Chapter 5

Mechanisms of Disease
Spirochette bacteria causing Syphilis
Diplomonad protozoa that causes Giardia
Protozoan causing malaria

- **Plasmodium** zygotes develop inside the gut of female mosquitoes. They become sporozoites, which migrate to the insect's salivary glands.
- Mosquito bites human, bloodstream carries the sporozoites to liver.
- Some of the merozoites enter liver, cause more malaria episodes.
- Female mosquito bites, sucks blood from infected human. Gametocytes in blood enter her gut, mature into gametes, which fuse to form zygotes.
- Male gametocyte in red blood cell.
- Sporozoites asexually reproduce in liver cells.
- Offspring (merozoites) enter blood, invade red blood cells, reproduce asexually. They can do so often, over a prolonged period. Disease symptoms (fever, chills, shaking) get more and more severe.
Protist causing red tide
Types of Viruses

- Vaccinia virus (cowpox)
- Paramyxovirus (mumps)
- Herpes simplex virus (fever blister)
- Poliovirus (polio)
- Rhinovirus (common cold)
- Adenovirus (respiratory virus)

0.5 μm (microns)
Ebola Virus-Hemorrhagic fever
West Nile Virus
Chlamydia bacteria—gram negative
Spirechete bacteria causing Lyme disease
Pathogenic aminal-Ticks-transmit spirochette bacteria
Rash is a sign of Lyme disease.
Tinea fungus causing athlete’s foot
What do we want to learn from chapter 5

• Define the terms *health* and disease
• List and describe the basic mechanisms of disease and risk factors associated with disease
• List and describe five categories of pathogenic organisms and explain how they cause disease
• Distinguish between the terms *benign* and *malignant* as they apply to tumors
• Describe the pathogenesis of cancer
• Outline the events of the inflammatory response and explain its role in disease
Studying Disease

• Disease terminology
  – Health—physical, mental, and social well-being—not merely the absence of disease
  – Disease—an abnormality in body function that threatens health
  – Etiology—the study of the factors that cause a disease
Studying Disease

• Disease terminology
  – Idiopathic—refers to a disease with an unknown cause
  – Signs and symptoms—the objective and subjective abnormalities associated with a disease
  – Sign-observed by a doctor, objective
  – Symptom-felt by the patient
  – Pathogenesis—the pattern of a disease’s development
• Patterns of disease
  – Epidemiology is the study of occurrence, distribution, and transmission of diseases in human populations
  – Endemic diseases are native to a local region
  – Epidemics occur when a disease affects many people at the same time
Studying Disease

• Patterns of disease, cont’d
  – Pandemics are widespread, perhaps global, epidemics—AIDS
  – Discovering the cause of a disease is difficult because many factors affect disease transmission
  – Disease can be fought through prevention and therapy (treatment)
Pathophysiology

• Mechanisms of disease
  – Pathophysiology—the study of underlying physiological aspects of disease
  – Genetic mechanisms-ex. Sickle cell, hemophillia. Literally hundreds
  – Infectious mechanism (pathogenic organisms and particles)
  – Neoplastic mechanism (tumors and cancer)
  – Traumatic mechanism (physical and chemical agents)
Pathophysicsiology

• Mechanisms of disease, cont’d
  – Metabolic mechanism (endocrine imbalances or malnutrition ex. Graves dis.)
  – Inflammatory mechanism
    • Autoimmunity
    • Inflammation
    • Degeneration
Pathophysiology

- Risk factors (predisposing conditions)
  - Genetic factors
  - Age
  - Lifestyle
  - Stress
  - Environmental factors
  - Preexisting conditions
Pathogenic Organisms

• Viruses
  – Microscopic, intracellular parasites that consist of a nucleic acid core with a protein coat
  – Invade host cells and pirate organelles and raw materials
  – Classified by shape, nucleic acid type, and method of reproduction
Pathophysiology

