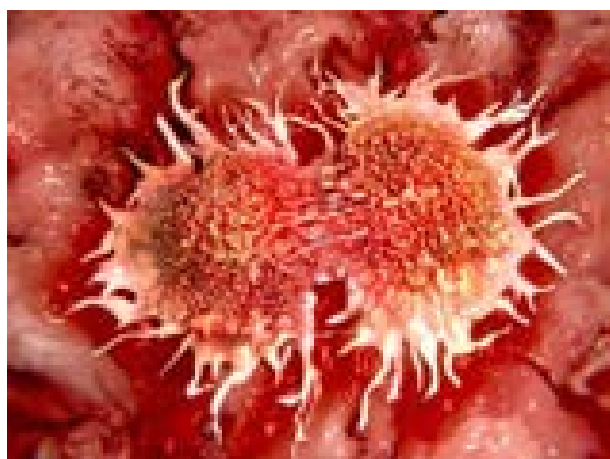




OBJECTIVES

This chapter will enable students to

- Know what cancer is
- Know the causes, symptoms and major types of cancer
- Learn treatment procedures
- Understand role of specific nutrients in the prevention of cancer
- Understand nutritional intervention in cancer



Cancer is an uncontrolled division of abnormal cells in the body which may invade other normal and healthy tissues. Cancer is also referred to as a “**malignant tumor**.” It can affect any part of the body, and originates from a single cell that transforms into a cancer cell through interactions between DNA/genes and external agents. Presently in India, it is a major cause of morbidity and mortality.

12.1 What is cancer?

The process of origin and development of cancer is termed as “**carcinogenesis**.” It is a multistage process that consists of three phases: **Initiation, promotion and tumor progression.**



Fig 12.1 Process of carcinogenesis

Initiation:

Initiation involves a genetic change in the normal cells caused by their interactions with chemicals, radiation or viruses. These substances are termed as **carcinogens**. A carcinogen may be any substance that has the ability to initiate cancer. Carcinogens enter the body through inhalation (e.g., of cigarette smoke), ingestion of heavy metals and pesticides, and by the absorption of chemicals through skin. Initiation occurs rapidly but the initiated cells remain inactive until it is activated by a promoting agent.

Promotion:

In the promotion phase, the initiated cells multiply and a new abnormal tissue with no useful function is formed. This is called “**neoplasm**”. Promotion takes place by a continuous exposure of the initiated cells to promoting agents.

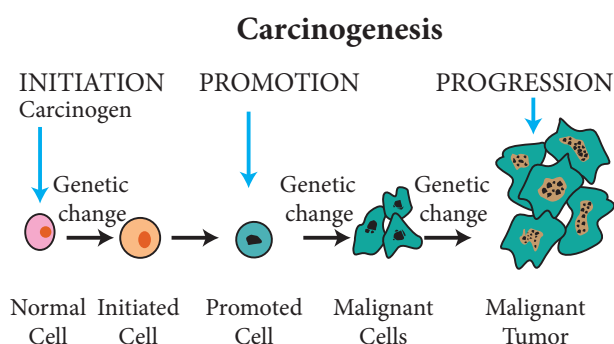


Fig 12.2 Genetic mutation of a normal cell to a cancer cell

Progression:

During the progression phase, the abnormal tissue grows and leads to the development of a fully malignant tumor. This tumor has the capacity to invade normal tissues which may ultimately lead to the spread of cancer to other parts of the body. This is called as “**metastasis**.” A Cancer that has spread to other parts of the body is said to have “metastasized”.

A tumor is an abnormal growth of cells that serves no purpose.

There are two types of tumors : Malignant and benign tumors

A benign tumor is a non-cancerous tumor that does not spread to other parts of the body. A malignant tumor is a cancerous tumor that may spread to other parts of the body

12.2 Classification of cancer

Cancers are of four main types based on the type of cell that produces it. They are carcinoma, sarcoma, lymphoma, and leukemia.

