settings, where they make their way into the food chain. Sadly, even after the highly toxic dichlorodiphenyltrichloroethane (DDT) was banned, risks still abound, both because of persistent DDT in the environment and because newer compounds intended to replace DDT (such as methoxychlor) are turning out to have their own cancer-inducing properties.
- **Tobacco smoke** is a serious health hazard causing more than 41,000 deaths per year. It can cause or make worse a wide range of damaging health effects in children and adults, including lung cancer, respiratory infections and asthma. Tobacco smoke causes approximately 7,330 deaths from lung cancer and 33,950 deaths from heart disease each year.
- **Dioxins** are commonly found in foods of animal origin (meat, dairy, and fish, depending on the country of origin).
- **Phthalates** are chemicals used to soften plastics. They are found in a wide variety of products, including bottles, shampoo, cosmetics, lotions, nail polish, and deodorant. Pre-natal exposure to phthalates is associated with adverse genital development and can significantly reduce masculine behavior in boys. Women with high exposure to phthalates while pregnant report significantly more disruptive behavior in their children, while other research has found phthalate exposure can lead to thyroid dysfunction in adults.
- **Triclosan** is an antibacterial and antifungal agent found in some consumer products, including toothpaste, soaps, detergents, toys, and surgical cleaning treatments. Its efficacy as an antimicrobial agent, the risk of antimicrobial resistance, and its possible role in disrupted hormonal development remains controversial.
- **Heterocyclic amines** are chemicals that form when meat is cooked at high temperatures (e.g., grilled or broiled).
- **Cyprodinil** is a fungicide. Cypronidil causes eye and skin irritation, and it may cause an allergic skin reaction. The major target organs of cyprodinil are the liver and kidney.
- **Ultraviolet radiation** is a natural component of sunlight, but serves as a powerful source of many of the changes that lead to cancer.

- **Electromagnetic field radiation**, especially the kind produced by cellular phones and their transmitting stations, are only now emerging as potential environmental threats. Such radiation is associated with DNA damage, potentially leading to cancer.

This is by no means an exhaustive listing of cancer-related environmental toxins. Toxins are ubiquitous, particularly in our highly industrialized society. They are, therefore, nearly impossible to avoid, but as we have read, we know that we are not helpless. We can arm ourselves with knowledge about natural products capable of offsetting much of the increased cancer risk posed by environmental toxins.

**Table 1. Toxins that induce or promote cancers
(International Agency for Research on Cancer, 2011)**

Basic Mechanism	Toxins
Increased DNA damage	<ul style="list-style-type: none"> • Aflatoxin A1 • Air pollutants (polycyclic aromatic hydrocarbons, tobacco smoke) • Arsenic • Bisphenol A (BPA) • Cadmium chloride • Microwave radiation • Mobile phone radiation • Nickel salts • Pesticides • Ultraviolet light
Activation by liver enzymes	<ul style="list-style-type: none"> • Aflatoxin B1 • Dioxin • Heterocyclic amines (from cooking meat) Nicotine • Polycyclic aromatic hydrocarbons (e.g., benzo[a]pyrene)
Suppress immune surveillance	<ul style="list-style-type: none"> • Dioxin • Mercury • Mycotoxins (e.g., aflatoxins, fumonisins, and deoxynivalenol) • Perfluorinated hydrocarbons • Tobacco smoke • Ultraviolet light

Endocrine disruption	<ul style="list-style-type: none"> • BPA • Cyprodinil (a fungicide related to polycyclic aromatic hydrocarbons) • Dioxin • Heavy metals (arsenic, cadmium, lead, mercury) • Methoxychlor • Phthalates • PCBs • Polycyclic aromatic hydrocarbons • Triclosan
Loss of apoptosis	<ul style="list-style-type: none"> • Aflatoxins • Heavy metals • Pesticides/herbicides • UV light

3. How Toxins Produce Cancer and Powerful Cancer Prevention from Nutrients

The heavily industrialized nature of our modern world constantly exposes us to toxic, cancer inducing, and cancer promoting influences. Chemical toxin as well as various sources of radiation can initiate cancer through DNA damage and promote tumor development through mechanisms involving liver enzyme systems, suppressed immunity, disruption of your hormones, and hijacking the cells' normal death-inducing programs. You can't realistically evade all of the factors that can cause cancer in your life, but you can leverage modern scientific knowledge to your benefit. Many nutrients are available with known cancer-fighting benefits, including those that directly counteract the major processes by which toxic compounds and radiation promote malignancies.

