Basics of Cancer Care Workshop

“Introduction to Cancer”

Nursing Division,

Ministry of Health, Malaysia

Learning Outcomes

By the end of this lesson, learners will be able to:

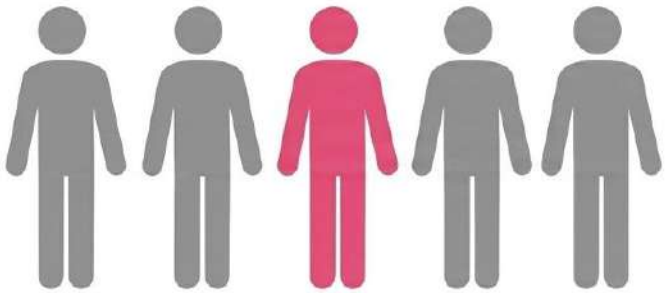
- Apply knowledge and understanding of the cell cycle and tumour growth

Cancer is a Global Health Problem

1 in 5 deaths

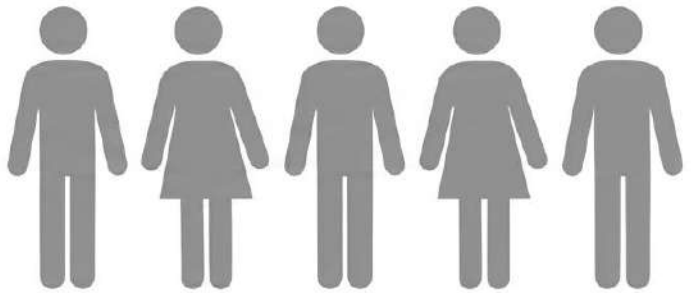
worldwide is caused by cancer

[Source: World Health Organization, 2024]



1 in 7 deaths

in Malaysia is caused by cancer



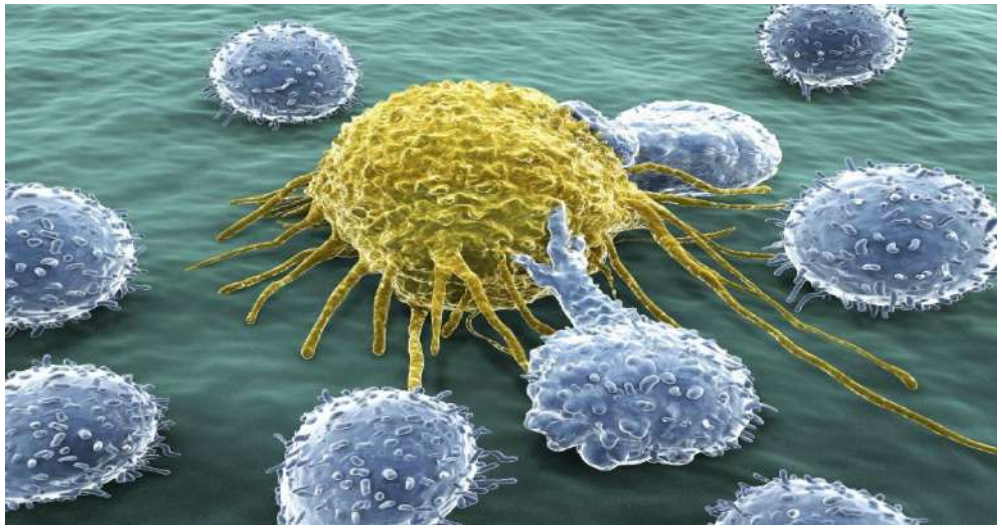
Data source: Based on official DOSM 2023 statistics on causes of death, Malaysia

Introduction to Cancer

Definition of Cancer

What is Cancer?

"Cancer is a disease of uncontrolled proliferation by transformed cells subject to evolution by natural selection" (Brown et al., 2023).



Introduction to Cancer

Factors Contributing to Cancer

Risk Factors for Cancer

Lifestyle
Smoking, alcohol, poor diet, inactivity

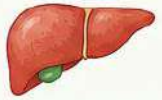
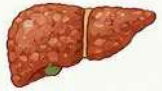
Infections
HPV, Hepatitis B/C

Environment
UV radiation, chemicals, pollution

Genetics
Family history, inherited mutations

ONCOGENIC VIRUSES

Viruses that can cause cancer in humans

VIRUS	FAMILY	ASSOCIATED CANCERS	KEY MECHANISM
Human Papillomavirus (HPV)	*Papillomaviridae*	• Cervical cancer • Anal cancer • Oropharyngeal cancer • Penile cancer 	Produces **E6 & E7** proteins that inactivate tumor suppressor genes (**p53, Rb**).
Epstein–Barr Virus (EBV)	*Herpesviridae*	• Burkitt lymphoma • Hodgkin lymphoma • Nasopharyngeal carcinoma 	Causes **B-cell transformation** and uncontrolled proliferation.
Hepatitis B Virus (HBV)	*Hepadnaviridae*	• Hepatocellular carcinoma (liver cancer) 	Chronic **inflammation** + viral **DNA integration** into host genome.
Hepatitis C Virus (HCV)	*Flaviviridae*	• Hepatocellular carcinoma (liver cancer) 	Long-term liver **inflammation** leading to **cirrhosis** and cancer.
Human T-cell Leukemia Virus-1 (HTLV-1)	*Retroviridae*	• Adult T-cell leukemia/ lymphoma 	Activates **T-cell proliferation** and disrupts immune regulation.
Kaposi Sarcoma-associated Herpesvirus (KSHV/HHV-8)	*Herpesviridae*	• Kaposi sarcoma • Primary effusion lymphoma 	Promotes **angiogenesis** and cell survival pathways.

HOW ONCOGENIC VIRUSES CAUSE CANCER

- Integrate into host DNA
- Trigger chronic inflammation
- Produce proteins that disable tumor suppressor genes
- Stimulate uncontrolled cell division and proliferation

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KEY GENETIC MUTATIONS IN CANCER & ASSOCIATED RISKS

GENE MUTATION	FUNCTION / TYPE	COMMON CANCER RISKS	KEY ASSOCIATIONS / CLINICAL USE
BRCA1 / BRCA2	Tumor Suppressor / DNA Repair (HR)	Breast (F/M), Ovarian, Pancreatic, Prostate	PARP Inhibitor Eligibility (e.g., Olaparib)
TP53	Master Tumor Suppressor / "Guardian of the Genome"	Multiple types (Li-Fraumeni), e.g., Sarcoma, Breast, Leukemia, Brain	High frequency in sporadic cancer
RB1 (Retinoblastoma)	Tumor Suppressor / Cell Cycle Checkpoint	Retinoblastoma, Osteosarcoma, Soft Tissue Sarcoma	First tumor suppressor gene identified
HER2/neu	Tumor Suppressor / Cell Cycle Checkpoint	Retinoblastoma, Osteosarcoma, Soft Tissue Sarcoma	-
	Proto-oncogene / Growth Factor Receptor	Breast (aggressive subtype), Stomach (Gastric), Esophageal	**Targeted Therapies** (e.g., Trastuzumab, Pertuzumab)
	Growth Factor Receptor	Breast (aggressive subtype), Stomach (Gastric), Esophageal	-
ALK EGFR BRAF KRAS / NRAS	**Proto-oncogenes / Cell Signaling (Oncogenes)**	Non-Small Cell Lung (NSCLC), Melanoma, Colorectal, Pancreatic, etc.	**Targeted Therapies** (e.g., Crizotinib, Erlotinib, Vemurafenib, Sotorasib); Resistance mechanism testing

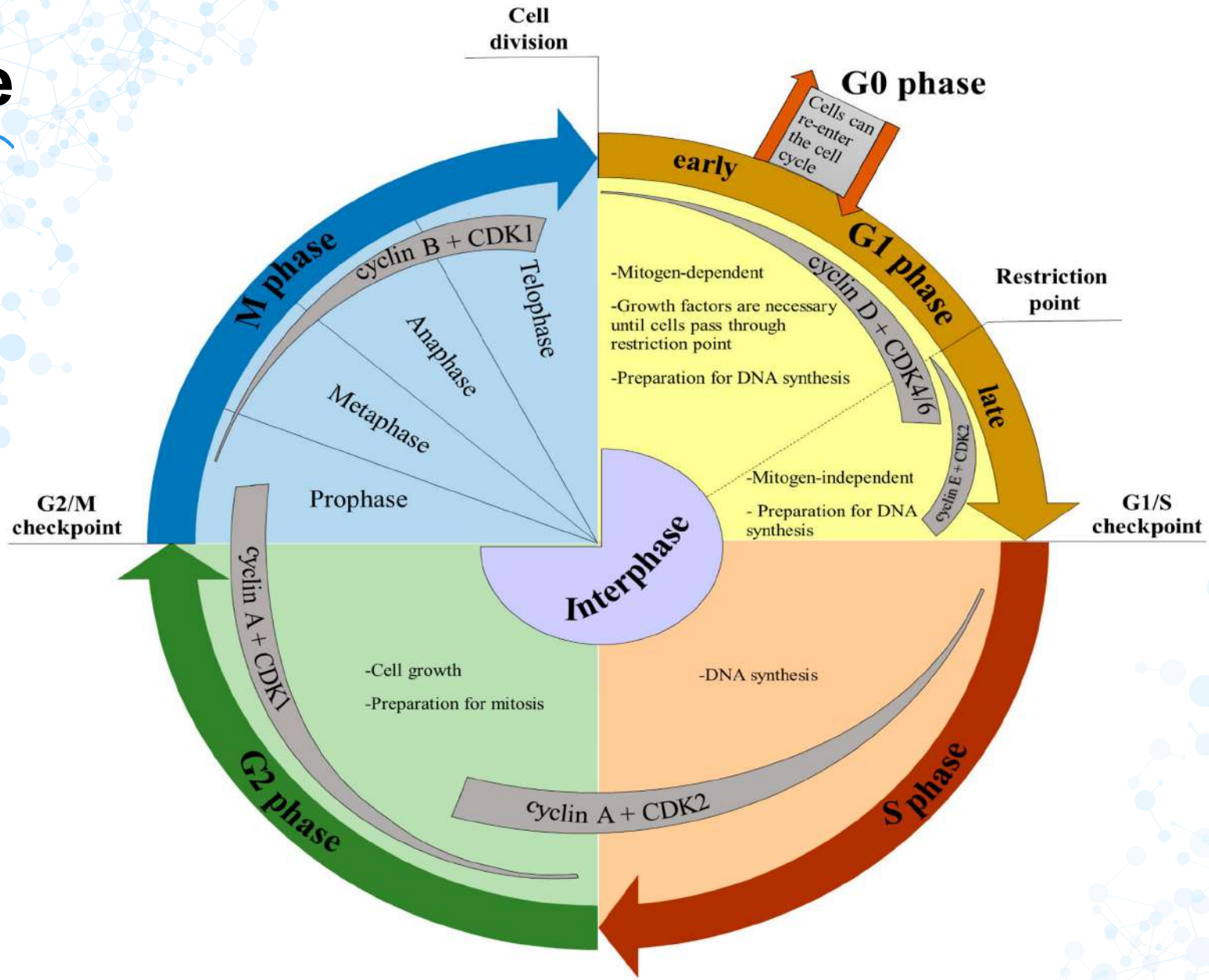
Tumor Suppressor (Breaks) | Proto-oncogene (Accelerator) | Hereditary (Germline) vs. Acquired (Somatic)