1. **Carcinoma** is cancer of the epithelial cells that line the digestive tract, urinary bladder and the uterus.
2. **Sarcoma** is cancer of the soft tissues of the body, such as muscle, fat, nerves, tendons, blood and lymph vessels.
3. **Lymphoma** is cancer of the lymphoid tissue. This includes the lymph nodes, bone marrow, spleen, and thymus gland.
4. **Leukemia** develops from the white blood cells and also affects the bone marrow and spleen.

The most common cancers in men are that of the lung, colon, pancreas, liver and prostate gland. In women, cancer of the breast, ovary, cervix, uterus and colon are common. Besides this, cancer can occur in any part of the body like the thyroid gland, stomach, oral cavity, esophagus, skin, brain etc.

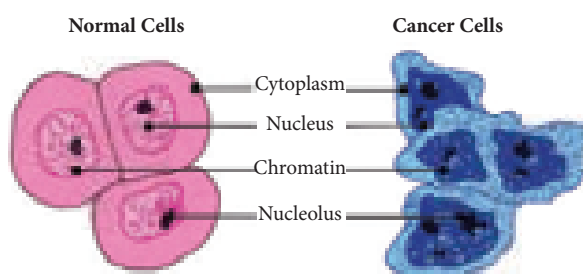


Fig 12.3 Comparison between a normal cell and a cancer cell

Carcinogenesis is the process in which normal cells turn into cancer cells.

Alterations (mutations) in DNA/genes occur during carcinogenesis. A carcinogen is a physical, chemical or viral agent that induces cancer by bringing about changes in the DNA.



12.3 Causes of cancer

Some of the causes of cancer are:

1. Exposure to toxic compounds such as benzene, asbestos, nickel, cadmium, vinyl chloride, benzidine and N-nitrosamines.
2. Exposure to radiations from x-rays, radioactive materials and atomic exhausts.
3. Exposure to cigarette smoke, pesticide residues, water and air pollutants, synthetic food additives and contaminants.
4. Non-ionizing radiation from sunlight may damage the DNA of cells leading to cancer.
5. Tumor-producing viruses are called oncogenic viruses. Some of the viruses associated with human cancers are Human papillomavirus (HPV), EBV or Epstein-Barr virus, hepatitis viruses and Kaposi's sarcoma-associated herpes virus (KSHV).
6. Salted, smoked and processed meats contain nitrites and their related compounds which get converted to carcinogenic N-nitroso compounds in the colon.
7. Fat that drips from meat while being barbecued / grilled creates smoke that contains carcinogenic chemicals called **polycyclic aromatic hydrocarbons** which surrounds the meat. Another group of carcinogenic chemicals known as **heterocyclic amines** are found in meat that has been fried or grilled for long periods of time.
8. Aflatoxins are toxins that are produced by certain fungi that grow on groundnuts. Ingestion of foods contaminated with aflatoxin is associated with cancer risk.
9. High-fat diets have been associated with cancer of the prostate gland, colon, breast, and uterus. By promoting obesity, a high sugar intake may indirectly increase cancer risk.

10. Individuals with reduced physical activity may be at an increased risk of developing cancer.

12.4 Symptoms of cancer

The American Cancer Society (2014) describes seven warning signs that a cancer may be present. They are:

- Changes in bowel or bladder habits
- A sore throat that does not heal
- Unusual bleeding or discharge
- Thickening or lump in the breast, testicles, or elsewhere
- Chronic indigestion and difficulty swallowing
- Noticeable change in the size, colour, shape, or thickness of a wart or mole
- Persistent cough or hoarseness.

Other signs may include the following:

- Loss of appetite
- Unexplained weight loss
- Persistent fatigue, nausea, or vomiting
- Unexplained low-grade fevers that may be either persistent or temporary



Oncology is a branch of medicine that deals with the prevention, diagnosis, and treatment of cancer. A doctor who specializes in treating cancer is called an **Oncologist**.

