

Study Outline Chapter 28

Food Microbiology (pp. 742- 749)

- The earliest methods of preserving foods were drying, the addition of salt or sugar, and fermentation.

Industrial Food Canning (pp. 742- 744)

- Commercial sterilization of food is accomplished by steam under pressure in a retort.
- Commercial sterilization heats canned foods to the minimum temperature necessary to destroy *Clostridium botulinum* endospores while minimizing alteration of the food.
- The commercial sterilization process uses sufficient heat to reduce a population of *C. botulinum* by 12 logarithmic cycles (12D treatment).
- Endospores of thermophiles can survive commercial sterilization.
- Canned foods stored above 45°C can be spoiled by thermophilic anaerobes.
- Thermophilic anaerobic spoilage is sometimes accompanied by gas production; if no gas is formed, the spoilage is called flat sour spoilage.
- Spoilage by mesophilic bacteria is usually from improper heating procedures or leakage.
- Acidic foods can be preserved by heat of 100°C because microorganisms that survive are not capable of growth in a low pH.
- *Byssoschlamys*, *Aspergillus*, and *Bacillus coagulans* are acid-tolerant and heat-resistant microbes that can spoil acidic foods.

Aseptic Packaging (p. 744)

- Presterilized materials are assembled into packages and aseptically filled with heat-sterilized liquid foods.

Radiation and Industrial Food Preservation (pp. 744- 745)

- Gamma radiation can be used to sterilize food, kill insects and parasitic worms, and prevent the sprouting of fruits and vegetables.

The Role of Microorganisms in Food Production (pp. 746- 749)

Cheese (pp. 746- 747)

- The milk protein casein curdles because of the action by lactic acid bacteria or the enzyme rennin.
- Cheese is the curd separated from the liquid portion of milk, called whey.
- Hard cheeses are produced by lactic acid bacteria growing in the interior of the curd.
- The growth of microbes in cheese is called ripening.
- Semisoft cheeses are ripened by bacteria growing on the surface; soft cheeses are ripened by *Penicillium* growing on the surface.

Other Dairy Products (p. 747)

- Old-fashioned buttermilk was produced by lactic acid bacteria growing during the butter-making process.

- Commercial buttermilk is made by letting lactic acid bacteria grow in skim milk for 12 hours.
- Sour cream, yogurt, kefir, and kumiss are produced by lactobacilli, streptococci, or yeasts growing in low-fat milk.

Nondairy Fermentations (pp. 747- 748)

- Sugars in bread dough are fermented by yeast to ethanol and CO₂; the CO₂ causes the bread to rise.
- Sauerkraut, pickles, olives, and soy sauce are products of microbial fermentations.

Alcoholic Beverages and Vinegar (pp. 748- 749)

- Carbohydrates obtained from grains, potatoes, or molasses are fermented by yeasts to produce ethanol in the production of beer, ale, sake, and distilled spirits.
- The sugars in fruits such as grapes are fermented by yeasts to produce wines.
- In wine-making, lactic acid bacteria convert malic acid into lactic acid in malolactic fermentation.
- Acetobacter and Gluconobacter oxidize ethanol in wine to acetic acid (vinegar).

Industrial Microbiology (pp. 750- 757)

Aquatic Microorganisms (pp. 725- 726)

- Microorganisms produce alcohols and acetone that are used in industrial processes.
- Industrial microbiology has been revolutionized by the ability of genetically engineered cells to make many new products.
- Biotechnology is a way of making commercial products by using living organisms.

Fermentation Technology (pp. 750- 753)

- The growth of cells on a large scale is called industrial fermentation.
- Industrial fermentation is carried on in bioreactors, which control aeration, pH, and temperature.
- Primary metabolites such as ethanol are formed as the cells grow (during the trophophase).
- Secondary metabolites such as penicillin are produced during the stationary phase (idiophase).
- Mutant strains that produce a desired product can be selected.

Immobilized Enzymes and Microorganisms (p. 753)

- Enzymes or whole cells can be bound to solid spheres or fibers. When substrate passes over the surface, enzymatic reactions change the substrate to the desired product.
- They are used to make paper, textiles, and leather and are environmentally safe.

Industrial Products (pp. 753- 756)

- Most amino acids used in foods and medicine are produced by bacteria.

- Microbial production of amino acids can be used to produce l-isomers; chemical production results in both d- and l-isomers.
- Lysine and glutamic acid are produced by *Corynebacterium glutamicum*.
- Citric acid, used in foods, is produced by *Aspergillus niger*.
- Enzymes used in manufacturing foods, medicines, and other goods are produced by microbes.
- Some vitamins used as food supplements are made by microorganisms.
- Vaccines, antibiotics, and steroids are products of microbial growth.
- The metabolic activities of *Thiobacillus ferrooxidans* can be used to recover uranium and copper ores.
- Yeasts are grown for wine- and bread-making; other microbes (*Rhizobium*, *Bradyrhizobium*, and *Bacillus thuringiensis*) are grown for agricultural use.

Alternative Energy Sources Using Microorganisms (pp. 756-757)

- Organic waste, called biomass, can be converted by microorganisms into alternative fuels, a process called bioconversion.
- Fuels produced by microbial fermentation are methane and ethanol.

Industrial Microbiology and the Future (p. 757)

- Genetic engineering will continue to enhance the ability of industrial microbiology to produce medicines and other useful products.