CONTROLLING MICROBIAL GROWTH IN THE ENVIRONMENT

CHAPTER 9

CCV

MICROBIOLOGY

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TABLE 9.1 Terminology of Microbial Control

Term	Definition	Examples	Comments
Antisepsis	Reduction in the number of microorganisms and viruses, particularly potential pathogens, on living tissue	Iodine; alcohol	Antiseptics are frequently disinfectants whose strength has been reduced to make them safe for living tissues.
Aseptic	Refers to an environment or procedure free of pathogenic contaminants	Preparation of surgical field; hand washing; flame sterilization of laboratory equipment	Scientists, laboratory technicians, and health care workers routinely follow standardized aseptic techniques.
-cide -cidal	Suffixes indicating destruction of a type of microbe	Bactericide; fungicide; germicide; virucide	Germicides include ethylene oxide, propylene oxide, and aldehydes.
Degerming	Removal of microbes by mechanical means	Hand washing; alcohol swabbing at site of injection	Chemicals play a secondary role to the mechanical removal of microbes.
Disinfection	Destruction of most microorganisms and viruses on nonliving tissue	Phenolics; alcohols; aldehydes; soaps	The term is used primarily in relation to pathogens.
Pasteurization	Use of heat to destroy pathogens and reduce the number of spoilage microorganisms in foods and beverages	Pasteurized milk and fruit juices	Heat treatment is brief to minimize alteration of taste and nutrients; microbes still remain and eventually cause spoilage.
Sanitization	Removal of pathogens from objects to meet public health standards	Washing tableware in scalding water in restaurants	Standards of sanitization vary among governmental jurisdictions.
-stasis -static	Suffixes indicating inhibition but not complete destruction of a type of microbe	Bacteriostatic; fungistatic; virustatic	Germistatic agents include some chemicals, refrigeration, and freezing.
Sterilization	Destruction of all microorganisms and viruses in or on an object	Preparation of microbiological culture media and canned food	Typically achieved by steam under pressure, incineration, or ethylene oxide gas.

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ACTION OF ANTIMICROBIAL AGENTS

1) ALTERATION OF CELL WALLS AND MEMBRANES

- CELL WALL MAINTAINS INTEGRITY OF CELL
  - WHEN DAMAGED, EFFECTS OF OSMOSIS CAUSE CELLS TO BURST
- CYTOPLASMIC MEMBRANE CONTAINS CYTOPLASM AND CONTROLS PASSAGE OF CHEMICALS INTO AND OUT OF CELL
  - WHEN DAMAGED, CELLULAR CONTENTS LEAK OUT
- NONENVELOPED VIRUSES CAN BETTER TOLERATE HARSH CONDITIONS

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ACTION OF ANTIMICROBIAL AGENTS

2) DAMAGE TO PROTEINS AND NUCLEIC ACIDS

- PROTEIN FUNCTION DEPENDS ON 3-D SHAPE
  - EXTREME HEAT OR CERTAIN CHEMICALS DENATURE PROTEINS
- CHEMICALS, RADIATION, AND HEAT CAN ALTER OR DESTROY NUCLEIC ACIDS
- PRODUCE FATAL MUTANTS
- HALT PROTEIN SYNTHESIS THROUGH ACTION ON RNA

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THE SELECTION OF MICROBIAL CONTROL METHODS

IDEALLY, AGENTS SHOULD BE:

- INEXPENSIVE
- FAST-ACTING
- STABLE DURING STORAGE
- CAPABLE OF CONTROLLING MICROBIAL GROWTH WHILE BEING HARMLESS TO HUMANS, ANIMALS, AND OBJECTS

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FACTORS AFFECTING THE EFFICACY OF ANTIMICROBIAL METHODS

1) SITE TO BE TREATED

- HARSH CHEMICALS AND EXTREME HEAT CANNOT BE USED ON HUMANS, ANIMALS, AND FRAGILE OBJECTS
- METHOD OF MICROBIAL CONTROL BASED ON SITE OF MEDICAL PROCEDURE

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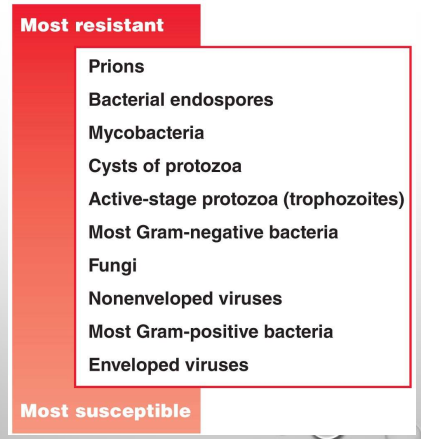
FIGURE 9.2 RELATIVE SUSCEPTIBILITIES OF MICROBES TO ANTIMICROBIAL AGENTS.