12.5 Stages of cancer

Staging describes the extent or spread of cancer at the time of diagnosis. Cancers fall between the stages of 0 to IV.

Stage 0: In this stage, cancers are still located in the place they started and have not spread to the surrounding tissues.

Stage I: It is also called early-stage cancer. This stage is usually a small cancer or tumor

that has not grown deeply into nearby tissues. It has also not spread to the lymph nodes or other parts of the body.

Stage II and Stage III: These 2 stages indicate bigger tumors that have grown more deeply into the nearby tissues. They may have also spread to lymph nodes but not to other parts of the body.

Stage IV: This stage means that the cancer has spread to other parts of the body. It may also be called advanced or metastatic cancer.

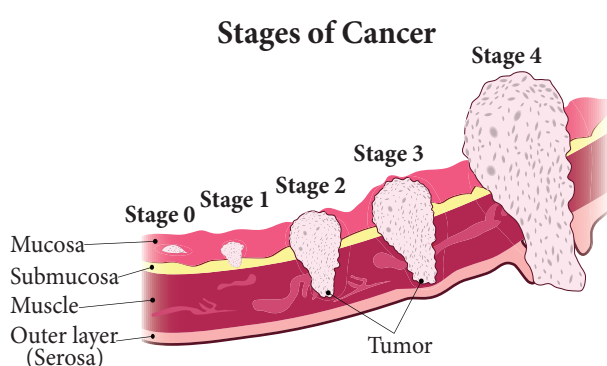


Fig 12.4 Stages of cancer

A classification system known as **TNM** is used to identify the size, the degree of growth and spread of the tumor.

- **T** stands for “**Tumor**” - it shows how large the primary tumor is and where it is located.
- **N** stands for “**Node**” - it shows whether the tumor has spread to the lymph nodes. If so, where and how many?
- **M** stands for “**Metastasis**” – it shows whether the cancer has spread to other parts of the body. If so, where and how much?



12.6 Diagnosis of cancer:

Detecting cancer is a multistage process which includes the following:

Imaging : Cancer detection often involves radiological imaging. Imaging involves creating pictures of areas inside the body that will help medical professionals to detect tumors. It is also used to check the spread of cancer and the progress of treatment. The most common imaging techniques used are

- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Positron Emission Tomography (PET)
- Ultra sound examination
- Endoscopic examinations
- Mammography and
- Isotopic diagnostics.

Tumor markers: These are biochemical substances that are produced by tumor cells or by other cells of the body in response to cancer. These substances can be found in the urine, blood, stool, tumor tissue and body fluids of individuals with cancer. They are produced at much higher levels in cancerous conditions. A tumor marker may be used along with other procedures to diagnose cancer. A few examples of tumor markers are **CA-125** (in ovarian cancer), **CA 15-3** (in breast cancer), **CEA** (in colon cancer), and **PSA** (in prostate cancer).

Biopsy test: A confirmatory test for the diagnosis of cancer involves an examination of the suspected tissue under a microscope by a pathologist. This is called a “**biopsy**.” A Biopsy is an analysis of tissue removed from a living body to find out the presence, cause, or extent of cancer.



A pathologist is one who interprets and diagnoses the changes caused by disease in tissues and body fluids.

12.7 Nutritional implications of cancer

There are three major nutrition related problems that are often exhibited in a cancer patient:

1. Anorexia
2. Drastic weight loss
3. Cancer cachexia.

1. Anorexia

Anorexia means “loss of appetite”. The anorexia of cancer may be related to depression, the trauma of the disease, as well as to the side effects of treatment. Chronic anorexia observed in cancer leads to “cancer cachexia which is characterised by severe loss of muscle mass and body weight.

