I ♥Control
Microbial Control

Controlling Microorganisms

- Microbial agents
- Sanitation
- Effectiveness
- Mode of action

Microbial agents

- -static agents
- -cidal agents
- Resistance
- Terms
- Effectiveness
- Mode of action

-static agents

- Temporarily preventing the growth of microbes
  - Bacteriostatic
  - Fungistatic

-cidal

- Killing or destroying a microorganism
  - Germicide
  - Bactericide

Resistance

- Highest resistance - bacterial spores and prions
- Moderate resistance - some bacteria, protozoan cysts, fungal sexual spores, naked viruses
- Least resistance - most bacteria, fungal nonsexual spores and hyphae, enveloped viruses, yeast, protozoan trophozoites

Terms

- Sterilization
- Disinfection
- Antisepsis
- Sanitation
- Degermination

Sterilization

- A process that destroys or removes all viable microorganisms, including spores and viruses
- Physical or chemical agents
- Inanimate objects
  - Surgical instruments, commercially packaged foods

Disinfection

- Use of physical process or chemical agent (disinfectant) to destroy vegetative pathogens.
- Removes toxins, but not bacterial endospores

Antisepsis

- Chemical agents (antiseptics) destroy or inhibit vegetative pathogens
- Skin and mucous membranes

Sanitation

- Reducing the number of microorganisms
- Physical chemical agents

Degermination

- Human skin - reducing the number of microorganisms
- Physical and chemical agents

Effectiveness

- Number of microorganisms
- Target population (bacteria, fungi, spores, viruses)
- Temperature and pH
- Concentration of agent
- Mode of action
- Interfering agents (solvents, debris, saliva, blood, feces)

Mode of action

- Cell wall
- Cell membrane
- Nucleic acid synthesis
- Protein synthesis
- Protein function

Cell wall

- Bacteria and fungi
  - Block synthesis
  - Degrade cellular components
  - Destroy or reduce stability
- Agent
  - Penicillin, detergents, alcohols

Cell membrane

- All microbes and enveloped viruses
  - Bind and penetrate lipids
  - Lose selective permeability (leakage)
- Agent
  - Surfactants

Nucleic acid synthesis

- Irreversibly binds to DNA
  - Stops transcription and translation
  - Mutations
- Agent
  - Chemical agent – formaldehyde
  - Physical agent – radiation

Protein synthesis

- Binds to ribosomes
  - Stops translation
  - Prevents peptide bonds
- Agent
  - Chloramphenicol

Protein function

- Block protein active sites
- Prevent binding to substrate
- Denature protein
- Agent
  - Physical – Heat, pH change
  - Chemical – alcohols, acids, phenolics, metallic ions

Physical Control

- Heat
- Radiation
- Filtration

Heat

- Mode of action
- Moist
- Dry

Mode of action

- Moist heat
  - Coagulation of proteins
  - Denaturation of proteins
- Dry heat
  - Dehydration
  - Denaturation
  - Oxidation (burning to ashes)
- Thermal death time

Moist heat

- Steam and pressure
- Tyndallization
- Pasteurization
- Boiling water

Steam and pressure

- Pressure above normal atmospheric pressure will result in temperatures above 100˚C
- Effectively destroys spores
- Sterilizes inanimate objects (glassware)
- Ex. Autoclave and home pressure cooker

Tyndallization

- Intermittent sterilization
- Used for heat-sensitive media, canned foods
- Will not destroy spores
- Ex. Exposure to free-flowing steam for 30 to 60 minutes

Pasteurization

- Disinfection of beverages
- Equivalent treatments
  - 63ºC for 30 min
  - High-temperature short-time 72ºC for 15 sec
  - Ultra-high-temperature: 140ºC for <1 sec
  - Thermoduric or thermophilic organisms survive
- Prevents the transmission of milk-borne diseases
  - *Salmonella, Campylobacter, Listeria, Mycobacteria*
- Examples: Milk industry, wineries, breweries