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FACTORS AFFECTING THE EFFICACY OF ANTIMICROBIAL METHODS

1) RELATIVE SUSCEPTIBILITY OF MICROORGANISMS

- GERMICIDE CLASSIFICATION
  - HIGH-LEVEL GERMICIDES
    - KILL ALL PATHOGENS, INCLUDING ENDOSPORES
  - INTERMEDIATE-LEVEL GERMICIDES
    - KILL FUNGAL SPORES, PROTOZOAN CYSTS, VIRUSES, AND PATHOGENIC BACTERIA
  - LOW-LEVEL GERMICIDES
    - KILL VEGETATIVE BACTERIA, FUNGI, PROTOZOA, AND SOME VIRUSES

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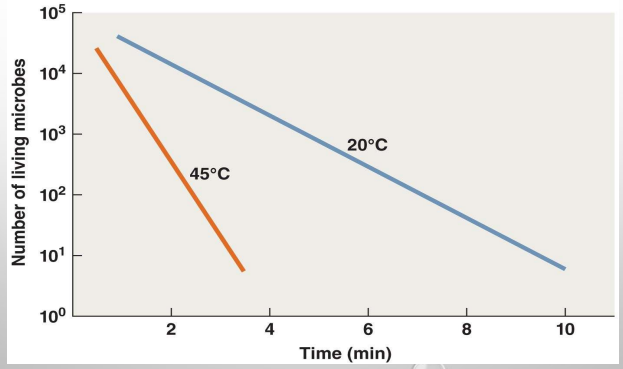
2) TEMPERATURE EFFECTS ON EFFICACY OF ANTIMICROBIAL AGENTS



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THE SELECTION OF MICROBIAL CONTROL METHODS

- **BIOSAFETY LEVELS**
  - FOUR LEVELS OF SAFETY IN LABS DEALING WITH PATHOGENS
    - BIOSAFETY LEVEL 1 (BSL-1)
      - HANDLING MICROBES THAT DO NOT CAUSE DISEASE IN HUMANS
    - BIOSAFETY LEVEL 2 (BSL-2)
      - HANDLING MODERATELY HAZARDOUS AGENTS
    - BIOSAFETY LEVEL 3 (BSL-3)
      - ALL MANIPULATIONS OF MICROBES DONE IN SAFETY CABINETS
    - BIOSAFETY LEVEL 4 (BSL-4)
      - HANDLING MICROBES THAT CAUSE SEVERE OR FATAL DISEASE
      - LAB SPACE IS ISOLATED, AND PERSONNEL WEAR PROTECTIVE SUITS

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FIGURE 9.4 A BSL-4 WORKER CARRYING EBOLA VIRUS CULTURES.

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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- EFFECTS OF HIGH TEMPERATURES
  - DENATURE PROTEINS
  - INTERFERE WITH INTEGRITY OF CYTOPLASMIC MEMBRANE AND CELL WALL
  - DISRUPT STRUCTURE AND FUNCTION OF NUCLEIC ACIDS
- THERMAL DEATH POINT
  - LOWEST TEMPERATURE THAT KILLS ALL CELLS IN BROTH IN 10 MIN
- THERMAL DEATH TIME
  - TIME TO STERILIZE VOLUME OF LIQUID AT SET TEMPERATURE

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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- MOIST HEAT
  - USED TO DISINFECT, SANITIZE, STERILIZE, AND PASTEURIZE
  - DENATURES PROTEINS AND DESTROYS CYTOPLASMIC MEMBRANES
  - MORE EFFECTIVE THAN DRY HEAT
  - METHODS OF MICROBIAL CONTROL USING MOIST HEAT
    - BOILING
    - AUTOCLAVING
    - PASTEURIZATION
    - ULTRAHIGH-TEMPERATURE STERILIZATION

