Foundations in Microbiology

Fifth Edition

Talaro

Chapter

11

Physical and Chemical Control of Microbes

Chapter 11

Control of microbes

Physical and chemical methods to destroy or reduce microbes in a given area

Relative resistance of microbes

- Highest resistance
  - Bacterial endospores
- Moderate resistance
  - *Pseudomonas sp.*
  - *Mycobacterium tuberculosis*
  - *Staphylococcus aureus*
  - Protozoan cysts
- Least resistance
  - most vegetative cells
  - Fungal spores
  - enveloped viruses
  - Yeast
  - Protozoan trophozoites

Terms

- **Sterilization** – a process that destroys all viable microbes, including viruses & endospores
- **Disinfection** – a process to destroy vegetative pathogens, not endospores
- **Sanitization** – any cleansing technique that mechanically removes microbes

Microbial death

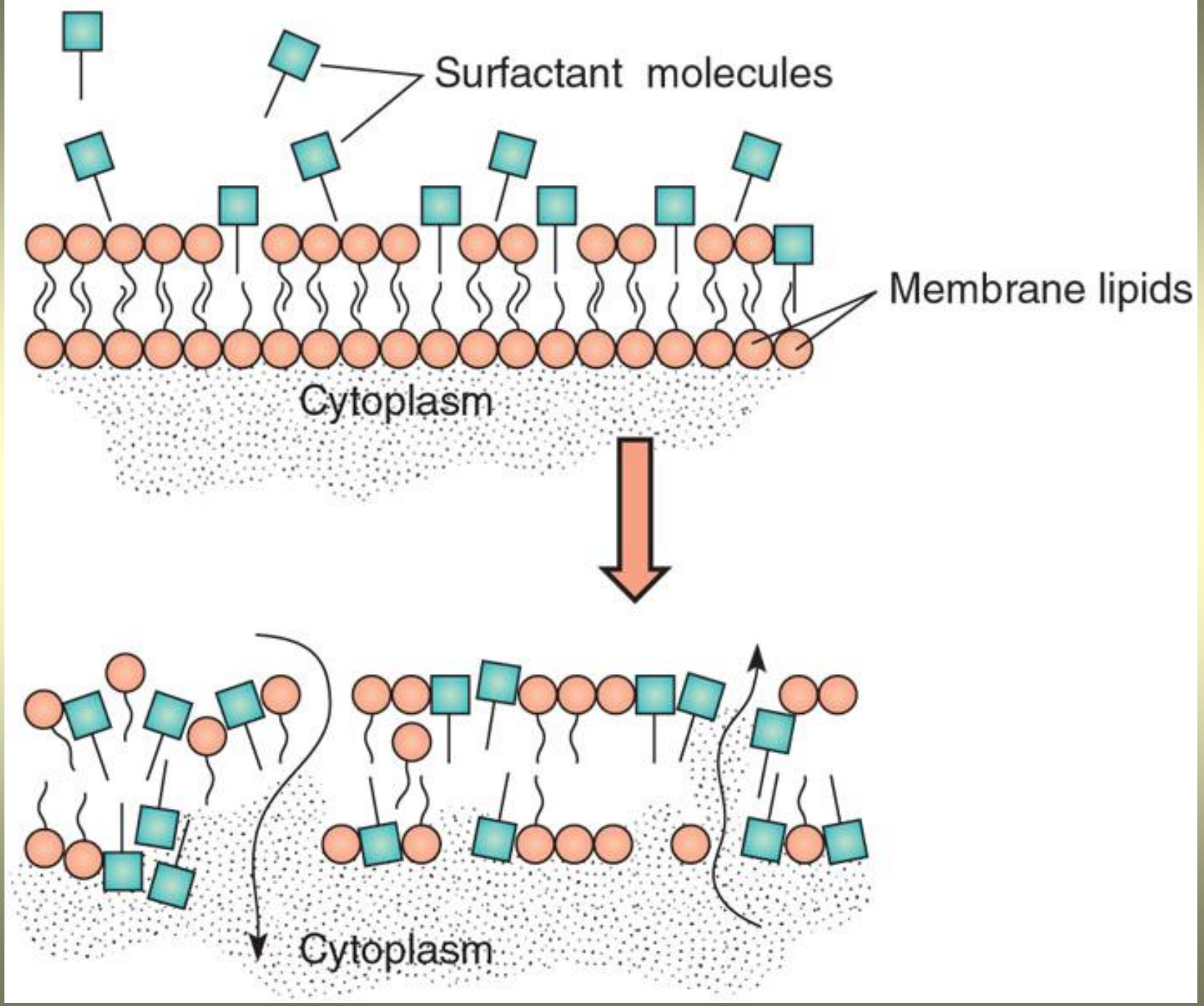
- Involves permanent loss of reproductive capability, even under optimum growth conditions

