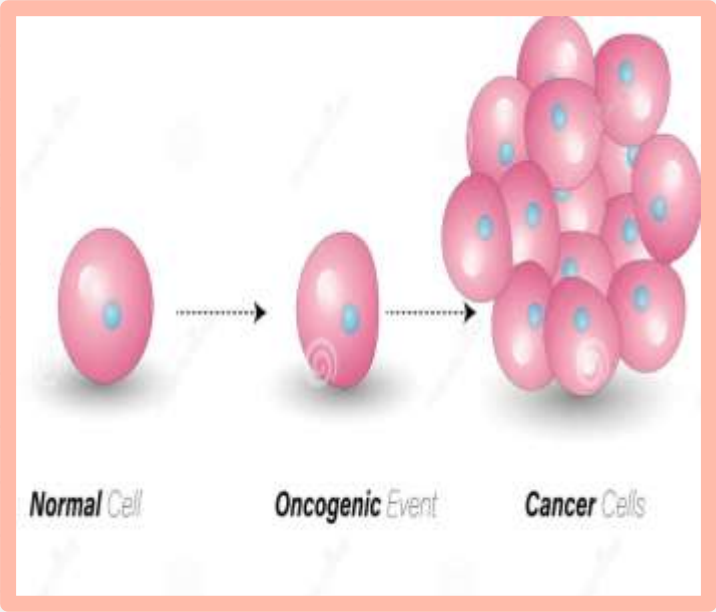
Cancer

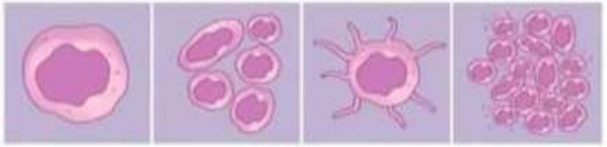
Cancer

- Cancer is a genetic disease because it can be traced to alterations within specific genes, but in most cases, it is not an inherited disease.
- Most cancers arise in a somatic cell due to genetic alterations in the DNA during the lifetime of the affected individual.
- Cancerous tumors spread into, or invade, nearby tissues and can travel to distant places in the body to form new tumors (a process called metastasis).
- Cancerous tumors may also be called malignant tumors. Many cancers form solid tumors, but cancers of the blood, such as leukemias, generally do not.



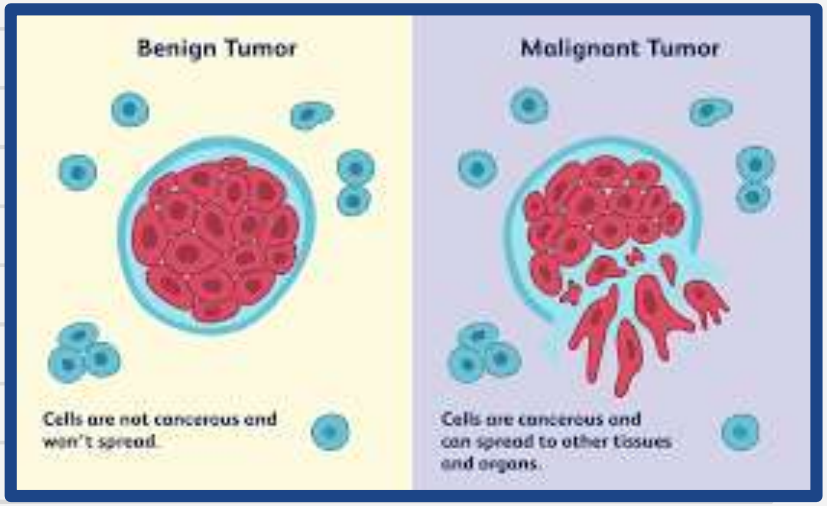
Normal and Cancer cells

Normal cell	Cancer cell
• Small, uniformly shaped nuclei • Relatively large cytoplasmic volume • Conformity in cell size and shape • Cells arranged into discrete tissues • May possess differentiated cell structures • Normal presentation of cell surface markers • Lower levels of dividing cells • Cell tissues clearly demarcated	• Large, variable shaped nuclei • Relatively small cytoplasmic volume • Variation in cell size and shape • Disorganized arrangement of cells • Loss of normal specialized features • Elevated expression of certain cell markers • Large number of dividing cells • Poorly defined tumor boundaries

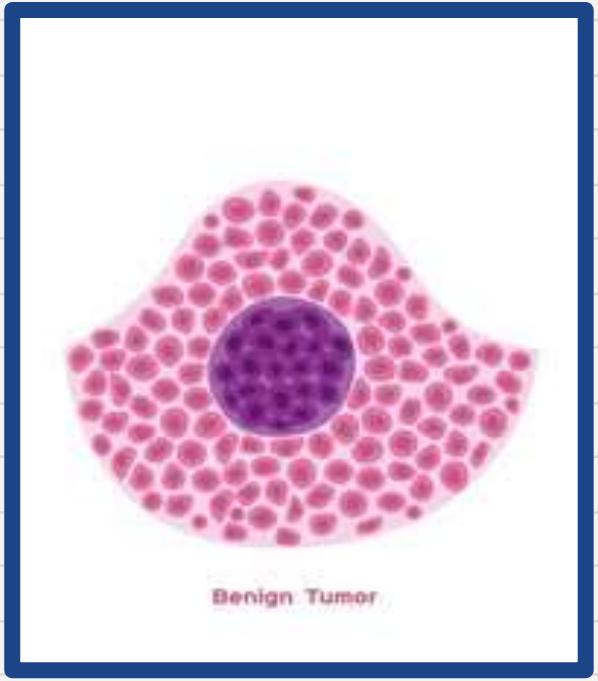


Different types of tumor

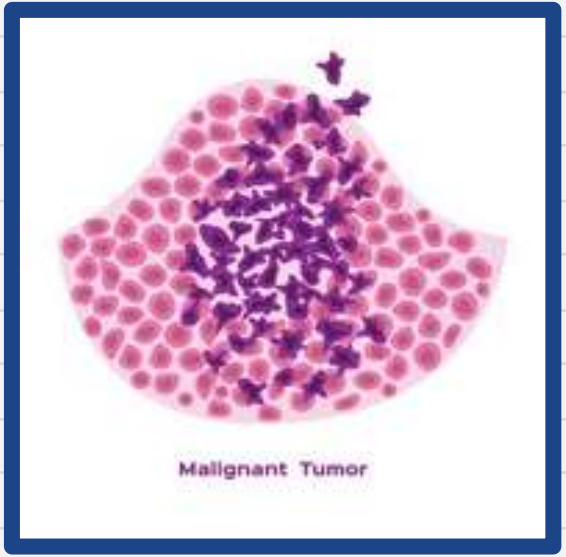
- Malignant Tumor
- Benign Tumor



Benign Tumor



Malignant Tumor



Benign Tumor

- A benign tumor is a mass of cells (tumor) that lacks the ability to either invade neighboring tissue or metastasize (spread throughout the body).

- When removed, benign tumors usually do not grow back, whereas malignant tumors sometimes do.

✓ **Examples** :- lipoma, angiolipoma, fibroma, benign fibrous histiocytoma, neurofibroma, schwannoma, neurilemmona, hemangioma, giant cell tumor of tendon sheath, and myxoma etc.

Malignant Tumor

- Malignant tumors are made up of cancer cells.
- They usually grow faster than benign tumors spread into surrounding tissues and cause damage may spread to other parts of the body in the bloodstream or through the lymph system to form secondary tumours.

