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Your Diet and Cancer

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Disclaimer

This book is for general informational purposes only. It is an overview of the subject, based on the latest available research and statistics.

I have tried to explain a complex and evolving subject in simple, non-medical terms. You can also [email](#) me.

If you have any questions CONSULT YOUR MEDICAL PRACTITIONER. This book DOES NOT replace your doctor's advice. You MUST consult your physician before changing your diet or any other part of your lifestyle and for further advice.

The author, publisher, and distributors are not involved in giving medical or other technical advice.

The author, publisher, and distributors accept no responsibility for any actions that anybody takes or defers after reading any part of this book. This book is a general overview in non-technical language.

The most important messages in this book:

"Do yourself a favor - eat right and stay healthy."

"Cancer is one of the main causes of death among humans and your way of consuming food affects the risk."

"Add fruits and vegetables to your daily menu."

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1. Introduction

Our body is made up of millions of cells that are continuously growing, dividing and dying.

The integrity of the body's systems is maintained by several factors that operate inside our body, protecting us from harmful indigenous and environmental factors.

The main factor that operates inside our body is our **DEFENSE MECHANISM**. It protects us from bad weather, anxious situations, chronic diseases and, most importantly, from cancers.

Risk factors that are present may affect a person's body at any time. Information about the causal relation of some of the factors for these diseases and cancers is still at a hypothetical stage. Many studies are going on to validate current assumptions.

The reasons for these cancers could be in our body itself:

If somebody has a genetic alteration in their cells, they are predisposed to cancer.

For example, there is a type of childhood cancer called 'Retinoblastoma', the cancer arising from 'retinal cells' of the eye.

In the familial form of Retinoblastoma, the cells of an individual acquire **one** 'mutant' gene (abnormal gene transmitted by germ line) from one of their parents¹.

When **another** gene in the representative pair is altered by other factors such as:

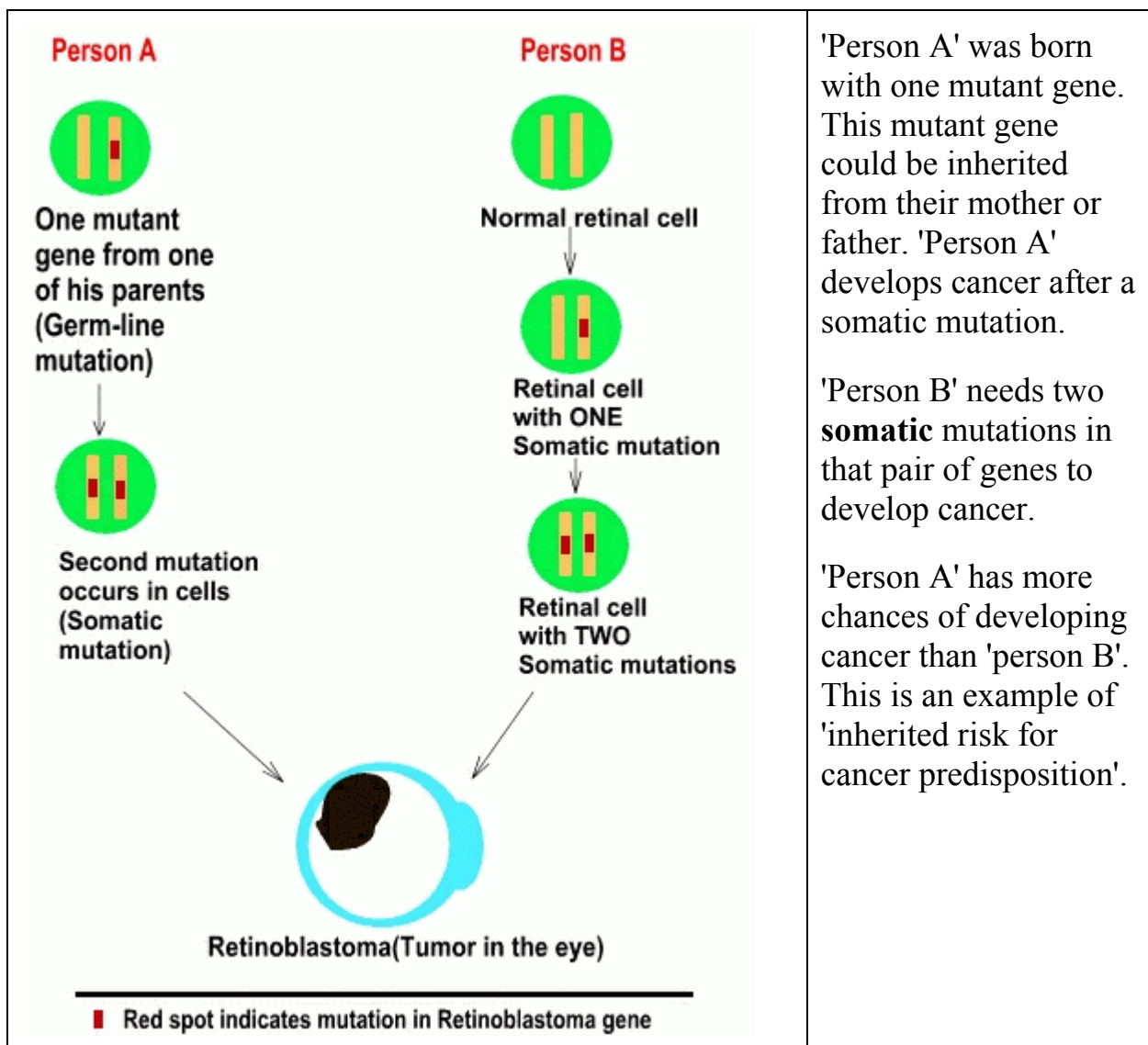
a point mutation of retinoblastoma gene locus or

deletion of a small part involving retinoblastoma gene locus or

total loss of the representative pair of chromosome 13 (on which the retinoblastoma gene was located),