Introduction to Cancer

Cell Cycle, Oncogenes and Tumour Suppressor Genes (TSGs)

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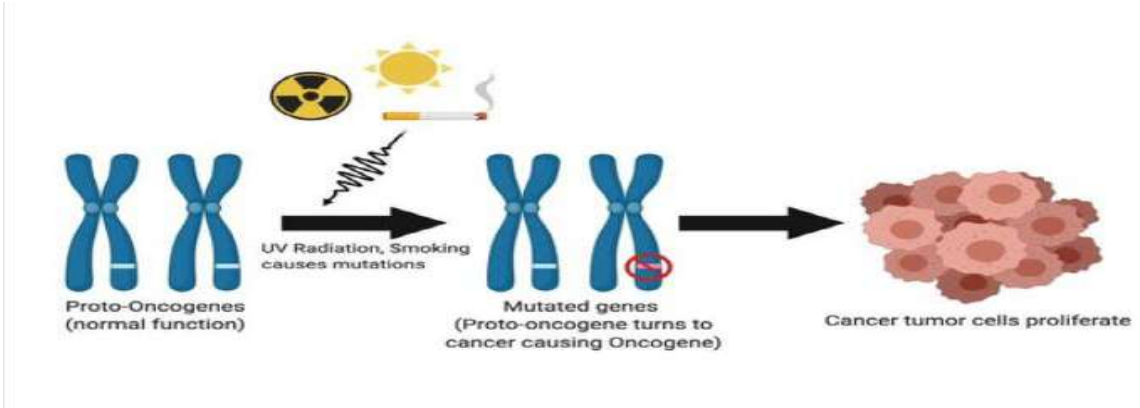
Cell Cycle


Cell division
G0 phase
Cells can re-enter the cell cycle
early
G1 phase
late
Restriction point
-Mitogen-dependent
-Growth factors are necessary until cells pass through restriction point
-Preparation for DNA synthesis
cyclin D + CDK4/6
cyclin E + CDK2
-Mitogen-independent
- Preparation for DNA synthesis
G1/S checkpoint
S phase
-DNA synthesis
cyclin A + CDK2
G2 phase
-Cell growth
-Preparation for mitosis
cyclin A + CDK1
G2/M checkpoint
M phase
cyclin B + CDK1
Prophase
Metaphase
Anaphase
Telophase
Interphase

Oncogene

An oncogene is a mutated or activated form of a proto-oncogene that can promote uncontrolled cell growth, division and survival.

When proto-oncogenes mutate or become activated as oncogenes, they can cause uncontrolled cell growth and tumour formation.

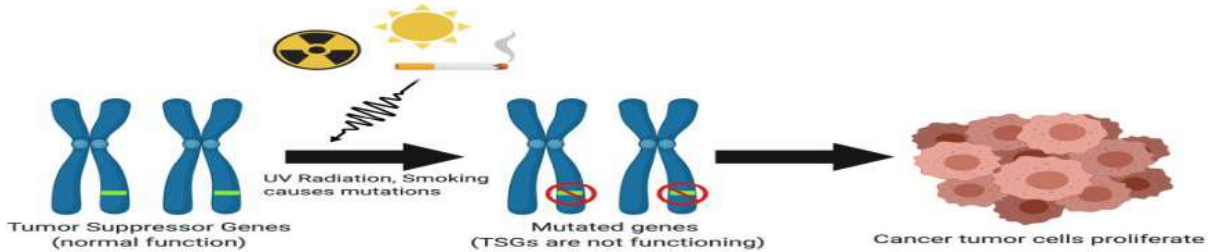


Tumour Suppressor Genes

Type of gene that regulates cell growth and division.

These genes act as "brakes" on the cell cycle, preventing cells from growing and dividing too rapidly or in an uncontrolled manner.

When a TSG is mutated, lost, or silenced (inactivated), it can no longer perform its function, leading to uncontrolled cell growth and contributing to the development of cancer.



Other mechanisms -cell growth control

Apoptosis

- Cells normally have protective mechanism to stop damaged DNA being replicated.
- BCL2-family genes and TP53 are involved in apoptosis and cell-cycle control.
- If these genes or pathways do not function properly, DNA damage may accumulate.

Immortal growth

- After each division the tips of their chromosomes (telomeres) shorten.
- Cancer cells can produce telomerase, an enzyme that maintains the length of these tips during division.

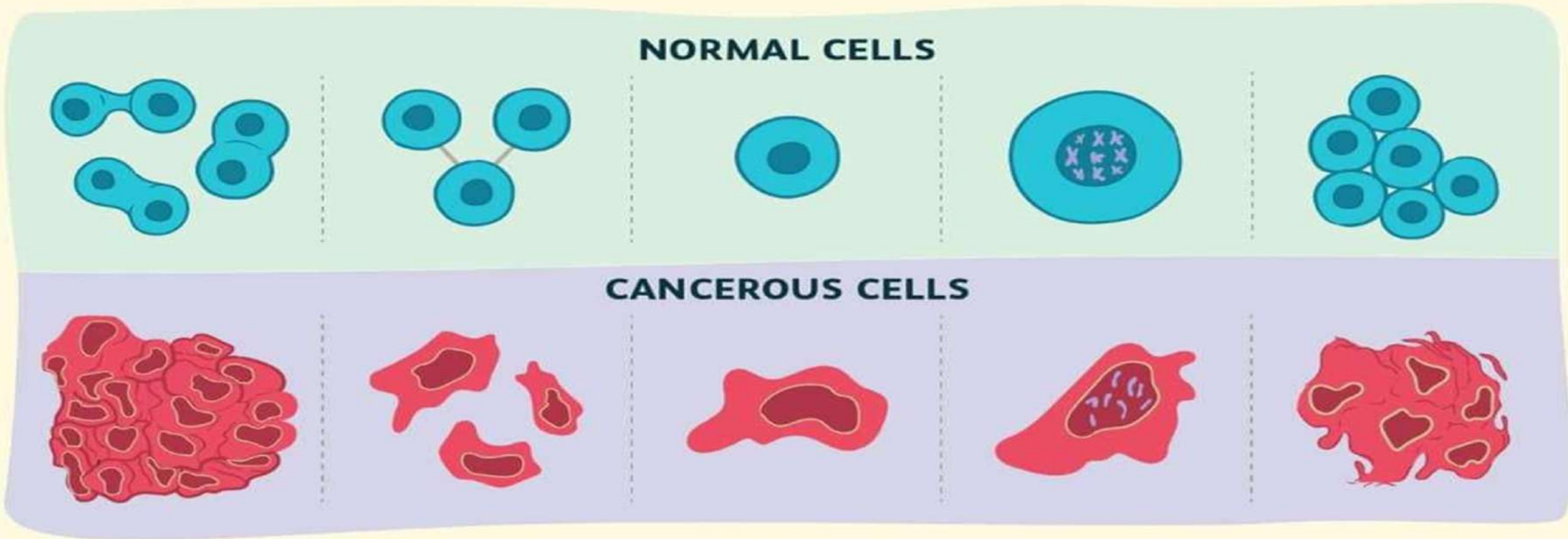
Tumor Heterogeneity

- As cancer develops the inherent genetic instability leads to different cell populations within a single tumour.
- This can make tumours more difficult to treat and may contribute to resistance to cytotoxic drugs and radiotherapy.

Introduction to Cancer

Differences Between Normal Cells and Cancer Cells

Comparison of Normal Cells and Cancerous Cells



UNDERSTANDING CANCER BIOLOGY: THE "ROGUE CELL" CITY ANALOGY

THE HEALTHY CELL CITY

BODY AS A CITY
MICRO-ENVIRONMENT

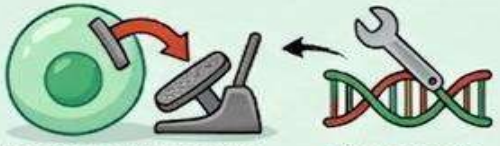
THE CANCER CELL ROGUE ACTIVITY

A THE ACCELERATOR (PROTO-ONCOGENE)



NORMAL GROWTH SIGNALS: Cells only grow and divide when needed.

B THE BRAKES (TUMOR SUPPRESSOR)



CONTROL MECHANISMS: Genes (e.g., TP53) stop division and check for damage.

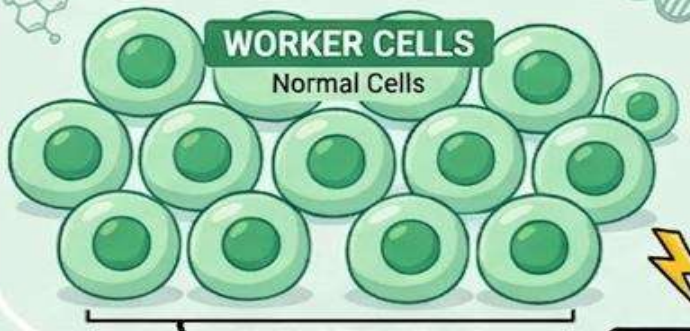
DNA REPAIR: Errors are fixed.