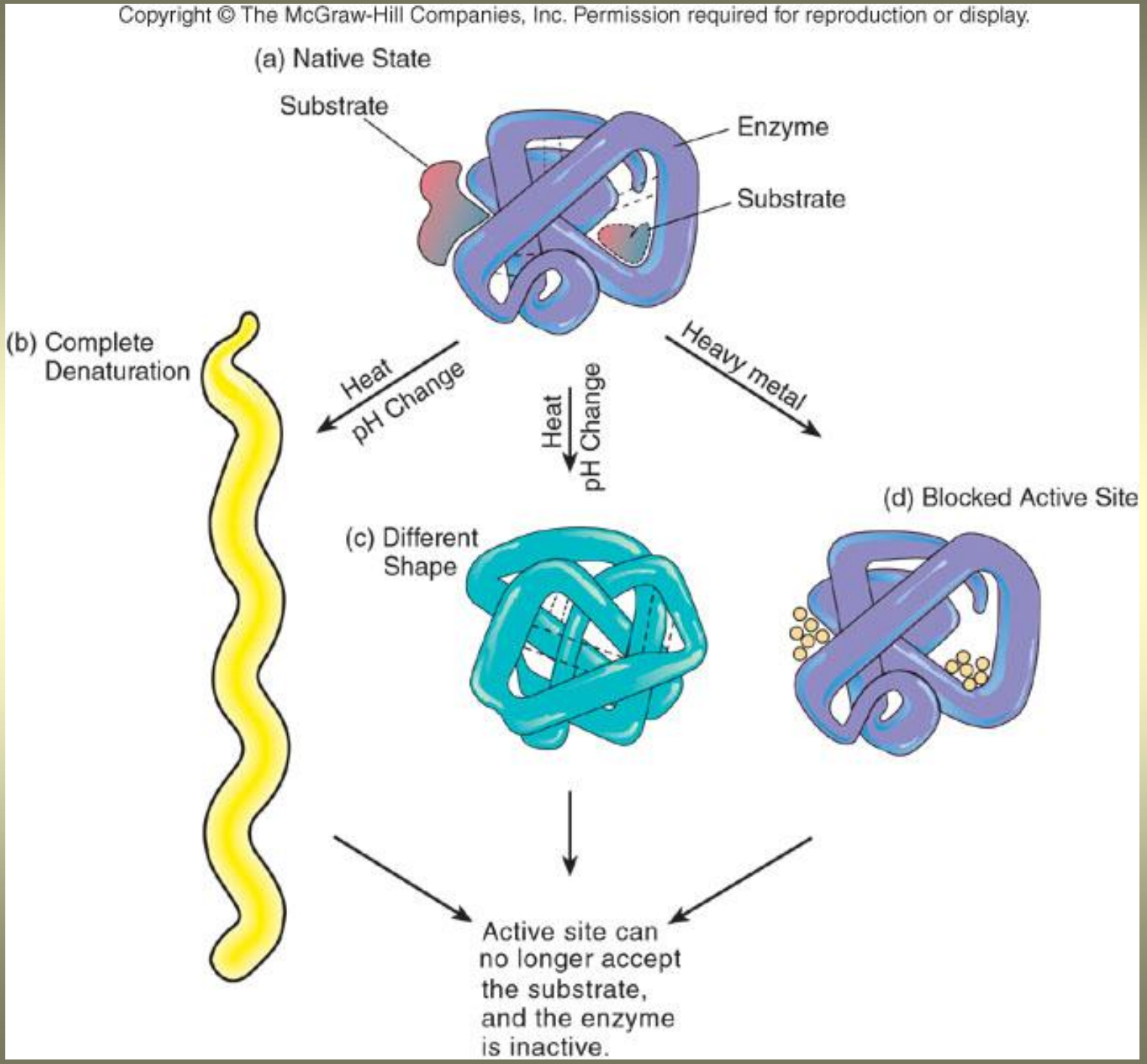
Factors that influence action of antimicrobial agents:

1. Number of microbes
2. Nature of microbes in the population
3. Temperature & pH of environment
4. Concentration or dosage of agent
5. Mode of action of the agent
6. Presence of solvents, organic matter, or inhibitors

Cellular targets of control

1. Cell wall
2. Cell membrane
3. Cellular synthetic processes (DNA, RNA)
4. Proteins





Practical concerns

- Does the application require sterilization?
- Is the item to be reused?
- Can the item withstand heat, pressure, radiation, or chemicals?
- Is the method suitable?
- Will the agent penetrate to the necessary extent?
- Is the method cost- and labor-efficient & is it safe?

