Controlling Microbial Growth

- Basic principles
- Selection of methods
- Physical control methods
- Chemical control methods
- Problems
Hospital Control

Famous Doctors
Semmelweis (1800) and Lister (early 1900)
Aseptic methods for surgery, boiled instruments
Disinfectants for hands/wounds
Nightingale (1800-1900)
Sanitary procedures and training
Procedures for reducing hospital overcrowding
Contamination

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

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Modes of Action

Alteration of cell membranes or walls
Damage to proteins or nucleic acids
Selection of methods

- Inexpensive
- Fast acting
- Stable during storage
- Site to be treated
- Relative susceptibility:

**Factors That Influence Growth**

- Nutrient and oxygen availability
- Temperature, pH, and pressure
- Moisture content and salt/sugar solute levels
General Strategies to Control Growth
Kill or inhibit microbes using chemicals or drugs
Block entry for microbes or carriers
Promote people’s natural defenses
Physical Methods

Heat

1. Dry heat or flaming/burning - many tools, glass
2. Boil/steam 5 min kills most - NOT spores
3. Only autoclave - 121°C 20 min - kills ALL
4. Pasteurize (60°C, 30 min.) does NOT = sterilize.
5. Ultrahigh temperatures = flash heating 140°C for 1-3 seconds
<table>
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<tr>
<th>Process</th>
<th>Treatment</th>
</tr>
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<tbody>
<tr>
<td>Historical (batch) pasteurization</td>
<td>63°C for 30 minutes</td>
</tr>
<tr>
<td>Flash pasteurization</td>
<td>72°C for 15 seconds</td>
</tr>
<tr>
<td>Ultrahigh-temperature pasteurization</td>
<td>134°C for 1 second</td>
</tr>
<tr>
<td>Ultrahigh-temperature sterilization</td>
<td>140°C for 1–3 seconds</td>
</tr>
</tbody>
</table>
Miscellaneous Physical Methods
Cold/Freezing: slows growth - does not always kill
Sound waves dislodges - does not kill well
Radiation
UV sterilizes surfaces; X-rays penetrate
Destroy DNA
Increasingly applied to mail and foods
Filtration
Filters made of nylon, porcelain, gauze, sand
Placed in air vents, water valves, masks, etc…
Pores/holes 0.45 microns trap most bacteria
Pores of 0.20 microns trap most viruses
Methods

![Diagram of a filtration setup]

**Table 9.3 Membrane Filters**

<table>
<thead>
<tr>
<th>Pore Size ($\mu m$)</th>
<th>Microbes That Are Trapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Multicellular algae, animals, and fungi</td>
</tr>
<tr>
<td>3</td>
<td>Yeasts and larger unicellular algae</td>
</tr>
<tr>
<td>1.2</td>
<td>Protozoa and small unicellular algae</td>
</tr>
<tr>
<td>0.45</td>
<td>Largest bacteria</td>
</tr>
<tr>
<td>0.22</td>
<td>Largest viruses and most bacteria</td>
</tr>
<tr>
<td>0.025</td>
<td>Larger viruses and pliable bacteria (mycoplasmas, rickettsias, chlamydia, and some spirochetes)</td>
</tr>
<tr>
<td>0.01</td>
<td>Smallest viruses</td>
</tr>
</tbody>
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Osmotic pressure

- Drying & Dessication
- Salting/brining
- pH
Chemical Antimicrobials

Ideal Chemicals
Effect happens in a reasonable time
Non-toxic or non-corrosive to materials
Water-soluble, easy to prepare, stable
Antiseptics for Human Tissues

Detergents disrupt cell membranes—Phenolics
Alcohols, hydrogen peroxide, iodine – disrupt proteins

Antibacterial soaps
Disinfectants for Non-Living Things
Formalin destroys DNA
Phenol, bleach - proteins
Gaseous agents

- Ozone
- Ethylene oxide

- Use in a chamber: when you cannot use heat or water soluble chemicals
Arguments Against…
Antimicrobial resistance
Loss of “good bacteria” that are protective
Low immune stimulation, chronic diseases
Hospital-Acquired Infections

Community-acquired – present at admission
Nosocomial – acquired in the hospital setting
Iatrogenic – acquired from health care provider
Reservoirs – people, objects, food/water

Nosocomial infections on the rise!
2 million patients per 40 million per year
Number of deaths = 75,000-100,000
Added cost = $4.5 billion; stay = 2-4 weeks
Why?

Indiscriminate use of antimicrobials
Diminished practice of aseptic procedures
Longer stays - aging, premature infants, AIDS
Patient overcrowding and staff shortages
Poorly-trained, low-end, temporary staff
Greater use of immune-suppressants
Indwelling catheters, respirators, dialysis
Major Kinds of Infections
Gram Positives – blood, boils
Gram Negatives – bladder
Various/both - pneumonia
70% agents drug-resistant
Health Care Workers Also At Risk
Blood/fluid – e.g. Hepatitis, AIDS
Aerosolized respiratory agents - e.g. Influenza
Contact contagious like Staphylococcus
30-70% carry resistant Staphylococcus
Health Care Infection Control Procedures

Medical Asepsis - Clean Technique
Goals– exclude pathogens, prevent transfer
Handwashing, handwashing, handwashing
Proper handling of instruments, fomites, waste
Standard Precautions

Goal - reduce transmission of via body fluids
Applied to ALL patients, regardless of status
Includes medical asepsis plus gloves, masks
Surgical Asepsis - Sterile Technique
Goal One – to exclude ALL microorganisms
Goal Two - to keep objects and areas sterile
Employs only sterile tools and techniques
Used during invasive procedures and in all labs
Hospital Infection Control Committee (ICC)
Surveillance, produce reports, educate staff
Set policy and take drastic action
Communicate with local public health
Work with hospital clinical microbiology lab