C RETIREMENT (APOPTOSIS)

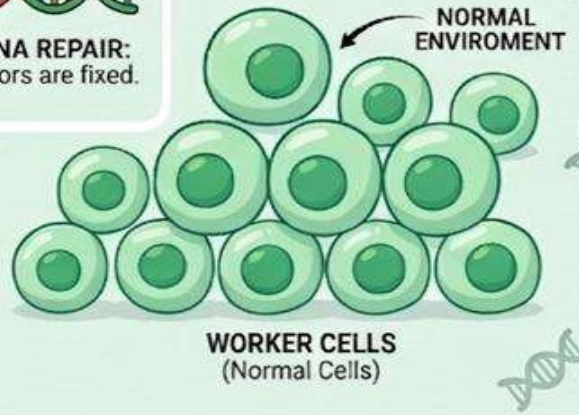


PROGRAMMED DEATH: Old or damaged cells die off naturally.

FOLLOWING THE RULES



WORKER CELLS
Normal Cells
FOLLOWING THE RULES



WORKER CELLS
(Normal Cells)

DNA DAMAGE
(THE GENETIC 'HIT')

BREAKING THE RULES

D ACCELERATOR STUCK (ONCOGENE)



ONCOGENE: Mutation (e.g., KRAS) sticks growth signal to ON.

E BRAKES FAIL (TUMOR SUPPRESSOR LOST)



TUMOR SUPPRESSOR INACTIVATED: (e.g., TP53 "guardian" lost). Control fails.

F REFUSING TO RETIRE (IMMORTALITY)



CANCER CELLS IMMORTAL: Defy signals to die and keep dividing.

ROGUE CELLS
Cancer Cells
BREAKING THE RULES

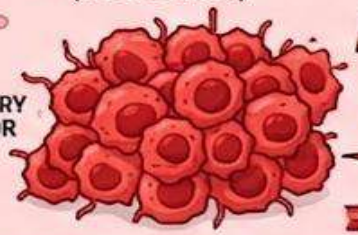
G A TUMOR FORMS (A BLOCKAGE)



PILE OF ROGUE CELLS: Form a lump (blockage) and demand resources.

NEW BLOOD VESSELS: Steal supplies (Angiogenesis).

G A TUMOR FORMS (A BLOCKAGE)

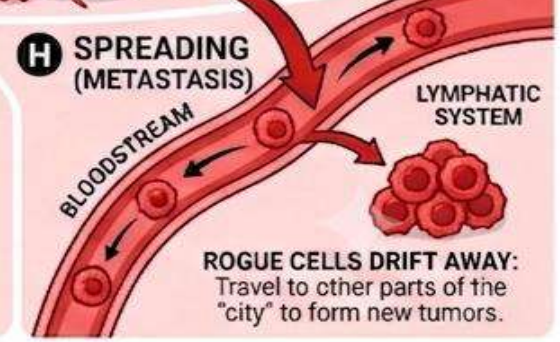


PILE OF ROGUE CELLS: Steal supples resoucegs.

PILE OF ROGUE CELLS: Form a lump (blockage) and demand resources.

NEW BLOOD VESSELS: Steal suppiies (Angiogenesis).

H SPREADING (METASTASIS)



ROGUE CELLS DRIFT AWAY: Travel to other parts of the "city" to form new tumors.

GENE MUTATIONS (THE CAUSE): Damages DNA. | **ONCOGENES (THE ACCELERATOR):** Stuck ON. | **TUMOR SUPPRESSORS (THE BRAKES):** Stuck OFF. | **APOPTOSIS (CELL DEATH):** Cancer cells may evade apoptosis.

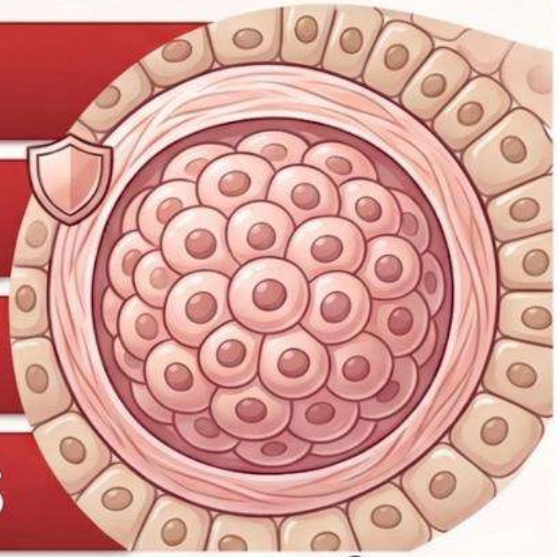
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Introduction to Cancer

