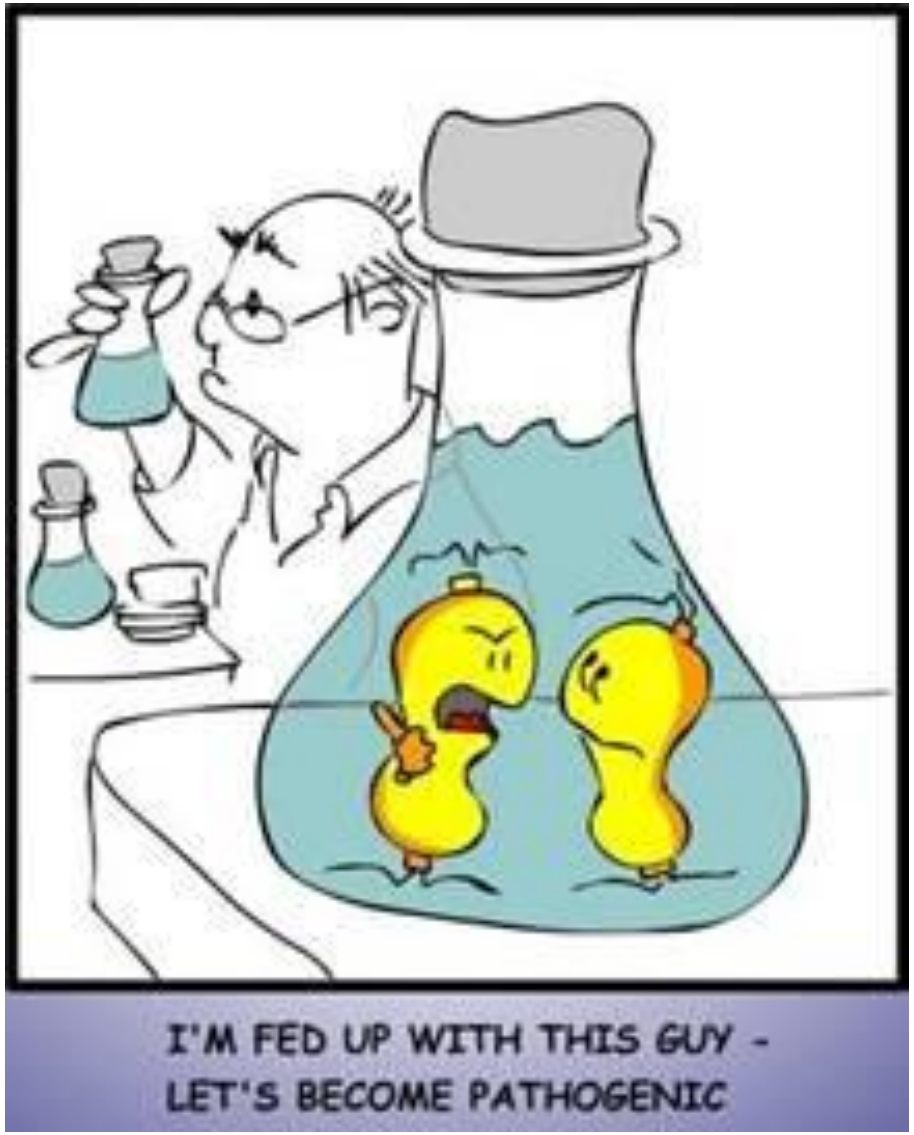