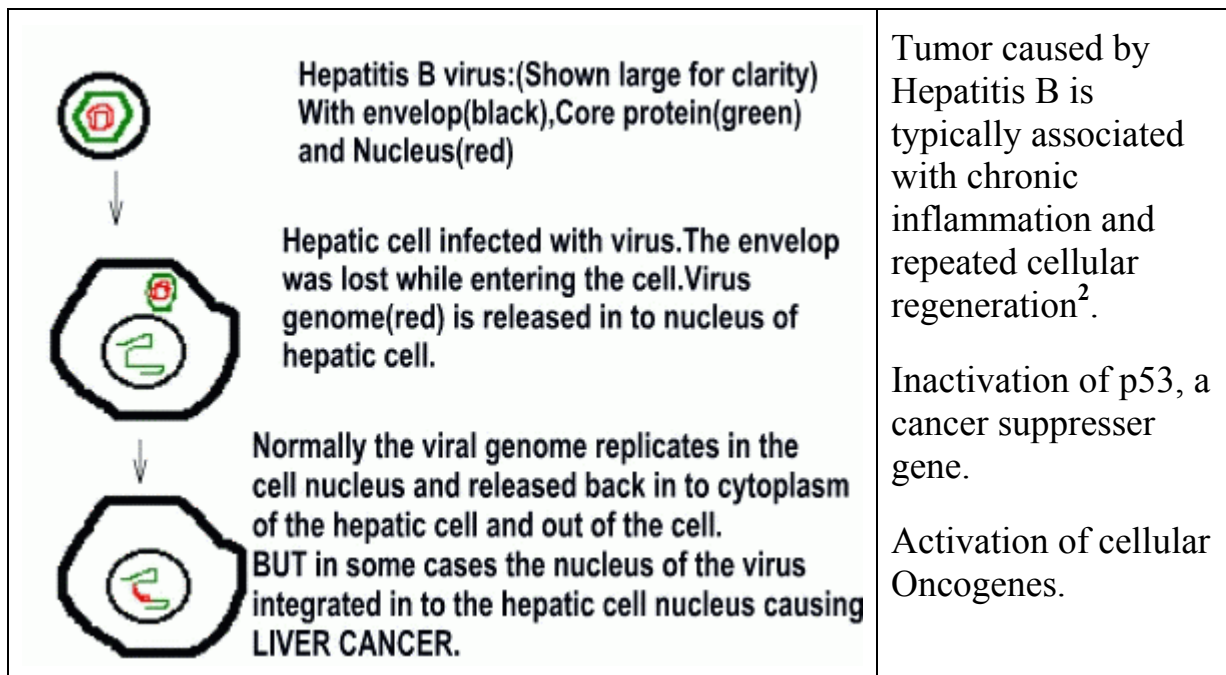
the individual develops Retinoblastoma. (Abnormal gene produced by somatic mutation).

People that already have one mutant gene of a pair are more likely to develop Retinoblastoma compared to someone with a normal pair of genes.



Other possible reasons are environmental factors from outside the body. For example, Hepatitis-B is a viral infection of the liver and it is said to be one of the risk factors for liver cancer. When Hepatitis B infects the hepatic cell, it usually replicates in the hepatic nucleus and is released out of the cell. But, in some cases, the nucleus of the virus integrates into the hepatic nucleus as shown in the figure.

Effects of Hepatitis on Liver cells:



In one case study, 20 out of 20 patients have the Hepatitis Viral DNA integrated in to the cell genome³.



Diet Fact

60-70% of cancers are due to dietary factors⁴. These may be prevented by changes in dietary habits.

One third of cancer deaths in the U.S.A. are associated with tobacco use, especially smoking⁴.

2. What is Cancer?

Cancer is **abnormal, uncontrollable** growth of cells in an **invasive** way, disrupting the function of an organ anywhere in the body or the whole body.

Cancer is characterised by:

- .Abnormal cells
- .Uncontrollable growth due to loss of contact inhibition
- .Invasiveness giving rise to metastasis

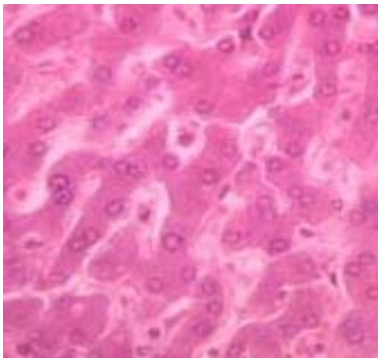


FIG 1

Fig 1 Regular, functioning cells of the human liver. Cells are regular in rows with same size nucleus (center dot like genetic material).

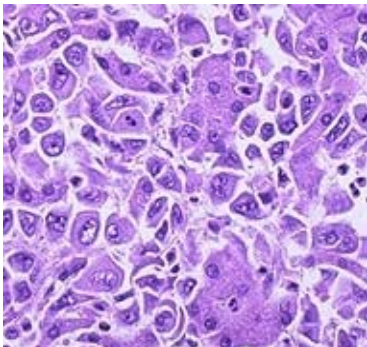
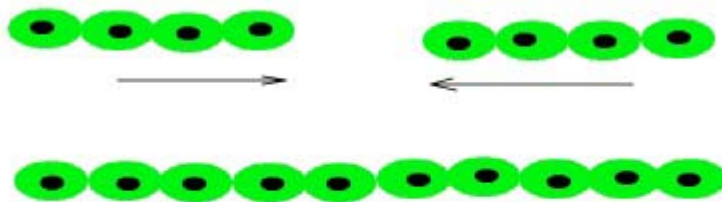


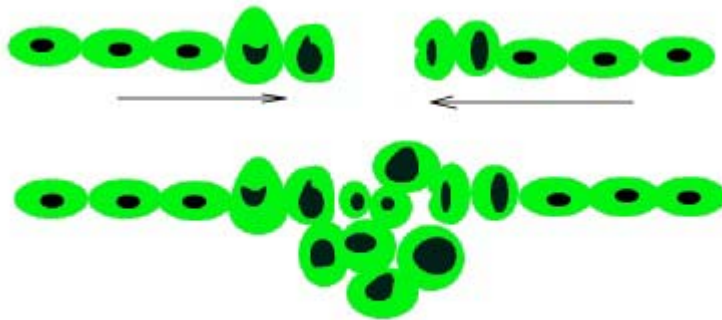
FIG 2

Fig 2 shows human liver cancer cells. Cells are different sizes with different sized nucleus.

Contact Inhibition



Cell division stopped by contact inhibition

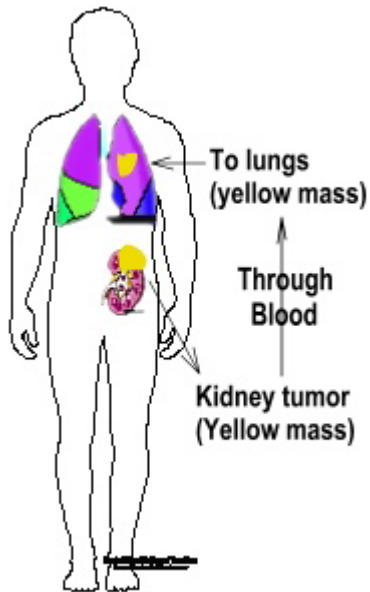


Cell division can not be stopped by contact inhibition

'contact inhibition' is when a normal cell comes in contact with another normal cell - it stops dividing. When you cut your skin, it heals nicely and the cells stop growing after they come in contact with each other. The skin layer grows back to its original position.

In contrast, cancer cells are **uncontrollable**. Cancer cells grow without the property of contact inhibition. When two cancer cells come near to each other, they continue to divide. This gives a mass tumor-like appearance.

Invasiveness



The cancer cells grow into other parts of the body. Medically, this is called a 'metastasis'. In this figure, the cancer is in the kidney (yellow color growth). The cancer cells detach from the primary tumor, and then go to the lungs through the blood. Metastasis reduces the chances of survival.