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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- MOIST HEAT
  - BOILING
    - KILLS VEGETATIVE CELLS OF BACTERIA AND FUNGI, PROTOZOAN TROPHOZOITES, AND MOST VIRUSES
    - BOILING TIME IS CRITICAL
      - DIFFERENT ELEVATIONS REQUIRE DIFFERENT BOILING TIMES
    - ENDOSPORES, PROTOZOAN CYSTS, AND SOME VIRUSES CAN SURVIVE BOILING

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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- MOIST HEAT
  - AUTOCLAVING
    - PRESSURE APPLIED TO BOILING WATER PREVENTS STEAM FROM ESCAPING
    - BOILING TEMPERATURE INCREASES AS PRESSURE INCREASES
    - AUTOCLAVE CONDITIONS: 121°C, 15 PSI, 15 MINUTES

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FIGURE 9.7 AN AUTOCLAVE

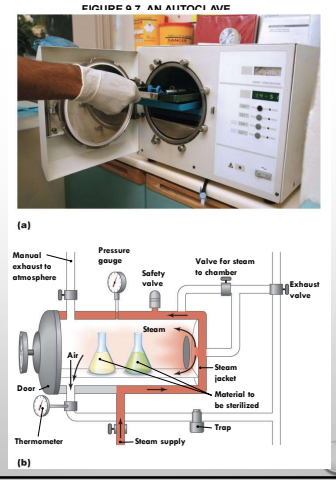

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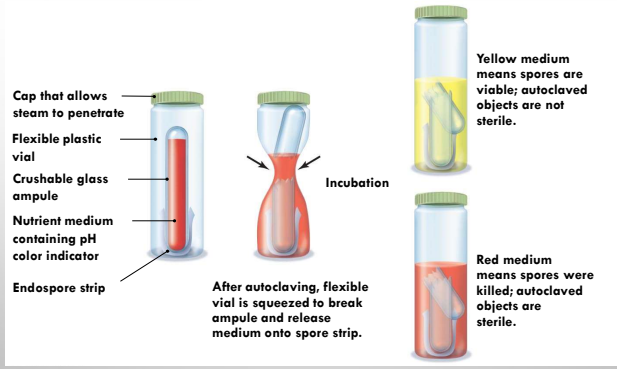
FIGURE 9.8 STERILITY INDICATORS.



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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- MOIST HEAT
  - PASTEURIZATION
    - USED FOR MILK, ICE CREAM, YOGURT, AND FRUIT JUICES
    - NOT STERILIZATION
      - HEAT-TOLERANT MICROBES SURVIVE
    - PASTEURIZATION OF MILK
      - BATCH METHOD
      - FLASH PASTEURIZATION
      - ULTRAHIGH-TEMPERATURE PASTEURIZATION

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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- MOIST HEAT
  - ULTRAHIGH-TEMPERATURE STERILIZATION
    - 140°C FOR 1 TO 3 SECONDS, THEN RAPID COOLING
    - TREATED LIQUIDS CAN BE STORED AT ROOM TEMPERATURE

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TABLE 9.2 Moist Heat Treatments of Milk

Process	Treatment
Historical (batch) pasteurization	63°C for 30 minutes
Flash pasteurization	72°C for 15 seconds
Ultra-high-temperature pasteurization	135°C for 1 second
Ultra-high-temperature sterilization	140°C for 1–3 seconds

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PHYSICAL METHODS OF MICROBIAL CONTROL

HEAT-RELATED METHODS

- DRY HEAT
  - USED FOR MATERIALS THAT CANNOT BE STERILIZED WITH MOIST HEAT
  - DENATURES PROTEINS AND OXIDIZES METABOLIC AND STRUCTURAL CHEMICALS
  - REQUIRES HIGHER TEMPERATURES FOR LONGER TIME THAN MOIST HEAT
  - INCINERATION IS ULTIMATE MEANS OF STERILIZATION

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PHYSICAL METHODS OF MICROBIAL CONTROL

REFRIGERATION AND FREEZING

- DECREASE MICROBIAL METABOLISM, GROWTH, AND REPRODUCTION
  - CHEMICAL REACTIONS OCCUR MORE SLOWLY AT LOW TEMPERATURES
  - LIQUID WATER NOT AVAILABLE
- REFRIGERATION HALTS GROWTH OF MOST PATHOGENS
- SOME MICROBES CAN MULTIPLY IN REFRIGERATED FOODS
- SLOW FREEZING IS MORE EFFECTIVE THAN QUICK FREEZING
- ORGANISMS VARY IN SUSCEPTIBILITY TO FREEZING

