Cancer

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What is Cancer?

Cancer is an abnormal and uncontrolled division of cells, known as cancer cells that invade and destroy the surrounding tissues.

Generally cancer is defined as uncontrolled proliferation of cells without any differentiation. Cancer cells are different from normal cells in some aspects. They do not remain confined to one part of the body. They penetrate and infiltrate into the adjoining tissues and dislocate their functions. Some of the cancer cells get detached from the main site of origin and travel by blood and lymph to sites distant from the original tumour and form fresh colonies, called metastasis or secondary growth.

How Cancer Cells Differ from Normal Cells?

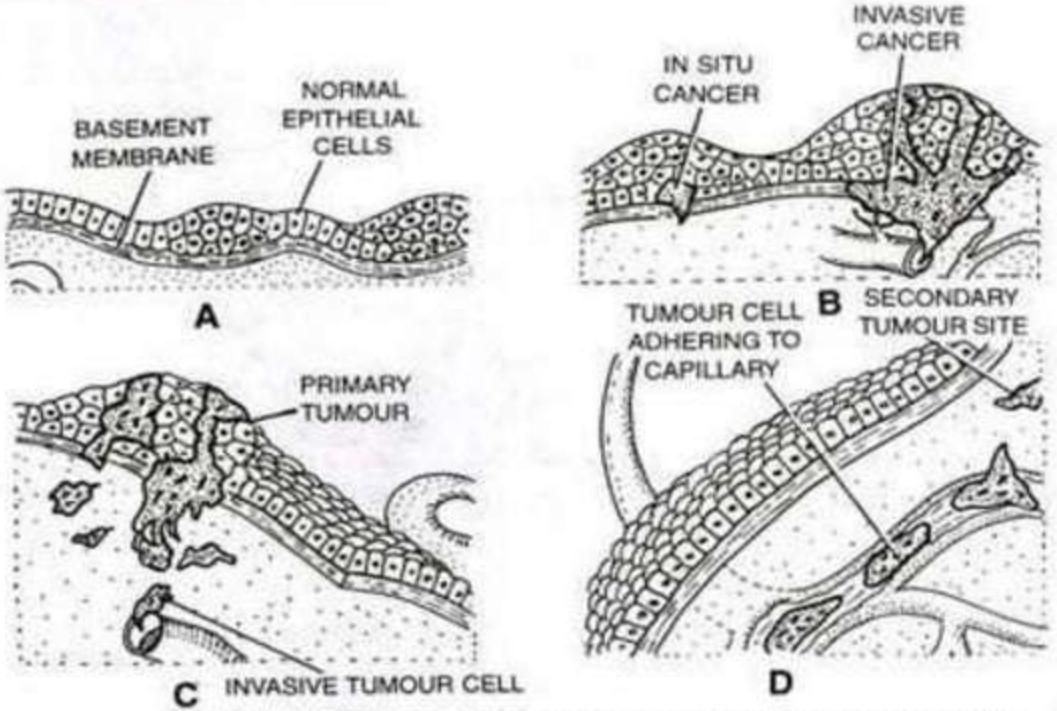
Normal cells have a limited life span. They are usually replaced by new cells through cell division and cell differentiation. Their production is regulated in such a manner that the number of a given cell type remains nearly constant. Normal cells show a property called contact inhibition.

Due to this property they contact with other cells, inhibit their uncontrolled growth. Cancer cells seem to have lost this property. But cancer cells do not respond to normal growth control mechanism. These cells proliferate in an unregulated manner and form clones of cells which can expand irregularly. This uncontrolled growth is called tumour or neoplasm.