Boiling water

- Decontaminates at 100 ˚C for 30 minutes
- Kills most non-spore forming pathogens
- Examples: home sanitizing and disinfecting, disinfecting unsafe water

Dry heat

- Hot air
- Incineration
- Temperature and time of exposure is greater than moist heat

Hot air

- Hot air
  - Oven
  - Effective at 150˚C to 180˚C for 2-4 hrs
  - Effective for inanimate objects and oils

Incineration

- Destroys microbes to ashes or gas
  - Flame - 1870˚C
  - Furnace - 800˚C to 6500˚C

Effects of cold and dessication

- Cold temperatures reduce the activity of some microbes, not psychrophiles

  - Not a disinfection or sterilization method
- Dessication or dehydration kill some microorganisms
  - Lyophilization – freezing and drying method used to preserve microbes

Radiation

- Types of radiation
- Modes of action
- Applications

Types of radiation

- Ionizing
  - Gamma rays (High energy)
  - X-rays (Intermediate energy)
  - Cathode rays (least energy)
- Nonionizing
  - Ultraviolet

Mode of actions

- Ionizing radiation ejects orbital electrons from an atom
  - High energy
    - Penetrates liquids and solids effectively
- Non-ionizing radiation raises atoms to a higher energy state
  - Low energy
    - Less penetration capability
    - Pyrimidine dimers

Applications

- Ionizing radiation
  - Alternative sterilization method
  - Materials sensitive to heat or chemicals
  - Some foods (fruits, vegetables, meats)
- Non-ionizing radiation
  - Alternative disinfectant
  - Germicidal lamp in hospitals, schools, food preparation areas (inanimate objects, air, water)

Filtration

- Removes microbes and spores from liquids and air
- Perforated membrane
  - Pore sizes vary
- Applications
  - Liquids that are sensitive to heat
    - Serum, vaccines, media

Chemical control

- Widely used agents

- Applications

Applications

- Halogens
- Phenolics
- Surfactants
- Hydrogen peroxide
- Detergents and soaps
- Heavy metals
- Aldehydes
- Gases
- Dyes, acids, and alkalis

Halogens

- Chlorine
  - Disinfectant and antiseptic
    - Disrupt sulfhydryl groups in amino acids
- Iodine
  - Topical antiseptic
    - Disruption is similar to chlorines

Phenolics

- Vary based on functional groups attached to the aromatic ring
- Examples: Hexachlorophene, Triclosan
  - Microcidal
  - Ingredient in soaps to kitty litter
    - Disrupts cell walls and membranes,

Alcohols

- Ethyl alcohol, isopropyl (rubber alcohol)
  - 70% concentration dissolve membrane lipids, disrupt cell surface tension, denatures proteins
- Germicidal and skin degerming

Hydrogen peroxide

- Colorless and caustic liquid
- Form hydroxyl free radicals
  - Effective against anaerobes
- Skin and wound cleaner
- Quick method for sterilizing medical equipment

Detergents and soaps

- Quaternary ammonium (quats)
  - Cationic
  - Bind and disrupt cell membrane
  - Low-level disinfectant in the clinical setting
- Soaps

  - Fatty acids, oils, sodium or potassium salts
  - Cleaning agents
  - More effective if mixed with germicides

Heavy metals

- Mercury, silver,
  - Inactivate proteins
  - Preservatives in cosmetics and ophthalmic solutions

Aldehydes

- Glutaraldehyde
  - Crosslink with proteins on the cell surface
  - Disinfectant for surgical instruments

Gases

- Ethylene oxide
  - Reacts with functional groups of DNA and proteins
  - Sterilizes and disinfects plastic materials

Dyes

- Crystal violet
- Effective against Gram positive bacteria
- Ointments

Acids and alkalis

- Acetic acid
- Ammonium hydroxide
- Prevents spore germination and vegetative growth
- Food preservative