• Mechanisms of disease
  – Physical and chemical agents
  – Autoimmunity - own immune system over-responds and attacks body
  – Inflammation
  – Degeneration - breaking apart of tissue, ex snakebite, poison
Pathophysiology

- Risk factors (predisposing conditions)
  - Genetic factors
  - Age
  - Lifestyle
  - Stress
  - Environmental factors
  - Preexisting conditions
Pathogenic Organisms

• Types of organisms and particles
  – Viruses
    • Microscopic, intracellular parasites that consist of a nucleic acid core with a protein coat
    • Invade host cells and pirate organelles and raw materials
    • Classified by shape, nucleic acid type, and method of reproduction
Pathogenic Organisms

- Types of organisms and particles
  - Bacteria
    - Tiny cells without nuclei
    - Secrete toxins, parasitize host cells, or form colonies
    - Classification
      - By growth requirements
        » Aerobic—require oxygen
        » Anaerobic—require no oxygen
Pathogenic Organisms

• Types of organisms and particles
  – Bacteria
    • Classification
      – By staining properties (depend on composition of cell wall)
        » Gram-positive—stained purple
        » Gram-negative—not stained
Pathogenic Organisms

• Types of organisms and particles
  – Bacteria
    • Classification
      – By shape and size
        » Bacilli—rod-shaped cells
        » Cocci—round cells, ex. staphylococci
        » Curved or spiral rods
        » Small bacteria—ex. chlamydia
    • Spores—bacteria that resist unfavorable environmental conditions. Ex desert, acid
Pathogenic Organisms

• Types of organisms and particles
  – Fungi
    • Simple organisms similar to plants but lacking chlorophyll
    • Yeasts—small, single-celled fungi, ex. Vaginal yeast infection
    • Molds—large, multicellular fungi
    • Mycotic infections—often resist treatment
Pathogenic fungi, vaginal and urinary tract yeast (A)
Pathogenic Organisms

• Types of organisms and particles
  – Protozoa
    • Large one-celled organisms that have organized nuclei
    • May infest human fluids and parasitize or destroy cells
Pathogenic Organisms

• Types of organisms and particles
  – Protozoa
    • Major groups
      – Amoebas—possess pseudopodia
      – Flagellates—possess flagella
      – Ciliates—possess cilia
      – Sporozoa (coccidia)—enter cells during one phase of a two-part life cycle; borne by vectors (transmitters) during the other phase
Protist causing red tide
Diplomonad protozoa that causes Giardia
Pathogenic Organisms

• Types of organisms and particles
  – Pathogenic animals
    • Large complex multicellular organisms
    • Parasitize or otherwise damage human tissues or organs
Protozoan causing malaria

**a.** Plasmodium zygotes develop inside the gut of female mosquitoes. They become sporozoites, which migrate to the insect’s salivary glands.

**b.** Mosquito bites human, bloodstream carries the sporozoites to liver.

**c.** Sporozoites asexually reproduce in liver cells.

**d.** Offspring (merozoites) enter blood, invade red blood cells, reproduce asexually. They can do so often, over a prolonged period. Disease symptoms (fever, chills, shaking) get more and more severe.

**e.** Some of the merozoites enter liver, cause more malaria episodes.

**f.** Others develop into male, female gametocytes that are released into bloodstream.

**g.** Female mosquito bites, sucks blood from infected human. Gametocytes in blood enter her gut, mature into gametes, which fuse to form zygotes.
Pathogenic Organisms

• Types of organisms and particles
  – Pathogenic animals
    • Major groups
      – Nematodes—roundworms
      – Platyhelminths—flatworms and flukes
      – Arthropods—these are often vectors of disease
        » Parasitic mites, ticks, lice, fleas
        » Biting or stinging wasps, bees, mosquitoes, spiders
Prevention and Control

• Mechanisms of transmission
  – Person-to-person contact
    • Can be prevented by education
    • Can be prevented by using aseptic technique
  – Environmental contact
    • Can be prevented by avoiding contact
    • Can be prevented by safe sanitation practices
Prevention and Control