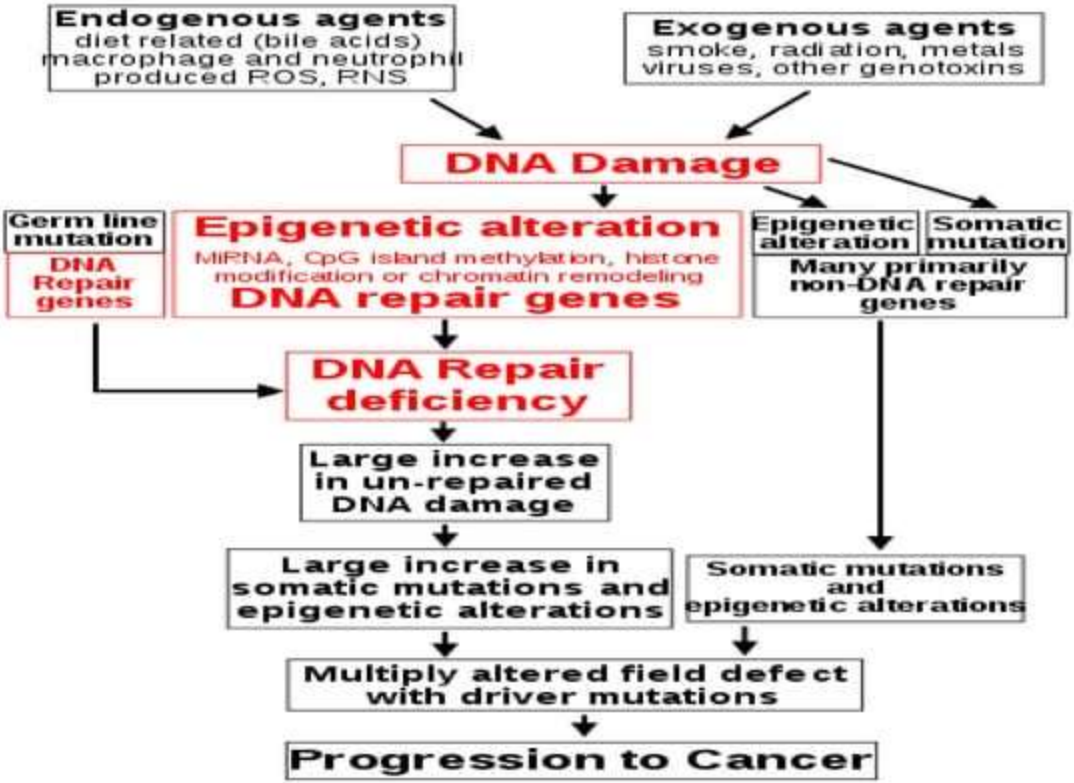
Types of Tumours:

There are two types of tumours: benign and malignant.

(i) Benign Tumour (= Non-malignant Tumour):
It remains confined to the site of its origin and does not spread to other parts of the body. It causes limited damage to the body. It is non-cancerous.
(ii) Malignant Tumour (= Cancerous Tumour):
It first grows slowly. No symptoms are noticed. This stage is called the latent stage. The tumour later grows quickly. The cancer cells go beyond adjacent tissue and enter the blood and lymph. Once this happens, they migrate to many other sites in the body where the cancer cells continue to divide. A phenomenon in which cancer cells spread to distant sites through body fluids to develop secondary tumour is called metastasis. Only malignant tumours are properly designated as cancer.
Properties of Cancer Cells,
(i) Uncontrolled proliferative ability,
(ii) Extracellular growth factors are not required,
(iii) Overgrowth and ability to invade new sites (metastasis),
(iv) Nucleus becomes irregular with abundant granules,
(v) There is increase in number of lysosomes, reduction in mitochondrial cristae, more melanin and debris in cytoplasm,
(vi) Cancer cells resist induction of cell death which promotes development of tumours.



Stages in development of cancer. Primary tumour may become metastatic and get transformed into secondary tumour.


Endogenous agents
diet related (bile acids)
macrophage and neutrophil
produced ROS, RNS
Exogenous agents
smoke, radiation, metals
viruses, other genotoxins
DNA Damage
Germ line mutation
DNA Repair genes
Epigenetic alteration
MiRNA, CpG island methylation, histone modification or chromatin remodeling
DNA repair genes
Epigenetic alteration
Somatic mutation
Many primarily non-DNA repair genes
DNA Repair deficiency
Large increase in un-repaired DNA damage
Large increase in somatic mutations and epigenetic alterations
Somatic mutations and epigenetic alterations
Multiply altered field defect with driver mutations
Progression to Cancer

Types of Cancers:

Cancers are classified on the basis of the tissue from where they arose. Cancers are of three main types:

1. Carcinomas:

This type is mainly derived from epithelial cells. They include cervical (cervix is part of uterus) cancer, breast cancer, skin cancer, brain cancer, lung cancer, stomach cancer, etc. About 80% of all tumours are carcinomas.