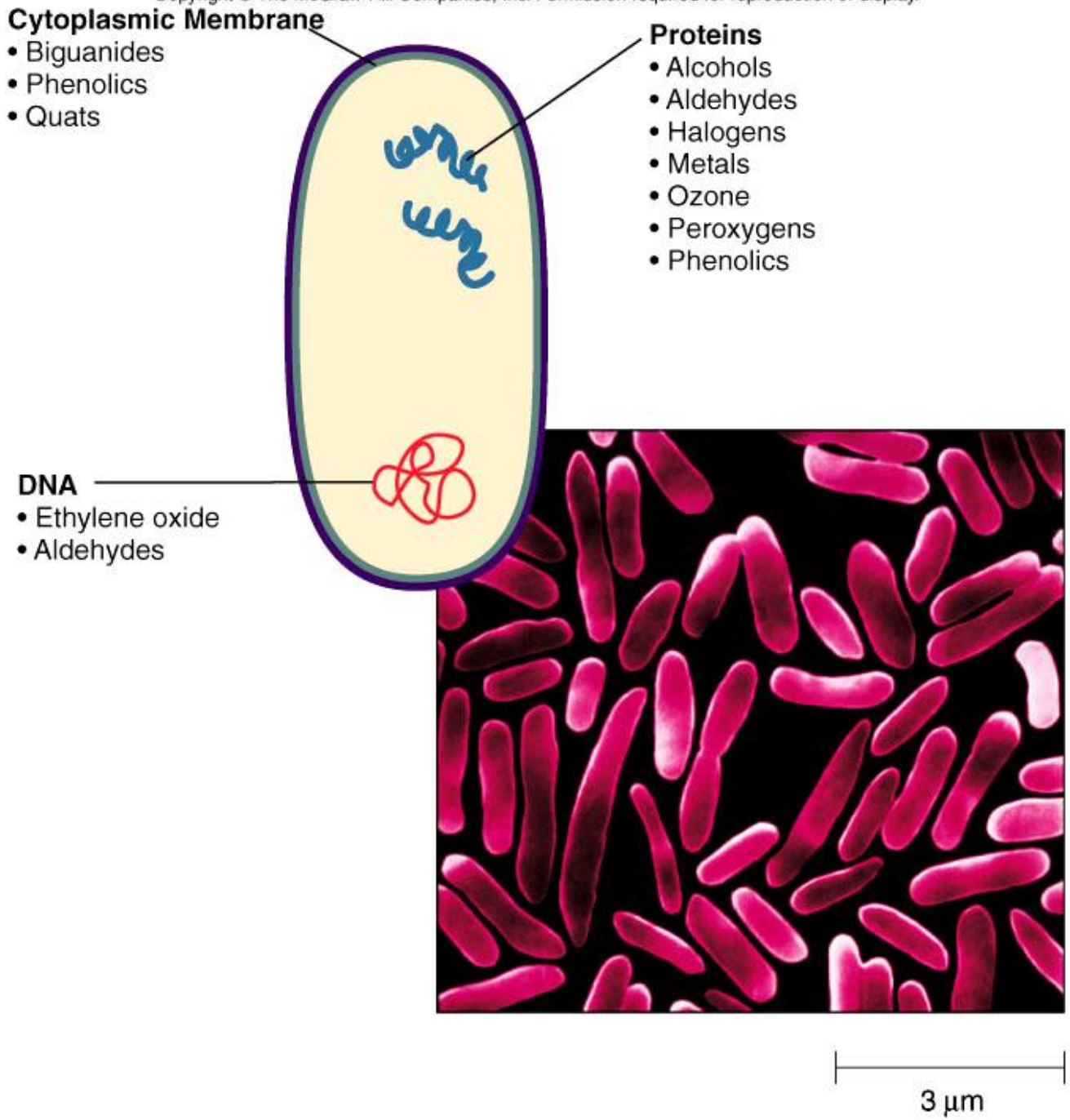
# Growth Control



