1 **Chapter 7**

The Control of Microbial Growth

2 **The Terminology of Microbial Control**

- Sepsis refers to microbial contamination
- Asepsis is the absence of significant contamination
- Aseptic surgery techniques prevent microbial contamination of wounds

3 **The Terminology of Microbial Control**

- Sterilization: Removing all microbial life
- Commercial sterilization: Killing *C. botulinum* endospores
- Disinfection: Removing pathogens
- Antisepsis: Removing pathogens from living tissue

4 **The Terminology of Microbial Control**

- Degerming: Removing microbes from a limited area
- Sanitization: Lowering microbial counts on eating utensils
- Biocide/germicide: Kills microbes
- Bacteriostasis: Inhibiting, not killing, microbes

5

✓ The usual definition of *sterilization* is the removal or destruction of all forms of microbial life; how could there be practical exceptions to this simple definition? 7-1

✓

✓

6

7 **A Microbial Death Curve**

8 **Effectiveness of Treatment**

- Depends on
  - Number of microbes
  - Environment (organic matter, temperature, biofilms)
  - Time of exposure
  - Microbial characteristics

9 **A Microbial Death Curve**

10 **Actions of Microbial Control Agents**

- Alteration of membrane permeability
- Damage to proteins
- Damage to nucleic acids

11

✓ Would a chemical microbial control agent that affects plasma membranes affect humans? 7-3

✓

✓

✓

✓

12 **Heat**

- Thermal death point (TDP): Lowest temperature at which all cells in a culture are killed in 10 min
- Thermal death time (TDT): Time during which all cells in a culture are killed

13 **Decimal Reduction Time (DRT)**
- Minutes to kill 90% of a population at a given temperature

14 **A Microbial Death Curve**

15 **Moist Heat Sterilization**
- Moist heat denatures proteins
- Autoclave: Steam under pressure

16 **An Autoclave**

17 **Steam Sterilization**
- Steam must contact item's surface

18 **Pasteurization**
- Reduces spoilage organisms and pathogens
- Equivalent treatments
  - 63°C for 30 min
  - High-temperature short-time: 72°C for 15 sec
  - Ultra-high-temperature: 140°C for <1 sec
  - Thermoduric organisms survive

19 **Dry Heat Sterilization**
- Kills by oxidation
  - Dry heat
  - Flaming
  - Incineration
  - Hot-air sterilization

20 **Filtration**
- HEPA removes microbes >0.3 µm
- Membrane filtration removes microbes >0.22 µm

21 **Physical Methods of Microbial Control**
- Low temperature inhibits microbial growth
  - Refrigeration
  - Deep-freezing
  - Lyophilization
- High pressure denatures proteins
- Desiccation prevents metabolism
- Osmotic pressure causes plasmolysis

22 **Radiation**

23 **Radiation**
- Ionizing radiation (X rays, gamma rays, electron beams)
  - Ionizes water to release OH•
  - Damages DNA
- Nonionizing radiation (UV, 260 nm)
  - Damages DNA
- Microwaves kill by heat; not especially antimicrobial

24
- ✓ How is microbial growth in canned foods prevented? 7-4
- ✓ Why would a can of pork take longer to sterilize at a given temperature than a can of soup that also contained pieces of pork? 7-5

- ✓ What is the connection between the killing effect of radiation and hydroxyl radical forms of oxygen? 7-6
- ✓
- ✓
- ✓
- ✓
- ✓

25 **Principles of Effective Disinfection**

- Concentration of disinfectant
- Organic matter
- pH
- Time

26 **Use-Dilution Test**

- Metal rings dipped in test bacteria are dried
- Dried cultures are placed in disinfectant for 10 min at 20°C
- Rings are transferred to culture media to determine whether bacteria survived treatment

27 **Disk-Diffusion Method**

28 **Clinical Focus**

- Which preparation is more effective?

29

- ✓ If you wanted to disinfect a surface contaminated by vomit and a surface contaminated by a sneeze, why would your choice of disinfectant make a difference? 7-7
- ✓ Which is more likely to be used in a medical clinic laboratory, a use-dilution test or a disk-diffusion test? 7-8
- ✓
- ✓
- ✓
- ✓
- ✓
- ✓

30 **Phenol & Phenolics**

- Disrupt plasma membranes
- Used for skin surfaces, mucous membranes and environmental surfaces

31 **Bisphenols**

- Hexacholorphene, triclosan
  - Disrupt plasma membranes
  - Used in soaps

32 **Biguanides**

- Chlorhexidine
  - Disrupt plasma membranes
  - Used in disinfectants and surgical scrubs

33 **Halogens**

- Iodine
  - Tinctures: In aqueous alcohol
  - Iodophors: In organic molecules
  - Alter protein synthesis and membranes
- Chlorine

- Bleach: Hypochlorous acid (HOCl)
- Chloramine: Chlorine + ammonia
- Oxidizing agents

- Both are excellent antiseptics for use in water treatments, dairy equip. eating utensils.

34 **Alcohols**

- Ethanol, isopropanol
  - Denature proteins, dissolve lipids
  - Requires water, used on surfaces only

35 **Heavy Metals**

- Ag, Hg, and Cu
  - Silver nitrate may be used to prevent gonorrheal ophthalmia neonatorum
  - Silver sulfadiazine used as a topical cream on burns
  - Copper sulfate is an algicide
- Oligodynamic action
  - Denature proteins
- Used in topical creams or algicides

36 **Surface-Active Agents, or Surfactants**

37 **Chemical Food Preservatives**

- Organic acids
  - Inhibit metabolism
  - Sorbic acid, benzoic acid, and calcium propionate
  - Control molds and bacteria in foods and cosmetics
- Nitrite prevents endospore germination
- Antibiotics
  - Nisin and natamycin prevent spoilage of cheese
    - –
    - –
  -

38 **Aldehydes**

- Inactivate proteins by cross-linking with functional groups ($–NH_2$, –OH, –COOH, –SH)
- Use: Medical equipment
  - Glutaraldehyde, formaldehyde, and ortho-phthalaldehyde

39 **Gaseous Sterilants**

- Denature proteins
- Use: Heat-sensitive material
  - Ethylene oxide

40 **Plasma**

- Free radicals destroy microbes
- Use: Tubular instruments

41 **Supercritical Fluids**

- CO_2 with gaseous and liquid properties
- Use: Medical implants

42 **Peroxygens**

- Oxidizing agents
- Use: Contaminated surfaces
  - O_3, H_2O_2, peracetic acid

43

- ✓ Why is alcohol effective against some viruses and not others? 7-9
- ✓ Is Betadine an antiseptic or a disinfectant when it is used on skin? 7-10
- ✓ What characteristics make surface-active agents attractive to the dairy industry? 7-11
- ✓ What chemical disinfectants can be considered sporicides? 7-12
- ✓ What chemicals are used to sterilize? 7-13
- ✓

44 **Microbial Characteristics**

45 **Endospores and Mycobacteria**

46

- ✓ The presence or absence of endospores has an obvious effect on microbial control, but why are gram-negative bacteria more resistant to chemical biocides than gram-positive bacteria? 7-14
- ✓
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- ✓
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- ✓
- ✓