(i) Cancerous growth of melanocytes (a type of skin cells) is called melanomas.

(ii) Cancer of glands is called adenocarcinoma.

(iii) Cancer of muscle tissue is known as myoma.

2. Sarcomas:

These cancers are located in connective and muscular tissues derived from mesoderm. Thus, they include the cancers of bones, cartilages, tendons, adipose tissue, lymphoid tissue and muscles.

(i) Cancer of bones is called osteoma.

(ii) Cancers of adipose tissue are known as lipomas.

(iii) Cancer of lymphoid tissues is called lymphoma. Hodgkin's disease is an example of human lymphoma. In Hodgkin's disease there is chronic enlargement of the production of lymphocytes by lymph nodes and spleen. They are rare in humans; about 1 per cent of all tumours are sarcomas.

3. Leukaemia's:

Leukaemia's (= leukaemias) are characterised by abnormal increase of white blood corpuscles count due to their increased formation in the bone narrow. Leukaemia's are commonly called blood cancers.

Cancer of glial cells of central nervous system is called glioma.

World Cancer Day — Feb. 4

The most common cancers in India are mouth-throat cancer in men and uterine-cervical cancer in women.

Causes of Cancer:

Study of cancer cells is called oncology. Chemical and physical agents that can cause cancer are called carcinogens, which belong to three categories.

(i) Oncogenic Transformations: (oncogenesis):

They are agents or factors which bring about changes in genetic material. They are of two types, radiations and chemicals.

(ii) Tumour Promoters:

They promote proliferation of cells which have undergone oncogenic transformation, e.g., some growth factors, hormones.

(iii) Tumour Viruses:

Some viruses are known to be connected with oncogenic transformations.

Another classification of carcinogens is as follows:

1. Physical irritants:

(i) Use of Kangri (an earthen pot containing burning coal) by Kashmiris causes abdominal skin cancer as these people keep Kangri close to their abdomen during winter,

(ii) Betel and tobacco chewing causes oral cancer,

(iii) Heavy smoking causes lung cancer and may also cause cancer of oral cavity, pharynx (throat) and larynx,

(iv) Jagged teeth may cause tongue cancer,

(v) Excessive exposure to sun light can cause skin cancer.

2. Chemical Agents:

Several chemicals are known to cause cancer. These are caffeine, nicotine, products of combustion of coal and oil and pesticides; constant use of artificial sweetener can cause cancer. An animal protein-rich diet is known to cause cancer of large intestine.

Breast cancer has hormonal relationship. Thus, some sex hormones and steroids if secreted or given in large amounts may cause cancer. Chimney sweepers can develop cancer of scrotum. Dye workers have a high rate of bladder cancer.

Carcinogens and Organs Affected:

S.No.	Carcinogens	Organs Affected
1.	Soot	Skin, lungs
2.	Coaltar (3, 4-benzopirene)	Skin, lungs
3.	Cigarette smoke (N-nitrosodimenthylene)	Lungs
4.	Cadmium Oxide	Prostate gland
5.	Aflatoxin (a mould metabolise)	Liver
6.	2-naphthylamine and 4-ami nobiphenyl	Urinary bladder
7.	Mustard gas	Lungs
8.	Nickel and Chromium compounds	Lungs
9.	Asbestos	Lungs, pleural membrane
10.	Diethylstibetorol (DES)	Vagina

3. Radiations:

The X-rays, cosmic rays, ultra-violet rays, etc. can cause cancer. Japanese people exposed to radiations from World War II nuclear bombing show five times the incidence of leukemia seen in the rest of the population.

4. Biological Agents:

Some viruses and other parasites, excessive secretion of certain hormones are believed to cause cancers.

Cancer and Genes:

Cancer-associated genes are divided into the following three categories.