✓ **Examples** :-histiocytoma (MFH), liposarcoma, and synovial sarcoma, neurosarcoma, rhabdosarcoma, fibrosarcoma, hemangiopericytoma, and angiosarcoma

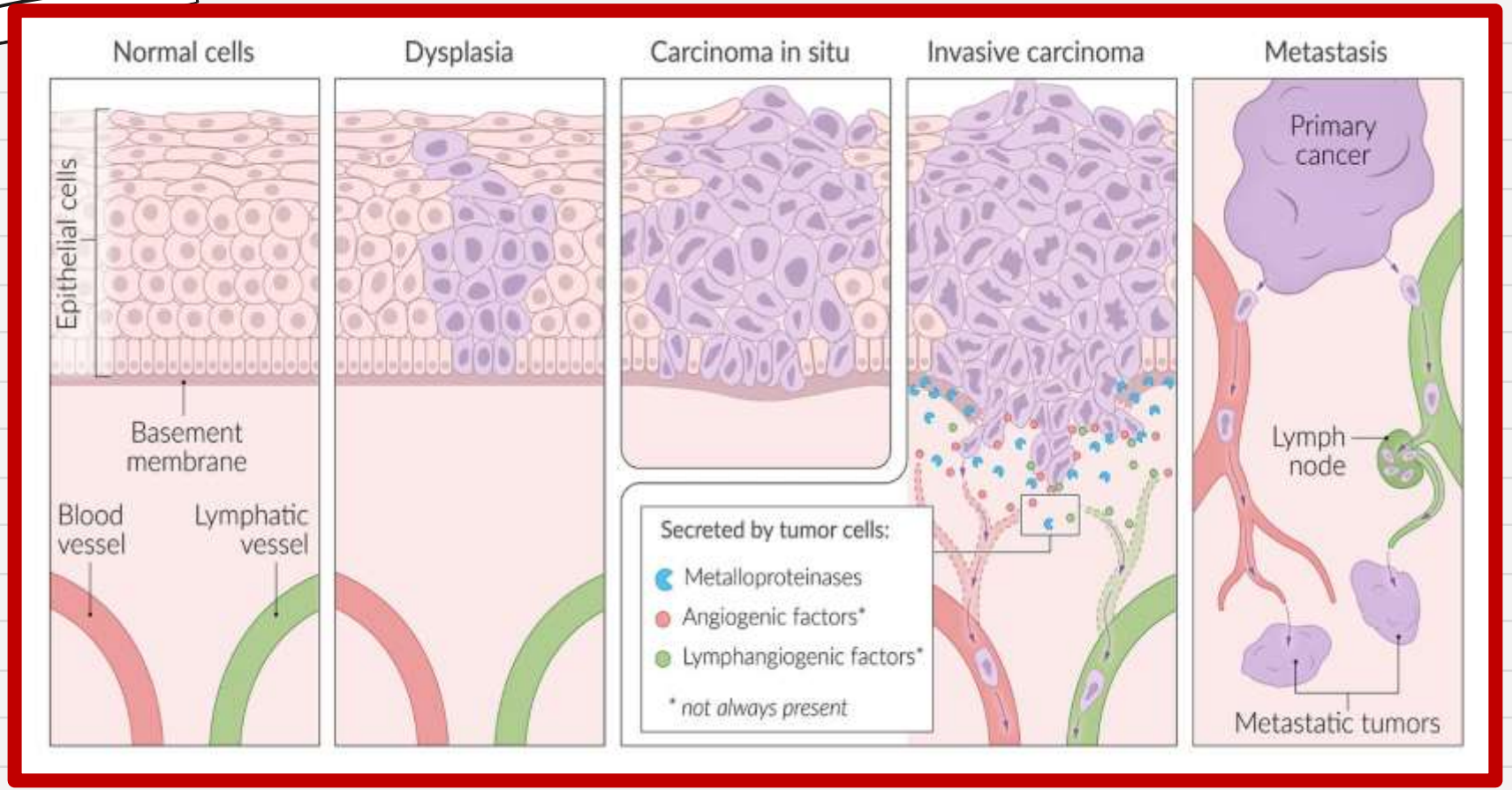
Differences between benign and melignant tumors

Benign Tumour	Malignant Tumour
It is a non-cancerous tumour.	It is a cancerous tumour.
Benign tumour does not show metastasis and is non-invasive.	It shows metastasis and thus invades other body parts.
It stops growth after reaching a certain size.	Malignant tumour shows indefinite growth.
Limited adherence occurs amongst cells of benign tumour.	There is no adherence amongst cells. They tend to slip past one another.
It is less fatal to the body.	It is more fatal to the body.

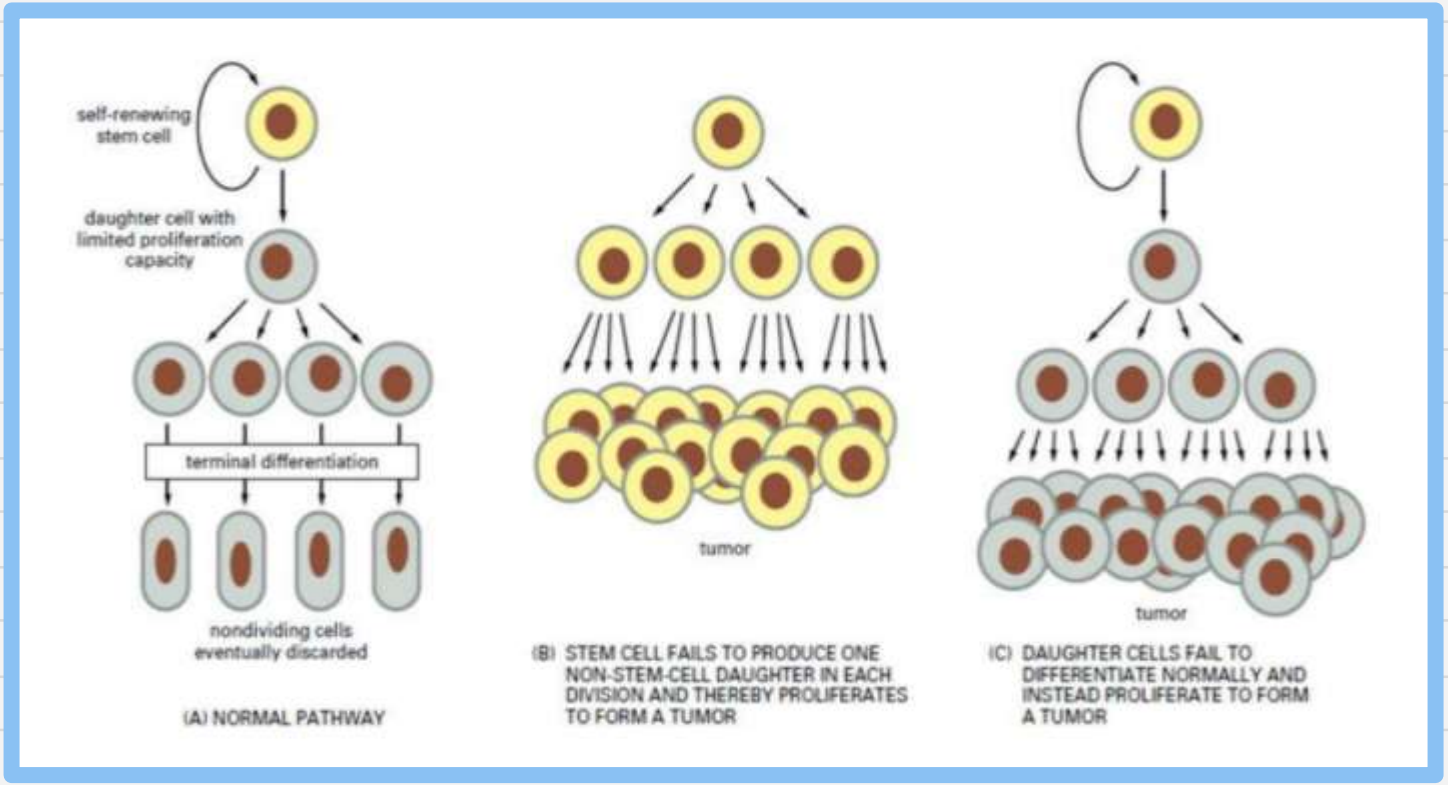
Types of Cancer

- ✓ Bladder Cancer
- ✓ Breast Cancer
- ✓ Colorectal Cancer
- ✓ Kidney Cancer
- ✓ Lung Cancer - Non-Small Cell
- ✓ Lymphoma - Non-Hodgkin
- ✓ Melanoma
- ✓ Oral and Oropharyngeal Cancer
- ✓ Pancreatic Cancer
- ✓ Prostate Cancer
- ✓ Thyroid Cancer
- ✓ Uterine Cancer