Methods of Physical Control

1. Heat
2. Cold temperatures
3. Desiccation
4. Radiation
5. Filtration

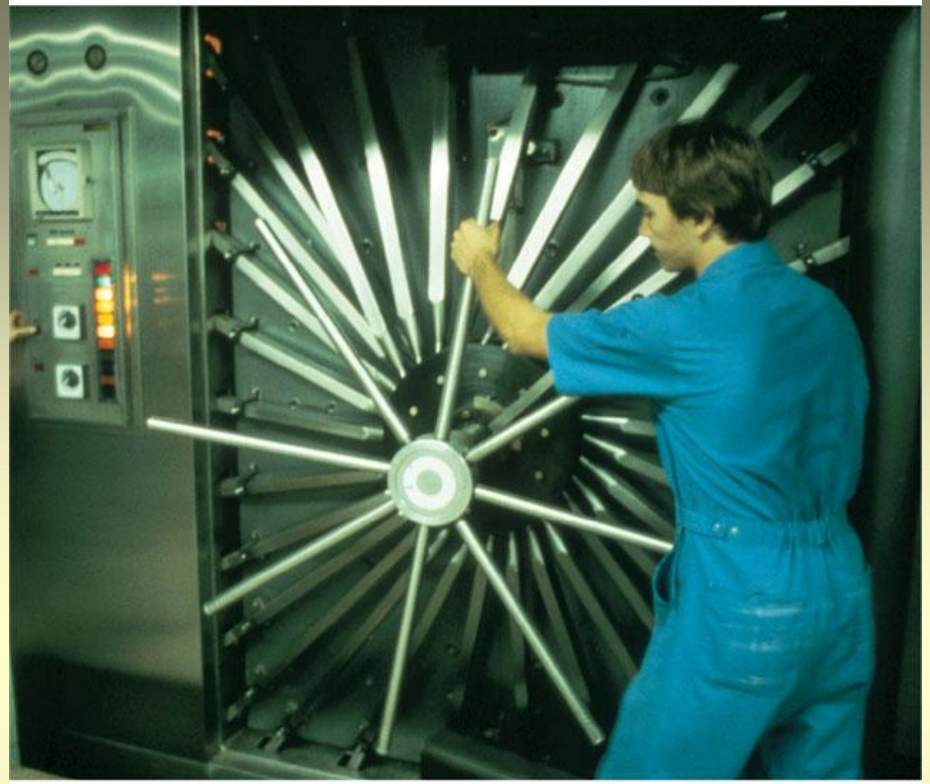
1. Heat

Moist heat – use of hot water or steam

- A. Mode of action – denaturation of proteins, destruction of membranes & DNA
  - **sterilization**

    autoclave 20 psi/121^{o}C/20 min

    intermittent sterilization – unpressurized steam at 100^{o}C 30-60 min for 3 days
  - **disinfection**
    - **Pasteurization** <100^{o}C for seconds; kills *Salmonella, Listeria* & overall microbe count
    - **Boiling** at 100^{o}C for 30 minutes to destroy non-spore-forming pathogens



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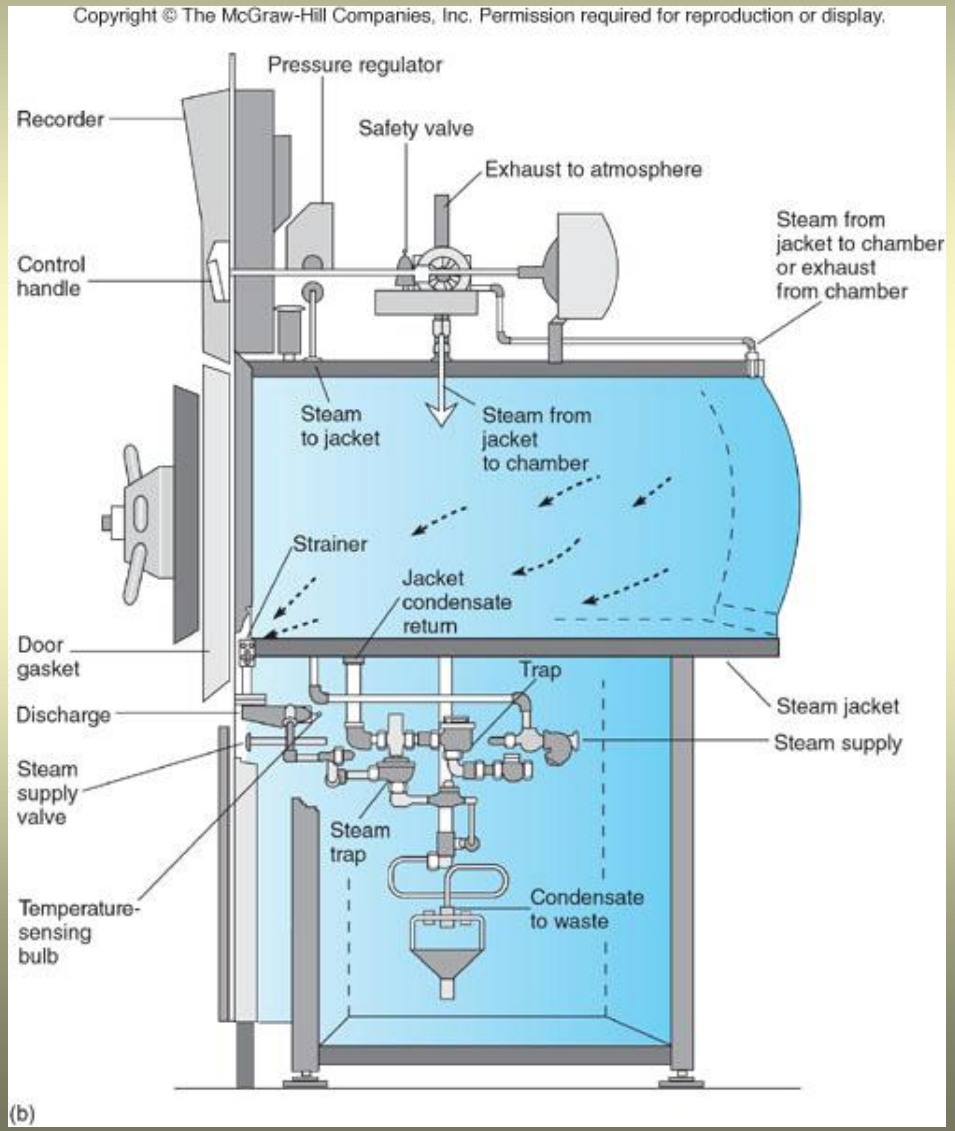