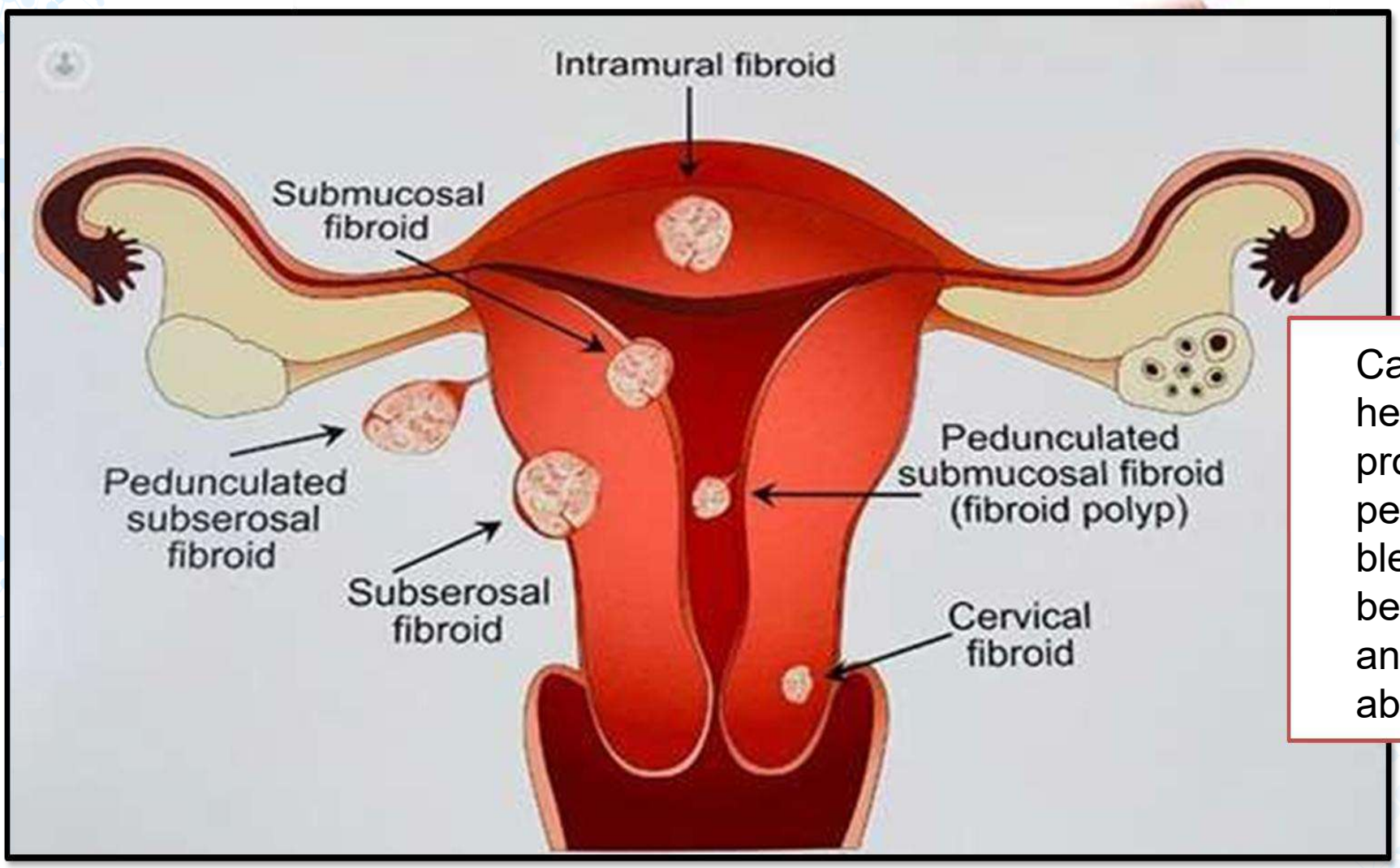
Types of Tumor

BENIGN

- BORDERED
- ENCAPSULATED
- NON-SPREADING
- IDENTICAL CELLS
- GOOD PROGNOSIS
- MAY OCCASIONALLY RECUR

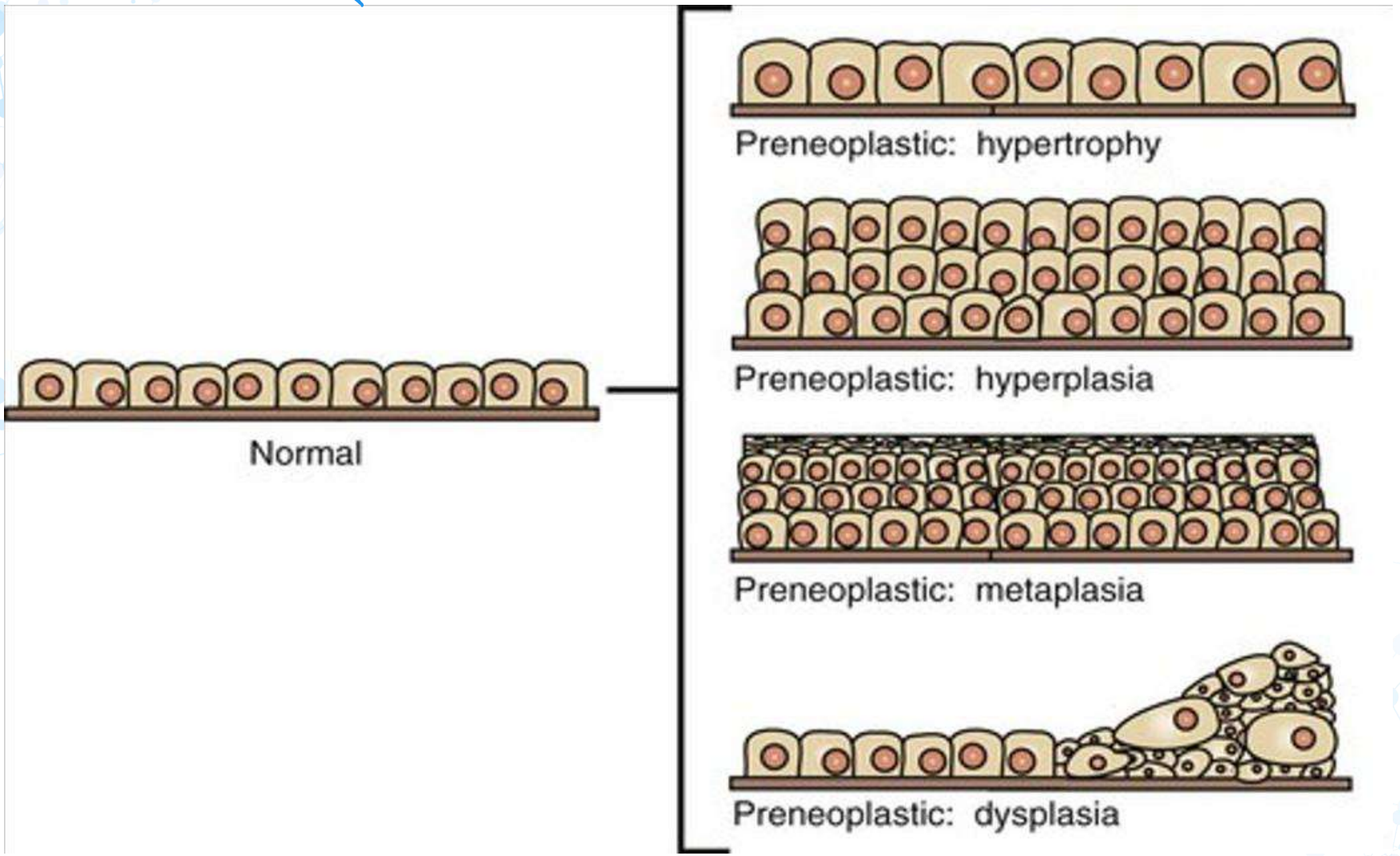


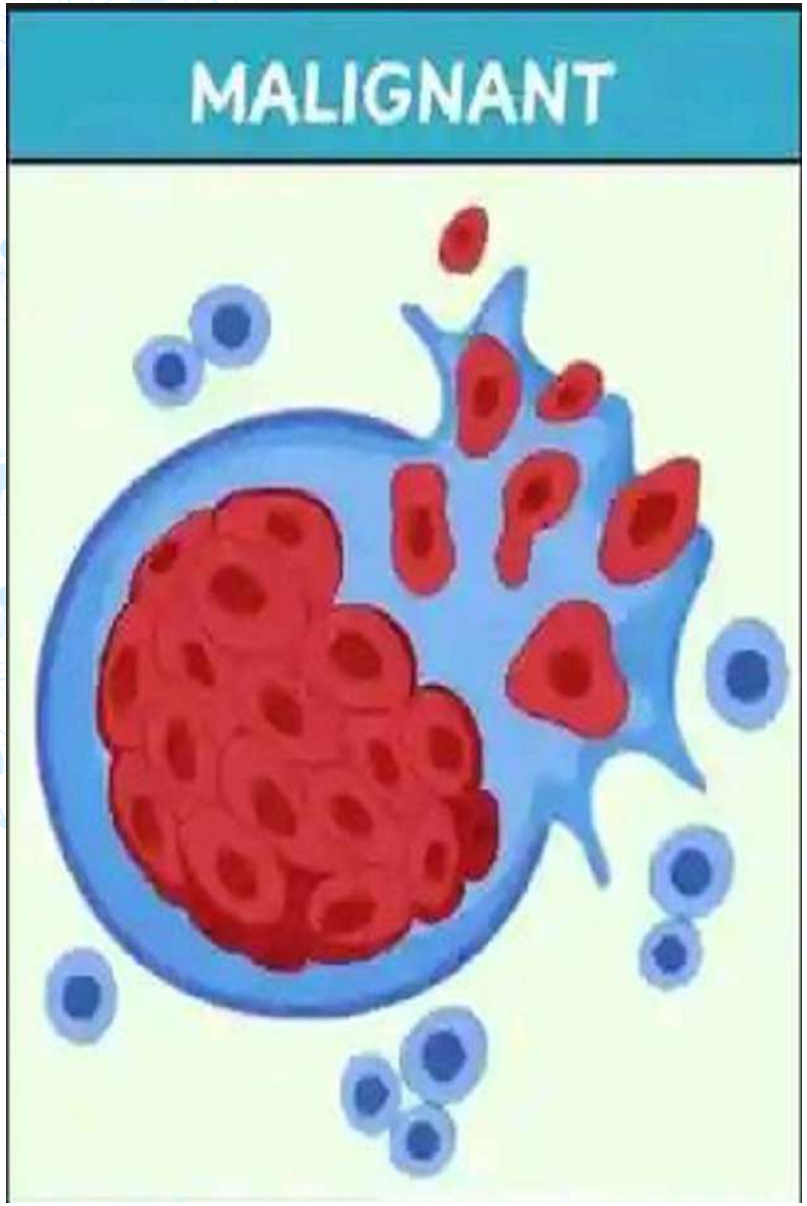
Fibroid



Can cause heavy, prolonged periods, bleeding between cycles, and a protruding abdomen.

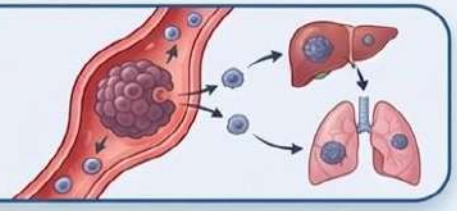
Adaptive and Pre-neoplastic Cellular Changes





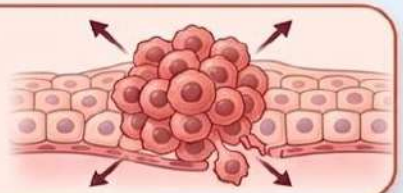
01 METASTASIS

Cancer cells break away and spread to distant organs or tissues via the bloodstream or lymphatic system.



02 AGGRESSIVE

Cells multiply rapidly, uncontrollably, and actively invade and destroy surrounding healthy tissues.



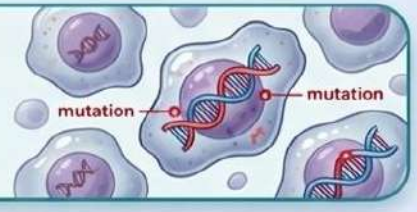
03 IRREGULAR EDGES

The borders are jagged, uneven, and poorly defined, making the tumor highly invasive and harder to surgically remove.



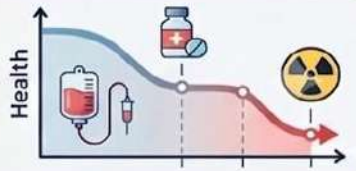
04 GENETIC CHANGES

Driven by profound DNA mutations that bypass the body's natural cell-death signals and growth controls.

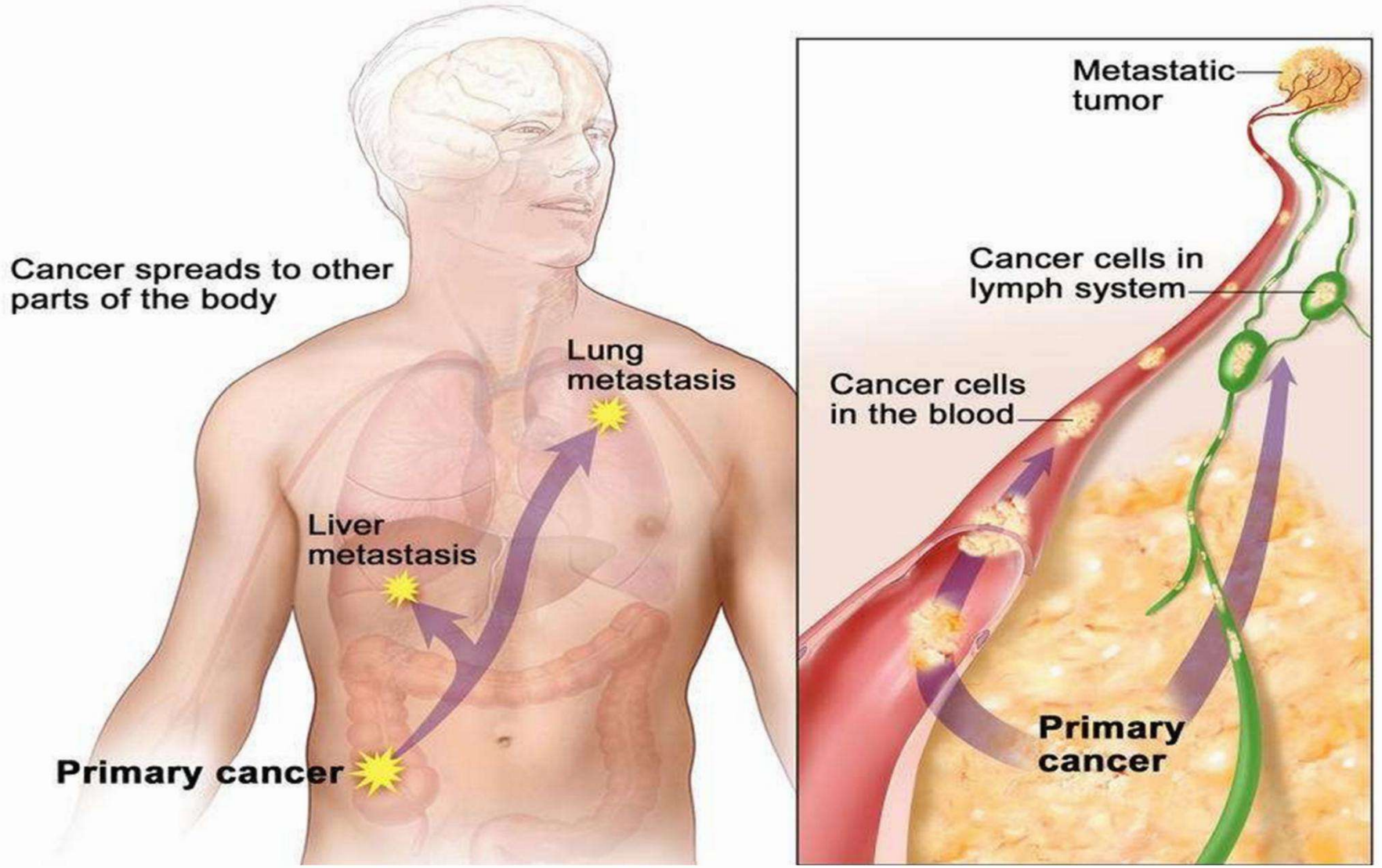


05 POOR PROGNOSIS

Malignant tumours may have a worse prognosis depending on tumour type, stage, grade, biology and treatment response.