Tumor Progression

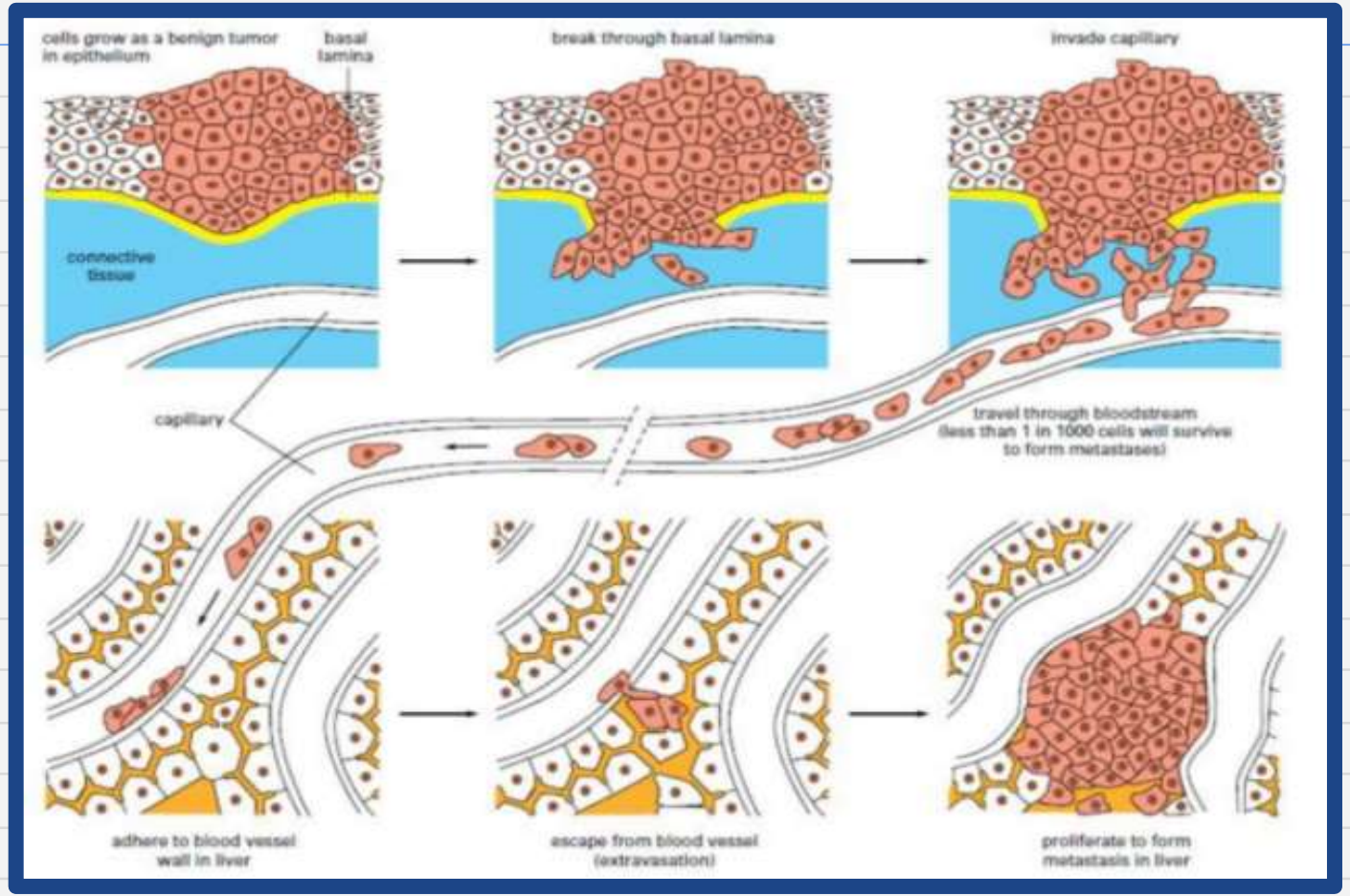


Cancerous growth often depends on defective control of cell death or cell differentiation



Metastasis

- In metastasis, cancer cells break away from where they first formed (primary cancer), travel through the blood or lymph system, and form new tumors (metastatic tumors) in other parts of the body.
- The metastatic tumor is the same type of cancer as the primary tumor.
- Metastatic cancer is commonly called stage IV cancer or advanced cancer. It occurs when cancer cells break off from the original tumor, spread through the bloodstream or lymph vessels to another part of the body, and form new tumors.
- Cancer metastasizes due to several factors, namely attack by the immune system, lack of oxygen and necessary nutrients, large amounts of lactic acid produced by glycolysis and increased cell death.
- Therefore, the majority of the presently available treatments for cancer also bear the potential to induce metastasis.


cells grow as a benign tumor in epithelium
basal lamina
connective tissue
break through basal lamina
invade capillary
capillary
travel through bloodstream (less than 1 in 1000 cells will survive to form metastases)
adhere to blood vessel wall in liver
escape from blood vessel (extravasation)
proliferate to form metastasis in liver

Causes Of Cancer

Cancer is caused by changes (mutations) to the DNA within cells.

The DNA inside a cell is packaged into a large number of individual genes, each of which contains a set of instructions telling the cell what functions to perform, as well as how to grow and divide.

- Errors in the instructions can cause the cell to stop its normal function and may allow a cell to become cancerous.
- Smoking and Tobacco.
- Diet and Physical Activity.
- Sun and Other Types of Radiation.
- Viruses and Other Infections.

Radiation

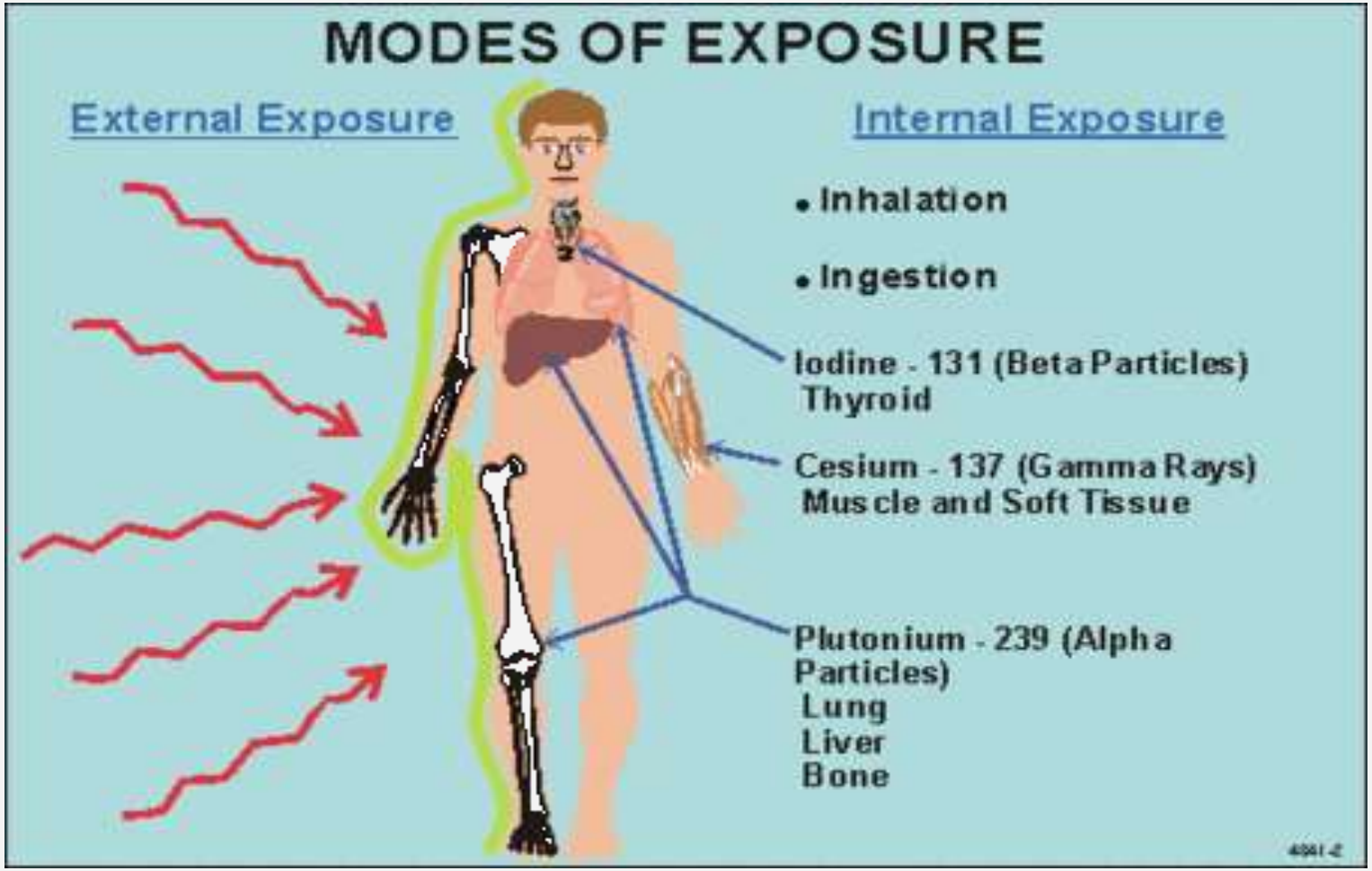
- Radiation of certain wavelengths, called ionizing radiation, has enough energy to damage DNA and cause cancer.