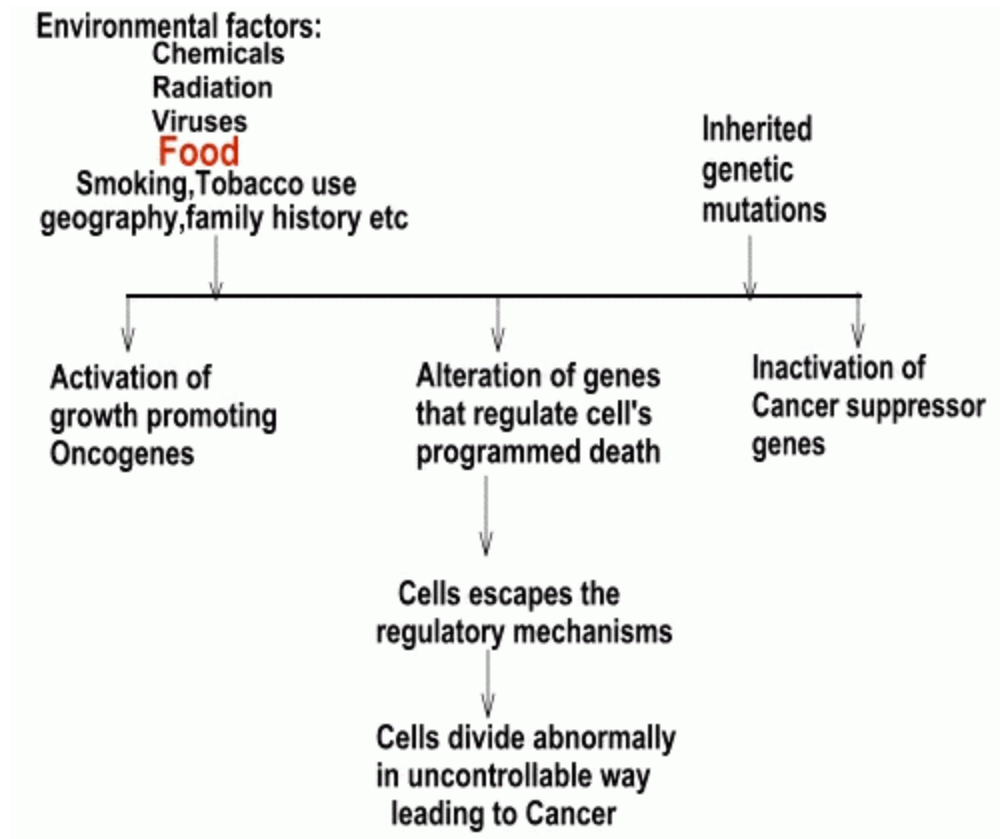
Diet Fact

Get anti-cancer constituents naturally from your diet rather than by using supplements.

3. The Risk Factors for Getting Cancer

Cancer is a multifactorial disease. This means that it can be caused by many factors that act in different ways.

A basic outline for the cancer risk



As the focus of this book is 'The Role of Diet in Cancer Risk', we will only briefly cover the other causes of cancer.

Here are some examples to help explain the picture above.

Environmental Factors:

Chemical carcinogens:

Our world is strongly affected by chemicals that we have introduced.

One important example is NNK, a tobacco specific nitrosamine and the polycyclic aromatic hydrocarbons produced when smoking cigarettes.

In most parts of the world, 30-40% of human cancers are related to tobacco use; lung cancer is prevalent in chronic smokers while oral cavity and esophageus cancers are common in tobacco chewers.

Non-smokers living with smokers have a greater risk of respiratory diseases and lung cancer than they would otherwise (5a, 5b).

Chemical carcinogens are electrophilic substances that react with important sites in the cell, like DNA, RNA and other proteins, to form compounds that damage the cell.

There are thousands of chemicals that come from the natural and man-made parts of our environment such as cigarette smoking, diet, industry chemicals, fungi etc.

Examples of chemical carcinogens:

Source	Carcinogen	Related cancer
Smoking	Polycyclic Hydrocarbons	Lung Cancer ⁶
Diet	Salted Food	Stomach Cancer ⁷
Asbestos	Asbestos enhances risk for smokers	Lung cancer ⁸

Viruses:

Viruses that cause cancer are called 'Oncogenic viruses'. Several studies confirm the role of a few viruses in causing cancers in humans.

Human papilloma virus etiology has been confirmed in cervical cancer in women.
(9)

Hepatitis B virus infections are claimed to be responsible for some cases of Hepatocellular carcinoma.

Radiation:

Radiation, in the form of X-rays and other particulate matter like protons, causes damage to cellular DNA, RNA and other structural proteins.

Radiation above certain levels increases the risk of leukemia, thyroid, breast cancers and other cancers.

Food:

Discussed throughout the book.

Inherited Genetic Mutations:

A question that doctors frequently hear in general practice is, "My father has cancer. What are my chances of getting it?" Hereditary predisposition occurs in some cancers.

In the previous section, I explained how the risk of retinoblastoma is greater in persons who inherit a mutated gene from their parents.

The three types of genes (that relate to cancers) in cells:

- Genes that promote the growth of the cell
- Genes that regulate the cell division
- Genes that continuously suppress the cancerous changes in the cell

Genes that promote the growth of the cell:

Some genes stimulate cell division. For example, we cut our finger. Genes in the cells at the edge of the cut stimulate the cells to divide so that new cells fill the gap and close up the wound. These cells stop dividing when they approach the cells on the other side of the cut (contact inhibition).

When genes that promote growth are over-stimulated, they make cells divide uncontrollably.

Genes that regulate a cell's programmed death:

Certain genes in cells program their cell to die to keep a limit on the cell population or keep order in the process of cell differentiation and repair.

For example, new cells will constantly replace cells in our intestine every minute by this programmed cell death.

Another example is that our muscles will become thin if we don't use our limbs for few months. This is an effect of programmed cell death.

Inactivation of cancer suppressor genes:

These genes don't suppress cancer cells that are already present in the body, but they **guard** normal cells against changing into cancer cells.

For example, the gene called 'p53' is present in every cell of your body to guard the cell. When a cell is damaged by chemical, viral or any other factors, then p53 senses that damage. If the cell was left to divide, it would form more damaged cells like itself. p53 stops the cell division and function of that cell until cell repair is finished.

p53 gives the cell time for repair. When the cell is repaired, p53 lets the cell divide and function normally. If the cell is beyond repair, it is programmed to die. This takes damaged cells out of the body.

Conclusion: Any alterations in these genes by any of these factor(s) may lead to cancer.



Diet Fact

The American National Cancer Institute's "5-A-Day" diet program tells us to eat 5 or more servings of fresh vegetables & fruits everyday. ONLY 23% of population do so.

4. Indications That DIET Influences Cancer Risk

We can say that diet is 'Double edged Sword'. Improper diet increases the risk of cancer but a proper, well balanced diet reduces the cancer risk.

According to present studies, diet can reduce the incidence of somatic mutations. This is explained under heading "Antioxidants".

Antioxidants are very well known to prevent DNA damage and spontaneous mutations¹⁰.

Diet is one of the most important lifestyle factors and has been estimated to account for up to **80%** of cancers of the large bowel, breast, and prostate. Diet affects the risk of many other cancers, including cancers of the lung, prostate, stomach, esophagus and pancreas to varying extents¹⁰.

These outcomes, reported from clinical trials, support the role of your diet in prevention, or reducing the risk, of cancer:

Prostate Cancer:

High consumption of meat, especially red meat, substantially increases the risk of prostate cancer.

Vegetables, especially cooked tomatoes, reduce the risk of prostate cancer¹⁰.