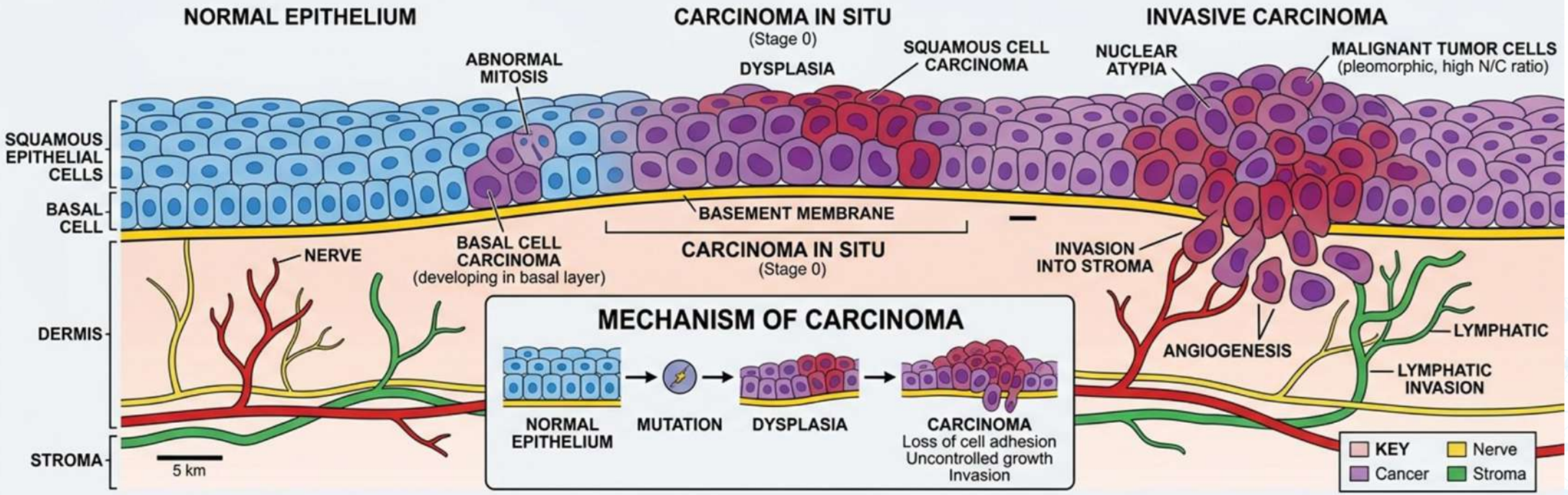
Metastasis


Cancer spreads to other parts of the body
Lung metastasis
Liver metastasis
Primary cancer
Metastatic tumor
Cancer cells in lymph system
Cancer cells in the blood
Primary cancer

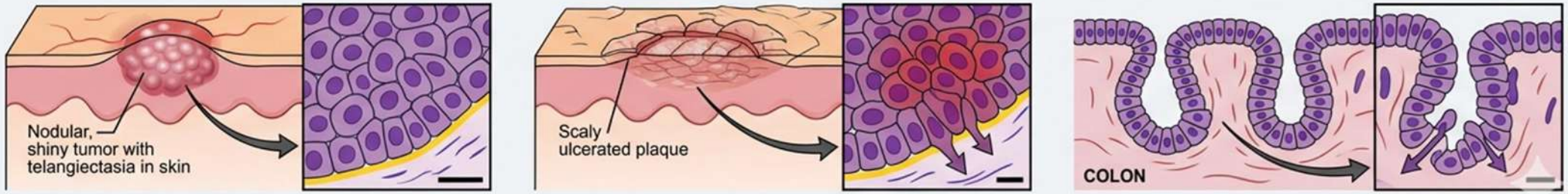
Introduction to Cancer

Tumour Classification

CARCINOMA: OVERVIEW

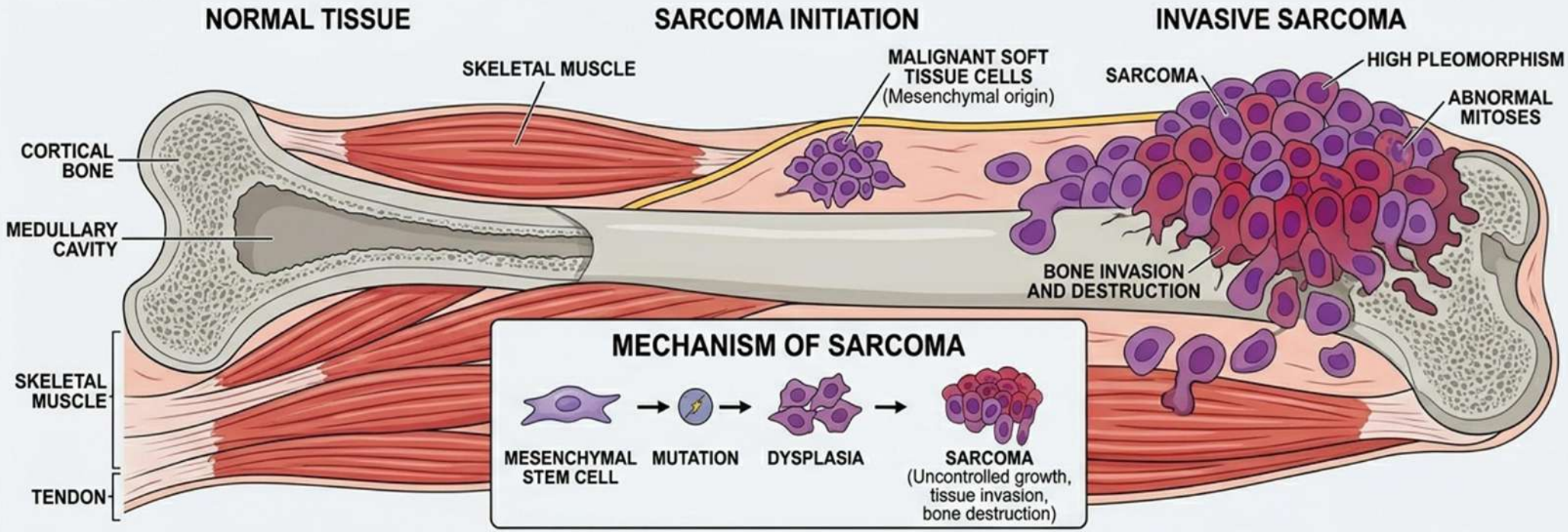


TYPES OF CARCINOMA

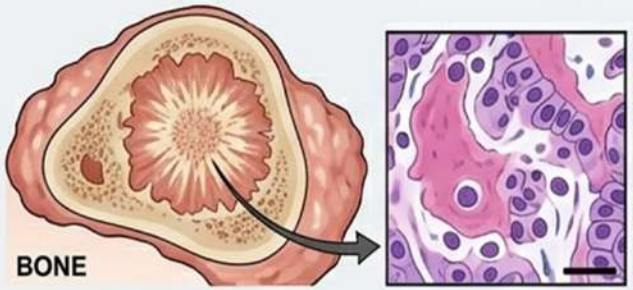


BASAL CELL CARCINOMA | SQUAMOUS CELL CARCINOMA | ADENOCARCINOMA

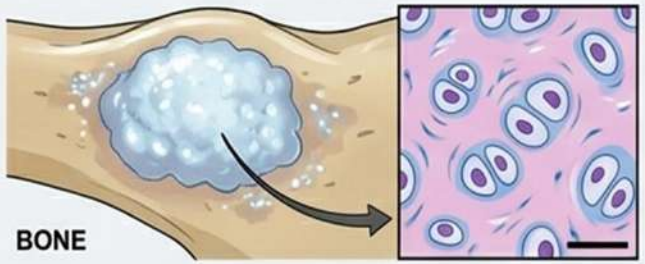
SARCOMA: OVERVIEW



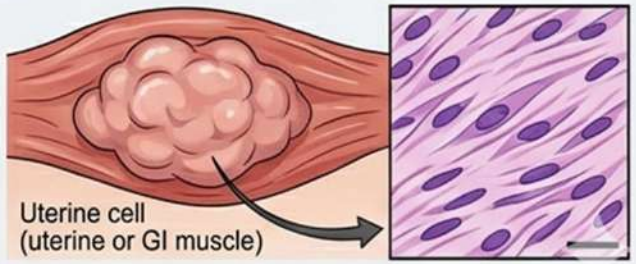
TYPES OF CARCINOMA



OSTEOSARCOMA (Bone-forming Sarcoma)



CHONDROSARCOMA (Cartilage-forming Sarcoma)



LEIOMYOSARCOMA (Smooth Muscle Sarcoma)

Adipose (Fatty) Tissue Tumors

Benign (Non-Cancerous)