(b)

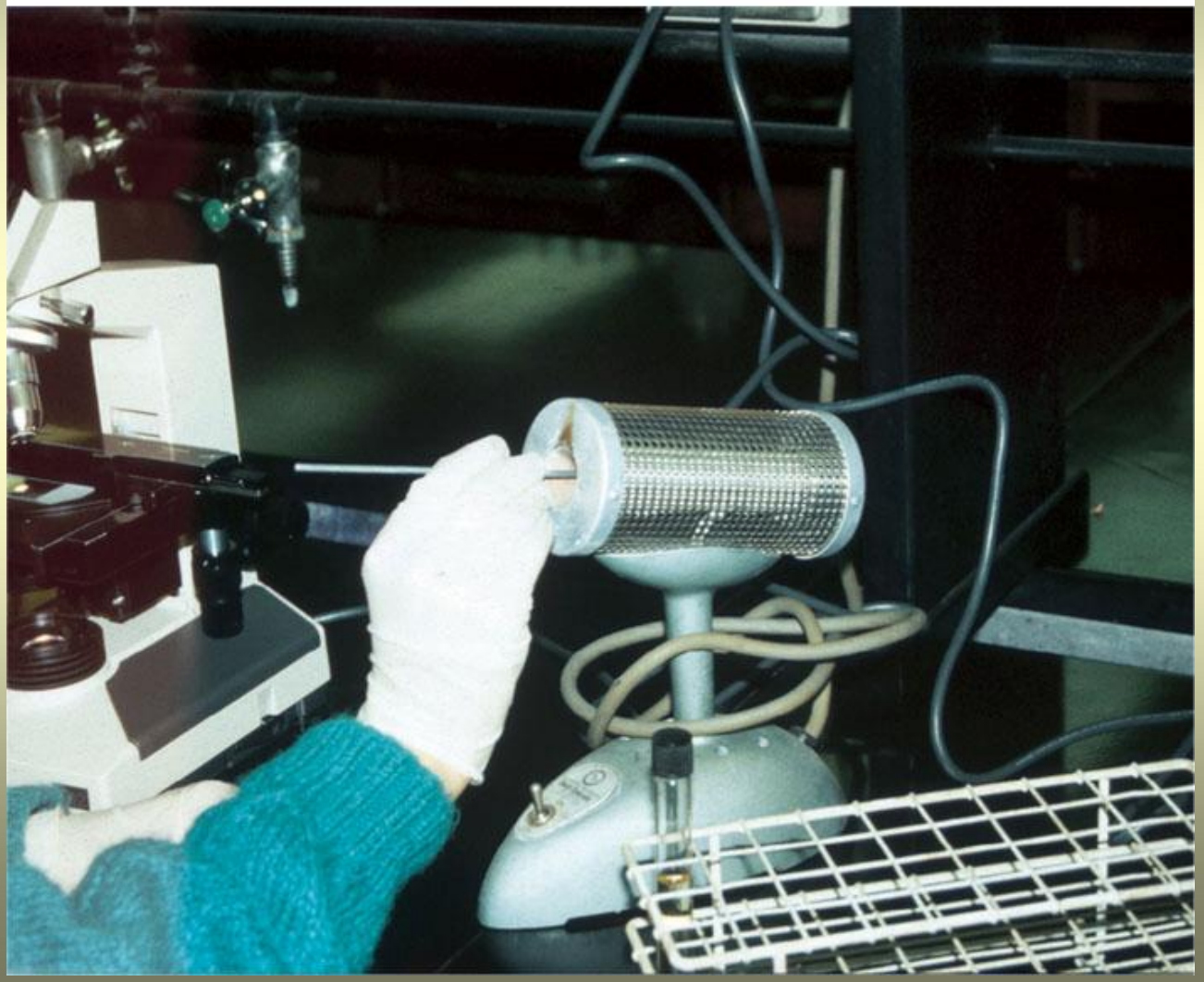
Autoclaving

Video

1. Heat

- **B. Dry heat** using higher temperatures than moist heat, can also sterilize
  - **incineration** – 600-1200^{o}C combusts & dehydrates cells
  - **dry ovens** – 150-180^{o}C- coagulate proteins

Dry heat



2. Cold temperatures

- Microbistatic – slows the growth of microbes
  - refrigeration 0-15^{o}C & freezing <0^{o}C
  - used to preserve food, media and cultures

3. Desiccation

- gradual removal of water from cells, leads to metabolic inhibition
