جامعة الانبار
كلية العلوم

قسم التقنيات الاحيائية
المادة: الاحياء المجهرية

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المرحلة : الثانية

The Control of Microbial Growth

The Terminology of Microbial Control

1. The control of microbial growth can prevent infections and food spoilage.
2. Sterilization is the process of removing or destroying all microbial life on an object.
3. Commercial sterilization is heat treatment of canned foods to destroy C. *botulinum* endospores.
4. Disinfection is the process of reducing or inhibiting microbial growth on a nonliving surface.
5 . Antisepsis is the process of reducing or inhibiting microorganisms on living tissue.
6. The suffix - *cide* means to kill; the suffix *-stat* means to inhibit.
7. Sepsis is bacterial contamination.

The Rate of Microbial Death

I. Bacterial populations subjected to heat or antimicrobial chemicals usually die at a constant rate.
2. Such a death curve, when plotted logarithmi· cally, shows this constant death rate as a straight line.
3. The time it takes to kill a microbial population is proportional to the number of microbes.
4. Microbial species and life cycle phases (e.g., endospores) have different susceptibilities to physical and chemical controls.
5. Organic matter may interfere with heat treatments and chemical control agents.
6. Longer exposure to lower heat can produce the same effect as shorter time at higher heat

Actions of Microbial Control Agents

Alteration of Membrane Permeability

I. The susceptibility of the plasma membrane is due to its lipid and

protein components.
2. Certain chemical control agents damage the plasma membrane by altering its permeability.

Damage to Proteins and Nucleic Acids

3. Some microbial control agents damage cellular proteins by breaking hydrogen bonds and covalent bonds.
4. Other agents interfere with DNA and RNA and protein synthesis.

Physical Methods of Microbial Control

Heat

I. Heat is frequently used to kill microorganisms.
2. Moist heat kills microbes by denaturing enzymes.
3. Thermal death point (TDP) is the lowest temperature at which all the microbes in a liquid culture will be killed in 10 minutes.
4. Thermal death time (TDT) is the length of time required to kill all bacteria in a liquid culture at a given temperature.
5. Decimal reduction time (DRT) is the length of time in which 90% of a bacterial population will be killed at a given temperature.
6. Boiling (I 00C) kills many vegetative cells and viruses within 10 minutes.
7. Autoclaving (steam under pressure) is the most effective method of moist heat sterilization. The steam must directly contact the material to be sterilized .
8. In HTST pasteurization, a high temperature is used for a short time (72 C for 15 seconds) 10 destroy pathogens without altering the flavor of the food. Ultra-high -temperature (UHT) treatment (I40 C for 4 seconds) is used to sterilize dairy products.
9. Methods of dry heat sterilization include direct flaming, incineration, and hot-air sterilization. Dry heat kills by oxidation.
10. Different methods that produce the same effect (reduction in microbial growth) are called equivalent treatments.

Filtration

11. Filtration is the passage of a liquid or gas through a filter with pores small enough to retain microbes.
12. Microbes can be removed from air by high-efficiency particulate air (HEPA) filters.

13. Membrane filters composed of cellulose esters are commonly used to filter out bacteria, viruses, and even large proteins.

Low Temperatures

14. The effectiveness of low temperatures depends on the particular microorganism and the intensity of the application.
15. Most microorganisms do not reproduce at ordinary refrigerator temperatures (0-7C) .
16. Many microbes survive (but do not grow) at the subzero temperatures used to store foods

High Pressure

17. High pressure denatures proteins in vegetative cells.

Desiccation

18. In the absence of water, microorganisms cannot grow but can remain viable.
19. Viruses and endospores can resist desiccation.

Osmotic Pressure

20. Microorganisms in high concentrations of salts and sugars undergo plasmolysis.
21. Molds and yeasts are more capable than bacteria of growing in materials with low moisture or high osmotic pressure.

Radiation

22. The effects of radiation depend on its wavelength, intensity, and duration .
23. Ionizing radiation (gamma rays, X rays, and high-energy electron beams) has a high degree of penetration and exerts its effect primarily by ionizing water and forming highly reactive hydroxyl radicals.
24. Ultraviolet (UV) radiation, a form of nonionizing radiation, has a low degree of penetration and causes cell damage by making thymine dimers in DNA that interfere with DNA replication; the most effective germicidal wavelength is 260 nm.
25. Microwaves can kill microbes indirectly as materials get hot.