In one clinical trial¹¹, the role of Vitamin E as a prostate cancer reducing factor was established. In this study there was a 32% decrease in prostate cancer incidence and 41% decrease in prostate cancer mortality in people receiving Vitamin E supplements when compared to controls.

Breast Cancer:

In Japan, people consume TOFU, a soya product. It contains isoflavones that moderate the estrogen receptors in the body such as breast tissue. The incidence of breast cancer is low in Japan when compared to Western women; only 1/4th of the mortality rate of Western women. Japanese women's low fat diet, high fish consumption and drinking green tea also decrease their breast cancer risk.

Experimental evidence for this observation is:

1. Reduced number of 7, 12-dimethylbenz(a) anthracene–induced mammary tumors observed in rats fed a diet containing soy¹².
2. One case control study conducted by Lee et al found that regular consumption of soy foods was associated with a marked decrease in breast cancer risk in premenopausal women. (No effect in post-menopausal women)¹³.
3. A Japanese case-control study also found that tofu intake (3 times/wk compared with less than 3 times/wk) was associated with decreased risk of breast cancer in premenopausal women. Again, soy intake was not protective against post-menopausal breast cancer¹⁴.
4. In one study conducted in America, the relation between soy intake and breast cancer risk found that tofu consumption was protective in both premenopausal and post menopausal Asian women¹⁵.

Though research has been conducted around the world on the effectiveness of soya in decreasing the breast cancer risk, this still needs some conclusive evidence.

Lung Cancer:

Lung cancer risk is substantially decreased by a variety of carotenoids.

Carotenoids act as antioxidants and thus minimize cell damage.

Studies that confirm these observations are:

1. One study in Boston focused on the effect of different types of carotenoids on lung cancer risk. It was observed that lung cancer risk was significantly lower in subjects who consumed a diet high in a variety of carotenoids.

This was especially true with non-smokers who had 63% less risk¹⁶.

2. One study conducted in Hawaii reported further evidence for a protective effect from certain carotenoids against lung cancer and that greater protection was afforded by consuming a variety of vegetables compared to only foods rich in a particular carotenoid¹⁷.

But higher serum carotenoid levels were significantly associated with increased lung cancer risk among alcoholics¹⁸.

Stomach Cancer:

Nitrates in food and other preservatives added to food including meat are converted in to 'nitrites' in the human stomach. The nitrites undergo nitrosation to form 'nitrosamines' and 'nitrosamides'. This increases the risk of stomach cancer in people eating vegetables from nitrate rich soil.

In one study, Vitamin C appeared to protect against the risk of stomach cancer by inhibiting formation of nitrates in stomach.

Cancer of the stomach is 5 times more common in Japanese people compared to Western populations. When Japanese people migrated to the United States, they progressively acquired the low incidence of the US due to changes in their diets.

Studies performed in many parts of the world confirm the dietary association with stomach cancer:

1. In one study conducted in Hawaii that involved both Japanese and Caucasians, the stomach cancer risk was associated with consumption of rice, pickled vegetables, and dried/salted fish, and a negative association with vitamin C intake¹⁹.

2. One ecological study in Belgium showed a relation between the nitrate and salt consumption and stomach cancer. The analysis of this model showed that the significance of nitrate as a risk factor for stomach cancer mortality increased markedly with higher sodium levels²⁰.
3. Dietary habits and stomach cancer risk was studied in Shanghai, China. According to this study, risks of stomach cancer were inversely associated with high consumption of several food groups, including fresh vegetables and fruits, poultry, eggs, plant oil, and some nutrients such as protein, fat, fiber, tea and antioxidant vitamins.

By contrast, risks increased with increasing consumption of dietary carbohydrates, frequent consumption of preserved, salty or fried foods and hot soup/porridge, with irregular meals, speed eating and binge eating. This provides evidence that diet plays a major role in stomach cancer risk²¹.

Diet related cancers are more studied in adults. The effects in children are yet to be investigated in depth.

No single food can completely prevent cancer but a balanced combination of different groups can help.



Diet Fact

Appropriate diet can prevent 3-4 million cancers each year. Major causes of cancer are tobacco and imbalanced diet.

5. Role of Diet In Causing Cancer

Our diet may increase the risks of cancer in different ways:

- Carcinogens (substances that cause cancer)
- High fat and excess calories
- Salted food
- Low fiber
- Alcohol
- Pesticides (No clear evidence in humans)

Their role in increasing the risk of cancer has been extensively studied but different outcomes may be seen, depending on how the study was carried out.

Nutritionally linked cancers

Promoter	Site	Carcinogen from	Mechanism	Inhibitors
Esophagus	Pickled, salted foods, alcohol	Alcohol	Carcinogen	Yellow-green vegetables, tea ¹
Stomach	Pickled, smoked foods, nitrate	Salt, Helicobacter pylori	Atrophic gastritis	Yellow-green vegetables, tea ¹
Liver	Hepatitis antigen, mycotoxins,	Hepatitis antigen	Cytotoxicity	Vaccine (possible)

	nitrosamines			
Liver	Senecio alkaloids	Alcohol	Cytotoxicity	
Colon ²	Fried foods, heterocyclic amines	Fats ³	Bile acids	Bran fiber, calcium, vegetables, tea ¹
Breast ⁴	Fried foods, heterocyclic amines	Fats ³	Hormonal balances	Vegetables, tea ¹ , fruit, soy foods, tea ¹
Prostate	Fried foods, heterocyclic amines, hydroxy radicals	Fats ³	Hormonal balances	Vegetables, fruit, cooked tomatoes, soy foods
	Endometrium & ovary Hydroxy radicals	Fats ³	Obesity, oestrogen	Vegetables, fruit, weight loss

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1. Effective tea polyphenols, the active antioxidant components of black or green tea, have begun to be marketed as capsules or pills.
2. Distal colon and rectum. For rectum, alcohol is an additional factor; for proximal colon, causes not clear.
3. Mostly mixed fats as prevalent in Western diets, with 30–40% of energy as fats; monounsaturated oils such as olive oil as used in the Mediterranean area have little promoting action.

4. Perimenopausal and post menopausal breast cancer, where obesity-generated estrogen also promotes. Causes of premenopausal breast cancer are distinct, where *BRCA1* and *BRCA2* may play a role; for such early cancers, obesity does not increase risk and soy proteins may lower risk.

By and large, some conclusions were made about the risk and much study is continuing in this field of dietary influence on the cancer.

Dietary Carcinogens:

- Naturally present carcinogens
- Carcinogens forming during food preparation
- Preservatives and coloring agents added to food (suggested but not established)
- Some substances are changed in to carcinogens in the body.

Naturally present carcinogens:

An example of this is 'Aflatoxin', a mycotoxin produced by fungi. Grains and nuts can be contaminated by fungus, which then produce chemicals called aflatoxins.

They are known to cause liver cancer in Africa and the Far East, especially in people who are carriers of hepatitis antigens.

Carcinogens forming during food preparation:

Polycyclic hydrocarbons, such as benzopyrenes, are formed during barbecuing meat on an open fire (e.g. preparing jerked chicken). These polycyclic hydrocarbons are also one of the main constituents in cigarette smoke that cause lung cancer).