- not effective microbial control – many cells retain ability to grow when water is reintroduced

4. Radiation

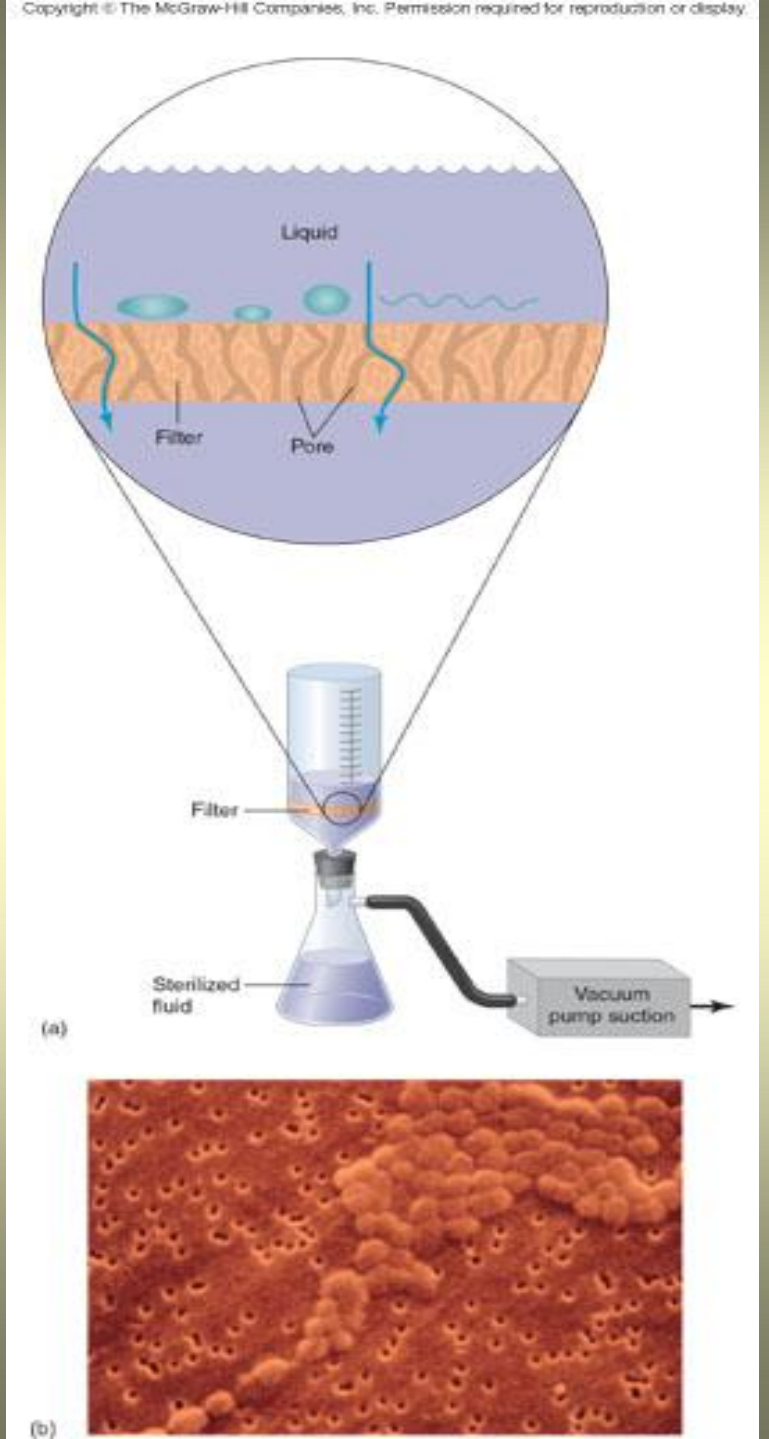
1. Ionizing radiation – deep penetrating power, breaks DNA,
   - gamma rays, X-rays, cathode rays
     - used to sterilize medical supplies & food products
2. Nonionizing radiation – little penetrating power to sterilize air, water & solid surfaces
   - uv light
     - creates thymine pyrmidines, which interfere with replication