- Ionizing radiation includes radon, x-rays, gamma rays, and other forms of high-energy radiation. Lower-energy, non-ionizing forms of radiation, such as visible light and the energy from cell phones, have not been found to cause cancer in people.

- Radon is formed when the radioactive element radium breaks down. Radium in turn is formed when the radioactive elements uranium and thorium break down. People who are exposed to high levels of radon have an increased risk of lung cancer.

- Certain medical procedures, such as chest x-rays, computed tomography (CT) scans, positron emission tomography (PET) scans, and radiation therapy can also cause cell damage that leads to cancer. However, the risks of cancer from these medical procedures are very small, and the benefit from having them is almost always greater than the risks.

MODES OF EXPOSURE



Chemical carcinogens

- Exposure to some chemicals and hazardous substances can increase the risk of cancer.
- A few well-known carcinogens are **asbestos, nickel, cadmium, radon, vinyl chloride, benzidene, and benzene**.
- These carcinogens may act alone or with another carcinogen to increase your risk.
- Carcinogens may increase the risk of cancer by **altering cellular metabolism or damaging DNA directly in cells**, which interferes with biological processes, and induces the uncontrolled, malignant division, ultimately leading to the formation of tumors.

Biological agents

- Six infectious agents have been shown to be carcinogenic primarily by inducing chronic inflam- mation. Those are the two hepatitis viruses, HBV and HCV, the bacterium Helicobacter pylori and, the three worms Schistosoma haematobium, Opistorchis viverrini, and Clonorchis sinensis.

- There are many biological carcinogens that cause cancer, as breast, endometrial and prostate cancers which are caused by steroid hormones that stimulate cell growth and the reproduction in sexual and somatic organs. Some types of bacteria increase the risk of cancer as in peptic ulcer bacteria Helicobacter pylori which is an intermediate stage in the development of gastric cancer

- In addition, there is a carcinogenic pathogenic bacteria, as in Helicobacter hepticus, which stimulates the development of gastroenteritis

VIRUS	ASSOCIATED TUMORS	AREAS OF HIGH INCIDENCE
DNA Viruses		
Papovavirus family		
Papillomavirus (many distinct strains)	warts (benign)	worldwide
	carcinoma of the uterine cervix	worldwide
Hepadnavirus family		
Hepatitis-B virus	liver cancer (hepatocellular carcinoma)	Southeast Asia, tropical Africa
Herpesvirus family		
Epstein-Barr virus	Burkitt's lymphoma (cancer of B lymphocytes)	West Africa, Papua New Guinea
	nasopharyngeal carcinoma	southern China, Greenland
RNA viruses		
Retrovirus family		
Human T-cell leukemia virus type I (HTLV-1)	adult T-cell leukemia/ lymphoma	Japan, West Indies
Human immuno-deficiency virus (HIV, the AIDS virus)	Kaposi's sarcoma	Central and Southern Africa

