REGULATION OF CELL CYCLE & CANCER

How cells regulate division.
Regulation of the Cell Cycle

- The cell cycle is regulated by a chemical control system that triggers and coordinates key events in the cell cycle.

- A checkpoint is a critical time in the cell cycle where “stop” and “go” signals can regulate cell division.

- If these “stop” and “go” signals are not given or received within the cell, serious problems can occur such as cancer.
Checkpoints in the Cell Cycle

G2 Checkpoint
Check for:
- Cell size
- DNA replication

Spindle Assembly Checkpoint
Check for:
- Chromosome attachment to spindle

G1 Checkpoint
Check for:
- Cell size
- Nutrients
- Growth factors
- DNA damage

Resting state
(G0)
Regulating the cell cycle

- In most animals, cell division stays in the “off” position, unless a stimulus is present.

- Chemical Signals / Stimuli:
  - Internal signals:
    - Enzymes (such as cyclins and kinases)
  - External signals:
    - Chemicals, hormones, and growth factors produced by other cells
Regulating the cell cycle

- Physical Signals / Stimuli:
  - **Cell Density**
    - Cells sense when they are too closely packed
    - Division is then turned off
    - Cells sense when they are not in contact with a surface and division is turned on.
What is cancer?

- Cancer is **uncontrolled cell division** that occurs when the cell cycle is not regulated.

- Cancer cells **do NOT respond** to the normal signals that would stop the cell division process.

- Cancer cells **continue to divide** even when they are very densely packed and/or there is no growth factor present.
A tumour is forming

Cancer cells dividing

Normal cells

Diagram showing how cancer cells keep on reproducing to form a tumour

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Characteristics of Cancer Cells

1. **Excessive growth:**
   - Tumor formation
     - Harmless = Benign
     - Harmful = Malignant

2. Can have **multiple nuclei**

3. Can undergo **metastasis**
   - Cancer cells spread to other parts of the body

4. Can evade the immune system
Normal and Cancer Cells

**Structure**

**Normal**
- Large cytoplasm
- Single nucleus
- Single nucleolus
- Fine chromatin

**Cancer**
- Small cytoplasm
- Multiple nuclei
- Multiple and large nucleoli
- Coarse chromatin

Normal cells  
Cancer cells
Progression of Cancer

- Healthy cells with few cancerous cells
- Multiplication of cancerous cells
- Metastasized cells

- Smooth muscle
- Lymphatic vessel
- Respiratory epithelial cells
- Connective tissue
- Blood vessel
- Tumour
- Carcinoma of the lung
- Metastatic cells
Types of Cancer

- **Carcinoma:**
  - Grows in tissues
  - Example: Lung or breast cancer

- **Lymphoma:**
  - May affect lymph nodes, spleen, or blood (WBC’s)
  - Example: Leukemia

- **Sarcoma:**
  - Grows in bone or muscle
  - Example: osteosarcoma

- **Melanoma:**
  - Skin cancer; irregular moles or spots on the skin
Breast carcinoma

osteosarcoma

Small cell lung carcinoma

leukemia
“ABCDE” Warning Signs for Skin Cancer

- **A** = Asymmetry (uneven)
- **B** = Border (irregular)
- **C** = Color (dark, multi)
- **D** = Diameter (6mm)
- **E** = Evolving (changes over time)
What causes cancer?

- **Carcinogen:**
  - Any substance known to produce or promote uncontrolled cell growth
  - Example: Tobacco (smoking & dip), asbestos

- **Radiation:**
  - High levels of UV exposure can lead to skin cancer; x-rays & gamma rays
  - Example: Nuclear weapons, uranium, x-rays

- **Hereditary factors:**
  - 5-10% of all cancers “run in the family”
  - Example: Breast, ovarian, and colon cancer
What causes cancer?

- **Diet & Exercise:**
  - Risk factors include *not eating enough fiber*, being overweight, excessive alcohol consumption, etc.

- **Viruses & Bacteria:**
  - Human Papilloma Virus (HPV) can increase the risk of cervical cancer in women

- **Unknown:**
  - Unfortunately there are many instances of seemingly “healthy” people who develop cancer
  - Example: Non-smokers with lung cancer
Treatments for Cancer

- **Surgery:**
  - The tumor is removed, as much as possible
  - Sometimes this is a complete cure, as with early detection of skin cancer

- **Radiotherapy:**
  - High level radiation is targeted at the tumor (to damage the cancer cell’s DNA) but it can also damage health tissue

- **Chemotherapy:**
  - Administering high doses of chemicals/drugs to kill the cancer cells
  - Unpleasant side effects (nausea, hair loss)
Cancer Facts

Cancer is the second leading cause of death in the U.S. (Heart disease is #1)

In the US, over 1.4 million people get cancer each year.

Most fatal type of cancer is lung cancer

In the US, men have a 1 in 2 chance of getting cancer. Women have a 1 in 3 chance of getting cancer.

Most common cancer in women = breast cancer
Most common cancer in men = prostate

Oncology is the study of cancer

Exposure to secondhand smoke causes 3,000 lung cancer deaths each year in US.