• Mechanisms of transmission
  – Opportunistic invasion
    • Can be prevented by avoiding changes in skin and mucous membranes
    • Can be prevented by cleansing of wounds
  – Transmission by a vector-lyme disease carried by deer tick
    • Can be prevented by reducing the population of vectors and reducing contact with vectors
Prevention and Control

• Other prevention and treatment strategies
  – Vaccination—stimulates immunity
  – Chemicals—destroy or inhibit pathogens
    • Antibiotics—natural compounds derived from living organisms
    • Synthetic compounds (e.g., ACV and AZT for HIV)
Tumors and Cancer

• Neoplasms (tumors)—abnormal growths of cells
  – Benign tumors remain localized
  – Malignant tumors spread, forming secondary tumors
  – Metastasis—cells leave primary tumor and start a secondary tumor at new location
Tumors and Cancer

• Classification of tumors
  – Benign, epithelial tumors
  – Benign, connective tissue tumors
Tumors and Cancer

• Classification of tumors
  – Carcinomas (malignant epithelial tumors)
    • Melanoma—involves melanocytes
    • Adenocarcinoma—glandular cancer
  – Sarcomas (connective tissue cancers)
    • Lymphoma—lymphatic cancer
    • Osteosarcoma—bone cancer
    • Myeloma—bone marrow tumor
    • Fibrosarcoma—cancer of fibrous tissue
Tumors and Cancer

• Causes of cancer—varied and still not clearly understood
  – Cancer involves hyperplasia (growth of too many cells) and anaplasia (development of undifferentiated cells)
Tumors and Cancer

- Causes of cancer
  - Factors that play a role in causing cancer
    - Genetic factors (e.g., oncogenes—cancer genes)
    - Carcinogens—chemicals that alter genetic activity
    - Age—changes in cell activity over time or accumulated effects of cell damage
    - Environment—chronic exposure to damaging substances
    - Viruses—cause change in genetic “machinery”
Tumors and Cancer

• Pathogenesis of cancer
  – Signs of cancer
  – Methods of detecting cancers
    • Self-examination
    • Diagnostic imaging—radiography (e.g., mammogram and CT scan), magnetic resonance imaging (MRI), ultrasonography
    • Biopsy (e.g., Pap smear)
    • Blood tests
Tumors and Cancer

- Staging—classifying tumors by size and extent of spread
- Grading—assessing the likely pattern of a tumor’s development
- Cachexia—syndrome including appetite loss, weight loss, and general weakness
- Causes of death by cancer—secondary infections, organ failure, hemorrhage, and undetermined factors
Tumors and Cancer

- Treatments
  - Surgery
  - Chemotherapy (chemical therapy)
  - Radiation therapy (radiotherapy)
  - Laser therapy
  - Immunotherapy
  - New strategies (e.g., rational drugs that target specific molecules, enzymes, or receptors)
Inflammation

• Inflammatory response—reduces injury to tissues, thus maintaining homeostasis
  – Signs—redness, heat, swelling, and pain
  – Inflammation mediators (histamine, prostaglandins, and kinins)
    • Some cause blood vessels to dilate, increasing blood volume (redness and heat); white blood cells travel quickly to injury site
Inflammation

• The inflammatory response reduces injury to tissues, thus maintaining homeostasis
  – Inflammation mediators (histamine, prostaglandins, and kinins)
    • Some increase blood vessel permeability (causing swelling or edema and pain); white blood cells move easily out of vessels; irritant is diluted; and exudate accumulates
    • Some attract white blood cells to injury site (chemotaxis)
Inflammation

• Inflammatory diseases
  – Inflammation can be local or systemic (body-wide)
    • Fever—high body temperature caused by a resetting of the body’s “thermostat”; destroys pathogens and enhances immunity
    • Chronic inflammation can constitute a disease itself because it causes damage to tissues