2. Drastic weight loss

Weight loss in cancer patients may be attributed to a chronic loss of appetite, persistent fever and changes in taste perception that reduces food intake. Individuals with cancer often lose weight drastically. Cancer cells compete with normal cells in utilizing nutrients and energy reserves of the body to grow. On the other hand, normal cells require energy to fight this abnormal growth. This increase in demand for nutrients and energy by both normal and cancer cells, results in a hypermetabolic state that causes a significant loss of weight. As cancer progresses, the individual becomes weaker and is less able to fight infections.

3. Cancer cachexia

Cancer cachexia is a “wasting syndrome” characterized by extreme loss of the body’s muscle and fat mass, anorexia, asthenia (abnormal physical weakness) and anemia (a deficiency of red cells or of haemoglobin in the blood). Tumor cells release substances that reduce appetite. Cancer and its treatment can also cause severe nausea and may damage the digestive system, leading to poor absorption

of nutrients. As the body gets fewer nutrients, it burns fat and muscle. Cancer cachexia is the most common indicator of advanced stage of the disease.



Fig 12.5 Wasting syndrome – Cancer cachexia

Consequences of malnutrition in cancer are:

- Severe loss of tissue proteins
- Compromised immune function increasing the individual’s susceptibility to infections.
- Poor wound healing
- Abnormal reactions to cancer drugs and treatment



Activity : 1

Match the following

Anorexia	-	wasting syndrome
Chemotherapy	-	spread of cancer to other parts of the body
Cachexia	-	The study of cancer
Oncology	-	treatment procedure for cancer
Metastasis	-	loss of appetite

12.8 Treatment procedures

Recommended treatment depends on the stage and the actual type of the cancer. Treatment may include surgery, chemotherapy, radiation therapy or a combination of these.

Surgery

Surgery is performed to remove the tumor. If all of it is successfully removed and there are no metastases, surgery may be the only treatment required.

Chemotherapy

Chemotherapy involves the use of chemical substances to kill cancer cells. Chemotherapy may be administered intravenously. These drugs stop the cancer cells from multiplying.



Fig 12.6 Administration of chemotherapy

Some of the effects of chemotherapy include hair loss, reproductive changes, diarrhoea, malabsorption, nausea, vomiting and loss of sense of taste.

Radiation therapy

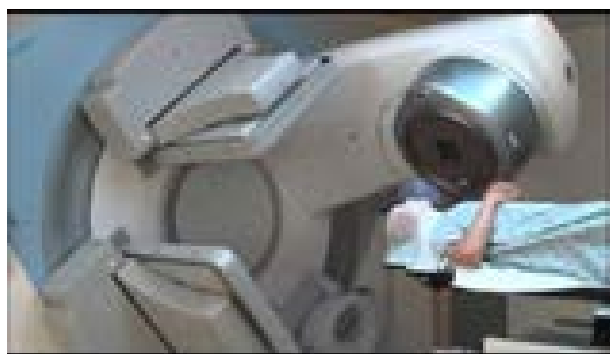


Fig 12.7 Administration of radiation therapy

The person receives specific doses of radiation at the cancerous areas of the body for a period of time. The aim of this treatment is to ensure that tumor cells do not grow again. It does not affect the entire body, as chemotherapy does. Healthy cells grow back after the treatment.



Activity : 2

Cancer Awareness Ribbons



Looped ribbons of different colours are used to create awareness on different types of cancers. Can you match the colours with the type of cancers they represent?

Pink loop	-	lung cancer
White loop	-	breast cancer
Yellow loop	-	cervical cancer
Teal loop	-	bone cancer
White and Teal loop	-	ovarian cancer

12.9 Nutrition related side effects of treatment

Some of the side effects of treatment procedures adopted in cancer that may hinder food intake are discussed as follows:

1. **Anorexia:** It is a common problem which may be minimized with a schedule of small meals and snacks.
2. **Fatty diarrhoea:** Radiation therapy may damage the cells of the small intestine leading to “fatty diarrhoea” also known as “steatorrhea” or “radiation enteritis” Dietary treatment involves limiting the intake of



fat, fiber, gas producing and spicy foods. Sometimes very hot or very cold foods may irritate the intestines. Foods that are only warm or cool may be better accepted.