**Antibiotic**

Naturally occurring or synthetic organic compounds which inhibit or destroy selective bacteria, generally at low concentrations.



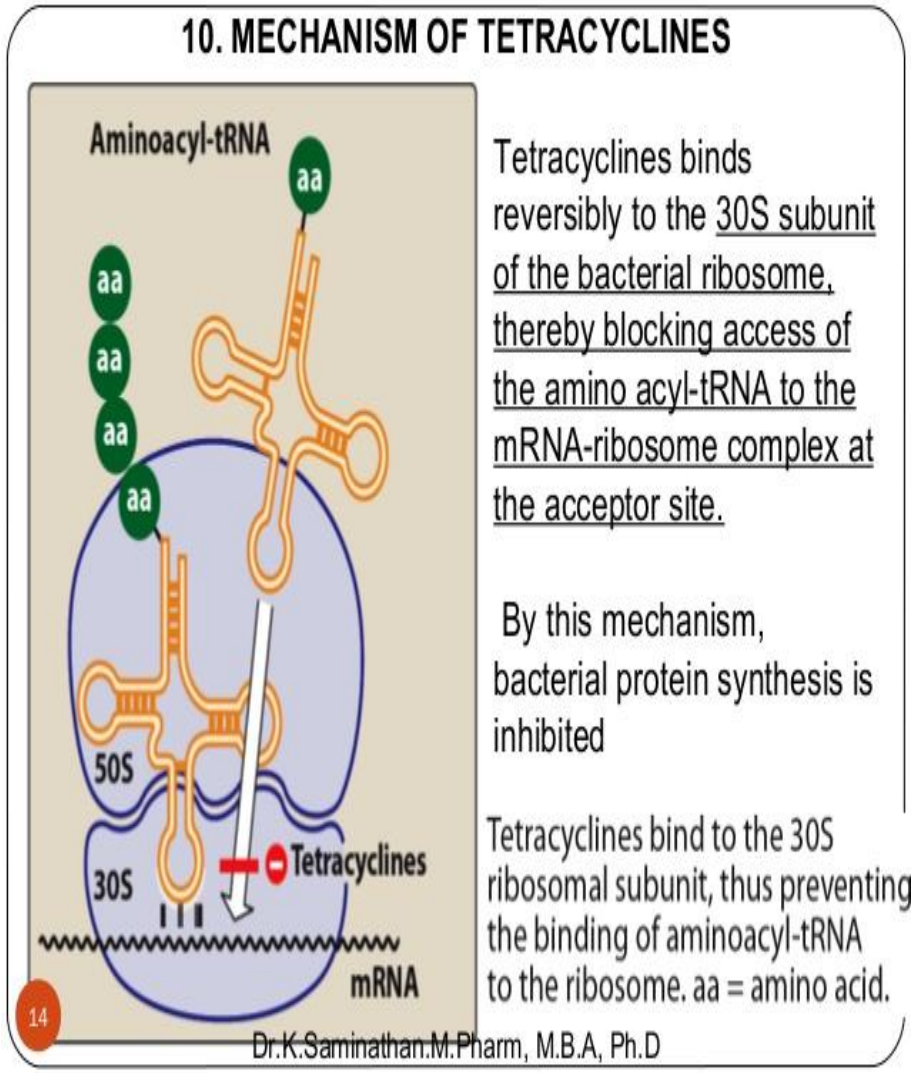
# Modes of Action

## Damage to DNA

- Quinolones are a key group of antibiotics that interfere with DNA synthesis by inhibiting topoisomerase, an enzyme involved in DNA replication. The fluoroquinolones, second-generation quinolones that include levofloxacin, norfloxacin, and ciprofloxacin, are active against both Gram-negative and Gram-positive bacteria.
- Topoisomerases are present in both prokaryotic and eukaryotic cells, but the quinolones are specific inhibitors of bacterial topoisomerase II.
- Inhibitors that are effective against mammalian topoisomerases, such as irinotecan and etoposide, are used as antineoplastic drugs to kill cancer cells.

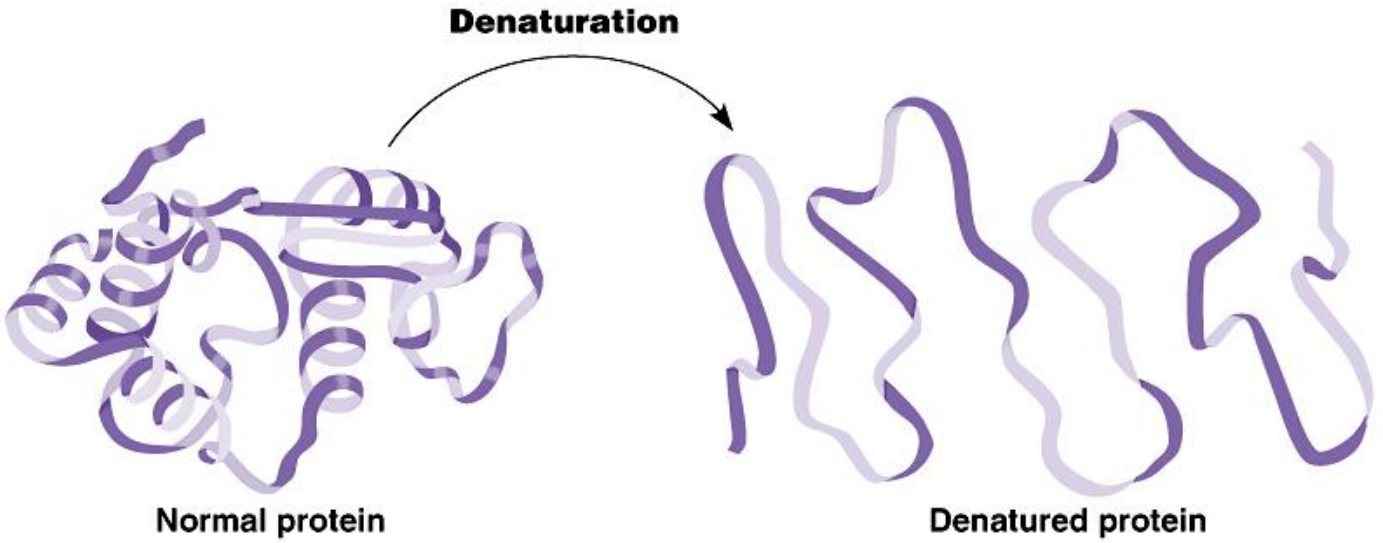
- A number of physical and chemical agents act by damaging DNA.
- Ionizing radiations, ultraviolet light, and DNA-reactive chemicals.
- Among the last category are alkylating agents and other compounds that react covalently with purine and pyrimidine bases to form DNA adducts or interstrand cross-links.
- Ultraviolet light induces cross-linking between adjacent pyrimidines on one or the other of the two polynucleotide strands, forming pyrimidine dimers.

