Chapter 20
Lecture Outline

See separate PowerPoint slides for all figures and tables pre-inserted into PowerPoint without notes.
Points to ponder

• What are characteristics of cancer cells?
• What are the three stages in the development of cancer?
• What are angiogenesis and metastasis?
• How do proto-oncogene and tumor-suppressor genes normally act, and how can they become cancerous?
• Explain different types of cancer, depending on tissue type involved.
• What are some genetic and environmental causes of cancer?
• What does CAUTION stand for in regards to cancer?
Points to ponder

• What are some regular screening tests you can get to help prevent cancer?
• Know how to do self exams.
• What are tumor marker and genetic tests?
• What are some standard treatments for cancer?
• What are some newer cancer therapies?
• What is your opinion on controlling tobacco?
Characteristics of cancer cells

1. Lack **differentiation** and do not contribute to body functioning
2. Have abnormal nuclei that are enlarged and may have an abnormal number of chromosomes
3. Unlimited ability to divide
   - One way is through turning on the telomerase gene that allows **telomeres** on chromosomes to continually be built, thus allowing a cell to divide over and over again.
Characteristics of cancer cells

4. Form **tumors**
   - **Benign** tumors are usually encapsulated and do not invade adjacent tissue, while a cancerous tumor usually is not encapsulated and eventually invades surrounding tissue.

5. Can divide without growth factors
6. Become abnormal gradually through a multistage process
7. Undergo angiogenesis and metastasis
3 phases in the development of cancer cells

- **Initiation** – a single cell undergoes a mutation that causes it to divide repeatedly

- **Promotion** – a tumor develops and cells within the tumor mutate

- **Progression** – a cell mutates in such a way that allows it to invade surrounding tissue
3 phases in the development of cancer cells

**Figure 20.2** Progression from a single mutation to a tumor.
What are angiogenesis and metastasis?

- **Angiogenesis** is the formation of new blood vessels to supply nutrients and oxygen to the tumor.

- **Metastasis** occurs when cells move into the bloodstream or lymphatic vessels and form new tumors at distant sites from the primary tumor.
The genetic basis for cancer

- **Proto-oncogenes** – products promote the cell cycle and prevent cell death (apoptosis)

- **Tumor suppressor genes** – products inhibit the cell cycle and promote apoptosis

- Mutations in these genes can cause cancer; in fact, proto-oncogenes that have mutated are cancer-causing genes called oncogenes.
Mutations in proto-oncogenes produce oncogenes that stimulate the cell cycle.

Figure 20.3 Mutations in proto-oncogenes produce oncogenes that stimulate the cell cycle.
Mutations in tumor suppressor genes cause a loss of cell cycle control.
Types of cancer

- **Oncology** is the study of cancer.
  - **Carcinomas**: cancers of the epithelial tissue
  - **Adenocarcinomas**: cancers of glandular epithelial cells
  - **Sarcomas**: cancers of muscle and connective tissues
  - **Leukemias**: cancers of the blood
  - **Lymphomas**: cancers of lymphatic tissues
Causes of cancer

- Genetics

- Environmental carcinogens
  - Radiation
  - Environmental carcinogens (tobacco smoke and pollutants)
  - Viruses
20.2 Causes and Prevention of Cancer

Estimated cases of cancer and cancer deaths in the United States

Figure 20.5 Estimated cases of cancer and cancer deaths in the United States.
Genetic causes of cancer

• Examples of genes associated with cancer
  – **BRCA1** and **BRCA2** are tumor suppressor genes that are associated with breast cancer.
  – **RB** is a tumor suppressor gene that is associated with an eye tumor.
  – **RET** is a proto-oncogene that is associated with thyroid cancer.

• Mutations of these genes predispose individuals to certain cancers but it takes at least one more acquired mutation during their lifetime to develop cancer.
Transposons

- Transposons ("jumping genes") are small, mobile sequences of DNA that have the ability to move throughout the genome, sometimes causing mutations.