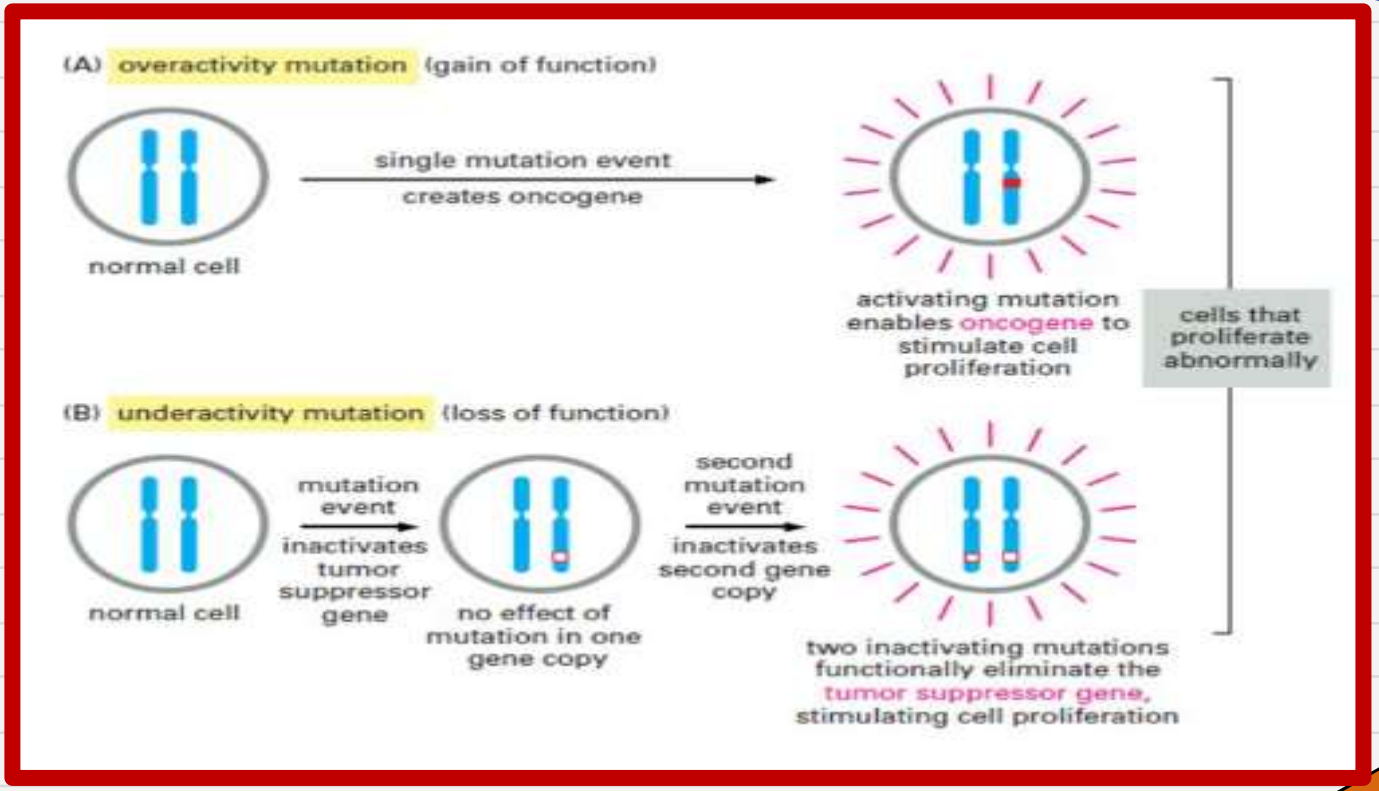
Mutation that causes Cancer

Genetics Of Cancer

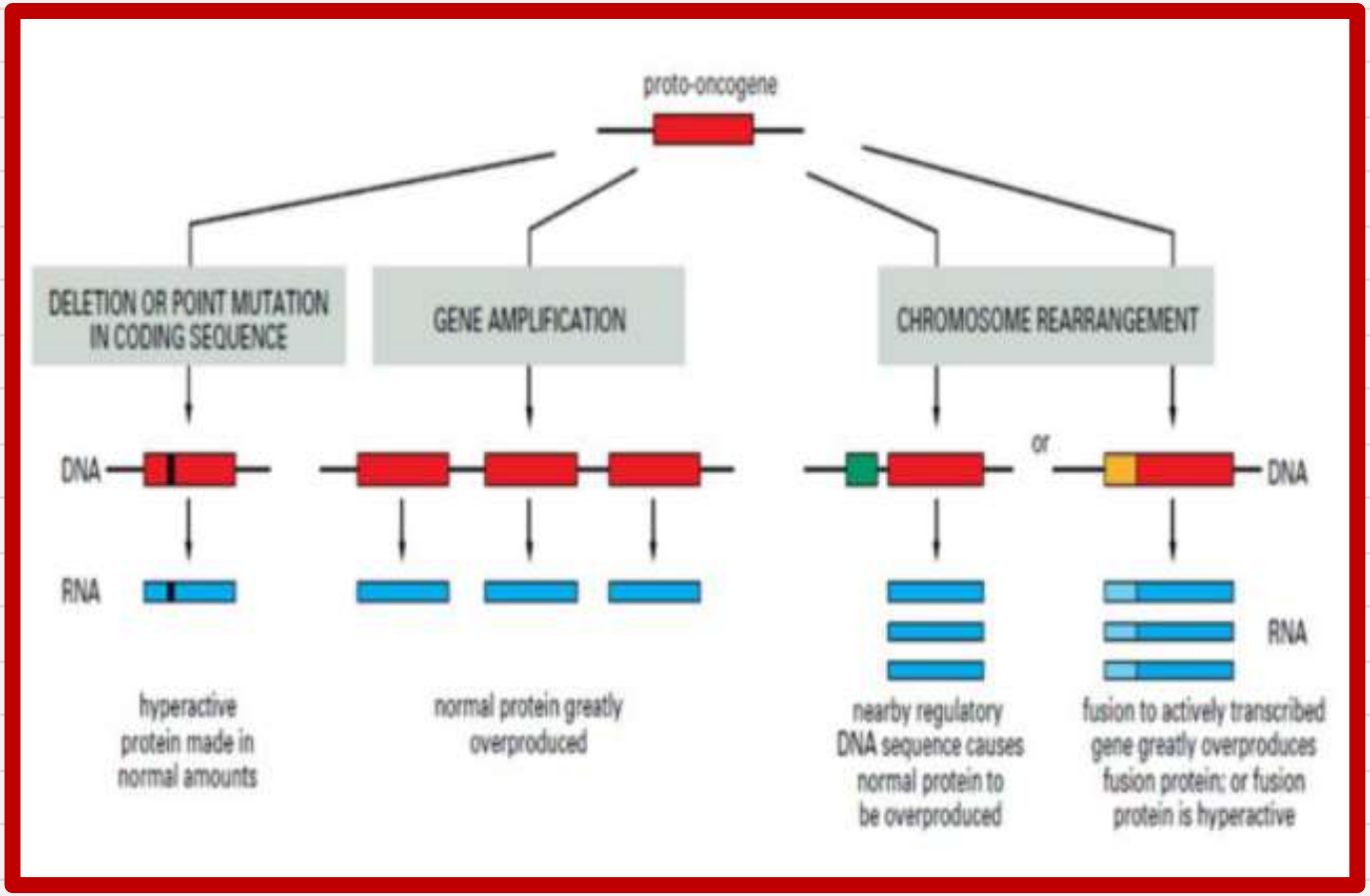
- Many genes are altered in the human cancers.
- Based on the mutation rate more risk arises
- There are two types genes:-

I. Proto-oncogene
II. Tumor Supressor Gene

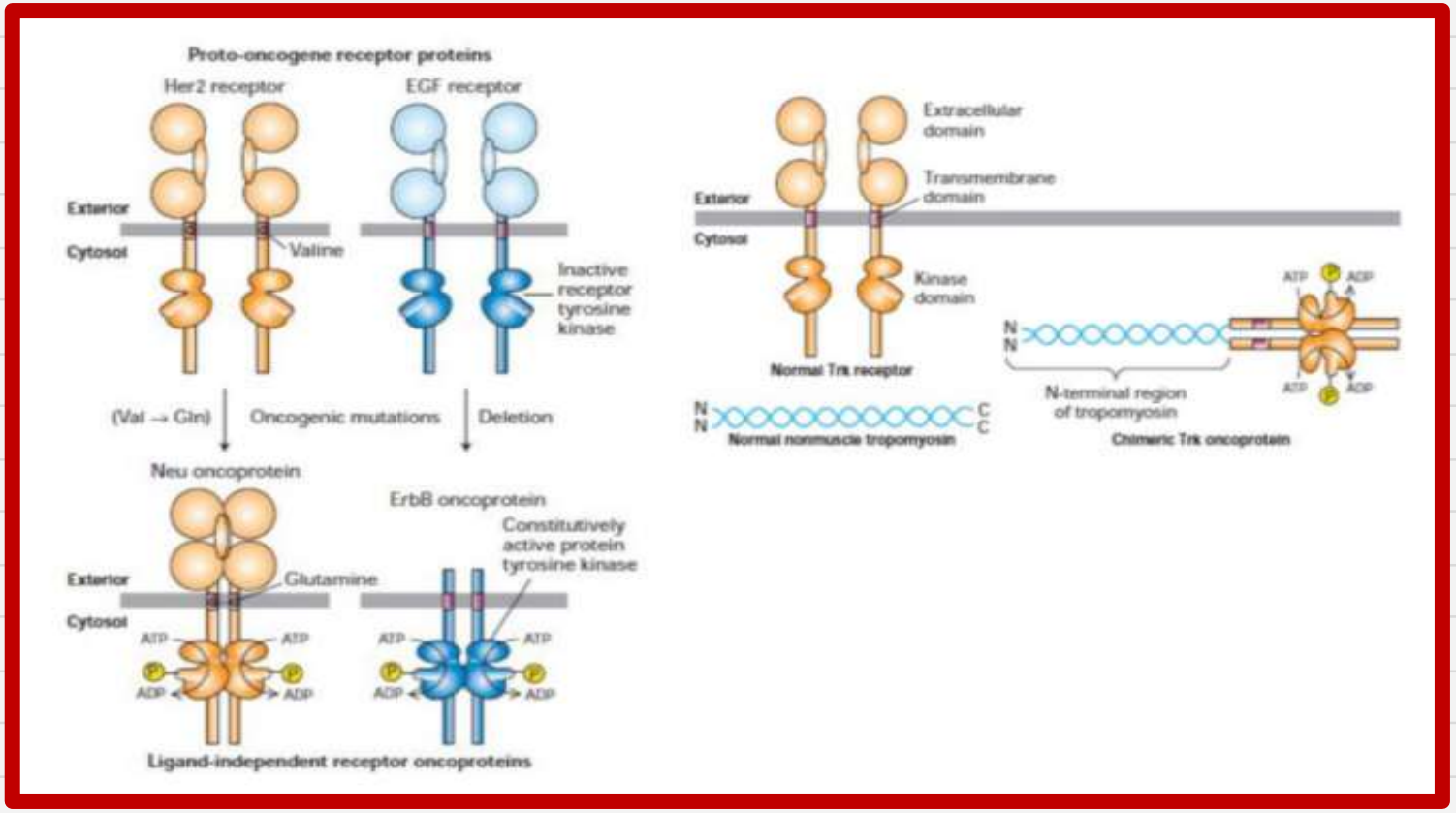
Proto-oncogene



How Proto-oncogene Get Mutated ?