Chemical Methods of Microbial Control

1. Chemical agents are used on living tissue (as antiseptics) and on inanimate objects (as disinfectants).
2. Few chemical agents achieve sterility.

Principles of Effective Disinfection

3. Careful attention should be paid to the properties and concentration of the disinfectant to be used.
4. The presence of organic matter, degree of contact with microorganisms, and temperature should also be considered.

Evaluating a Disinfectant

5. In the use-dilution test, bacterial survival in the manufacturer's recommended dilution of a disinfectant is determined.
6. Viruses, endospore-forming bacteria, mycobacteria, and fungi can also be used in the use-dilution test.
7. In the disk-diffusion method, a disk of filte r paper is soaked with a chemical and placed on an inoculated agar plate; a zone of inhibition indicates effectiveness.

Types of Disinfectants

Phenol and Phenolics

8. Phenolics exert their action by injuring plasma membranes.

Bisphenols

9. Bisphenols such as tridosan (over the counter) and hexachlorophene (prescription) are widely used in household products.

Biguanides

10. Biguanides damage plasma membranes of vegetative cells.

Halogens

11. Some halogens (iodine and chlorine) are used alone or as components of inorganic or organic solutions.
12. Iodine may combine with certain amino acids to inactivate enzymes and other cellular proteins.
13. Iodine is available as a tincture (in solution with alcohol) or as an iodophor (combined with an organic molecule).
14. The germicidal action of chlorine is based on the formation of hypochlorous acid when chlorine is added to water.

Alcohols

15. Alcohols exert their action by denaturing proteins and dissolving lipids.
16. In tinctures, they enhance the effectiveness of other antimicrobial chemicals.

17. Aqueous ethanol (60-95%) and isopropanol are used as disinfectants.

Heavy Metals and Their Compounds

18. Silver, mercury, copper, and zinc are used as germicides.
19. They exert their antimicrobial action through oligodynamic action. When heavy metal ions combine with sulfhydryl (-SH) groups, proteins are denatured.

Surface-Active Agents

20. Surface-active agents decrease the surface tension among molecules of a liquid; soaps and detergents are examples.
21. Soaps have limited germicidal action but assist in removing . . microorganisms.
22. Acid-anionic detergents are used to dean dairy equipment.
23. Quats are cationic detergents attached to NH4 +.
24. By disrupting plasma membranes, quats allow cytoplasmic constituents to leak out of the cell.
25. Quats are most effective against gram-positive bacteria.

Chemical Food Preservatives

26. S02, sorbic acid, benzoic acid, and propionic acid inhibit fungal metabolism and are used as food preservatives.

27. Nitrate and nitrite salts prevent germination of C. *botulinum* endospores in meats.

Antibiotics

28. Nisin and natamycin are anibiotics used to preserve foods, especially cheese.

Aldehydes

29. Aldehydes such as formaldehyde and glutaraldehyde exert their antimicrobial effect by inactivating proteins.

30. They are among the most effective chemical disinfectants.

Chemical Sterilization

31. Ethylene oxide is the gas most frequently used for sterilization.
32. It penetrates most materials and kills all microorganisms by protein denaturation.

Plasmas

33. Free radicals in plasma gases are used to sterilize plastic instruments.

Supercritical Fluids

34. Supercritical fluids, which have properties of liquid and gas, can sterilize at low temperatures.

Peroxygens and Other Forms of Oxygen

35. Hydrogen peroxide, peracetic acid, benzoyl peroxide, and ozone exert their antimicrobial effect by oxidizing molecules inside cells.

Microbial Characteristics and Microbial Control

I . Gram-negative bacteria are generally more resistant than gram-positive bacteria to disinfectants and antiseptics.
2. Mycobacteria, endospores, and protozoan cysts and oocysts are very resistant to disinfectants and antiseptics.
3. Nonenveloped viruses are generally more resistant than enveloped viruses to disinfectants and antiseptics.
4. Prions are resistant to disinfection and autoclaving.

References': 1- Microbiology an introduction TWELFTH EDITION. Gerard. Tortora.2016.

2- Microbiology an introduction TENTH EDITION. Gerard. Tortora.2010.