3. **Dry and sore mouth:** Patients may suffer from dry and sore mouth and may have problems with chewing and swallowing. Soft, bland and pureed foods are better tolerated. Frequent liquid intake is recommended. Using a straw instead of a spoon makes swallowing easier.
4. **Nausea and vomiting:** It may occur in any type of treatment. Eating dry foods such as crackers, toast, rice or other grain products, drinking beverage separate from meals, and serving foods cool instead of steaming hot are recommended.

12.10 Nutritional care in cancer

A well balanced nutritious diet is essential in order to maintain a healthy body weight and also to cope with the side effects of treatment procedures.

1. **Energy, carbohydrate, protein and fat:** The nutrient and calorie needs of a cancer patient are greater than they were before the onset of the disease. Tissues must be rebuilt and the nutrients lost to the cancer must be replaced. Therefore additional protein intake is required to rebuild tissues and to maintain a healthy immune system. Energy demands are high in cancer. Carbohydrates and fat will be needed to provide this energy and spare protein for tissue building and immune function. A high-protein and high calorie diet may be recommended during the treatment phase.
2. **Vitamins and minerals:** They are essential for metabolism and tissue maintenance. Vitamin and mineral supplements are provided to enhance immune function.

3. **Fluids:** Adequate fluid intake is required to keep the body hydrated and to maintain electrolyte balance. Fluids are important to help the kidneys eliminate the metabolic wastes and the toxins from drugs.
4. **Neutropenic diet:** A neutropenic diet is given to individuals with weakened immune systems. This diet helps to protect them from bacteria and other harmful organisms found in some food and drinks. In this diet, all raw fruits, vegetables and nuts are avoided. Fruits and vegetables may be consumed in the well-cooked form.
5. If chewing is a problem, a soft diet may be helpful. In case of diarrhoea, a low-residue diet may be recommended. A low residue diet limits the intake of fibre rich foods such as greens, whole grains, nuts and raw fruits and vegetables.
6. Oral feedings are preferred. However in extreme cachexia, enteral (tube feeding) or total parenteral (intravenous) feedings may become necessary.

Case Study

Mrs. R is a 45 year old woman who was diagnosed with stage III breast cancer. She underwent mastectomy (surgical removal of the whole breast). This was followed by chemo and radiation therapies. As an associated effect of the treatment procedures, she has developed mouth ulcers, diarrhoea and anorexia. What kind of dietary modification would you recommend to ensure nutritional adequacy?

12.11 Role of food in the prevention of cancer







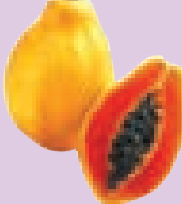














A diet rich in plant - based foods can help lower the risk of cancers. Specific components found in certain plant foods aid in preventing cancer. Here are a few:

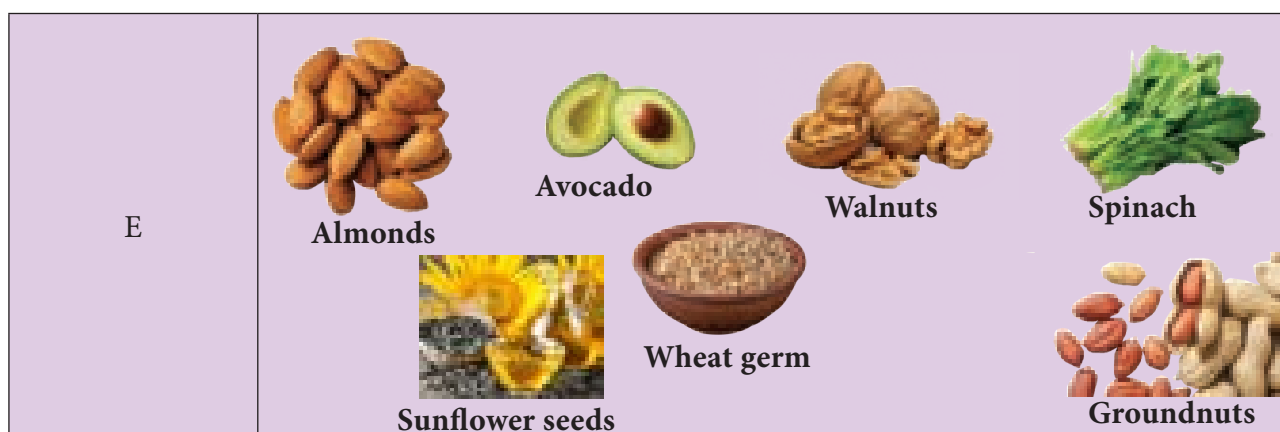
1. Antioxidants

A number of free radicals are constantly produced in our body. These free radicals are highly reactive and can damage cellular

components such as the cell membrane and DNA. This leads to an increased risk of cancer. Antioxidants play a role in cancer prevention by scavenging these free radicals. Antioxidants are compounds present in fruits and vegetables which help protect tissues from being damaged by the attack of free radicals. Vitamin C, vitamin E, and vitamin A are called antioxidant vitamins. The body cannot synthesize these vitamins and therefore they need to be provided in the diet.

Table 12.1 Foods rich in antioxidant vitamins A, C and E

Vitamin	Food Source
A	<div>     </div> <div>     </div>
C	<div>      </div> <div>     </div> <div>     </div>



2. Phytonutrients

Phytonutrients are natural compounds found in plant-based foods that give plants their rich pigment as well as their distinctive

taste and smell. These pigments have several protective compounds that exhibit cancer-fighting and immune-boosting power. This is shown in table 12.2.

Table 12.2 The rainbow of natural pigments in plants

Colour	Protective substance	Foods present
Red	Lycopene	Tomatoes, water melon, guava
Orange	Carotene	Sweet potato, yellow pumpkin, mango, carrot
Yellow-orange	Flavonoids	Orange, lemon, grapefruit, papaya, peach
Green	Folate	All green leafy vegetables
Green- white	Indoles, lutein	Broccoli, Brussels sprouts, cauliflower, cabbage
White-green	Allyl sulphides	Garlic, onion, chive, asparagus
Blue	Anthocyanins	Blue berries, purple grapes, plums, red cabbage
Red- purple	Resveratrol	Red grapes, cranberries
Brown	fibre	Whole grains, legumes

3. Cruciferous vegetables

The Brassica (Brassicaceae) family includes cruciferous vegetables such as cabbage, broccoli, kale, turnips, cauliflower,

and brussels sprouts. These contain flavones and indoles which are thought to have anti-cancer activities.