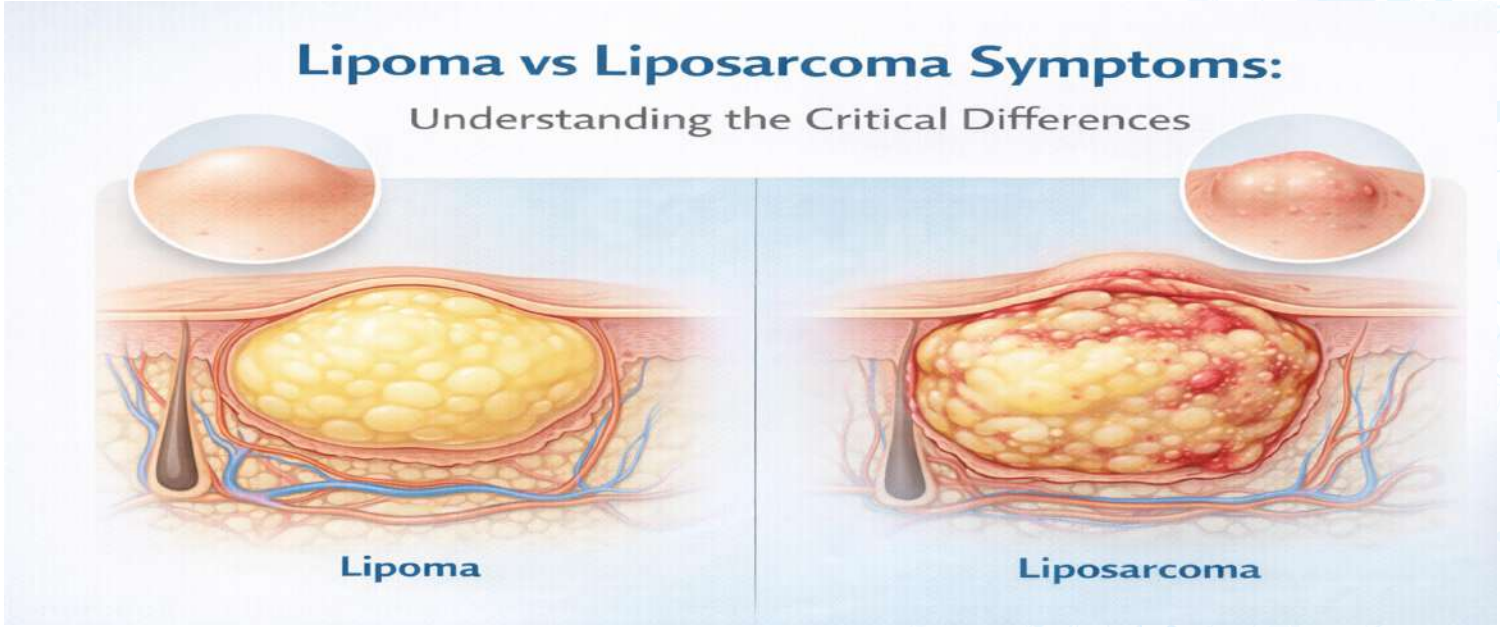
Benign adipocytic tumours are usually localised and non-metastasising; malignant adipocytic tumours such as liposarcoma can recur or metastasise depending on subtype and grade.

- Lipomas
- Lipoblastomas

Malignant (Cancerous)

Aggressive neoplasms characterized by cellular atypia and potential for metastasis. Often occur in deep tissues of adults.

- Liposarcomas



CLASSIFICATION OF MUSCLE TUMORS

BENIGN

LEIOMYOMAS

- Originates in Smooth Muscle (**Involuntary Muscle**).
- Can develop **almost anywhere** (starts from blood vessel walls).
- Most common place: Uterus Wall (Fibroids).



RHABDOMYOMAS

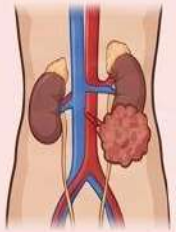
- Tumor of Skeletal Muscle.



MALIGNANT

LEIOMYOSARCOMAS

- Most common in Retroperitoneum, Internal Organs, and Blood Vessels.

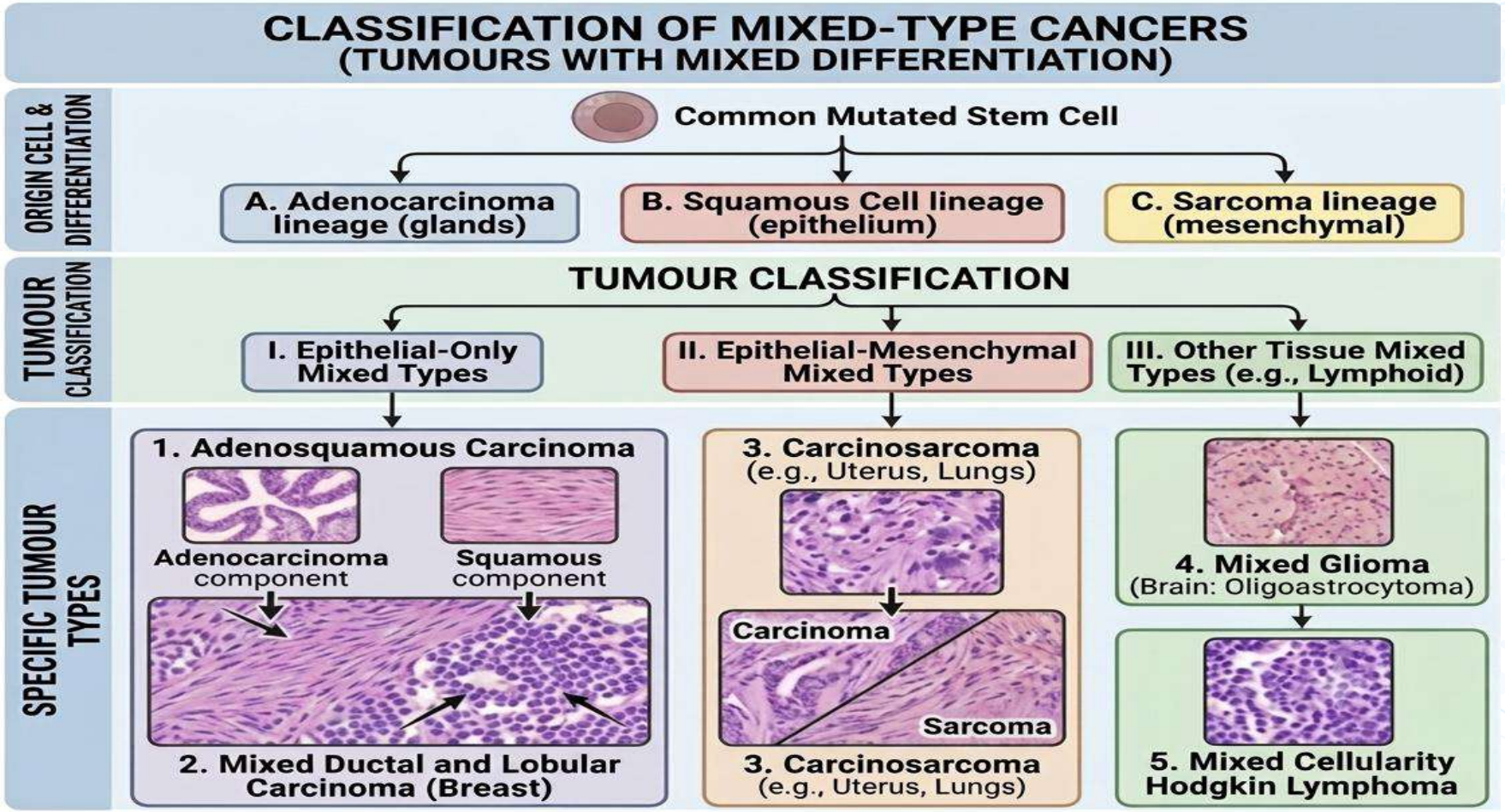


RHABDOMYOSARCOMAS

- Common in:
  - Arms/Legs
  - Head/Neck
  - Reproductive/Urinary (e.g., Vagina, Bladder)
- Population:
  - Children affected much more often than adults.



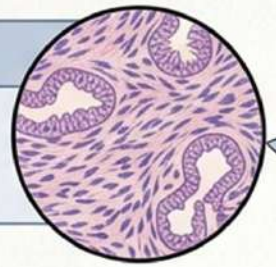
Mixed-Type Cancer Differentiation: Adenosquamous Carcinoma and Other Major Mixed Cancers



TUMORS OF JOINT TISSUE

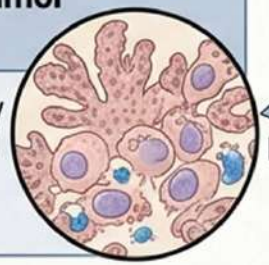
Synovial Sarcoma

Malignant tumor, typically in young adults, common in extremities.



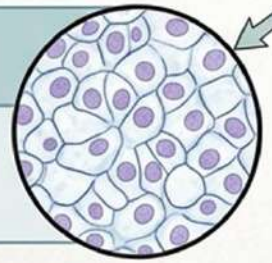
Pigmented Villonodular Synovitis (PVNS) Tenosynovial Giant Cell Tumor (diffuse type)

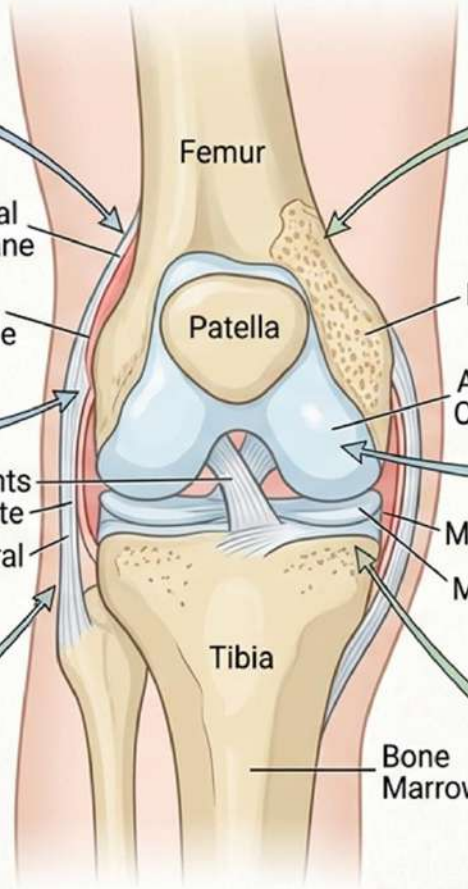
Locally aggressive but usually non-cancerous, characterized by brown-pigmented, villous overgrowth.