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PHYSICAL METHODS OF MICROBIAL CONTROL

DESICCATION AND LYOPHILIZATION

- DESICCATION (DRYING) INHIBITS GROWTH AS A RESULT OF REMOVAL OF WATER
- LYOPHILIZATION (FREEZE-DRYING) IS USED FOR LONG-TERM PRESERVATION OF MICROBIAL CULTURES
  - PREVENTS FORMATION OF DAMAGING ICE CRYSTALS

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FIGURE 9.9 THE USE OF DESICCATION AS A MEANS OF PRESERVING APRICOTS IN PAKISTAN.

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FIGURE 9.10 FILTRATION EQUIPMENT USED FOR MICROBIAL CONTROL.

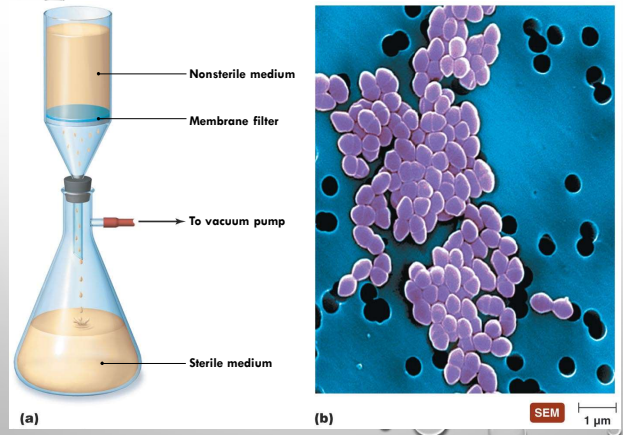

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TABLE 9.3 Membrane Filters

Pore Size (μm)	Smallest Microbes That Are Trapped
5	Multicellular algae, animals, and fungi
3	Yeasts and larger unicellular algae
1.2	Protozoa and small unicellular algae
0.45	Largest bacteria
0.22	Largest viruses and most bacteria
0.025	Larger viruses and pliable bacteria (mycoplasmas, rickettsias, chlamydias, and some spirochetes)
0.01	Smallest viruses

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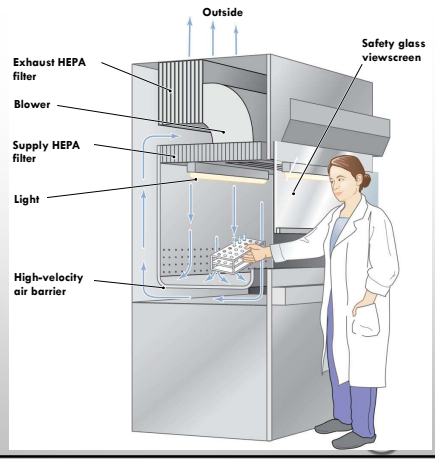
FIGURE 9.11 THE ROLES OF HIGH-EFFICIENCY PARTICULATE AIR (HEPA) FILTERS IN BIOLOGICAL SAFETY CABINETS.



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PHYSICAL METHODS OF MICROBIAL CONTROL

OSMOTIC PRESSURE

- HIGH CONCENTRATIONS OF SALT OR SUGAR IN FOODS TO INHIBIT GROWTH
- CELLS IN HYPERTONIC SOLUTION OF SALT OR SUGAR LOSE WATER
- FUNGI HAVE GREATER ABILITY THAN BACTERIA TO SURVIVE HYPERTONIC ENVIRONMENTS

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PHYSICAL METHODS OF MICROBIAL CONTROL

RADIATION

- **TWO TYPES OF RADIATION**
  - **PARTICULATE RADIATION**
    - HIGH-SPEED SUBATOMIC PARTICLES FREED FROM THEIR ATOMS
  - **ELECTROMAGNETIC RADIATION**
    - ENERGY WITHOUT MASS TRAVELING IN WAVES AT THE SPEED OF LIGHT
    - THE SHORTER THE WAVELENGTH, THE MORE ENERGY THE WAVE CARRIES
  - ALL TYPES OF RADIATION ARE DESCRIBED AS EITHER **IONIZING OR NONIONIZING**
    - BASED ON THE EFFECTS TO CHEMICALS WITHIN CELLS