Despite the vast number and diversity of cancer types, there are a relatively small number of events that typically occur in the progression from healthy cell to malignancy. Toxic environmental chemicals, electromagnetic fields, and ionizing radiation may initiate and/or promote malignancy, operating along a number of mechanisms. Important five mechanisms include:

- DNA damage,
- Liver detoxification impairment,
- Immune impairment,
- Endocrine disruptors, and
- Loss of apoptosis.

3.1. DNA Damage

The first way toxins may lead to cancer is by breaking DNA strands. Damage to DNA is a major initiating factor in cellular transformation to cancer. DNA damage can be caused by toxins that break

DNA strands (such as pro-oxidant chemicals or ionizing radiation). Such damage can induce mutations in the DNA that trigger cancer. That is why nutrients that prevent DNA damage, or ones that promote its **repair**, are so potent in protecting against cancer. Given the role of oxidative stress in causing such damage, **nutrients that reduce DNA damage** (i.e. **vitamins C and E** and the trace mineral **selenium**), are often considered as a first line of defense.

Surprisingly, **probiotics**, which are normally associated with improved gastrointestinal function, have been found to be effective at reducing DNA damage specifically in the colon. This may help to prevent **colon cancer**, the third cause of cancer-related deaths in the US. And, while sunlight exposure can boost vitamin D levels, such exposure also raises DNA skin damage, but **vitamin D supplementation** can protect against DNA damage throughout the body. Nearly a dozen nutrients have been found to prevent DNA damage, resulting in a positive impact on cancers of the prostate, colon, breast, skin, liver, and more.

Powerful Cancer Prevention from nutrients that reduce DNA damage. It is easy to become fearful about the vast numbers of toxic chemicals and other influences all around us, lurking to produce catastrophic cancers. Fortunately, there are solutions in the form of specific nutrients with powerful cancer-preventing effects. Compelling scientific studies show that specific nutrients counteract major processes by which toxic compounds and radiation promote malignancies. Table 2 lists a few of the nutrients known for their DNA-protective effect.

Table 2. Nutrients that reduce DNA damage
(International Agency for Research on Cancer, 2011)

Nutrient	Cancers Affected
Carotenoids (lutein, astaxanthin, lycopene)	Prostate, colon
Coenzyme Q10	Colon, head-and-neck
Fish oil (omega-3 fats)	Colon, skin
Genistein (from soy)	Leukemia
Plant polyphenols	Multiple
Probiotics (<i>Lacto-bacillus rhamnosus</i>)	Colon
Quercetin	Head-and-neck
Selenium	Colon, breast
Vitamin C	Breast, colon, skin
Vitamin D	Colon, skin
Vitamin E	Liver, breast

3.2. Liver Detoxification Systems

The second way environmental toxins cause cancer is through their detrimental impact on liver detoxification systems. **Liver detoxification systems** play a major role in managing ingested toxins because blood from the digestive tract goes to the liver before being pumped around to the remainder of the body.

The liver has two major detoxification pathways: Phase I and Phase II. In **Phase I** enzymes convert toxic chemicals into compounds that may be more toxic than the parent compound. Unfortunately, if the toxic load is too heavy, it can cause overactivity of Phase I enzymes, which can

have the reverse effect of converting relatively harmless substances into potential DNA-damaging carcinogens. Making matters worse, the worst offenders of overactive Phase I enzymes are substances some people encounter on a daily basis, including alcohol, saturated fats, and exhaust fumes, among others.

In **Phase II** detoxification, the liver adds another substance to the toxic chemical in order to make it more water soluble. This allows your body to excrete the toxin through bile or urine, helping remove the potentially carcinogenic substance from the body. For these reasons, cancer-preventive nutrients that influence liver metabolism are generally those that *regulate* toxin-enhancing Phase I reactions, promote toxin-neutralizing Phase II reactions, or, in many cases, do both. Nutrients that regulate these liver detoxification systems come largely from dietary plants and their extracts.

Several nutrients have this dual action on liver enzymes, including curcumin, folic acid, and garlic, among others. Research suggests this may have a positive impact on preventing some of the most common and deadly cancers. List of nutrients that prevent cancer by regulating the liver’s detoxification enzymes are shown in Table 3.