The traditionally high intake of fried and broiled food, such as meats, can increase the risk of breast, distal colon, prostate and pancreas cancers.

Several studies showed that populations that eat fried or broiled meats have a relative risk greater than 2 (deviation from median) for colon and breast cancer. More than 20 such chemicals have been identified. They are present in fairly small amounts, but their action is promoted, an effect associated with n-6 polyunsaturated oils such as corn or safflower oil at 30-40% of energy in animal and human studies. A lower fat intake, 15-22% of energy, dramatically decreases those effects^{22,23}

Preservatives and coloring agents added to food: (Need some more tests to establish this relationship).

Food colorings are added to increase the appeal of the food but not all are good for us. An example is "butter yellow".

Artificial sweeteners (like saccharine & cyclamates) and preservatives which produce nitrosamines are known to cause bladder and stomach cancers respectively.

Some substances are converted in to carcinogens:

Nitrosamines are formed from sodium nitrite. Sodium nitrite is present in drinking water and vegetables.

High fat diet and excess calories:

People that consume food containing high levels of fat are more likely to have colon, prostate, breast and pancreatic cancers. Low incidence of nutritionally-linked cancer in Japan and around the Mediterranean is due to the popularity of monounsaturated oil such as olive oil and, n-3 polyunsaturated oils such as fish oils.

Dietary fats, especially the omega-6-polyunsaturated oils, are powerful promoters of breast, colon, prostate and pancreatic cancers in humans and also in animal studies. This effect is observed with 40% of calories but not with 15-20% of calories. Intake of diet typical of the American diet increased mammary tumorigenesis effectively when fed as 40% of calories²⁴.

Saturated fats - like butter, cheese, red meat, egg yolk etc. - are more dangerous than mono unsaturated fat. (One type of fat oil present in fish oils called 'OMEGA-3-fatty acids' is good for health in preventing heart disease.)

Fish contain 20-25% of saturated fat and are a rich source of n-3-fatty acids, Vitamin D and E. An inverse relationship exists between the colon and rectal cancers and intake of fish^{25a}.

Excess fat can affect in different ways:

1. The by-products that are **produced** after fat digestion may stimulate tiny growths in the intestinal mucosa. These tiny growths called 'polyps' can change to frank cancers.
2. High fat in the diet stimulates can increase the level of bile acids (a digestive juice constituent produced by the liver and secreted in to the intestine). These bile acids alter the microflora of the intestine and colon. Bile acids act as promoters and increase cell duplication.
3. Though the fat and consequent obesity is associated with breast cancers in most of the studies, definitive evidence is still lacking. Fat may affect hormonal balance and affects the risk of cancer in some way.

Total intake of fat should be limited to less than 20-25% of energy and use oils, such as canola and olive oils, to reduce the risk of cancer^{25b}.

Excess calories:

Excess calories increase the rate of cell division and there will be more chance of something going wrong in the faster cell cycles.

Colon cancer and breast cancer are common in people taking in excess calories.

We should think about how many calories we are getting from our diet. A high vegetable intake usually lowers total caloric intake. A high-fat diet usually increases it. A 40% reduction in calorie intake decreased the rate of cancer incidence²⁶ in animal studies.

In one study, the lowering calorie intake decreased the cancer progression in animals with induced cancers²⁷.

Salted food like fish and pickled vegetables:

Stomach and esophageus cancers are more common in people eating salted food.

Salt damages the protective layer on the stomach mucosa and exposes the sensitive mucosa to carcinogens and chemicals.

In America, the cancer of glandular stomach and mortality due to that disease were high before 1920s with the traditional use of salt and saltpetre to preserve food. But the incidence began to decrease in later years as refrigerated storage became available²⁸.



Diet Fact

Folic acid is found in vegetables, beans, fruits, and whole grains. Low dietary folic acid increases the risk of colon, rectum, & breast cancers.

Alcohol consumption:

Alcohol increases the risk of mouth, larynx, esophageus, stomach and rectum cancers. The incidence of these cancers among alcoholics is ten times greater than in the general population.

Chronic alcoholism accelerates chemically induced rectal carcinogenesis and raises the possibility that acetaldehyde, probably generated through bacterial ethanol oxidation, may be involved in this process. The secondary hyperregeneration of the mucosa, observed after alcohol drinking could, by itself, favor carcinogenesis²⁹.

No more than 2 drinks per day are advised.

Pesticides and fungicides: (No clear evidence in humans).

These are used to keep the vegetable crops free of pests and diseases. They are present in low amounts on the vegetables. Wash the vegetables and fruits well before eating them.

Low fiber:

We will discuss the role of fiber in later chapters.



Diet Fact

Vegetables don't lose their nutritional value when cooked in a microwave.

6. How Certain Foods May Reduce the Risk Of Cancer

You don't need to know how many milligrams of vitamin C is in one orange but you should know that eating oranges gives your body Vitamin C that helps protect you from diseases.

Health awareness is increasing in the general population, day by day. People are becoming more conscious about what they are doing or what they can do to maintain good health.

For example people are getting to know about the screening tests, their risks if they have a family member with cancer...

A 35 year old women comes to genetic counseling to know her chances of having a Downs syndrome baby.

People are thinking more and more every day about their health and they are concerned about the risk factors in and around them.

You should make yourself aware of factors that can affect your health.

Food helps us to fight against diseases by supplying many needed micronutrients such as vitamins, minerals etc.

Your genetic make-up can make you susceptible to a few types of cancer. Your way of eating plays a major role in increasing or reducing the risk of cancer.

How do some foods help us fight against cancer? phytochemicals:

Phytochemicals are non-nutritive substances found in plants (phyto=plant). They defend the plants against diseases and they offer protection to US against diseases when they are in our body.

These are more than 900 phytochemicals present in plants.

Important facts about phytochemicals:

If you don't eat tomatoes, you won't die of lycopene deficiency. But middle aged men need it to decrease the prostate cancer risk.

If you don't eat soya, you won't die of isoflavone deficiency. But the isoflavones certainly decreases the risk of breast cancer for premenopausal women.

Important phytochemicals and their sources:

Soya³⁰: Consumption is common in Japan. They use it as tofu, soya paste etc.

Soya contains:

Isoflavones like genistein & daidzein

Protease inhibitors

Phytosterols

Phytates

Saponins

Phenolic acids

The most important and most studied are isoflavones, especially genistein.

Although isoflavones are weak estrogens, the prevailing hypothesis has been that isoflavones exert antiestrogenic effects when placed in a high-estrogen environment, such as exists in pre-menopausal women, and estrogenic effects when in a low-estrogen environment, such as exists in post-menopausal women.

Daidzein: This was found to inhibit the growth of cancer cells in many studies.

Genistein: Cancer cells have their own protective mechanisms to defy our defenses. But this isoflavone:

- reduces the protective mechanisms of cancer cells, making them more liable to be destroyed by our defenses.
- Acts as an antioxidant.
- Inhibits several enzymes in cellular signalling pathways.
- Increases levels of transforming growth factor-beta' that inhibits the growth of tumor cells.
- Inhibits the growth of wide range of both hormone-dependent and hormone-independent cancer cells.