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PHYSICAL METHODS OF MICROBIAL CONTROL

RADIATION

- **IONIZING RADIATION**
  - WAVELENGTHS SHORTER THAN 1 NM
    - ELECTRON BEAMS, GAMMA RAY, SOME X RAYS
  - EJECTS ELECTRONS FROM ATOMS TO CREATE IONS
  - IONS DISRUPT HYDROGEN BONDING, OXIDIZE DOUBLE COVALENT BONDS, AND CREATE HYDROXYL RADICALS
    - IONS DENATURE OTHER MOLECULES (DNA)
  - ELECTRON BEAMS EFFECTIVE AT KILLING MICROBES BUT DO NOT PENETRATE WELL
  - GAMMA RAYS PENETRATE WELL BUT REQUIRE HOURS TO KILL MICROBES
  - X RAYS REQUIRE LONG TIME TO KILL MICROBES
    - NOT PRACTICAL FOR MICROBIAL CONTROL

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FIGURE 9.12 A DEMONSTRATION OF THE INCREASED SHELF LIFE OF FOOD ACHIEVED BY IONIZING RADIATION.

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PHYSICAL METHODS OF MICROBIAL CONTROL

RADIATION

- **NONIONIZING RADIATION**
  - WAVELENGTHS GREATER THAN 1 NM
  - EXCITES ELECTRONS, CAUSING THEM TO MAKE NEW COVALENT BONDS
    - AFFECTS 3-D STRUCTURE OF PROTEINS AND NUCLEIC ACIDS
  - UV LIGHT CAUSES PYRIMIDINE DIMERS IN DNA
  - UV LIGHT DOES NOT PENETRATE WELL
  - SUITABLE FOR DISINFECTING AIR, TRANSPARENT FLUIDS, AND SURFACES OF OBJECTS

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TABLE 9.4 Physical Methods of Microbial Control

Method	Conditions	Action	Representative Use(s)
Moist heat			
Boiling	10 min at 100°C	Denatures proteins and destroys membranes	Disinfection of baby bottles and sanitization of restaurant cookware and tableware
Autoclaving (pressure cooking)	15 min at 121°C	Denatures proteins and destroys membranes	Autoclave: sterilization of medical and laboratory supplies that can tolerate heat and moisture; pressure cooker: sterilization of canned food
Pasteurization	15 sec at 72°C	Denatures proteins and destroys membranes	Destruction of all pathogens and most spoilage microbes in dairy products, fruit juices, beer, and wine
Ultra-high-temperature sterilization	1–3 sec at 140°C	Denatures proteins and destroys membranes	Sterilization of dairy products
Dry heat			
Hot air	2 h at 160°C or 1 h at 171°C	Denatures proteins, destroys membranes, oxidizes metabolic compounds	Sterilization of water-sensitive materials, such as powders, oils, and metals
Incineration	1 sec at more than 1000°C	Oxidizes everything completely	Sterilization of inoculating loops, flammable contaminated medical waste, and diseased carcasses
Refrigeration	0–7°C	Inhibits metabolism	Preservation of food
Freezing	0°C	Inhibits metabolism	Long-term preservation of foods, drugs, and cultures
Desiccation (drying)	Varies with amount of water to be removed	Inhibits metabolism	Preservation of food
Lyophilization (freeze drying)	−196°C for a few minutes while drying	Inhibits metabolism	Long-term storage of bacterial cultures
Filtration	Filter retains microbes	Physically separates microbes from air and liquids	Sterilization of air and heat-sensitive ophthalmic and enzymatic solutions, vaccines, and antibiotics
Osmotic Pressure	Exposure to hypertonic solutions	Inhibits metabolism	Preservation of food
Ionizing radiation (electron beams, gamma rays, X rays)	Seconds to hours of exposure (depending on wavelength of radiation)	Destroys DNA	Sterilization of medical and laboratory equipment and preservation of food
Nonionizing radiation (ultraviolet light)	Irradiation with 260-nm-wavelength radiation	Formation of thymine dimers inhibits DNA transcription and replication	Disinfection and sterilization of surfaces and of transparent fluids and gases