Table 3. Nutrients that prevent cancer by regulating the liver’s detoxification enzymes. (International Agency for Research on Cancer, 2011)

Nutrient	Impact on Liver Enzymes	Cancers Affected
Chlorophyllin	Inhibit Phase I; boost Phase II	Liver, colon, prostate
Curcumin	Inhibit Phase I; boost Phase II	Breast, colon, prostate, pancreas
Folic acid	Inhibit Phase I; boost Phase II	Breast, pancreas
Garlic	Inhibit Phase I; boost Phase II	Breast, liver, prostate
Genistein	Boost Phase II	Colon
Isothiocyanates (sulforaphane, PEITC) from cruciferous vegetables	Inhibit Phase I; boost Phase II	Liver, colon, breast, prostate
Plant flavonoids (i.e. chrysin, genistein, quercetin)	Inhibit Phase I; boost Phase II	Multiple
Silymarin (milk thistle)	Boost Phase II	Liver

3.3. Immune Surveillance

The third way environmental toxins can cause cancer is through their impact on immune surveillance. **Immune surveillance** refers to the immune system’s continual search for cells bearing signs that they have become cancerous. A number of environmental toxins can suppress immune surveillance, raising the risk that a malignant cell will slip under the radar, form a tumor, and successfully spread to other parts of the body. **Nutrients that enhance immune surveillance** are only

now being recognized as powerful contributors to the body’s lifelong fight against cancer. These nutrients boost those components of the immune system that are responsible for recognizing the unique tumor “markers” displayed on the surface of malignant cells, and then destroying those cells.

Table 4. Nutrients that boost immune surveillance.
(International Agency for Research on Cancer, 2011)

Nutrient	Immune Mechanism	Cancers Affected
Enzymatically modified rice bran	Increases natural killer cell activity	Leukemia, Multiple Myeloma, Liver
<i>Cistanche</i> extracts	Increases naïve T-cells, increased expression of transforming growth factor beta, decreases inflammation	Colon
Grape seed proanthocyanidins	Induction of immunoregulatory cytokines; stimulation of tumor-destroying T cells	Skin
Green tea polyphenols (EGCG)	Activation of tumor-killing T-lymphocytes and natural killer cells; induction of immuno-regulatory cytokines	Colon, skin, lung, prostate, breast
Probiotics (lactic acid bacteria)	Decrease inflammation; increase immunoregulatory cytokines; increased interferon-gamma production	Colon, skin
Reishi mushroom (<i>Ganoderma lucidum</i>)	Enhanced proliferation of tumor-killing T-lymphocytes, antibody-producing B-lymphocytes, and natural killer cells	Liver, lymphoma, lung
Resveratrol	Sensitizes tumor cells to killing by cytokine-induced killer cells; enhances cytokine-induced killer cell activity	Leukemia
Silymarin	Induction of immunoregulatory cytokines; stimulation of tumor-destroying T cells	Skin
Vitamin D	Reduced inflammation	Colon

Nutrients that enhance immune surveillance may stimulate growth and proliferation of **tumor-detecting lymphocytes**, promote a vigorous attack on tumor cells by so-called “**natural killer cells**,” and/or stimulate **antibody production**, which aids in immobilization and destruction of malignant cells. Table 4 lists nutrients capable of activating one or more components of the immune system in order to destroy developing cancers.

3.4. Endocrine Disruptors

The fourth way environmental toxins can cause cancer is through their impact on endocrine disruptors. **Endocrine disruptors** are chemicals that interact with sex hormones and/or their receptors to promote cancer development. Not surprisingly, **nutrients that inhibit endocrine disruptors** show promise in preventing hormone-dependent cancers such as those of the breast, uterus, and prostate. Although scientists don’t yet fully know how these nutrients work to inhibit endocrine disruptors, it may involve enhanced excretion or reduced absorption of toxins from the intestinal tract.

Table 5. Nutrients capable of inhibiting endocrine-disrupting pollutants (International Agency for Research on Cancer, 2011)

Nutrient	Toxin Inhibited	Cancers Affected
<i>Chlorella pyrenoidosa</i> (More efficiently obtained as chlorophyllin)	Dioxin (a polychlorinated biphenyl [PCB]), perfluorinated compounds (PFCs)	Breast, prostate
Folic acid	Bisphenol A (BPA), phthalates	Breast, prostate
Genistein	BPA, phthalates	Breast, prostate
Probiotics (<i>Lactobacillus</i> , <i>Bifidobacterium</i>)	BPA	Breast, prostate
Vitamin C	Heavy metals (lead, copper, iron)	Liver, lung, prostate
Vitamin E	Heavy metals (lead, copper, iron)	Liver, lung, prostate

Table 5 lists nutrients capable of inhibiting endocrine-disrupting pollutants. In addition, there are also a number of **plant flavonoids** (i.e. chrysin, genistein, quercetin) that are effective against endocrine disrupting toxins. They appear to reduce the activity of estrogen-producing enzymes such as aromatase, thereby reducing overall sex hormone predominance and starving hormone-dependent tumors of their vital growth factors.