5. Filtration

- physical removal of microbes by passing a gas or liquid through filter

- used to sterilize heat sensitive liquids & air in hospital isolation units & industrial clean rooms

Filtration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Liquid
Filter
Pore
Filter
Sterilized fluid
Vacuum pump suction
(a)
(b)

Chemical Control

1. Halogens
2. Phenolics
3. Chlorhexidine
4. Alcohols
5. Hydrogen peroxide
6. Detergents & soaps
7. Heavy metals
8. Aldehydes

1. Halogens

- Chlorine – Cl_2, hypochlorites (chlorine bleach), chloramines
  - Denaturation of proteins by disrupting disulfide bonds
  - Can be sporicidal

- Iodine - I_2, iodophors (betadine)
  - Denature proteins
  - Can be sporicidal
  - Milder medical & dental degerming agents, disinfectants, ointments

2. Phenolics

- Disrupt cell membranes & precipitating proteins; bactericidal, fungicidal, virucidal, not sporicidal
  - Lysol
  - triclosan- antibacterial additive to soaps

3. Chlorhexidine

- Hibiclens, Hibitane
- A surfactant & protein denaturant with broad microbicidal properties
- Not sporicidal
- Used as skin degerming agents for preoperative scrubs, skin cleaning & burns

4. Alcohols

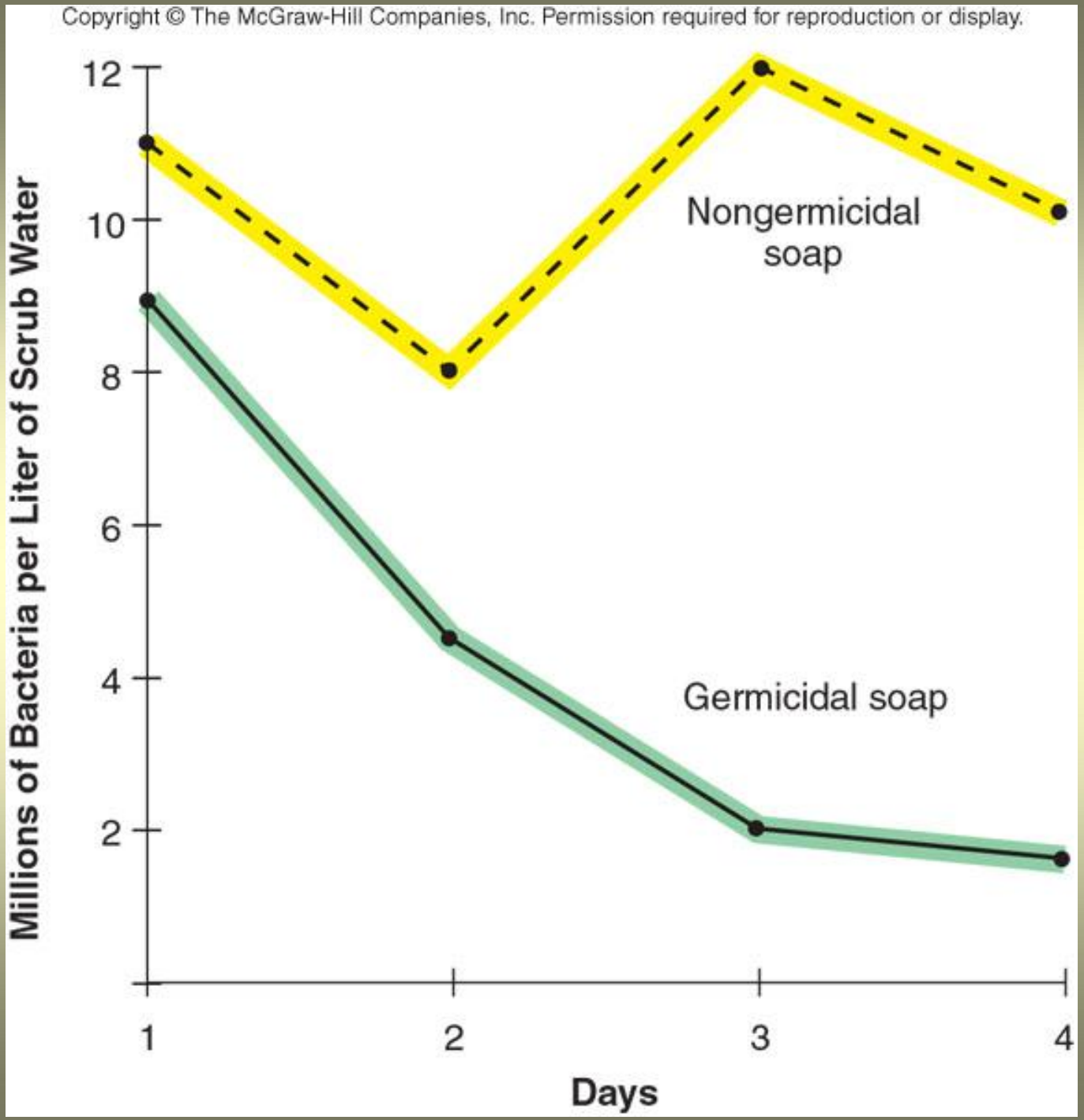
- Ethyl, isopropyl in solutions of 50-90%
- Act as surfactants dissolving membrane lipids and coagulating proteins of vegetative bacterial cells and fungi
- Not sporicidal