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CHEMICAL METHODS OF MICROBIAL CONTROL

- AFFECT MICROBES' CELL WALLS, CYTOPLASMIC MEMBRANES, PROTEINS, OR DNA
- EFFECT VARIES WITH DIFFERING ENVIRONMENTAL CONDITIONS
- OFTEN MORE EFFECTIVE AGAINST ENVELOPED VIRUSES AND VEGETATIVE CELLS OF BACTERIA, FUNGI, AND PROTOZOA

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CHEMICAL METHODS OF MICROBIAL CONTROL

PHENOL AND PHENOLICS

- DENATURE PROTEINS AND DISRUPT CELL MEMBRANES
- EFFECTIVE IN PRESENCE OF ORGANIC MATTER
- REMAIN ACTIVE FOR PROLONGED TIME
- COMMONLY USED IN HEALTH CARE SETTINGS, LABS, AND HOMES
- HAVE DISAGREEABLE ODOR AND POSSIBLE SIDE EFFECTS

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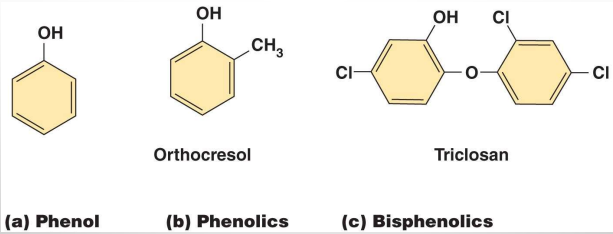
FIGURE 9.13 PHENOL AND PHENOLICS.



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CHEMICAL METHODS OF MICROBIAL CONTROL

ALCOHOLS

- INTERMEDIATE-LEVEL DISINFECTANTS
- DENATURE PROTEINS AND DISRUPT CYTOPLASMIC MEMBRANES
- MORE EFFECTIVE THAN SOAP IN REMOVING BACTERIA FROM HANDS
- SWABBING SKIN WITH ALCOHOL PRIOR TO INJECTION REMOVES MOST MICROBES

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CHEMICAL METHODS OF MICROBIAL CONTROL

HALOGENS

- INCLUDE IODINE, CHLORINE, BROMINE, AND FLUORINE
- INTERMEDIATE-LEVEL ANTIMICROBIAL CHEMICALS
- DAMAGE PROTEINS BY DENATURATION
- WIDELY USED IN NUMEROUS APPLICATIONS
  - IODINE TABLETS, IODOPHORES, CHLORINE TREATMENT, BLEACH, CHLORAMINES, BROMINE DISINFECTION, AND THE ADDITION OF FLUORIDE TO WATER AND TOOTHPASTES

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FIGURE 9.14 DEGERMING IN PREPARATION FOR SURGERY ON A HAND.

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CHEMICAL METHODS OF MICROBIAL CONTROL

OXIDIZING AGENTS

- PEROXIDES, OZONE, AND PERACETIC ACID
- KILL BY OXIDATION OF MICROBIAL ENZYMES
- HIGH-LEVEL DISINFECTANTS AND ANTISEPTICS
- HYDROGEN PEROXIDE CAN DISINFECT AND STERILIZE SURFACES
  - NOT USEFUL FOR TREATING OPEN WOUNDS BECAUSE OF CATALASE ACTIVITY
- OZONE TREATMENT OF DRINKING WATER
- PERACETIC ACID IS EFFECTIVE SPORICIDE USED TO STERILIZE EQUIPMENT

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CHEMICAL METHODS OF MICROBIAL CONTROL

- **SURFACTANTS**
  - "SURFACE ACTIVE" CHEMICALS
    - REDUCE SURFACE TENSION OF SOLVENTS
  - SOAPS AND DETERGENTS
    - SOAPS HAVE HYDROPHILIC AND HYDROPHOBIC ENDS
      - GOOD DEGERMING AGENTS BUT NOT ANTIMICROBIAL
    - DETERGENTS ARE POSITIVELY CHARGED ORGANIC SURFACTANTS
      - QUATERNARY AMMONIUM COMPOUNDS (QUATS)
        - LOW-LEVEL DISINFECTANTS
        - DISRUPT CELLULAR MEMBRANES
        - IDEAL FOR MANY MEDICAL AND INDUSTRIAL APPLICATIONS

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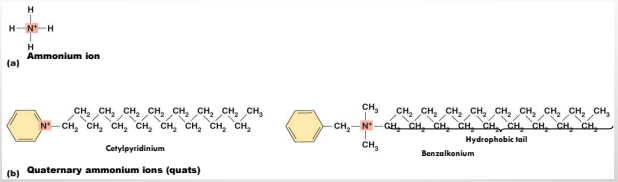
FIGURE 9.15 QUATERNARY AMMONIUM COMPOUNDS (QUATS).



