Chapter 5 Control of Microbial Growth

Summary Outline

5.1. Approaches to Control: The methods used to destroy or remove microorganisms and viruses can be:
- A. **Physical** such as heat treatment, irradiation and filtration or **Chemical**
- B. Principles of control
  1. **Sterilization** destroys all microorganisms and viruses.
  2. **Disinfection** eliminates most disease-causing bacteria or viruses.
  3. **Disinfectants** are chemicals used for disinfecting inanimate objects
  4. **Antiseptics** are chemicals formulated for use on skin.
  5. **Pasteurization** uses heat treatment to reduce the number of spoilage organisms or kill disease-causing microbes.
- C. **Situational considerations**
  1. Hospitals must be scrupulous in controlling microorganisms because of the danger of **nosocomial infections**.
  2. Microbiology laboratories must use aseptic technique to avoid contaminating cultures with extraneous microbes and to protect workers and the environment from contamination.
  3. Foods and other perishable products retain their quality and safety when the growth of contaminating microorganisms is prevented.

5.2 **Selection** of an antimicrobial procedure
- A. Type of microorganism
  1. **Type** of microbial population present.
  2. The **endospores** of ***Bacillus*** and ***Clostridium*** are most resistant.
  3. The **waxy cell wall** of **mycobacteria** makes them resistant.
  4. ***Pseudomonas*** are common environmental organisms are very resistant.
  5. **Viruses** that **lack a lipid envelope** are more resistant to disinfectants than are enveloped viruses.
- B. **Numbers of microorganisms initially present**
- C. **Environmental conditions** affect death rate of microorganisms
  1. pH
  2. Presence of fats and other organic compounds
- D. **Potential risk of infection**

5.3. Using heat to destroy microorganisms and viruses
- A. **Moist heat—**Moist heat, such as boiling water and pressurized steam, destroys microorganisms by causing the irreversible coagulation of their proteins.
- B. **Dry heat—**Dry heat, such as in direct flaming and ovens destroy microorganisms by oxidizing cells to ashes or irreversibly denaturing their proteins.

5.4 Using chemicals to destroy microorganisms and viruses
- A. **Germicidal chemicals** can be used to disinfect and, in some cases, sterilize, but they are less reliable than heat. Most chemical germicides react irreversibly with vital enzymes and other proteins, the cytoplasmic membrane, or viral envelopes.
- B. **Potency** of germicidal chemical formulations
  1. Sterilants
  2. High-level disinfectants
  3. Intermediate-level disinfectants
  4. Low-level disinfectants

C. **Selection** factors for the appropriate germicidal chemical
   1. Toxicity
   2. Residue
   3. Activity in the presence of organic matter
   4. Compatibility with the material being treated
   5. Cost and availability
   6. Storage and stability
   7. Ease of disposal

D. **Classes** of germicidal chemicals
   1. **Ethyl or isopropyl alcohol** (60-80% solution) in water rapidly kills vegetative bacteria and fungi by coagulating enzymes and other essential proteins, and by damaging lipid membranes.
   2. **Gluteraldehyde** and **formaldehyde** destroy microorganisms and viruses by inactivating proteins and nucleic acids. A 20% solution of alkaline gluteraldehyde is one of the most widely used chemical sterilants.
   3. **Chlorhexidine** is a **biguanide** extensively used in antiseptic products.
   4. **Ethylene oxide** is a gaseous sterilizing agent that penetrates well and destroys microorganisms and viruses by reacting with proteins.
   5. **Sodium hypochlorite** (liquid bleach) is one of the least expensive and most readily available forms of chlorine. Chlorine dioxide is used as a sterilant and disinfectant. Iodophores are iodine-releasing compounds used as antiseptics.
   6. **Metals** interfere with protein function. Silver-containing compounds are used to prevent wound infections.
   7. **Ozone** is used as an alternative to chlorine disinfection of drinking water and wastewater.
   8. **Peroxide** and **peracetic acid** are both strong oxidizing agents that can be used alone or in combination as sterilants.
   9. **Phenolic compounds** destroy cytoplasmic membranes and denature proteins.
   10. **Quaternary ammonium compounds** are cationic detergents that are non-toxic enough to be used to disinfect food preparation surfaces.

5.5 Removal of microorganisms by filtration

A. Filtration of fluids
   1. **Depth filters** have complex, tortuous passages that retain microorganisms while letting the suspending fluid pass through the small holes.
   2. **Membrane filters** are produced with graded pore sizes extending below the dimensions of the smallest known viruses.

B. Filtration of air
   1. **High efficiency particulate air (HEPA) filters** remove nearly all microorganisms.
   2. HEPA filters are used in specialized hospital rooms to protect patients, biological safety cabinets and laminar flow hoods.

5.6 Using **radiation** to destroy microorganisms and viruses

A. **Gamma irradiation** cause biological damage by producing superoxide and hydroxyl free radicals. Irradiation can be used to:
   1. Sterilize heat-sensitive materials
   2. Decrease the numbers of microorganisms in foods.

B. **Ultraviolet light** is used to disinfect surfaces by damaging nucleic acids by causing the formation of covalent bonds between adjacent thymine molecules in DNA, creating **thymine dimers**.

C. **Microwaves** do not affect microorganisms directly but they can kill microorganisms by the heat they generate in a product.

5.7 **Preservation** of perishable products by techniques that slow or halt the growth of microorganisms to delay spoilage.

A. **Chemical preservatives**
   1. Organic acids such as benzoic, sorbic and propionic acids
   2. Nitrate and nitrite

B. **Low temperature storage**
   1. Low temperatures above freezing inhibit microbial growth.
   2. Freezing essentially stops all microbial growth.

C. **Reducing the available water** by addition of sugars and salts

D. **Lyophilization** is used for preserving food