- If a transposon causes a loss of cell cycle control, it can cause cancer.
Environmental causes of cancer

• **Radiation**
  – Environmental factors such as UV light (in sunlight or tanning lights) and X-rays can cause mutations.

• **Organic chemicals**
  – Tobacco smoke increases cancer of lungs, mouth, larynx, and others.
  – Pollutants such as metals, dust, chemicals, and pesticides increase the risk of cancer.
Environmental causes of cancer

- **Viruses**
  - Hepatitis B and C viruses can cause liver cancer.
  - Epstein-Barr virus can cause Burkitt lymphoma.
  - Human papillomavirus can cause cervical cancer.
  - HTLV-1 (human T-cell lymphotropic virus, type 1) can cause hairy cell leukemia.
  - HIV and Kaposi’s sarcoma, associated herpesvirus (KSHV), can cause Kaposi’s sarcoma and certain lymphomas.
7 warning signs of cancer

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

- **A** – asymmetry
- **B** – border is irregular
- **C** – color varies from one area to another
- **D** – diameter is larger than 6 mm

*Figure 20.8 The ABCDE test for melanoma.*
Some routine screening tests for cancer

- Self-examination – monthly exams of breasts and testicles starting at age 20
- Colonoscopy – every five years starting at age 50
- Mammogram – yearly after age 40
- Pap test – should begin three years after vaginal intercourse or no later than age 21

Figure 20.9 Mammograms can detect breast cancer.
20.3 Diagnosis of Cancer

Self exams

Figure 20A  Shower check for breast cancer.

Figure 20B  Mirror check for breast cancer.

Figure 20C  Shower check for testicular cancer.
Other ways to detect cancer

• Tumor marker tests – blood tests for tumor antigens/antibodies
  – CEA (carcinoembryonic antigen) antigen can be detected in someone with colon cancer
  – PSA (prostate-specific antigen) test for prostate cancer
  – AFP (alpha-fetoprotein) test for liver tumors
Other ways to detect cancer

- Genetic tests – tests for mutations in proto-oncogenes and tumor suppressor genes
  - RET gene (thyroid cancer)
  - P16 gene (associated with melanoma)
  - BRCA1 (breast cancer)

- A diagnosis of cancer can be confirmed by performing a biopsy.
Prevention of Cancer

- Protective behaviors
  - Don’t use tobacco.
  - Don’t sunbathe or use a tanning booth.
  - Avoid radiation.
  - Be tested for cancer.
  - Be aware of occupational hazards.
  - Be aware of postmenopausal hormone therapy.
  - Get vaccinated.
Prevention of Cancer

• The right diet
  – Avoid obesity.
  – Eat plenty of high-fiber foods.
  – Increase consumption of foods that are rich in vitamins A and C.
  – Reduce consumption of salt-cured, smoked, or nitrite-cured foods.
  – Include vegetables from the cabbage family in the diet.
  – Drink alcohol in moderation.
20.4 Treatment of Cancer

Standard cancer treatments

- **Surgery** – removal of small cancers

- **Radiation therapy** – localized therapy that causes chromosomal breakage and disrupts the cell cycle

- **Chemotherapy** – drugs that treat the whole body and kill cancer cells by damaging their DNA or interfering with DNA synthesis

- **Bone marrow transplants** – transplant bone marrow from one individual to another
Newer cancer therapies

- **Immunotherapy** – inject immune cells that are genetically engineered to bear the tumor’s antigens

- **Passive immunotherapy** – antibodies that are linked to radioactive isotopes or chemotherapeutic drugs are injected into the body

- **p53 gene therapy** – a retrovirus in clinical trial that is injected into the body where it will infect and kill only tumor cells (cells that lack p53 = tumor cells)

- **Angiogenesis inhibition** - angiostatin and endostatin are drugs in clinical trials that appear to inhibit angiogenesis
20.4 Treatment of Cancer

Immunotherapy

Figure 20.12 Use of immunotherapy to treat cancer.