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CHEMICAL METHODS OF MICROBIAL CONTROL

HEAVY METALS

- HEAVY-METAL IONS DENATURE PROTEINS
- LOW-LEVEL BACTERIOSTATIC AND FUNGISTATIC AGENTS
- 1% SILVER NITRATE ONCE COMMONLY USED TO PREVENT BLINDNESS CAUSED BY *N. GONORRHOEAE*
- THIMEROSAL USED TO PRESERVE VACCINES
- COPPER CONTROLS ALGAL GROWTH

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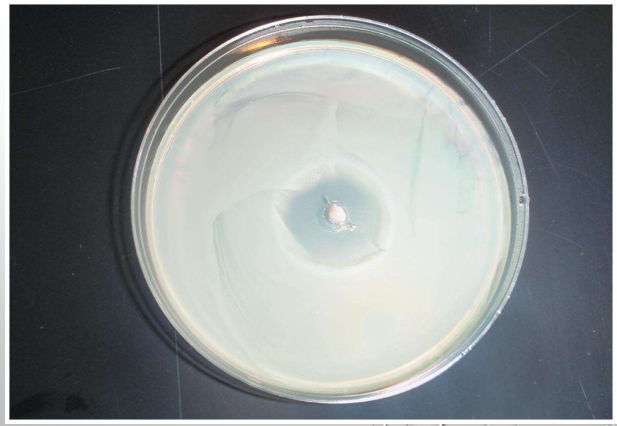
FIGURE 9.16 THE EFFECT OF HEAVY-METAL IONS ON BACTERIAL GROWTH.



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CHEMICAL METHODS OF MICROBIAL CONTROL

ALDEHYDES

- COMPOUNDS CONTAINING TERMINAL –CHO GROUPS
- CROSS-LINK FUNCTIONAL GROUPS TO DENATURE PROTEINS AND INACTIVATE NUCLEIC ACIDS
- GLUTARALDEHYDE DISINFECTS AND STERILIZES
- FORMALIN USED IN EMBALMING AND IN DISINFECTION OF ROOMS AND INSTRUMENTS

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CHEMICAL METHODS OF MICROBIAL CONTROL

GASEOUS AGENTS

- MICROBICIDAL AND SPORICIDAL GASES USED IN CLOSED CHAMBERS TO STERILIZE ITEMS
- DENATURE PROTEINS AND DNA BY CROSS-LINKING FUNCTIONAL GROUPS
- USED IN HOSPITALS AND DENTAL OFFICES
- DISADVANTAGES
  - CAN BE HAZARDOUS TO PEOPLE
  - OFTEN HIGHLY EXPLOSIVE
  - EXTREMELY POISONOUS
  - POTENTIALLY CARCINOGENIC

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CHEMICAL METHODS OF MICROBIAL CONTROL

ENZYMES

- ANTIMICROBIAL ENZYMES ACT AGAINST MICROORGANISMS
- HUMAN TEARS CONTAIN LYSOZYME
  - DIGESTS PEPTIDOGLYCAN CELL WALL OF BACTERIA
- USES OF ENZYMES TO CONTROL MICROBES IN THE ENVIRONMENT
  - LYSOZYME IS USED TO REDUCE THE NUMBER OF BACTERIA IN CHEESE
  - PRIONZYME CAN REMOVE PRIONS ON MEDICAL INSTRUMENTS

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CHEMICAL METHODS OF MICROBIAL CONTROL

ANTIMICROBIALS

- ANTIBIOTICS AND SEMISYNTHETIC AND SYNTHETIC CHEMICALS
- TYPICALLY ARE USED TO TREAT DISEASE
- SOME ARE USED FOR ANTIMICROBIAL CONTROL OUTSIDE THE BODY