(i) Cancer causing viruses are called oncogenic viruses. The genes of oncogenic viruses are known as viral oncogenes. It is now held that all cells carry some cancer causing genes called oncogenes which when activated under certain conditions could change into oncogenic cells. Jumping genes are often involved in this conversion.

(ii) Tumour suppressor genes that inhibit cell proliferation.

(iii) Genes that regulate programmed cell growth.

How Cancer Spreads?

Abnormal increase in number of cells in a tissue or organ forms a clone of proliferative cells. This excessive proliferation gives rise to a mass of cells which is initially known as benign tumour.

The benign tumour cells enter into the blood vessels and migrate to other sites in the body where these cells continue to divide, such tumour cells are known as malignant cells and tumours are called malignant tumours. The malignant tumours are designated as cancer.

Detection and Diagnosis of Cancer:

It depends upon histological features of malignant structure,

(i) Bone marrow biopsy (a piece of the suspected tissue cut into thin sections is stained and examined under microscope by a pathologist) and abnormal count of WBCs in leukaemia,

(ii) Biopsy of tissue, direct or through endoscopy. Also endoscopic observation. Pap's test (cytological staining) is used for detecting cancer of cervix and other parts of genital tract,

(iii) Techniques such as radiography (use of X-rays), CT (computed tomography), MRI (magnetic resonance imaging) are very useful to detect cancers of the internal organs. In CT, X-rays are used to generate a three dimensional image of internal organs. In MRI strong magnetic fields and non-ionizing radiations are used to detect pathological and physiological changes in the living tissue. Antibodies against cancer specific antigens are also used for detection of certain cancers. Techniques of molecular biology can be applied to detect genes in individuals. Mammography is radiographic examination of breasts for possible cancer,

(iv) Monoclonal antibodies coupled to appropriate radioisotopes can detect cancer-specific antigens and hence cancer.

Different Sites of Cancer:

Some of the important sites of cancer are skin, mouth, oesophagus, stomach, colon, rectum, liver, gall bladder, pancreas, blood, lymph, adipose tissue, lung, uterine cervix, breast, brain, penis, prostate, muscles, thyroid, kidney and bones.

Possible Symptoms of Cancer:

(i) A persistent cough or hoarseness in a smoker,
(ii) A persistent change in digestive and bowel habits,
(iii) A change in a wart or mole,
(iv) A lump or hard area in the breast,
(v) Unexpected diminished or lost appetite,
(vi) Unexplained low- grade fever,
(vii) Unexplained loss of weight,
(viii) Any un-curable ulcer,
(ix) Bleeding in vagina at times other than the menstruation,
(x) Non-injury bleeding from the surface of the skin, mouth or any other opening of the body.

Treatment of Cancer:

Four general methods of treatment for cancer are currently available.

1. Surgery:

It involves the removal of the entire cancerous tissue.

2. Radiation therapy:

It involves the exposure of the cancerous parts of the body to X-rays which destroy rapidly growing cells without harming the surrounding tissue. Radon (Rn-220), Cobalt (Co-60) and Iodine (1-131) are radioisotopes which are generally used in radiotherapy.

3. Chemotherapy:

It involves the administration of certain anticancer drugs. These drugs check cell division by inhabiting DNA synthesis. These drugs may be more toxic to cancerous cells than to normal cells. Thus chemotherapeutic drugs kill cancerous cells. Majority of drugs have side effects like hair loss, anaemia etc.

Most cancers are treated by combination of surgery, radiotherapy and chemotherapy. Patients are given substances called biological response modifiers like a interferon which activates their immunity system and help in destroying the tumours. A common weed Catharanthus roseus is the source of two anticancer drugs, Vinblastine and Vincristine used in the treatment of leukaemia.

4. Immunotherapy:

It involves natural anti-cancer immunological defence mechanisms. Monoclonal antibodies are used in various ways, e.g., radio-immunotherapy for treatment of cancer. These therapies can be used either singly, or in a suitable combination. Efforts are being made to develop cancer vaccines.

Thank you

References: Online notes, notes from research papers and Books by google search Engine