Clear Cell Sarcoma of Soft Tissue

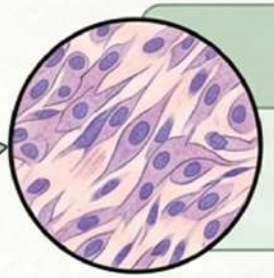
Often arises near tendons and aponeuroses, sometimes near joints. Distinct translocation





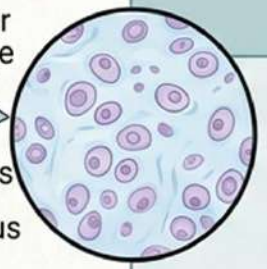
Osteosarcoma (Juxta-articular)

The most common primary bone cancer. Can occur near joints, especially in the knee.



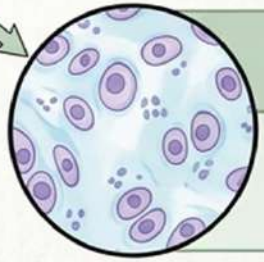
Chondrosarcoma (Juxta-articular)

Malignant tumor that produces cartilage matrix. Occurs near joint surfaces. Disorganized chondrocytes with cytological in an abundant, often calcified, hyaline or myxoid matrix.



Chondrosarcoma of Tissue

Malignant tumor that produces **cartilage matrix**. Occurs near joint surfaces.

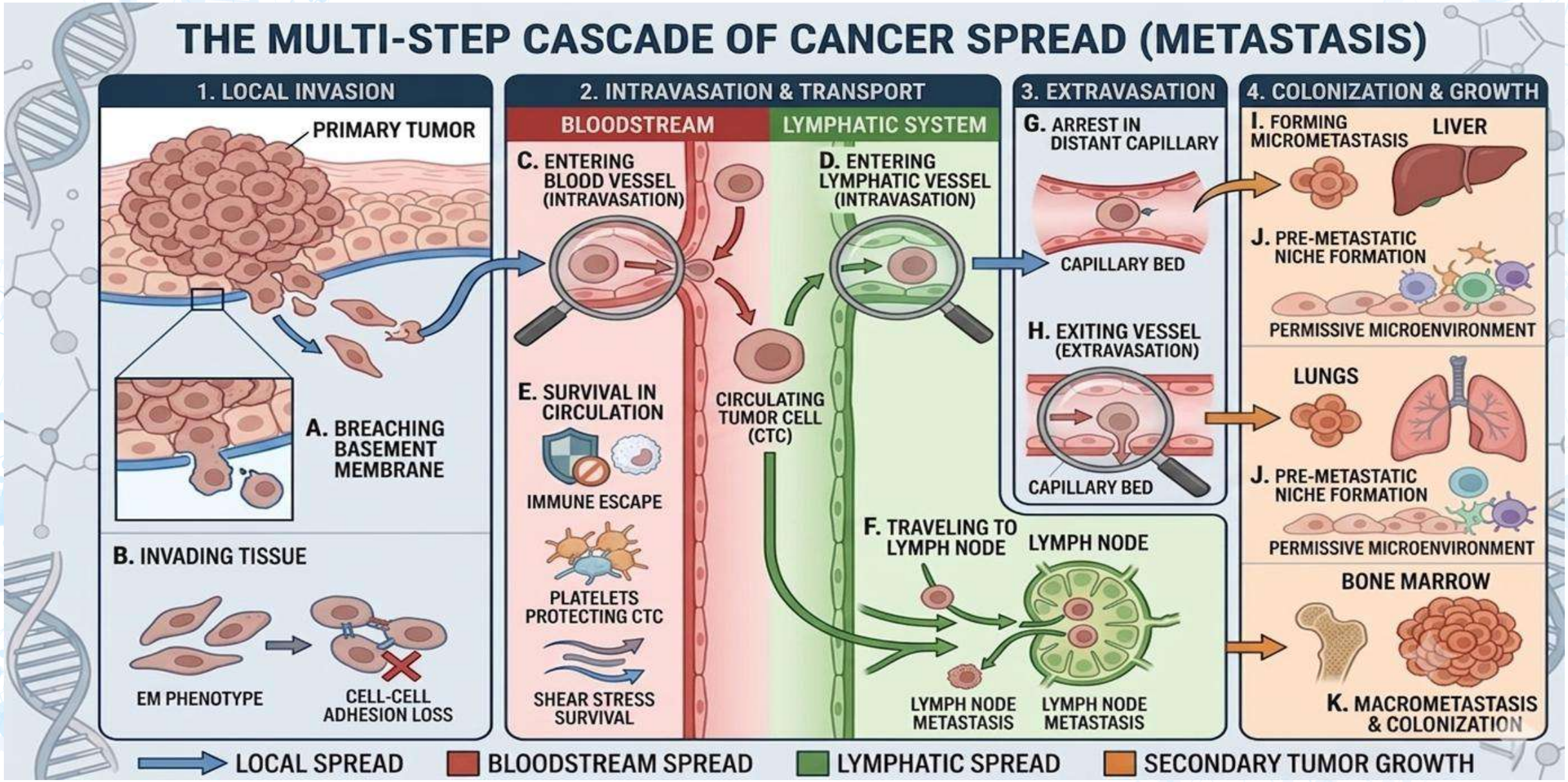


Classification of vascular and lymphatic neoplasms

Vessel Type	Benign (Non-Cancerous)	Malignant (Cancerous)
Blood Vessels (Vascular)	**Hemangioma**	**Angiosarcoma**
	• Description: A very common, soft, reddish-blue skin nodule or birthmark made of normal, well-organized blood vessels. • Key Feature: Regular, uniform endothelial cells with no aggressive tissue invasion or mitotic activity.	• Description: A rare, highly aggressive, rapidly growing cancer of the blood vessel endothelial lining. • Key Feature: Chaotic, poorly formed, branching vessels that aggressively infiltrate local tissue and cause extensive hemorrhage.
Lymph Vessels (Lymphatic)	**Lymphangioma**	**Kaposi Sarcoma (Dual origin)**
	• Description: A spongy, multi-cystic benign mass made of dilated, thin-walled lymphatic channels. • Key Feature: Instead of blood, these well-circumscribed channels are filled with clear, protein-rich lymph fluid.	• Description:HHV-8/KSHV-associated vascular neoplasm involving blood and lymphatic endothelium; risk is increased with immunosuppression such as HIV or post-transplant immunosuppression. • Key Feature: Proliferation of atypical spindle cells forming slit-like vascular spaces that leak red blood cells.

Introduction to Cancer

Pathways of Malignant Progression


THE MULTI-STEP CASCADE OF CANCER SPREAD (METASTASIS)
1. LOCAL INVASION
PRIMARY TUMOR
A. BREACHING BASEMENT MEMBRANE
B. INVADING TISSUE
EM PHENOTYPE
CELL-CELL ADHESION LOSS
2. INTRAVASATION & TRANSPORT
BLOODSTREAM
LYMPHATIC SYSTEM
C. ENTERING BLOOD VESSEL (INTRAVASATION)
D. ENTERING LYMPHATIC VESSEL (INTRAVASATION)
E. SURVIVAL IN CIRCULATION
IMMUNE ESCAPE
PLATELETS PROTECTING CTC
SHEAR STRESS SURVIVAL
CIRCULATING TUMOR CELL (CTC)
F. TRAVELING TO LYMPH NODE
LYMPH NODE
LYMPH NODE METASTASIS
LYMPH NODE METASTASIS
3. EXTRAVASATION
G. ARREST IN DISTANT CAPILLARY
CAPILLARY BED
H. EXITING VESSEL (EXTRAVASATION)
CAPILLARY BED
4. COLONIZATION & GROWTH
I. FORMING MICROMETASTASIS
LIVER
J. PRE-METASTATIC NICHE FORMATION
PERMISSIVE MICROENVIRONMENT
LUNGS
J. PRE-METASTATIC NICHE FORMATION
PERMISSIVE MICROENVIRONMENT
BONE MARROW
K. MACROMETASTASIS & COLONIZATION
LOCAL SPREAD
BLOODSTREAM SPREAD
LYMPHATIC SPREAD
SECONDARY TUMOR GROWTH

Introduction to Cancer

Diagnosis and Staging

CANCER DIAGNOSIS PATHWAY: From Symptoms to Confirmation

PATIENT
(Symptoms & Risk Factors)

- Change in bowel/ bladder habits
- A sore that does not heal
- Unusual bleeding/ discharge
- Thickening or lump
- Indigestion/difficulty swallowing
- Obvious change in wart/mole
- Nagging cough or hoarseness

STEP 1 IDENTIFYING SYMPTOMS & WARNING SIGNS

7 WARNING SIGNS OF CANCER

- Change in bowel/ bladder habits
- A sore that does not heal (bandaged)
- Unusual bleeding/discharge
- Thickening or lump (lump on neck)
- Indigestion/difficulty swallowing (throat/stomach)

STEP 2 CLINICAL EXAMINATION



- **MEDICAL HISTORY REVIEW** (Family, Lifestyle)
- **PHYSICAL EXAMINATION** (Check for lumps, abnormalities, health status)
- **BASIC TESTS** (Blood work, Urinalysis)

STEP 3 DIAGNOSTIC IMAGING

- **MRI SCAN**
- **CT SCAN** (Computed Tomography)
- **PET SCAN** (Positron Emission Tomography)
- **X-RAY**
- **ULTRASOUND**

visualize tumors, location, size, and spread.