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TABLE 9.5 Chemical Methods of Microbial Control

Method	Action(s)	Level of Activity	Some Uses
Phenol (carbolic acid)	Denatures proteins and disrupts cell membranes	Intermediate to low	Original surgical antiseptic; now replaced by less odorous and injurious phenolics
Phenolics (chemically altered phenol; bisphenols are composed of a pair of linked phenolics)	Denature proteins and disrupt cell membranes	Intermediate to low	Disinfectants and antiseptics
Alcohols	Denature proteins and disrupt cell membranes	Intermediate	Disinfectants, antiseptics, and as a solvent in tinctures
Halogens (iodine, chlorine, bromine, and fluorine)	Presumably denature proteins	Intermediate	Disinfectants, antiseptics, and water purification
Oxidizing agents (peroxides, ozone, and peracetic acid)	Denature proteins by oxidation	High	Disinfectants, antiseptics for deep wounds, water purification, and sterilization of food-processing and medical equipment
Surfactants (soaps and detergents)	Decrease surface tension of water and disrupt cell membranes	Low	Soaps: degerming; detergents: antiseptic
Heavy metals (arsenic, zinc, mercury, silver, copper, etc.)	Denature proteins	Low	Fungistats in paints; silver nitrate cream: surgical dressings, burn creams, and catheters; copper: algicide in water reservoirs, swimming pools, and aquariums
Aldehydes (glutaraldehyde and formaldehyde)	Denature proteins	High	Disinfectant and embalming fluid
Gaseous agents (ethylene oxide, propylene oxide, and beta-propiolactone)	Denature proteins	High	Sterilization of heat- and water-sensitive objects
Enzymes	Denature proteins	High against target substrate	Removal of prions on medical instruments
Antimicrobials (antibiotics, semisynthetics, and synthetics)	Act against cell walls, cell membranes, protein synthesis, and DNA transcription and replication	Intermediate to low	Disinfectants and treatment of infectious diseases

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CHEMICAL METHODS OF MICROBIAL CONTROL

METHODS FOR EVALUATING DISINFECTANTS AND ANTISEPTICS

- PHENOL COEFFICIENT
  - EVALUATES EFFICACY OF DISINFECTANTS AND ANTISEPTICS
  - COMPARES TO PHENOL AN AGENT'S ABILITY TO CONTROL MICROBES
  - GREATER THAN 1.0 INDICATES AGENT IS MORE EFFECTIVE THAN PHENOL
  - HAS BEEN REPLACED BY NEWER METHODS

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CHEMICAL METHODS OF MICROBIAL CONTROL

METHODS FOR EVALUATING DISINFECTANTS AND ANTISEPTICS

USE-DILUTION TEST

- METAL CYLINDERS DIPPED INTO BROTH CULTURES OF BACTERIA
- CONTAMINATED CYLINDER IMMERSED INTO DILUTION OF DISINFECTANT
- CYLINDERS REMOVED, WASHED, AND PLACED INTO TUBE OF MEDIUM
- MOST EFFECTIVE AGENTS ENTIRELY PREVENT GROWTH AT HIGHEST DILUTION
- CURRENT STANDARD TEST IN THE U.S.
- NEW STANDARD PROCEDURE BEING DEVELOPED

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CHEMICAL METHODS OF MICROBIAL CONTROL

METHODS FOR EVALUATING DISINFECTANTS AND ANTISEPTICS

- **IN-USE TEST**
  - SWABS TAKEN FROM OBJECTS BEFORE AND AFTER APPLICATION OF DISINFECTANT OR ANTISEPTIC
  - SWABS INOCULATED INTO GROWTH MEDIUM AND INCUBATED
  - MEDIUM MONITORED FOR GROWTH
  - ACCURATE DETERMINATION OF PROPER STRENGTH AND APPLICATION PROCEDURE FOR EACH SPECIFIC SITUATION

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CHEMICAL METHODS OF MICROBIAL CONTROL

DEVELOPMENT OF RESISTANT MICROBES

- LITTLE EVIDENCE THAT PRODUCTS CONTAINING ANTISEPTIC AND DISINFECTING CHEMICALS ADD TO HUMAN OR ANIMAL HEALTH
- USE OF SUCH PRODUCTS PROMOTES DEVELOPMENT OF RESISTANT MICROBES

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