5. Hydrogen peroxide

- Weak (3%) to strong (25%)
- Produce highly reactive hydroxyl-free radicals that damage protein & DNA while also decomposing to O_2 gas – toxic to anaerobes
- Strong solutions are sporicidal

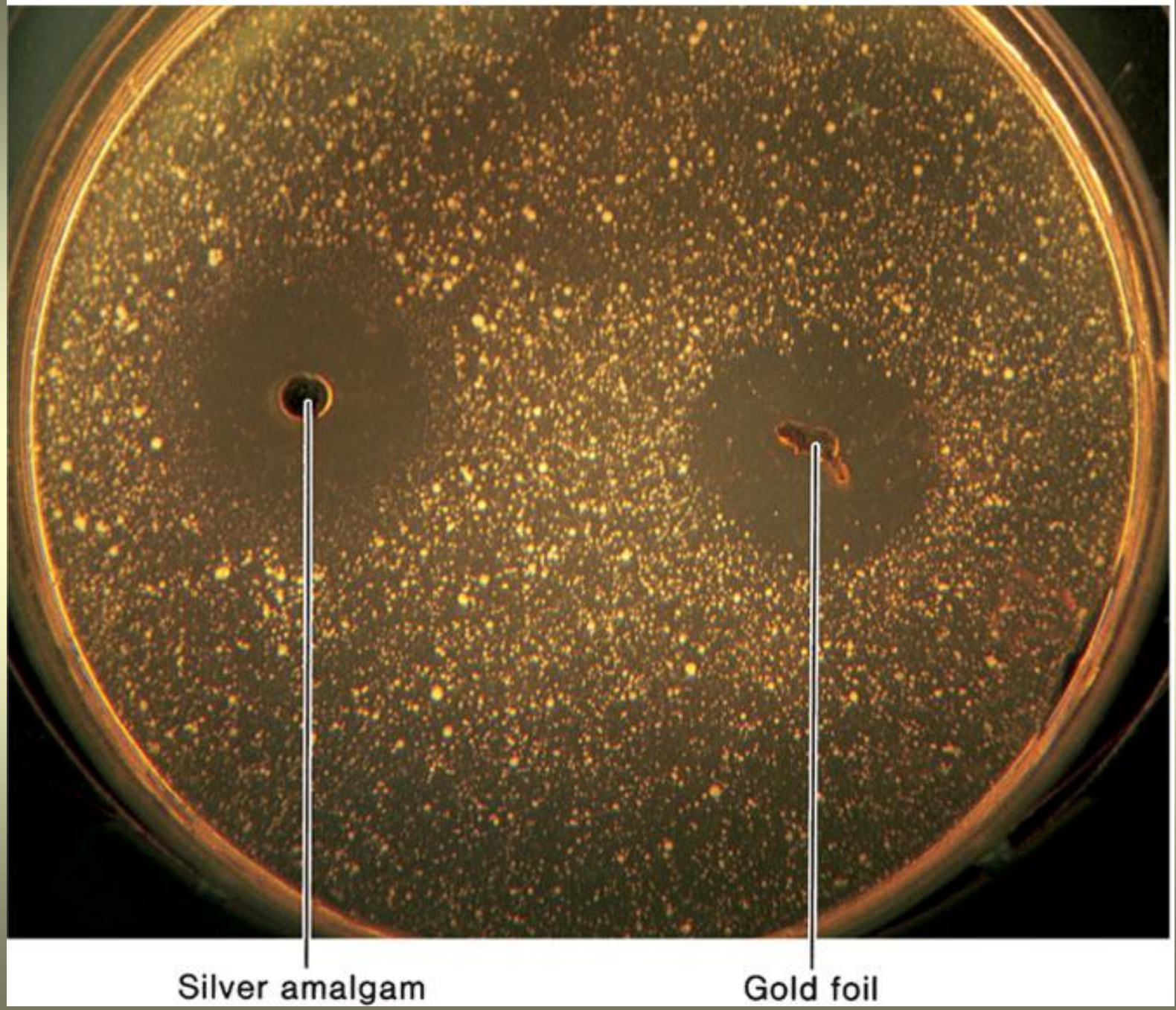
6. Detergents & soaps

- Quaternary ammonia compounds act as surfactants that alter membrane permeability of some bacteria & fungi
  - Not sporicidal
- Soaps- mechanically remove soil and grease containing microbes



7. Heavy metals