Cell surface receptors can cause excessive Proliferation



Tumor Supressor Gene

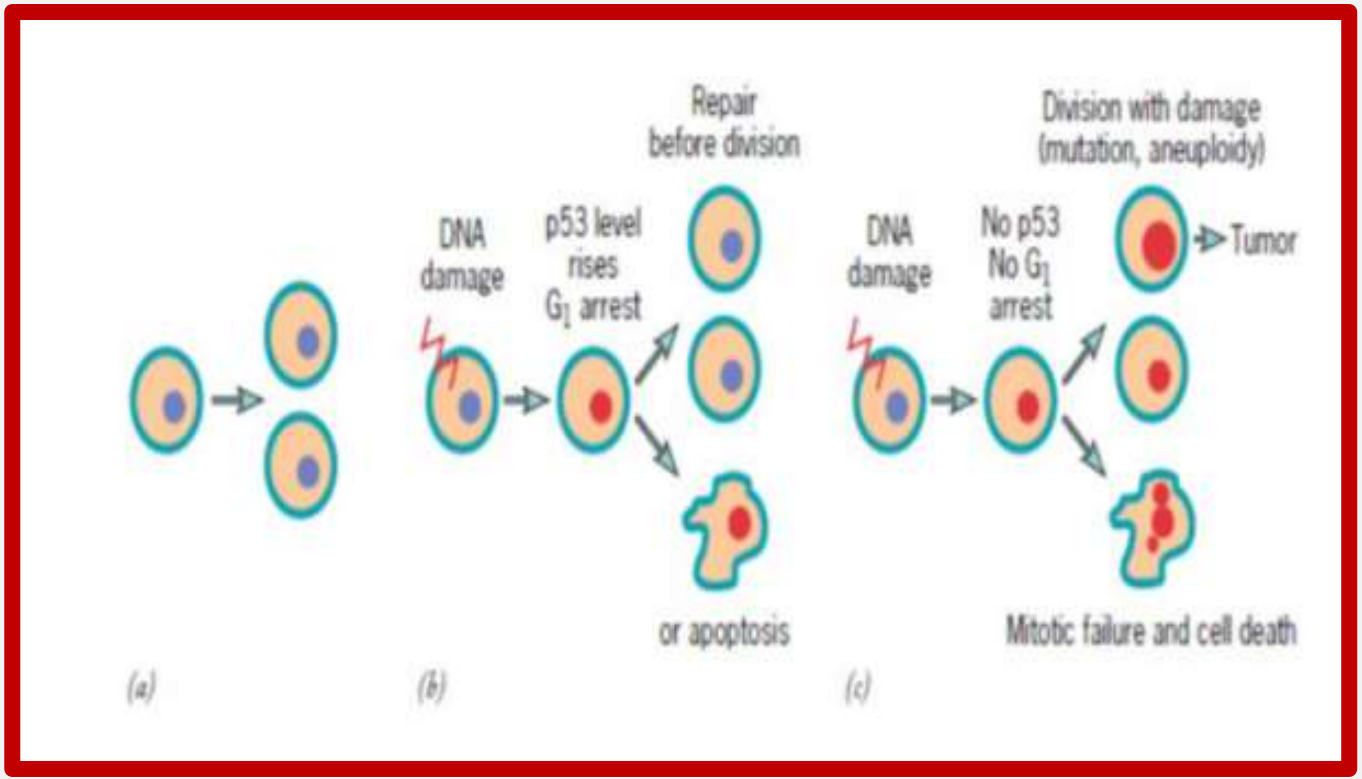
- Tumor suppressor genes are normal genes that slow down cell division, repair DNA mistakes, or tell cells when to die (a process known as apoptosis or programmed cell death).
- When tumor suppressor genes don't work properly, cells can grow out of control, which can lead to cancer.
- A tumor suppressor gene directs the production of a protein that is part of the system that regulates cell division.
- The tumor suppressor protein plays a role in keeping cell division in check. When mutated, a tumor suppressor gene is unable to do its job, and as a result uncontrolled cell growth may occur
- Methylation and expression gene features can identify potential tumor suppressor and oncogenic behavior in various forms of cancer
- Furthermore, this epigenetic significance can be identified when both expression and methylation data types are examined at amplified and deleted CNV changes.
- Examples of tumor suppressor genes are the BRCA1/BRCA2 genes, otherwise known as the "breast cancer genes."

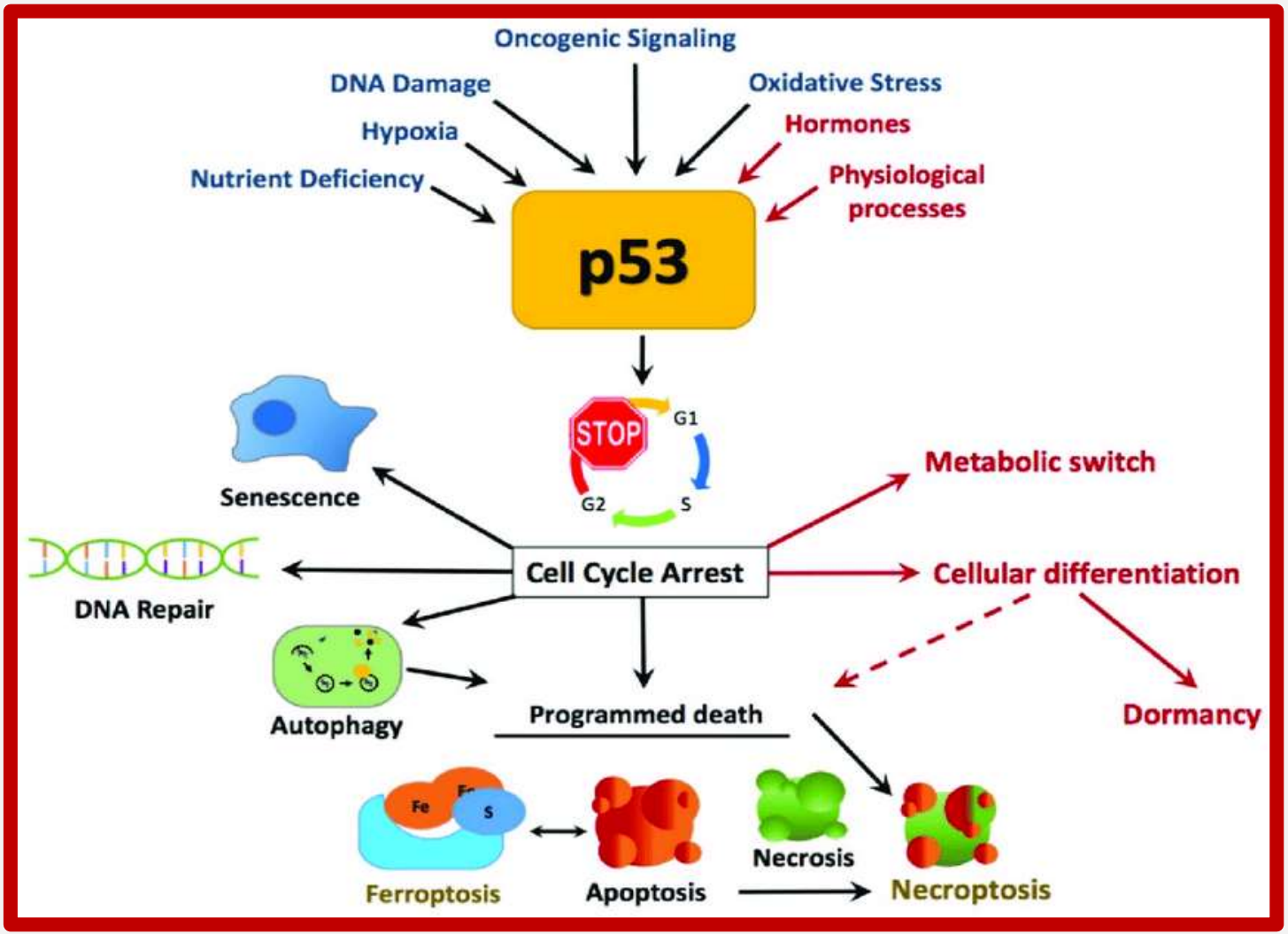
P53

- Tumor protein P53, also known as p53, cellular tumor antigen p53 (UniProt name), the Guardian of the Genome, phosphoprotein p53, tumor suppressor p53, antigen NY-CO-13, or transformation-related protein 53 (TRP53), is any isoform of a protein encoded by homologous genes in various organisms.

- The TP53 gene provides instructions for making a protein called tumor protein p53 (or p53). This protein acts as a tumor suppressor, which means that it regulates cell division by keeping cells from growing and dividing (proliferating) too fast or in an uncontrolled way.

- p53 is a nuclear transcription factor with a pro-apoptotic function. Since over 50% of human cancers carry loss of function mutations in p53 gene, p53 has been considered to be one of the classical type tumor suppressors. Mutant p53 acts as the dominant-negative inhibitor toward wild-type p53.