3.5. Loss of Apoptosis

Another way environmental toxins are associated with cancer is through inducing a loss of apoptosis, or programmed cell death. **Loss of apoptosis** refers to the “immortality” typical of cancer cells. Normal body cells are programmed to die off when appropriate. Cancer cells have lost this ability (often as a result of DNA damage), which allows them to reproduce essentially without limit. A number

of chemical toxins, particularly *aflatoxin*, a potent inducer of liver damage, can switch off the gene responsible for producing apoptosis, which results in cancer promotion.

Nutrients that restore cells’ natural ability to die by apoptosis represent the final category in our listing of nutrients that help fight against cancers caused by environmental toxins. These nutrients typically act by modifying various signaling pathways. This means that they can activate genes that become suppressed when cells become cancerous, including genes that normally support the graceful death of a cell that is no longer useful or poses a threat. By restoring the natural self-destruction program initiated by apoptosis genes, these nutrients put a sharp roadblock in the way of a developing tumor. This allows other anticancer mechanisms such as immune surveillance to clear the remainder of the battlefield. Nutrients known to promote apoptosis include coffee extract, quercetin, pine bark extract, and selenium. Research shows they have a positive impact on bladder, colon, and ovarian cancers, among others. Detailed list of nutrients that promote or restore apoptosis capabilities in malignant cells are shown in Table 6.

**Table 6. Nutrients that promote or restore apoptosis
(International Agency for Research on Cancer, 2011)**

Nutrient	Cancers Affected
Chlorophyllin	Bladder
Coffee extract	Colon
Curcumin	Leukemia, colon
<i>Emblica officinalis</i> (amla; Indian gooseberry)	Ovary
Green tea extract (EGCG)	Leukemia, lymphoma, head-and-neck
Lycopene	Prostate
Phenyl isothiocyanate (PEITC) from cruciferous vegetables	Bladder, lung
Pine bark extract (Enzogenol)	Leukemia
Prebiotics (fermentable fiber, which produces butyrate, induces apoptosis)	Colon
Probiotics (<i>Lactobacillus salivarius</i>)	Oral
Propolis	Colon
Quercetin	Ovary
Red clover isoflavones	Prostate
Rosemary (carnosol)	Prostate, colon, skin, breast, kidney, liver
Sarsaparilla (<i>Smilax glabra</i>)	Multiple
Selenium	Colon, lung, prostate
Soy isoflavones (genistein, daidzein)	Prostate

4. Conclusion

We are awash in a sea of toxins and invisible radiation that constantly promotes malignant transformation of our cells, leading to persistently high rates of cancer. Despite the seemingly immeasurable amount of environmental toxins, there are five mechanisms through which they typically work to promote cancer. This allows us to identify nutrients that have cancer-fighting properties that work specifically against these mechanisms. Just as the chemicals that cause cancer do so by multiple mechanisms, natural products offer multiple, overlapping, and complementary approaches to cancer prevention.

By becoming familiar with the major cancer-inducing and cancer-promoting toxic influences in your world, you can then develop a supplement regimen that covers all five mechanisms by which we know that toxins and radiation induce cancerous changes. By choosing carefully from among the nutrients listed in this article, you can establish a solid cancer-fighting base in your own body—one that works with your natural defenses to defeat cancers before they get established.

Environmental toxins can cause serious health effects when exposure is allowed to accumulate. Problems usually result from prolonged or excessive exposure. While it is impossible to completely eliminate exposure, a few simple steps will go a long way towards protecting you and your family:

1. Filtering home tap water and not storing water in plastic bottle.
2. Not using plastic plates to heat food in a microwave oven.
3. Reduce use of canned foods and eat mostly fresh or frozen foods.
4. Use baby bottles that are BPA free (or better yet use glass bottles) and look for toys labeled BPA free.
5. Use PVC-free containers. Buy plastic wrap and bags made from polyethylene and use glass containers. If you do use plastic containers, do not heat or microwave them.
6. Choose phthalate-free toys. Many large toymakers have pledged to stop using phthalates, but be sure to look for toys made from polypropylene or polyethylene.
7. Purchase phthalate-free beauty products. Avoid nail polish, perfumes, colognes, and other scented products that list phthalates as an ingredient.
8. Eating food grown without pesticides or chemical fertilizers.
9. Avoiding processed, charred and well-done meats.
10. Reducing cell phone usage.
11. Reducing exposure to radiation from medical sources by discussing with healthcare providers whether medical tests or procedures (such as CT-scans) that use radiation are really necessary.
12. Get your home air and water checked for radon.

There is no need to freak out over occasional exposure to environmental toxins. Just look for simple ways to reduce your everyday exposure. Make changes slowly, one at a time, in a manageable way, and you will decrease your risk with minimal stress.

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