Protease inhibitors inhibit enzyme production in tumour cells and decrease tumor cell growth in turn.

Decreased rates of breast, uterus and prostate cancers are associated with soya consumption because of its antiestrogenic action.

Lycopenes:

Tomatoes, watermelon and other orange-to-red colored vegetables and fruits like paprika, rose-hips etc. contain abundant lycopenes. A better level of Lycopene is produced from tomatoes when they cooked with olive or canola oil.

Lycopenes are natural carotenoids that act as antioxidants.

Lycopenes also block the conversion of food mutagens found in fried, cooked meats and fish in the form of heterocyclic amines.

Lycopenes are good inhibitors of cell proliferation.

Lycopenes lowers the oxidation of LDL-cholesterol thus minimizing the heart disease risk.

Lycopenes reduce the risk for stomach, colon and prostate (40% reduced risk in prostate cancer).

Interestingly, both raw and cooked tomatoes have same amount of cancer fighting power³¹.

Indoles, sulforaphane and isothiocyanates:

Found in cruciferous vegetables like cabbage, cauliflower, broccoli, turnip, brussels sprouts and water cress etc.

3 day old sprouts of broccoli and cauliflower contains higher levels of Glucoraphanin and very low levels of tumor promoting factors compared to mature plants³².

Lycopenes stimulate the enzymes that block the carcinogenic damage to the cell.

Lycopenes reduce the risk of breast, stomach and lung cancers.

Carotenoids:

Carrots, peaches, sweet potatoes and green leafy vegetables contain carotenoids.

There are many different types of carotenoids such as alpha-carotene, beta-carotene, lutein, lycopene (the one that is present abundantly in tomatoes), Zeaxanthin etc.

These act as antioxidants to reduce the cancer risk especially of colon and lung cancers. (This is discussed in a later section 'Antioxidants').

Some of the carotenoids like beta-carotene, alpha-carotene and beta-cryptoxanthin are precursors of Vitamin A and converted to retinol in the body. These mainly exert antioxidant properties.

Though they are structurally related to Vitamin A, the carotenoids lutein and Zeaxanthin don't have all the Vitamin A-like properties, just antimutagenic and anticarcinogenic properties.

Lemonins:

Oranges, lemons and other citrus fruits contain lemonins and phenols.

They block carcinogenic formation in our bodies and helps in elimination.

Lemonene protects the lung tissue by increasing the production of lung detoxifying enzymes.

Phenolic compounds³⁴:

Phenols are responsible for the bitter taste in fruits and vegetables. They are present in the plants to protect them from pests and act as natural pesticides for the plants.

There are more than 15 subclasses of phenols. They range from low molecular weight Flavonoids to high molecular weight Tannins.

Bitter Phenolic Compounds:

Some of the bitter phenolic compounds are Flavonoids, Green tea(contains catechins and epigallocatechins), Red wine(contains catechins and tannins) and Soya beans(contains isoflavones).

Flavonoids: Flavonoids are also known as bioflavonoids and are seen in grapes, soybeans, citrus etc.

They are antioxidants and enhance the activity of Vitamin C. They also inhibit production of estrogens in the body and influence the estrogen-induced cancers.

Plant flavonoids may protect against LDL oxidation through a reduction of free radicals, chelation of metal ions or protection, or regeneration, of alpha-tocopherol. Studies of their anti-carcinogenic action focused on the activation of enzymes involved in the metabolism of xenobiotics.

Green Tea³⁵: Animal studies showed that polyphenols in green tea protect the animals from chemical carcinogens and ultraviolet radiation induced skin cancers.

All the effects of tea are carried by many mechanisms that:

Activate enzymes in cellular signaling pathways that regulate gene expressions

Induce apoptosis and cell cycle arrest which is specific to cancer cells

Inhibit extracellular signals that stimulates cell proliferation

Inhibit cell transformation

A potent antioxidant property protects us from heart disease and carcinogenesis

Tea selectively modifies intestinal flora, replacing harmful bacteria with beneficial bacteria.

Though the effects of these polyphenols are widely publicized through animal models, we need more tests to be done in humans.

Ellagic acid: Grapes contains ellagic acid that scavenges carcinogens. Strawberries, blueberries, blackberries also contains ellagic acid.

Allyl sulfides: Garlic and onions contain allyl sulfides.

Eliminates carcinogens from the body.

Phytic acid: Grains, legumes Contains phytic acid. Binds to minerals like iron which produces cancer causing free radicals.

Antioxidants:

Antioxidants are substances that protect you against free radicals.

Free radicals are unstable oxygen radicals that are produced continuously in our bodies by our body's metabolisms such as breathing, digestion and other activities (smoking etc.). They damage the cells and DNA in the cells causing diseases, cancers, more rapid aging etc.

Free radicals are also produced by carcinogens in our body. These carcinogens attack the cell DNA leading to oxidative DNA damage. The damaged DNA should be fixed before the cell division, otherwise the altered DNA are carried on to the next generation of cells.

This DNA damage accumulates as the person is aging and mutations occur.

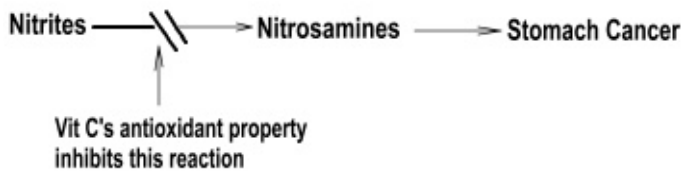
The actions of free radicals are:

- Damage to DNA, leading to mutations
- Alters the cell proliferation
- Prevents the programmed cell death called apoptosis
- Damage to DNA repair enzymes
- Free radicals cause lipid peroxidation. The end products of lipid peroxidation bind to DNA bases leading to DNA damage and they change LDL cholesterol.

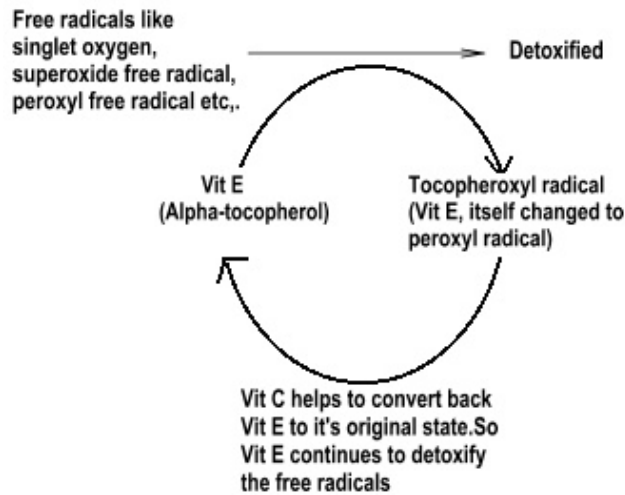
Our body's whole line of antioxidant defense mechanism comes from our dietary intake of antioxidant vitamins and minerals plus enzymes present in the body, like glutathione.

How Antioxidants work:

We will take Vitamin C as example. Vitamin C is very good antioxidant. It inhibits the conversion of nitrites to nitrosamines.



Vitamin C also regenerates Vitamin E from its peroxy radical state thus indirectly helping to maintain Vitamin E's antioxidant property.