Repair
before division
DNA
damage
p53 level
rises
G_1 arrest
or apoptosis
(a)
(b)
Division with damage
(mutation, aneuploidy)
DNA
damage
No p53
No G_1
arrest
Tumor
Mitotic failure and cell death
(c)


Oncogenic Signaling
DNA Damage
Oxidative Stress
Hypoxia
Hormones
Nutrient Deficiency
Physiological processes
p53
STOP
G1
G2
S
Senescence
Metabolic switch
DNA Repair
Cell Cycle Arrest
Cellular differentiation
Autophagy
Programmed death
Dormancy
Fe
S
Necrosis
Ferroptosis
Apoptosis
Necroptosis

pRB

- The retinoblastoma protein (protein name abbreviated pRb; gene name abbreviated Rb, RB or RB1) is a tumor suppressor protein that is dysfunctional in several major cancers.
- One function of pRb is to prevent excessive cell growth by inhibiting cell cycle progression until a cell is ready to divide.
- pRB, the tumor suppressor product of the retinoblastoma susceptibility gene, is regarded as one of the key regulators of the cell cycle. This protein exerts its growth suppressive effect through its ability to bind and interact with a variety of cellular proteins.
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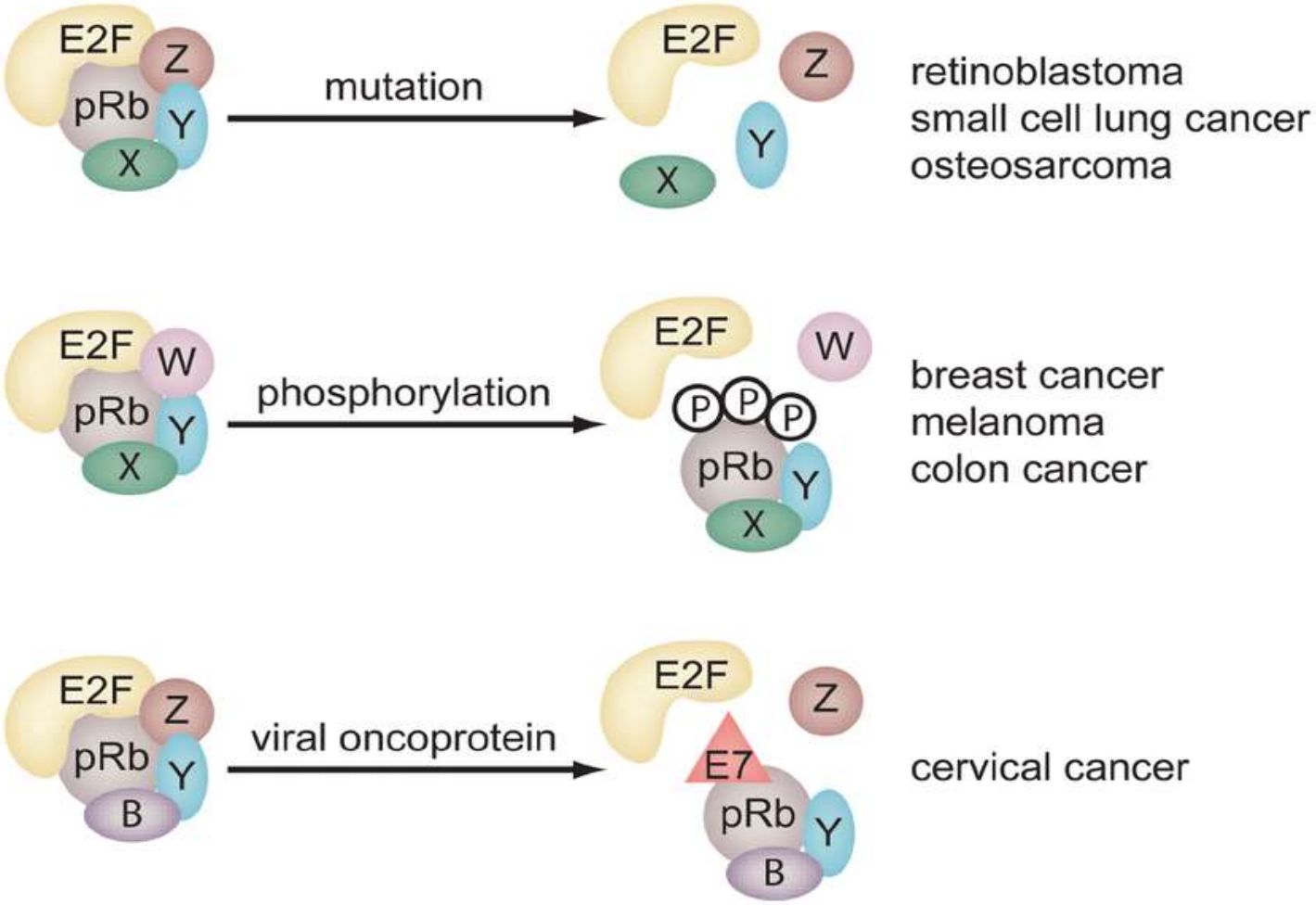
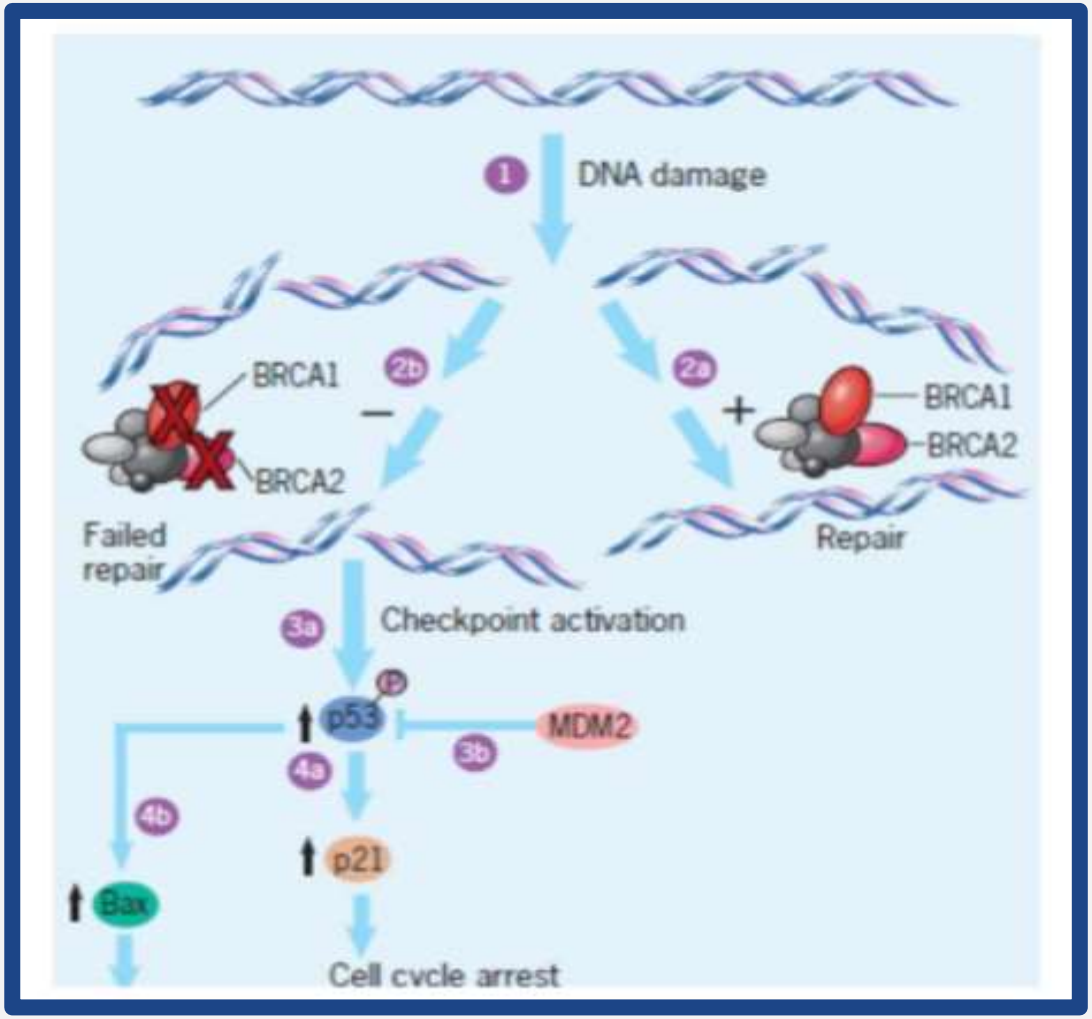

E2F
Z
pRb
Y
X
mutation
E2F
Z
Y
X
retinoblastoma
small cell lung cancer
osteosarcoma
E2F
W
pRb
Y
X
phosphorylation
E2F
W
P
P
P
pRb
Y
X
breast cancer
melanoma
colon cancer
E2F
Z
pRb
Y
B
viral oncoprotein
E2F
Z
E7
pRb
Y
B
cervical cancer