4 BIOPSY & TISSUE ANALYSIS

Obtaining Tissue Sample → Pathology Lab Analysis

- Histopathology (Examining cells under a microscope)
- Immunohistochemistry
- Genetic/Molecular Testing

DIAGNOSIS CONFIRMATION

CANCER CONFIRMED (Identify type, stage, grade)

OR

NON-CANCEROUS/ BENIGN

→ **TREATMENT PLANNING & FOLLOW-UP**

Nursing Division,
Ministry of Health Malaysia

CANCER DIAGNOSIS AND MONITORING: COMMON TUMOR MARKER EXAMPLES

SERUM/BLOOD MARKERS | URINE MARKERS | TISSUE BIOMARKERS

TUMOR MARKER EXAMPLE (with full name and common abbreviation)	ASSOCIATED CANCER(S)	COMMON CLINICAL USE(S) (Diagnosis, Monitoring, Prognosis)
PSA (Prostate-Specific Antigen)	Prostate Cancer	Screening, Diagnosis aid, Treatment monitoring, Recurrence check
CA 125 (Cancer Antigen 125)	Ovarian Cancer	Diagnosis aid, Monitoring treatment, Recurrence check
CEA (Carcinoembryonic Antigen)	Colorectal, Lung, Breast, Pancreatic Cancers	Monitoring treatment, Prognosis, Recurrence check
AFP (Alpha-Fetoprotein)	Liver (Hepatocellular), Germ Cell Cancers (Testes/Ovaries)	Diagnosis aid, Staging, Monitoring, Prognosis
CA 19-9 (Carbohydrate Antigen 19-9)	Pancreatic, Gallbladder, Bile Duct Cancers	Monitoring, Recurrence check
hCG (human Chorionic Gonadotropin)	Gestational Trophoblastic Disease, Germ Cell Cancers (Testes/Ovaries)	Diagnosis, Staging, Monitoring
HER2/neu (Human Epidermal Growth Factor Receptor 2)	Breast Cancer, Stomach Cancer	**TISSUE BIOMARKER:** Treatment decision (e.g., targeted therapy)
ER/PR (Estrogen Receptor / Progesterone Receptor)	Breast Cancer	**TISSUE BIOMARKER:** Treatment decision (hormone therapy)
5-HIAA (5-Hydroxyindoleacetic Acid)	Carcinoid Tumors (Neuroendocrine)	**URINE MARKER:** Diagnosis and monitoring

IMPROVED PATIENT OUTCOME VIA OPTIMIZED CARE PATHWAY

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Grading & Staging

Grading :

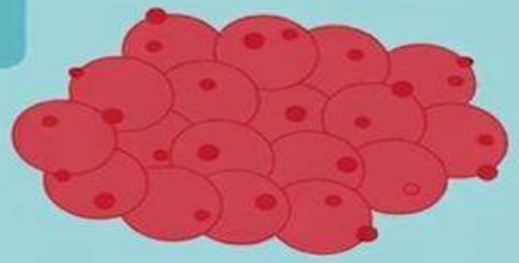
- Based on the microscopic features of the cells which compose a tumor and is specific for the tumour types.

Staging:

- Based on clinical, radiological and pathological/surgical information.
- Tumor size, involvement of regional lymph nodes and presence of metastases.
- Usually has prognostic value.

TNM System for Staging Breast Cancer

T



Tumor size

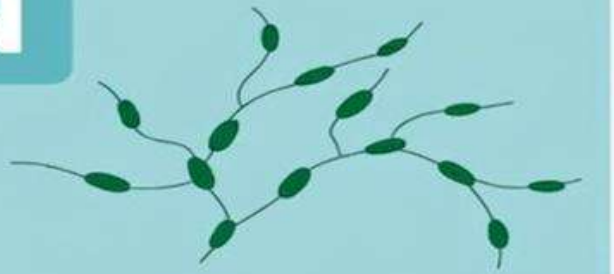
T-1: 0-2 centimeters

T-2: 2-5 centimeters

T-3: >5 centimeters

T-4: Tumor has broken through skin or attached to chest wall

N



Lymph Node Status

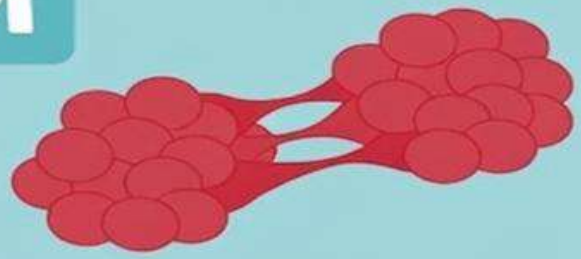
N-0: Surgeon can't feel any nodes

N-1: Surgeon can feel swollen nodes

N-2: Nodes feel swollen and lumpy

N-3: Swollen nodes located near collarbone

M



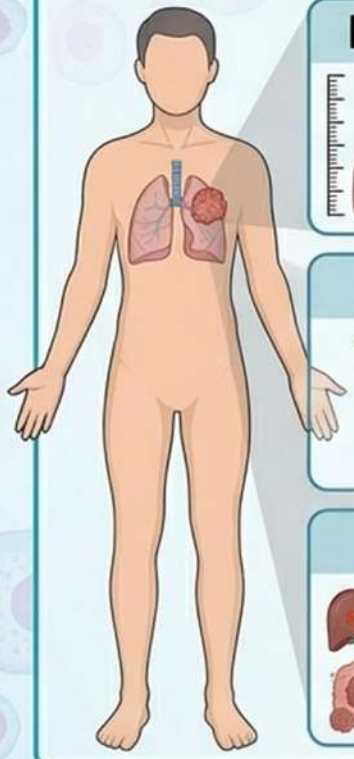
Metastasis

M-0: No distant metastasis

M-1: Distant organ spread like bone, lung, liver

CANCER STAGING: TNM vs. FIGO SYSTEMS

TNM SYSTEM
(GLOBAL STANDARD for many cancers)

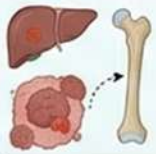


PRIMARY TUMOR (T)


T0: No Tumor
T1-T4: Size & Extent

LYMPH NODES (N)


N0: No Nodes
N1-N3: Degree of Involvement

METASTASIS (M)


M0: No Metastasis
M1: Distant Spread

OVERALL STAGE (0-IV)

STAGE CORRELATION
(General Equivalence)



≈ **TNM T1, N0, M0**



≈ **TNM T2, N0, M0**

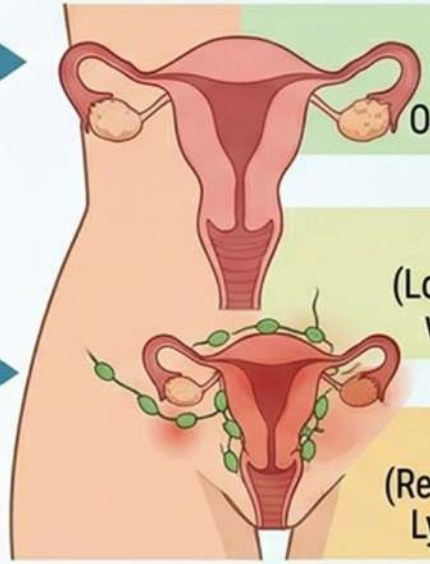


≈ **TNM T3, N1-3, M0**



≈ **TNM Any T, Any N, M1**

FIGO SYSTEM
(**GYNECOLOGICAL CANCERS** only)



STAGE I
(Limited to Organ of Origin)

STAGE II
(Local Extension within Pelvis)

STAGE III
(Regional Spread/ Lymph Nodes)

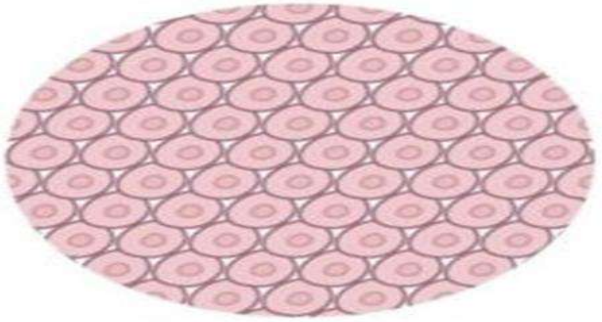
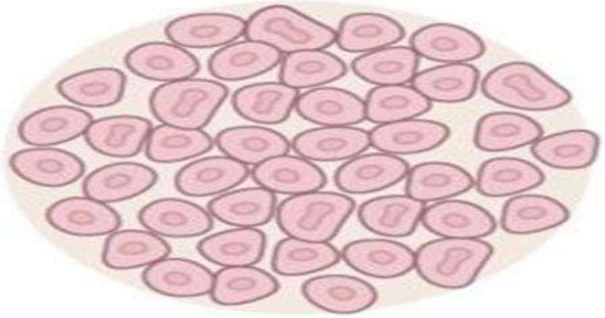
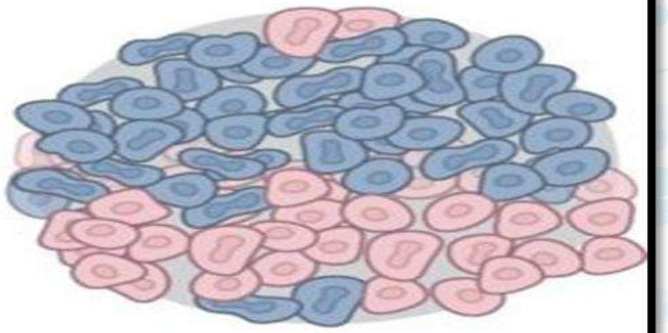
STAGE IV
(Distant Metastasis/ Spread)



STAGING DETERMINES TREATMENT & PROGNOSIS

Grading

Prognosis ↓ Grade ↑

Grade 1	Grade 2	Grade 3
		
Glandular/Tubular Differentiation: >75% of tumor forms glands	**Glandular/Tubular Differentiation:** 10% to 75% of tumor forms glands	**Glandular/Tubular Differentiation:** <10% of tumor forms glands
Nuclear Pleomorphism: Uniform cells with small nuclei similar in size to normal breast epithelial cells	**Nuclear Pleomorphism:** Cells larger than normal with open vesicular nuclei, visible nucleoli, and moderate variability in size and shape	**Nuclear Pleomorphism:** Cells with vesicular nuclei, prominent nucleoli, marked variation in size and shape
Mitotic Count: < 7 mitoses per 10 high power fields	**Mitotic Count:** 8-15 mitoses per 10 high power fields	**Mitotic Count:** > 16 mitoses per 10 high power fields

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THANK YOU