ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
AUTONOMOUS INSTITUTION
Approved by AICTE & Affiliated to Anna University
NBA Accredited for BE (ECE, EEE, MECH) | Accredited by NAAC with A+ Grade
Anjugramam - Kanyakumari Main Road, Palkulam, Variyoor P.O. - 629 401, Kanyakumari District.

DEPARTMENT OF BIOMEDICAL ENGINEERING

VII Semester

OBT357 BIOTECHNOLOGY IN HEALTH CARE

UNIT- 2 CLINICAL DISEASES

2.9 Non-Communicable diseases: Cancer

- Cancer is a non-communicable disease caused by abnormal changes in normal cells, resulting in uncontrolled growth that forms a lump, known as a tumour.
- The top ten cancers **globally** for 2020, according to the Global Cancer Observatory were:

1.Breast	2. Lung	3. Prostate
4. Colon	5. Stomach	6. Liver
7. Rectum	8. Cervix	9. Oesophagus
10. Thyroid		

- The top ten cancers **in India** for 2020, according to the Global Cancer Observatory were:

  - Men (Top 5 Cancers by Incidence/Mortality)

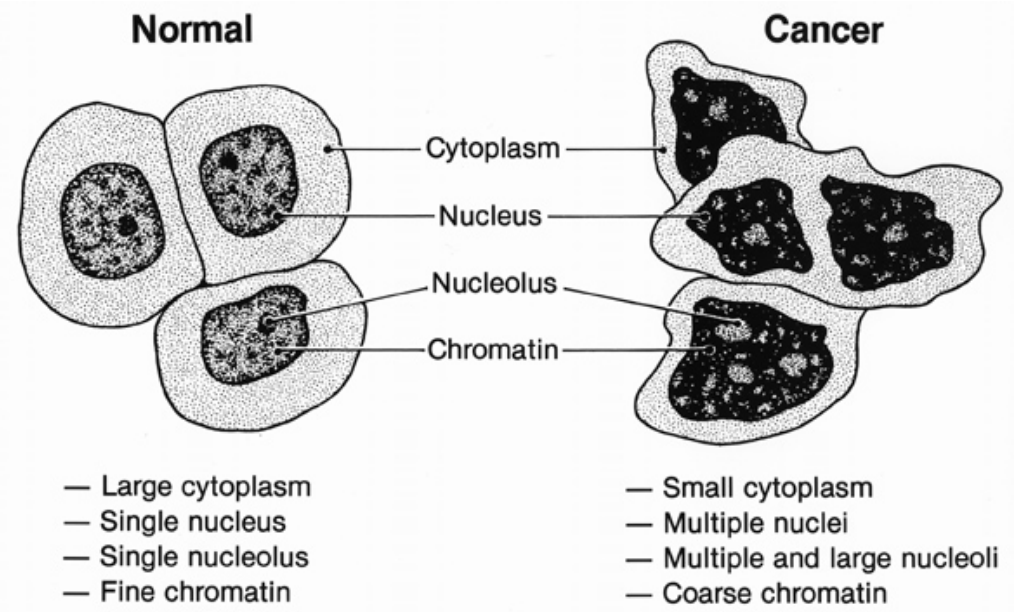
    1. **Lip, Oral Cavity**: Most common cancer in men (24.3% of new cases, 21.6% of cancer deaths in 2022 data, likely similar in 2020).
    2. **Lung**: Second most common, strongly linked to tobacco use.
    3. **Stomach**: Significant burden, noted as a major gastrointestinal cancer.
    4. **Colorectum**: Increasing incidence, linked to lifestyle changes.
    5. **Pharynx**: Includes nasopharynx and oropharynx, tied to tobacco and betel quid use.

  - Women (Top 5 Cancers by Incidence/Mortality)

    1. **Breast**: Most common cancer in women (31.1% of new cases in 2022, leading cause of cancer deaths in 2020).

2. **Cervix**: Second most common, high mortality (20.6% of female cancer deaths in 2022, similar trend in 2020).
3. **Colorectum**: Rising incidence, noted in top five.
4. **Ovary**: Significant contributor to female cancer burden.
5. **Lip, Oral Cavity**: Also prevalent in women, linked to tobacco chewing.