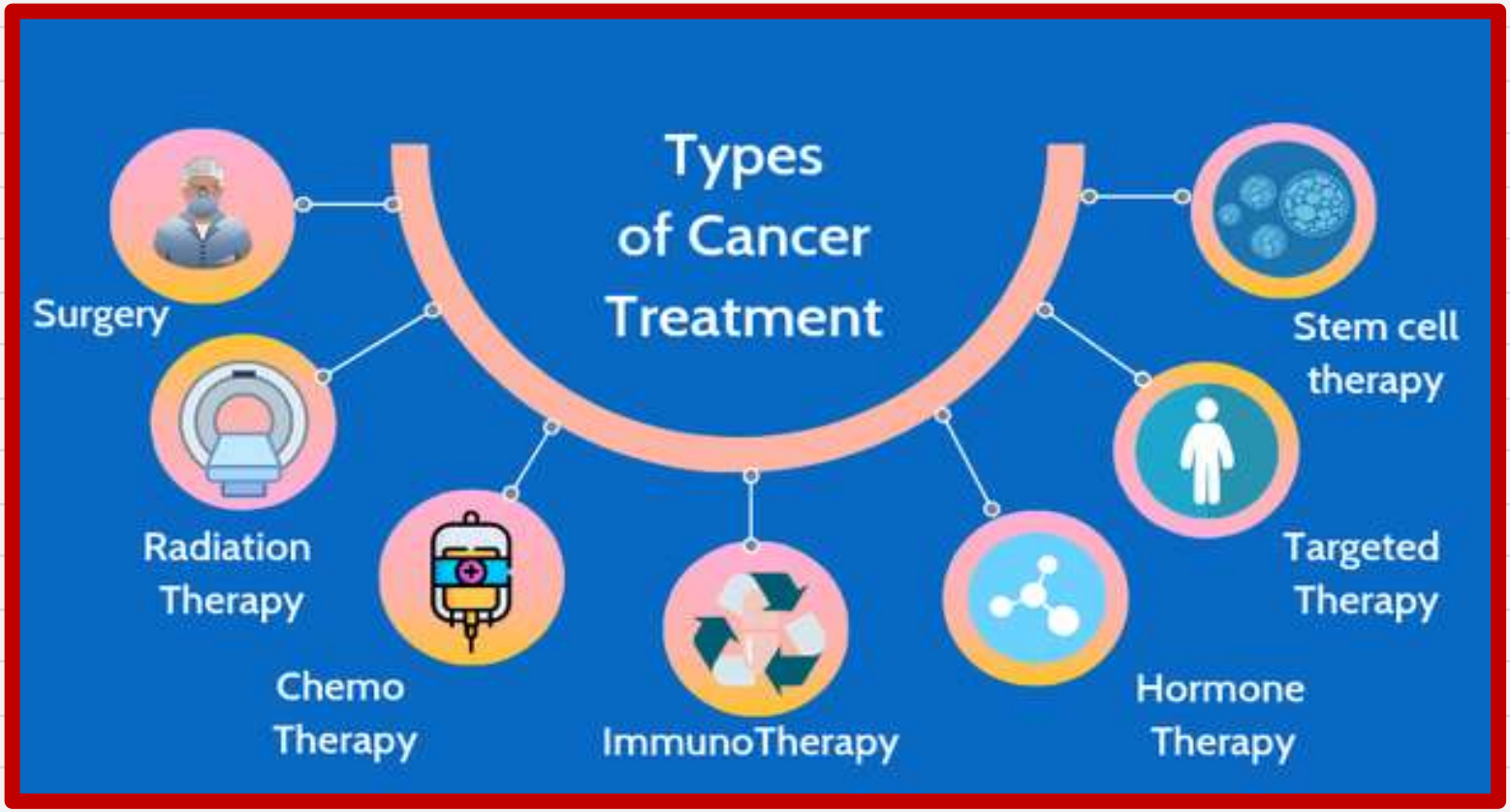
BRCA1 & BRCA2

- BRCA1 (BReast CAncer gene 1) and BRCA2 (BReast CAncer gene 2) are genes that produce proteins that help repair damaged DNA. Everyone has two copies of each of these genes—one copy inherited from each parent.

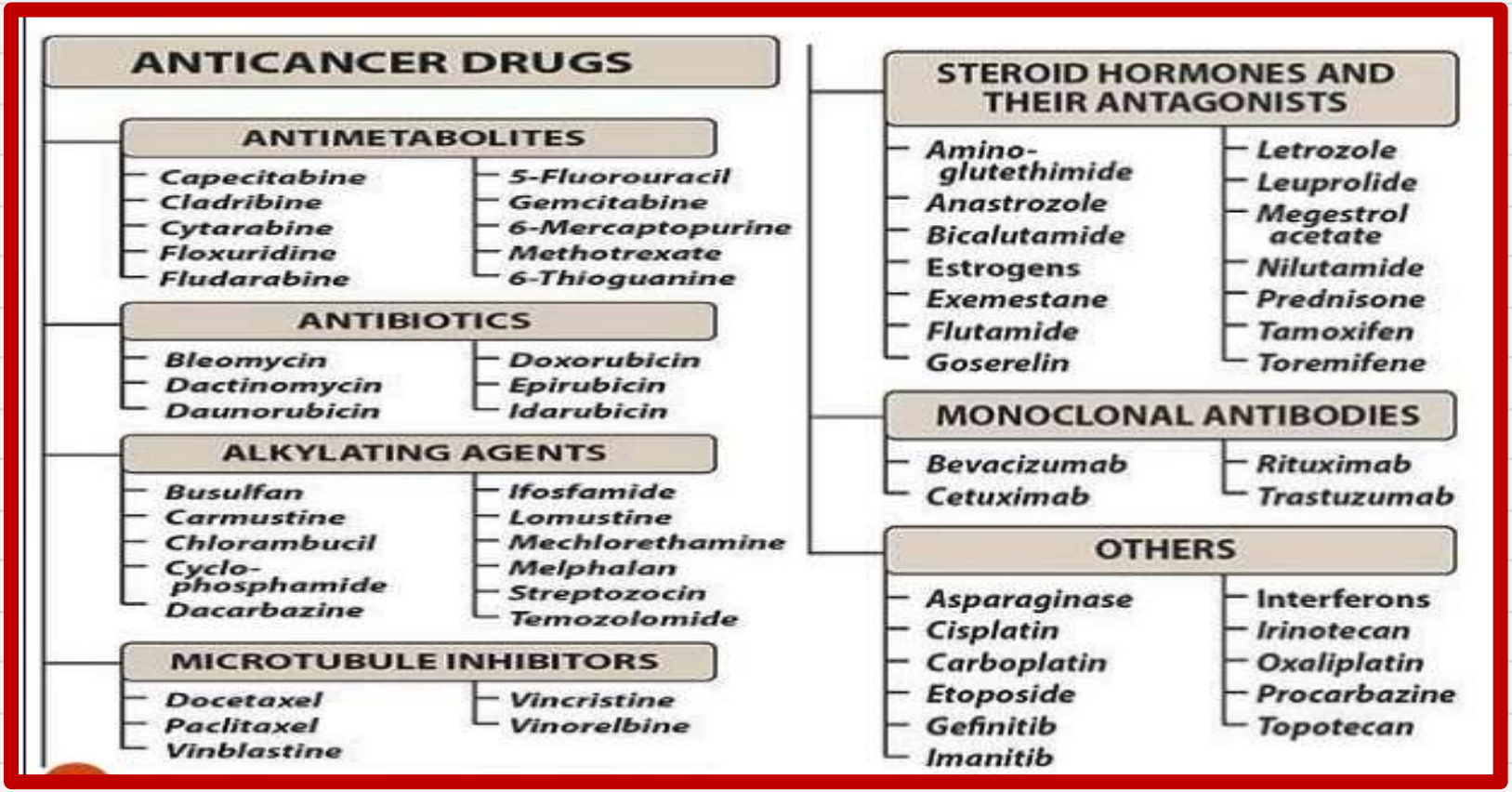
- BRCA1- and BRCA2-associated hereditary breast and ovarian cancer syndrome (HBOC) is characterized by an increased risk for female and male breast cancer, ovarian cancer (includes fallopian tube and primary peritoneal cancers), and to a lesser extent other cancers such as prostate cancer, pancreatic cancer, and melanoma


1
DNA damage
2b
BRCA1
BRCA2
Failed repair
2a
BRCA1
BRCA2
Repair
3a
Checkpoint activation
P
p53
MDM2
3b
4a
4b
p21
Bax
Cell cycle arrest

Treatment


Types of Cancer Treatment
Surgery
Radiation Therapy
Chemo Therapy
ImmunoTherapy
Hormone Therapy
Targeted Therapy
Stem cell therapy

Anti Cancer Drugs



THANK YOU