The most important antioxidant agents are:

Vitamin C

Vitamin E

Carotenoids and retinoids

Selenium

Glutathione

Vitamin C:

Abundant in citrus fruits.

Most important, as it is a water-soluble vitamin and cannot be synthesized in the body. A daily supply of vitamin C is required to maintain good health.

Vitamin C also inhibits the formation of nitrosamines in the stomach from nitrites. Ascorbic acid supplementation and addition of ascorbic acid rich foods to a controlled experimental diet have been shown to inhibit endogenous formation of N-nitroso compounds in humans³⁶.

Vitamin C regenerates other antioxidants that are utilized in clearing the free radicals like Vitamin E, glutathione, beta-carotene³⁷.

- Alpha-tocopherol (vitamin E) from the -tocopheroxyl radical.
- Glutathione from glutathionyl radical.
- Beta-carotene from beta-carotene radicals.

Foods with vitamin C protect us against cancers of:

- Oral cavity
- Esophagus
- Stomach

Vitamin E: Present in milk, green leafy vegetables, egg, meat. Wheat germ and sunflower seed oil are other good sources.

Vitamin E is said to be the first line of defense against free radicals.

Vitamin E is an intracellular antioxidant that protects polyunsaturated fatty acids in cell membranes from oxidative damage.

Another possible mechanism for vitamin E relates to its capacity to keep selenium in the reduced state. Selenium changes free radicals into harmless substances by reducing them. In this process, the selenium is oxidised and loses its capacity to

reduce another free radical. Then the vitamin E helps the Selenium to regain its active form ("free radical" is explained under antioxidants).

Vitamin E inhibits the formation of nitrosamines, especially at low pH.

One important thing to remember is that Vitamin E will be destroyed by commercial cooking, food processing and even deep-freezing.

Carotenoids³⁸: Carotenoids are seen in carrots and other yellow-orange - vegetables, spinach and winter squash.

There are many types of carotenoids:

- alpha-carotene
- beta-carotene
- lycopene
- lutein
- cryptoxanthin
- zeaxanthin etc.

All these have these effects:

- Antioxidant property
- Anticarcinogenic property
- Antimutagenic property
- Enhances the immune functions of body

Lutein is more protective against colon cancer than others. (39)

Selenium: Shell fish, grains and plant products are good sources for selenium. The amount depends on the selenium content of the soil.

Selenium acts synergistically with Vitamin E to enhance its antioxidant property.

Selenium enhances the ability of garlic to inhibit chemically induced mammary tumors in animal studies⁴⁰

Selenium functions as a cofactor for glutathione peroxidase, an enzyme that protects against oxidative tissue damage.

Selenium acts as an inhibitor to prevent the expression of neoplasia in cells that have been previously exposed to a carcinogen.

Glutathione: Avocados are an excellent source of glutathione, a powerful antioxidant & of beta-carotene.

Glutathione is a major endogenous antioxidant without which exogenous antioxidants like Vitamin C and E cannot work properly.

In addition to neutralizing the free radicals, glutathione helps the excretion of carcinogens from the body.



Diet Fact

Prunes, strawberries, blackberries & blueberries have the highest amounts of antioxidants in fruits. Kale, spinach, broccoli & brussel-sprouts have the highest amount of antioxidants in vegetables.

High fiber:

Fiber is resistant to digestion. As it passes down the intestine, it binds with cancer producing chemicals formed during the digestion process.

There are two types of fiber; soluble and insoluble. The insoluble type that is present in bran helps to prevent constipation and diverticulosis, and lower the incidence of colon cancer. 20g of insoluble fiber per day is recommended. (41)

The soluble type that is present in fruits and vegetables, affects stool bulk relatively little but interrupts the reabsorption of products that are harmful to body.

There is a high fiber content in whole wheat, rye, grains, cereals.

Fiber does not contain any cancer fighting substances but it acts in various ways to reduce the risks, especially of colon cancer.

- Fiber binds with carcinogens produced during digestion
- Fiber attracts water from the food and dilutes the carcinogens and cancer promoters
- Fiber also maintains the normal intestinal flora and acidity to eliminate the possibility of growing harmful flora.
- Increases the stool bulk and decreases the transit time in the intestine. This lowers the contact time between the potential carcinogens and intestinal epithelium
- Short chain fatty acids that are produced from the dietary fiber is associated with lowered serum cholesterol and decreased risk of cancer⁴².
- Dilutes secondary bile acids in the intestine. These secondary bile acids are derived from primary acids in the intestine and promote intestinal epithelial proliferation.
- Short chain fatty acids, especially butyrate acts as antineoplastic⁴².

- Short chain fatty acids from fiber, decrease the pH of the intestinal contents and thus inhibit the production of secondary bile acids.

You should take plenty of water along with the fiber to help it work best for you.



Diet Fact

Consume a well balanced diet with whole grains, vegetables, fruits & beans.

Exercise:

You can stop obesity by balancing your caloric intake and energy expenditure.

Exercise helps in these ways:

- Consumed food is utilized optimally
- Burns off the calories
- Prevents obesity that is associated with prostate, breast, ovary and colon cancers
- Speeds up transit time of food in the intestine, so carcinogens' contact time with intestine is reduced
- Immune system functions properly
- Increases the levels of free radical scavengers

Whole grains⁴²:

Grain intake reduces the risk of many cancers, especially breast and colon cancers.

Major grains in our diet are wheat, brown rice and corn.

Minor grains are oats, barley, rye, millet, sorghum etc.

Whole grains are rich source of:

- Phytochemicals
- Dietary fiber
- Vitamins like vitamin E
- Phenolic compounds
- Phytic acid
- Resistant starch, oligosaccharides etc.

Antioxidants in whole grains:

- Inositols
- Lignin
- Phenolics
- Phytates
- Phytoestrogens
- Selenium
- Tocopherols (Vitamin E)
- Zinc

These antioxidants fight against the oxygen free radicals and protect the intestinal mucosal epithelium from damage by these radicals.

Lignans and phytoestrogens have structural similarity to estrogens, so they are said to decrease the hormone dependent tumors.

Phenolic compounds acts as anti-carcinogens because of their ability to prevent the formation of carcinogens from precursor compounds and blocking the reaction of carcinogens with critical cellular macromolecules.

Tumor suppressing factors in whole grains:

- Flavonoids
- Phenolics
- Phytoestrogens
- Protease inhibitors
- Saponins
- Selenium

Protease inhibitors, phytic acid, phenolic compounds and saponins were shown to reduce the risk of cancers of the colon and breast in animals.

Other important components of whole grains are dietary fiber, starch and oligosaccharides.

Dietary fiber, starch, Oligosaccharides:

Starch in whole grains are more resistant to digestion compared to starch in refined grains.

Oligosaccharides are thought to have effects similar to the soluble dietary fibers in the human gut. In addition, studies consistently found that oligosaccharides were able to alter the human fecal flora.

Dietary fiber and oligosaccharides will function as:

- Enzyme modulator
- Binding scavenger
- Chemical inactivator
- Cholesterol-lowering
- Gut modifier ... and
- Has hormonal effects

Most of these components are found in wheat germ and bran but are reduced in the grain-refining process. The most potent protective components of whole grains need to be identified so that efforts can be directed toward minimizing the loss of physiologically important constituents of grains during processing.