- Solutions of silver & mercury kill vegetative cells in low concentrations by inactivating proteins
- Oligodynamic action
- Not sporicidal

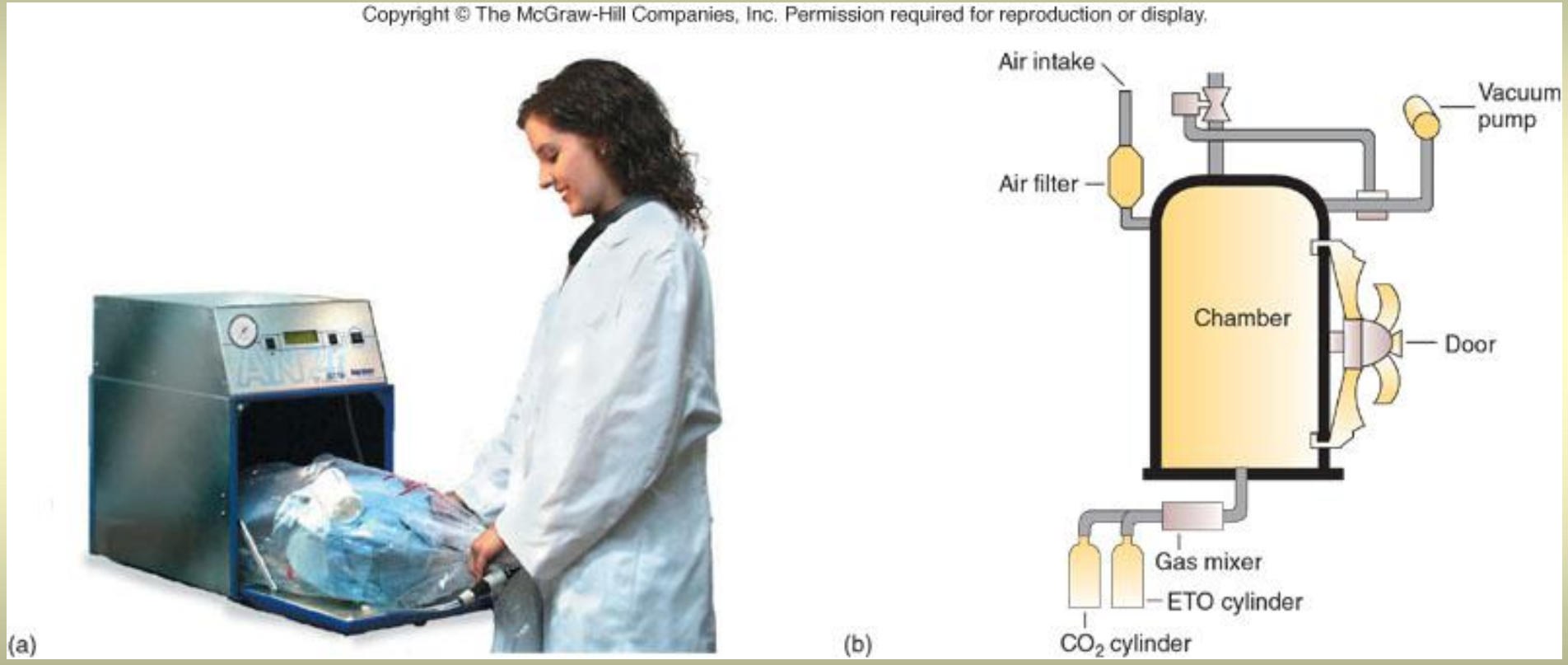


8. Aldehydes

- Glutaraldehyde & formaldehyde kill by alkylating protein & DNA
- glutaraldehyde in 2% solution (Cidex) used as sterilant for heat sensitive instruments
- formaldehyde - disinfectant, preservative, toxicity limits use

Gases & aerosols

- Ethylene oxide, propylene oxide, betapropiolactone & chlorine dioxide
- Strong alkylating agents, sporicidal



When germ relationships go bad