2.9.1 Cancer Cell Structure:



- **Small Cytoplasm** – Cancer cells prioritize rapid division over normal cell functions, so cytoplasm volume is reduced.
- **Multiple Nuclei** – Abnormal DNA replication and mitosis result in more than one nucleus per cell.
- **Large Nucleoli** – Increased ribosome production supports uncontrolled protein synthesis for cell growth.
- **Coarse Chromatin** – DNA in cancer cells is more condensed and irregular, linked to uncontrolled gene expression.

2.9.2 Causes of Cancer:

- Cancer arises from the **transformation of normal cells** into tumour cells in a multi-stage process that generally progresses from a pre-cancerous lesion to a malignant tumour.
- These changes are the result of the interaction between a person's **genetic factors** and three categories of external agents, including:
    - ✓ **physical carcinogens**, such as ultraviolet and ionizing radiation;
    - ✓ **chemical carcinogens**, such as asbestos, components of tobacco smoke, alcohol, aflatoxin (a food contaminant), and arsenic (a drinking water contaminant); and
    - ✓ **biological carcinogens**, such as infections from certain viruses, bacteria, or parasites.
- Cancer is caused by a combination of genetic, environmental, and lifestyle factors;
    - ✓ Smoking (cigarettes, bidis), chewing tobacco (gutka, paan with betel quid), and second-hand smoke exposure
    - ✓ Viruses and bacteria can cause cancer by altering cell DNA
    - ✓ Unhealthy Diet:
    - ✓ Obesity:
    - ✓ Physical Inactivity:
    - ✓ Alcohol
    - ✓ Environmental and Occupational Exposures
    - ✓ Genetic and Hereditary Factors

2.9.3 Symptoms for Cancer:

1. **Unexplained Weight Loss**:
    - Losing 10 pounds or more without trying, especially if it's rapid, can be a sign of cancers like pancreatic, stomach, lung, or esophageal cancer.
2. **Fatigue**:

- Persistent, severe tiredness that doesn't improve with rest may be associated with cancers like leukemia or those causing internal blood loss (e.g., colon or stomach cancer).

3. **Fever**:
   - Unexplained fevers, especially at night or recurring, can be a symptom of cancers like leukemia or lymphoma.
4. **Pain**:
   - Persistent pain, such as headaches (brain tumors), bone pain (bone cancer or metastasis), or abdominal pain (pancreatic or colorectal cancer), may occur, often in later stages.
5. **Skin Changes**:
   - Yellowing (jaundice), darkening, or reddening of the skin, excessive hair growth, or itching can be linked to cancers like liver or skin cancer.
   - New or changing moles, sores that don't heal, or unusual skin growths may indicate skin cancer (e.g., melanoma).

Symptoms by Specific Cancer Types

1. **Lung Cancer**:
   - ❖ Persistent cough, coughing up blood, shortness of breath, chest pain, or hoarseness.
2. **Breast Cancer**:
   - ❖ Lump or mass in the breast or armpit, changes in breast size/shape, nipple discharge (especially bloody), or skin changes (e.g., dimpling, redness).
3. **Colorectal Cancer**:
   - ❖ Changes in bowel habits (diarrhea, constipation, or narrow stools lasting weeks), blood in stool, abdominal discomfort, or feeling the bowel isn't emptying completely.
4. **Prostate Cancer**:
   - ❖ Difficulty urinating, weak urine flow, frequent urination (especially at night), or blood in urine/semen.
5. **Leukemia**:
   - ❖ Frequent infections, easy bruising or bleeding, pale skin, swollen lymph nodes, or bone/joint pain.