Low fat intake:

Most of your diet should come from plants. Try to avoid red meat.

Fat gives you an amount of calories. Minimize your fat intake. Saturated fat is much more harmful than polyunsaturated fat. The best fat is monosaturated oils at 20% of calories because these are needed to absorb fat soluble micronutrients.



Diet Fact

Excess boiling takes away water-soluble vitamins like B and C.

7. Common Questions about Diet and Cancer

Is there any difference between fresh vegetables and fruits and canned food?

Canned food is said to be inferior in levels of some vitamins because they may be lost in the canning process.

Frozen food is superior in some constituents like vitamin C and A because the crops are frozen immediately after picking. Fresh vegetables and fruits with long shelf life have less Vitamin C.

If you don't have time to buy vegetables each day, buy them for a week, wash them and cut into pieces and you can store them in the freezer in air-tight bags. Use them within one week.

Can supplements reduce the risk of cancer?

Fresh foods contain hundreds of phytochemicals and vitamins. They interact with each other in various ways to reduce the risk.

Supplements cannot provide so many constituents in one pill. They concentrate mainly on one or two types of phytochemicals or vitamins.

One study conducted by The ATBC study group, 1994, Greenburg et al, showed that supplements cannot reduce the risk of lung cancer in smokers.

Does drinking a lot of water have any role in reducing the cancer risk?

Water has no direct effect on cancer risk but drinking plenty of water, about 8 cups each day, is advisable to eliminate carcinogens from the body and keep you in good health.

People who drink lot of water have a very low incidence of bladder cancer as a good amount of water daily dilutes the carcinogens and lessens the time of contact between bladder wall and these substances.

"There is cancer incidence in my family. Can my diet reduce the risk?"

Genetic factors have a very complicated role in cancer induction. Good diet can delay or prevent cancer by minimizing cell damage and other effects as explained before. Tobacco use should be avoided.

Based on the current knowledge, the answer must be carefully qualified. According to present evidence, large numbers of cancers are influenced by both environmental and hereditary causes. For example, lung cancer is most clearly related to smoking (an environmental factor). But the mortality from lung cancer is influenced by hereditary predisposition. Mortality is four times greater among non-smoking relatives of lung cancer patients than non-smoking relatives.

Lots of research is continuing in this area. Stick to a healthy diet that includes fresh vegetables and fruits.

What about children and the cancer risk?

All the conclusions were made from research in adult populations. We need more research to find out what is the situation with children. But, as in adults, healthy food and good exercise are advised for children too.



Diet Fact

Gamma-tocotrienol, Beta-ionone present in many fruits & vegetables was shown to block growth of cancer cells in leukemia, breast & colon cancer.

8. FIVE Colors of Your Diet

Deeply colored fruits and vegetables provide wide range of vitamins, minerals, phytochemicals and fiber that keeps you in good health.

The five colors for your diet are:



Red

Yellow/Orange




Blue/Purple

Green

White/Brown

<p>Red</p> 	<p>Get your lycopenes and anthocyanins from Red colored fruits & vegetables to help protect from heart disease & stomach & prostate cancers.</p>	<p>Tomatoes Water melon Strawberries Cherries Pomegranates Cranberries Red apples Beets Red cabbage</p>
<p>Yellow/Orange:</p> 	<p>Get your carotenoids & bioflavonoids from orange colored fruits & vegetables to help protect from heart diseases, vision & immune system</p>	<p>Oranges Cantaloupe Lemons Papaya Carrots Corn Peaches Mangoes</p>

Your Diet and Cancer

	problems, also colon & lung cancers.	Pumpkin Pineapple
<p>Blue/Purple:</p> 	Get your phenolic compounds in Blue/Purple colored fruits & vegetables to help maintain health while aging & protect from breast, prostate cancers etc.	<p>Grapes Blueberries Blackberries Raisins Blackcurrants Egg plants</p>
<p>Green</p> 	Get your lutein and indoles from Green colored fruits & vegetables that are good sources of phytochemicals to protect you from a wide range of cancers.	<p>Apples Grapes Green leafy vegetables Cucumber Lettuce Celery Broccoli Green peas String beans Green eggplants</p>
<p>White/brown:</p> 	Get your indoles & isothiocyanates from white/brown colored fruits and vegetables to help protect you from heart diseases & stomach, breast and lung cancers.	<p>Cauliflower Garlic Onions Mushrooms Bananas Turnips</p>

9. Five A Day: From the American National Cancer Institute

'5 A Day' program is jointly sponsored by the National Cancer Institute (NCI) and the Produce for Better Health Foundation (PBH).

Goal: The goal of this '5-a-day' campaign is to increase the average consumption of fruits and vegetables to 5 or more servings daily.

Objectives: The first objective is to increase public awareness of the importance of eating 5 or more servings of fruits and vegetables every day to keep up good health.

The second objective is to provide consumers with specific information on how to include more servings of fruits and vegetables in their daily eating patterns.

What's a Serving? All varieties of fruits and vegetables - fresh, frozen, canned, dried and 100 percent juice can be taken into account when estimating a serving. The National Cancer Institute, co-sponsor of the 5 A Day for Better Health program, defines a serving as:

- One medium-sized fruit (ex. apple, orange, banana, pear)
- 1/2 cup of raw, cooked, canned or frozen fruits or vegetables
- 3/4 cup (6 oz.) of 100 percent fruit or vegetable juice
- 1/2 cup cut-up fruit
- 1/2 cup cooked or canned legumes (beans and peas)
- 1 cup of raw, leafy vegetables (ex. lettuce, spinach)

- 1/4 cup dried fruit (ex. raisins, apricots, mango)

For more information on this '5 A Day' campaign, you can contact them at:

National Cancer Institute

National Institutes of Health

6130 Executive Blvd., Room 4050

Bethesda, MD 20892-7335

Phone: (301) 496-8520

Fax: (301) 480-2087

10. Some great tips to follow

1. Include vegetables and fruits in **every meal**. Plant-based food is low in fat and high in fiber as well as the best source for phytochemicals and oxidants. At least 5 servings/day of fruits and vegetables are necessary to keep you in good health.

Always keep fruit juices, canned vegetables, fruit chunks in the fridge ready to eat any time.

2. Limit fried food and other oil stuff.

3. Avoid foods like moldy or spoiled food, salted fish, smoked food like bacon, corned beef etc. burnt and charred food

4. Avoid eating cheese-burgers, red meat (especially pork).

5. Don't overcook vegetables. More than half of the nutrients and vitamins may be lost in the cooking process.

6. Try to keep the fiber content of your food at approx. 20 grams per day. Whole wheat bread, barley, oats and fruits are good sources of fiber.

7. Cut down the sweets and sugar.

8. Quit smoking and alcohol consumption. Smoking is the worst enemy of humans, causing lung cancer.

9. Drink plenty of water. (1-1.5 l/d)

10. Do regular exercise and take your physician's advice.



Diet Fact

Cancer risk can be lowered with a diet that is rich in vegetables & fruits & low in fat.

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