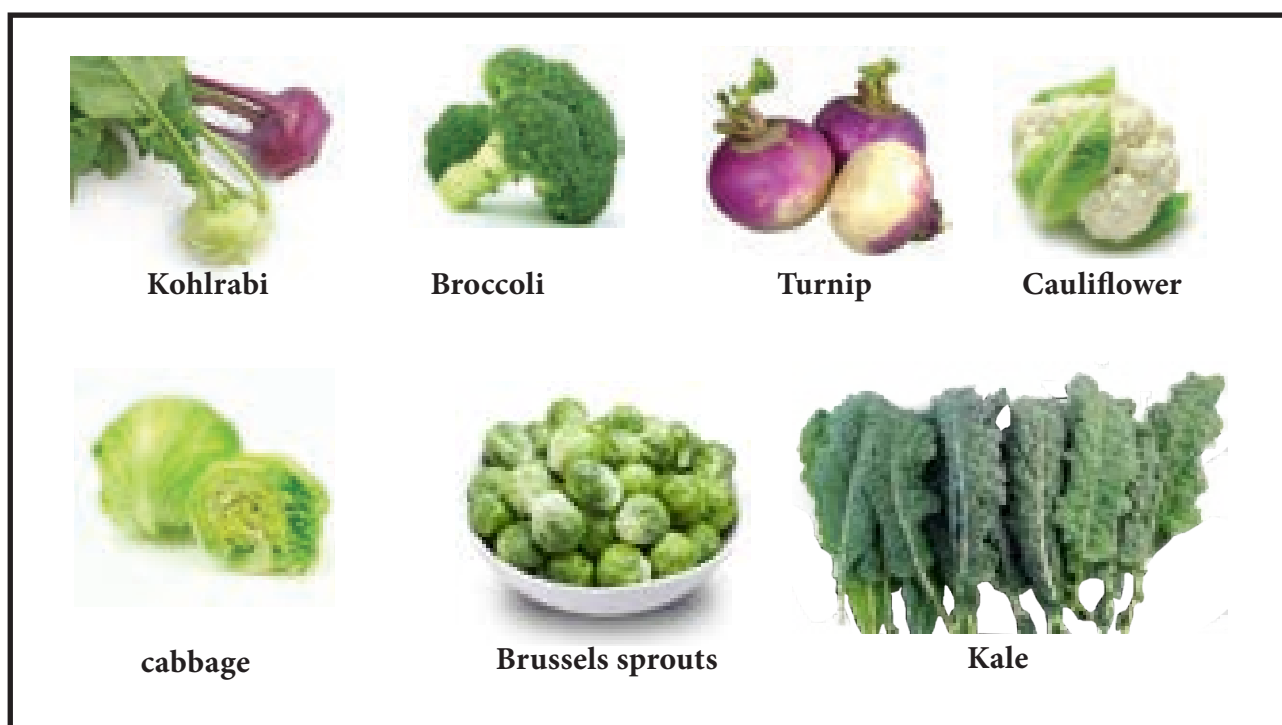
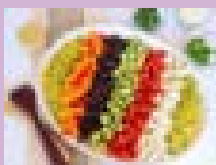


Fig 12.8 Cruciferous vegetables of the Brassica family



Activity : 2

Prepare a rainbow salad rich in antioxidants and phytonutrients by choosing vegetables and fruits of different colours.



4. Fibre intake

Dietary fibre increases stool bulk and speeds the transit of food through the colon, thus reducing the absorption of carcinogens.

Bile acids are secreted into the intestine to help digest fat. There, bacteria act on the bile acids and produce chemicals which may promote colon cancer. Dietary fibre binds

with these bile acids and expels them from the intestines.

12.12 General recommendations to prevent cancer

- Reusing cooking oil is very harmful to health. Carcinogenic aldehydes form when the same cooking oil is reused.
- Frying, broiling, or grilling meat at very high temperatures forms chemicals such as polycyclic aromatic hydrocarbons and heterocyclic aromatic amines that are potent carcinogens. Limiting the intake of such foods is recommended to reduce cancer risk.



Fig 12.9 High temperature grilling of meat produces polycyclic aromatic hydrocarbons

- Fats and oils can become oxidized on exposure to light, air or heat. Many of the oxidation products are carcinogenic. Storing oil in airtight containers prevents the oil from getting oxidized.
- Avoid intake of processed meat.
- Avoid ingestion of foods that look or smell mouldy, as they may contain toxic carcinogens like aflatoxin.
- The inclusion of fresh organic fruits and vegetables containing different natural plant pigments in the daily diet ensures meeting the phytochemical and antioxidant needs.
- Liberal intake of water prevents accumulation of toxic wastes by flushing them out of the body.
- A healthy diet, adequate physical activity and maintaining an ideal body weight reduce cancer risk.
- Excess intake of calories in the form of sugar and fat lead to excess body fat that has been strongly linked to several types of cancers.
- Trans fats are formed when liquid vegetable oils are made solid by the process of called hydrogenation. These fats are commonly used in processed food such as cookies, crackers, snack foods, fried foods, and pastries as they give foods the desirable taste, shape, and texture. Research has shown that regular intake of foods rich in trans-fat increases the risk for cancer.
- Smoking and tobacco chewing are the most preventable factors in the incidence of oral and lung cancer.
- Excessive intake of alcohol may act as an irritant, especially in the mouth and throat. Cells that are damaged by alcohol may undergo alteration in their DNA leading to cancer.
- Avoid exposure to harmful radiation and chemicals that cause cancer.