6. **Lymphoma**:
   - ❖ Swollen lymph nodes (neck, armpit, or groin), night sweats, itching, or unexplained fever.
7. **Pancreatic Cancer**:
   - ❖ Abdominal or back pain, jaundice, loss of appetite, nausea, or new-onset diabetes.
8. **Skin Cancer (Melanoma**):
   - ❖ Asymmetrical moles, irregular borders, multiple colors (brown, black, red, white, blue), diameter >6mm, or evolving moles (ABCDE criteria).
9. **Ovarian Cancer**:
   - ❖ Bloating, pelvic/abdominal pain, feeling full quickly, or urinary urgency/frequency.
10. **Brain Cancer**:
    - ❖ Headaches (often worse in the morning), seizures, vision/hearing changes, nausea, or personality/memory changes.

Other Possible Signs

- **Lumps or Masses**: Any new or growing lump under the skin, in the breast, testicles, or elsewhere.
- **Unusual Bleeding**: Blood in urine, stool, or abnormal vaginal bleeding (e.g., after menopause).
- **Difficulty Swallowing or Persistent Indigestion**: Common in esophageal or stomach cancer.
- **Chronic Hoarseness or Sore Throat**: May indicate throat or laryngeal cancer.
- **Changes in Appetite**: Loss of appetite or feeling full after small meals.

2.9.4. Diagnostic methods:

Diagnosing cancer involves a combination of methods to detect, confirm, and stage the disease. The specific approach depends on the suspected cancer type, symptoms, and patient history. Below is a concise overview of common cancer diagnostic methods, grouped by category,

1. **Medical History and Physical Examination:**

- Identify symptoms, risk factors (e.g., smoking, family history), and physical signs (e.g., lumps, swollen lymph nodes).
- A doctor assesses symptoms, medical history, and performs a physical exam to check for abnormalities.
- **Examples**:
  - ✓ Palpation for breast or testicular lumps.
  - ✓ Checking lymph nodes for swelling (lymphoma).

2. **Imaging Tests**

Imaging creates detailed pictures of the body to detect tumors, their size, location, and spread.

- **X-ray**: Detects abnormalities in lungs, bones, or chest (e.g., lung cancer).
- **Ultrasound**: Uses sound waves to evaluate organs (e.g., liver, ovaries) or guide biopsies.
- **CT (Computed Tomography) Scan**: Detailed cross-sectional images for cancers like lung, pancreatic, or colorectal.
- **MRI (Magnetic Resonance Imaging)**: High-resolution images for brain, spinal, or soft tissue cancers.
- **PET (Positron Emission Tomography) Scan**: Detects cancer spread by highlighting metabolically active cells (often combined with CT).
- **Mammography**: Specialized X-ray for breast cancer screening.
- **Bone Scan**: Detects bone metastases in cancers like prostate or Breast

3. **Laboratory Tests:**

Blood, urine, or other tests detect biomarkers or abnormalities suggestive of cancer.

- **Complete Blood Count (CBC)**: Identifies anemia or abnormal white cell counts (e.g., leukemia).

- **Tumor Markers**:
  - PSA (Prostate-Specific Antigen) for prostate cancer.
  - CA-125 for ovarian cancer.
  - AFP (Alpha-Fetoprotein) for liver cancer.
  - CEA (Carcinoembryonic Antigen) for colorectal cancer.
- **Liver/Kidney Function Tests**: Assess organ health, which cancer may affect.
- **Limitations**: Markers can be elevated in non-cancerous conditions; not definitive alone.

4. **Biopsy**

A definitive method where tissue is removed and examined under a microscope to confirm cancer.

- **Types**:
  - ✓ **Needle Biopsy**: Fine-needle aspiration (FNA) or core biopsy (e.g., breast, liver).
  - ✓ **Surgical Biopsy**: Excisional (removes entire mass) or incisional (removes part).
  - ✓ **Endoscopic Biopsy**: Uses a scope to sample tissue (e.g., colon, lung).
  - ✓ **Bone Marrow Biopsy**: For blood cancers like leukemia or lymphoma.
- **Analysis**: Pathologists check for cancer cells, type, and grade (how aggressive).

5. Endoscopy:

A flexible tube with a camera examines internal organs for abnormalities.

- **Types**:
  - ✓ **Colonoscopy**: For colorectal cancer.
  - ✓ **Bronchoscopy**: For lung cancer.
  - ✓ **Upper Endoscopy**: For esophageal or stomach cancer.