# Protein denaturation




- Protein synthesis is a complex, multi-step process involving many enzymes as well as conformational alignment. However, the majority of antibiotics that block bacterial protein synthesis interfere with the processes at the 30S subunit or 50S subunit of the 70S bacterial ribosome.

- Proteins exist in a folded, three-dimensional state determined by intramolecular covalent disulfide linkages and a number of noncovalent linkages such as ionic, hydrophobic, and hydrogen bonds.
- This state is called the tertiary structure of the protein; it is readily disrupted by a number of physical or chemical agents, causing the protein to become nonfunctional. The disruption of the tertiary structure of a protein is called protein denaturation.



# Disruption of Cell Membrane or Wall

- Specific antibacterials interfere with the synthesis of the cell wall, weakening the peptidoglycan scaffold within the bacterial wall so that the structural integrity eventually fails. Since mammalian cells have a plasma membrane but lack the peptidoglycan wall structure, this class of antibacterials selectively targets the bacteria with no significant negative effect on the cells of the mammalian host.

# Physical Agents

**Heat**

- A temperature of 100°C will kill all but spore forms of bacteria within 2–3 minutes in laboratory-scale cultures.
- A temperature of 121°C for 15 minutes is utilized to kill spores.
- Steam is generally used, both because bacteria are more quickly killed when moist and because steam provides a means for distributing heat to all parts of the sterilizing vessel.
- heat acts by denaturing cell proteins and nucleic acids and by disrupting cell membranes

## Radiation

- Ultraviolet light and ionizing radiations have various applications as sterilizing agents.

# Chemical Agents

**Alcohols**

- Ethyl alcohol, isopropyl alcohol, and *n*-propanol exhibit rapid, broad-spectrum antimicrobial activity against vegetative bacteria, viruses, and fungi but are not sporicidal. Activity is optimal when they are diluted to a concentration of 60–90% with water.

## Aldehydes

- Glutaraldehyde is used for low-temperature disinfection and sterilization of endoscopes and surgical equipment. It is normally used as a 2% solution to achieve sporicidal activity. Formaldehyde is bactericidal, sporicidal, and virucidal.

## Biguanides

- Chlorhexidine is widely used in hand washing and oral products and as a disinfectant and preservative. Mycobacteria are generally highly resistant.

## Bisphenols

- The bisphenols are widely used in antiseptic soaps and hand rinses. In general, they are broad-spectrum but have little activity against *Pseudomonas aeruginosa* and molds. Triclosan and hexachlorophene are bactericidal and sporostatic.

## Halogen-Releasing Agents

- The most important types of chlorine-releasing agents are sodium hypochlorite, chlorine dioxide, and sodium dichloroisocyanurate, which are oxidizing agents that destroy the cellular activity of proteins.
- Hypochlorous acid is the active compound responsible for the bactericidal and virucidal effect of these compounds. At higher concentrations, these compounds are sporicidal.
- Iodine is rapidly bactericidal, fungicidal, tuberculocidal, virucidal, and sporicidal. Iodophors (eg, povidone-iodine) are complexes of iodine and a solubilizing agent or carrier, which acts as a reservoir of the active $I_2$.

## Heavy Metal Derivatives

- Silver sulfadiazine, a combination of two antibacterial agents, $Ag^{+}$ and sulfadiazine, has a broad spectrum of activity. Binding to cell components such as DNA may be responsible for its inhibitory properties.

## Organic Acids

- Organic acids are used as preservatives in the pharmaceutical and food industries. Benzoic acid is fungistatic; propionic acid is both bacteriostatic and fungistatic.

## Peroxygens

- Hydrogen peroxide has broad-spectrum activity against viruses, bacteria, yeasts, and bacterial spores. Sporicidal activity requires higher concentrations (10–30%) of $H_2O_2$ and longer contact times.

## Phenols

- Phenol and many phenolic compounds have antiseptic, disinfectant, or preservative properties.

## Quaternary Ammonium Compounds

- These compounds have two regions in their molecular structures, one a water-repelling (hydrophobic) group and the other a water-attracting (hydrophilic) group.
- Cationic detergents, as exemplified by quaternary ammonium compounds (QACs), are useful antiseptics and disinfectants.
- QACs have been used for a variety of clinical purposes (eg, preoperative disinfection of unbroken skin) as well as for cleaning hard surfaces. They are sporostatic; they inhibit the outgrowth of spores but not the actual germination process. QACs are also mycobacteriostatic and have an effect on lipid-enveloped but not lipid-nonenveloped viruses.