SUMMARY

- ❖ Cancer is a disease characterized by abnormal cell division. It can occur in any body tissue.
- ❖ Energy and nutrients needs increase during cancer as the tumour and normal cells compete with each other for their supply of nutrients. This hypermetabolic state coupled with a lack of appetite and poor intake of food leads to extreme muscle wasting termed cancer cachexia.
- ❖ Treatment of cancer includes surgery, radiation, and chemotherapy.
- ❖ Improving the patient's nutritional status is a challenge due to the aggressive nature of the illness and anorexia. In such a scenario, resorting to parenteral or enteral nutrition may be necessary.





A-Z GLOSSARY

Carcinogen	Any agent capable of causing cancer
Carcinogenesis	The initiation of cancer formation.
Neoplasm	Abnormal growth of tissue
Metastasis	The development of cancer in other parts of the body, away from its first site of occurrence.
Free radicals	Highly unstable and reactive molecules that can damage tissues of the body.
Antioxidants	A substance that inhibits oxidation and protects the tissues from the damage caused by free radicals
Phytonutrients	Phytochemicals are compounds naturally present in plants that keep plants healthy. They are found to be beneficial to humans as well.



Evaluation



I. Choose the correct answer

- _____ is an uncontrolled division of abnormal cells in the body which may invade other tissues
a) cancer b) fibroid
c) apoptosis d) neoplasm
- The process of origin and development of cancer is termed as _____
a) carcinogenesis b) Oogenesis
c) metastasis d) sarcoma
- _____ is a carcinogen
a) turmeric b) vitamin A
c) vitamin C d) cigarette smoke
- Radiation therapy may damage the cells of the small intestine leading to “fatty diarrhoea” also known as _____
a) steatorrhea b) loose motion
c) constipation d) dysentery
- _____ scavenge free radicals
a) electrons b) antioxidants
c) water d) oil
- _____ is a plant pigment
a) carotenoids b) hydrocarbons
c) amines d) aldehydes
- _____ is a cruciferous vegetable that helps in preventing cancer
a) cauliflower b) tomato
c) potato d) brinjal
- _____ are formed while reusing cooking oils which is carcinogenic
a) aldehydes b) ketones
c) amides d) amines





II. Write short answer (2 marks)

1. Define neoplasm
2. What is metastasis?
3. What is a malignant tumor?
4. Define the term “cancer cachexia”
5. Define anorexia
6. Differentiate between carcinoma and sarcoma
7. Why should one restrict the intake of barbecued food?

III. Answer in brief (3 marks)

1. List the risks associated with malnutrition in cancer
2. Why does a cancer patient lose weight?
3. Is high calorie high protein liquid supplement useful for improving the nutritional status of cancer patients? Explain
4. What are antioxidants? Give the food sources for the same
5. What is a neutropenic diet?
6. What does consuming a rainbow of fruits and vegetables ensure?

IV. Answer in detail (5 marks)

1. Define cancer and explain the three phases in the development of cancer.
2. Give the classification of cancer based on the type of cell that produces it.
3. Spell out the risk factors for cancer
4. List the symptoms of cancer.
5. Explain the stages of cancer.
6. Elaborate on the techniques used in the diagnosis of cancer.
7. Spell out the nutritional implications of cancer
8. What treatment procedures are adopted in cancer? Explain the nutrition related side effects of the treatment.
9. Discuss what kind of nutritional intervention would be needed during the treatment phase of cancer.
10. Explain the role of antioxidants and phytonutrients in the prevention of cancer