- ✓ **Cystoscopy**: For bladder cancer.

❖ **Purpose**: Visualizes tumors, allows biopsy during procedure.

6. **Screening Tests:**

Used to detect cancer in asymptomatic individuals, often for early-stage disease.

- ❖ **Mammogram**: Breast cancer screening (women typically 40+).
- ❖ **Pap Smear/HPV Test**: Cervical cancer screening.
- ❖ **Colonoscopy/Stool Tests (e.g., FIT)**: Colorectal cancer screening (adults typically 45+).
- ❖ **Low-Dose CT Scan**: Lung cancer screening for high-risk individuals (e.g., smokers).
- ❖ **PSA Test**: Prostate cancer screening (controversial due to false positives).
- ❖ **Limitations**: False positives/negatives; not all cancers have effective screening.

7. **Genetic and Molecular Testing:**

Analyzes DNA or proteins to identify cancer-specific mutations or guide treatment.

❖ **Examples**:

- ✓ **BRCA1/BRCA2 Testing**: For breast/ovarian cancer risk.
- ✓ **EGFR/KRAS Mutations**: For lung or colorectal cancer treatment planning.
- ✓ **HER2 Testing**: For breast cancer therapy decisions.
- ✓ **Liquid Biopsy**: Detects circulating tumor DNA in blood for non-invasive diagnosis or monitoring.

❖ **Purpose**: Identifies targeted therapies or hereditary cancer risks.

2.9.5. Some Treatment for Cancer:

1. Surgery:

- Early-stage cancers (e.g., breast, prostate, colorectal) where the tumor is localized.
- Debulking (removing part of a tumor) when complete removal isn't possible.
- Palliative surgery to relieve symptoms (e.g., removing blockages in advanced cancer).

2. Radiation Therapy:

- Uses high-energy rays (e.g., X-rays, protons) to kill cancer cells or shrink tumors.
- **Types**:
  - ✓ **External Beam Radiation**: Targets tumors from outside the body.
  - ✓ **Brachytherapy**: Radioactive material placed inside or near the tumor (e.g., prostate, cervical cancer).

3. Chemotherapy:

- **Purpose**: Uses drugs to kill rapidly dividing cancer cells or stop their growth.
- **Applications**:
  - ✓ Systemic cancers (e.g., leukemia, lymphoma) or cancers with metastasis.
  - ✓ Adjuvant therapy (post-surgery to kill remaining cells).
  - ✓ Neoadjuvant therapy (pre-surgery to shrink tumors).

4. Immunotherapy

- **Purpose**: Boosts the immune system to recognize and attack cancer cells.
- **Types**:

- **Checkpoint Inhibitors**: Block proteins (e.g., PD-1, CTLA-4) that cancer uses to evade the immune system (e.g., melanoma, lung cancer).
- **CAR T-Cell Therapy**: Modifies patient's T-cells to target blood cancers (e.g., leukemia, lymphoma).
- **Cancer Vaccines**: Stimulate immune response (e.g., HPV vaccine for cervical cancer prevention).

5. Targeted Therapy:

- **Purpose**: Uses drugs to target specific molecules or pathways in cancer cells (e.g., HER2 in breast cancer, EGFR in lung cancer).
- **Applications**:
  - ✓ Cancers with specific genetic mutations (e.g., BRAF in melanoma, ALK in lung cancer).
  - ✓ Often used when genetic testing identifies actionable mutations.

6. Hormone Therapy:

- **Purpose**: Blocks hormones that fuel certain cancers (e.g., estrogen in breast cancer, testosterone in prostate cancer).
- **Applications**:
  - ✓ Breast cancer (e.g., tamoxifen, aromatase inhibitors).
  - ✓ Prostate cancer (e.g., androgen deprivation therapy).

7. Stem Cell or Bone Marrow Transplant:

- **Purpose**: Replaces damaged bone marrow with healthy stem cells, often after high-dose chemotherapy or radiation.
- **Applications**: Blood cancers (e.g., leukemia, lymphoma, multiple myeloma).

****