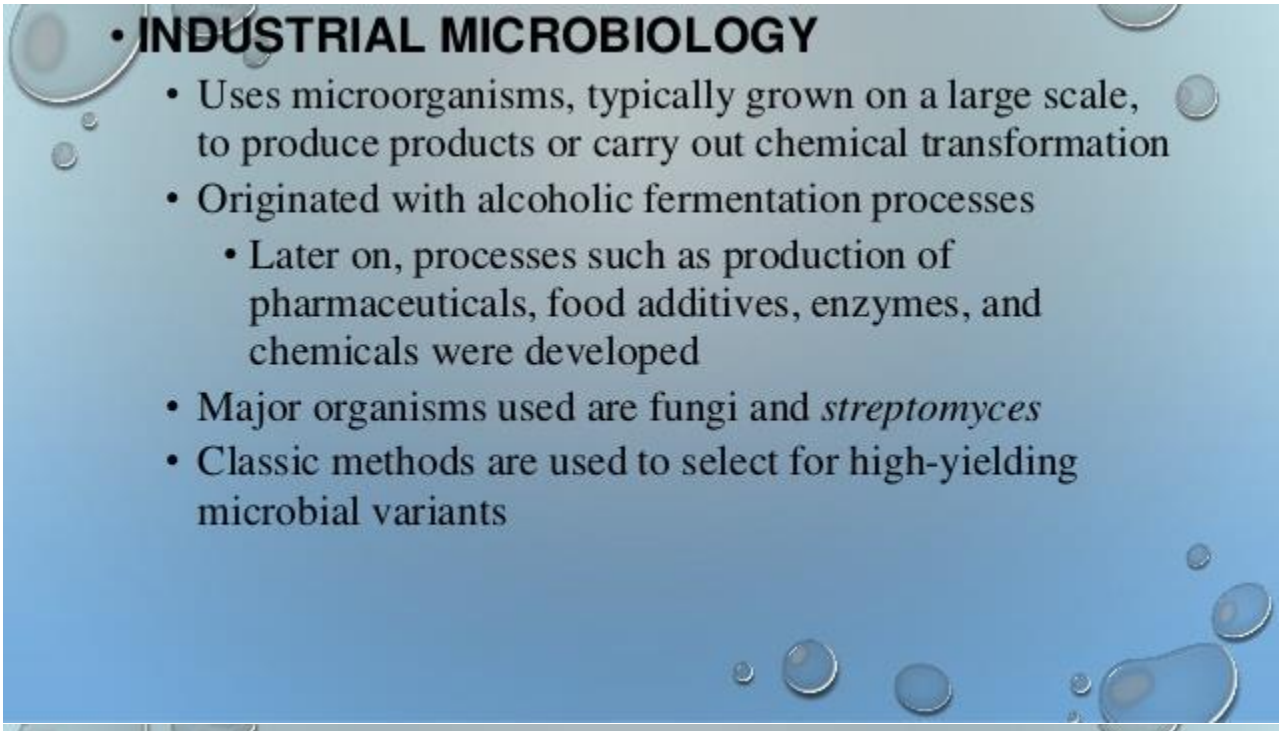
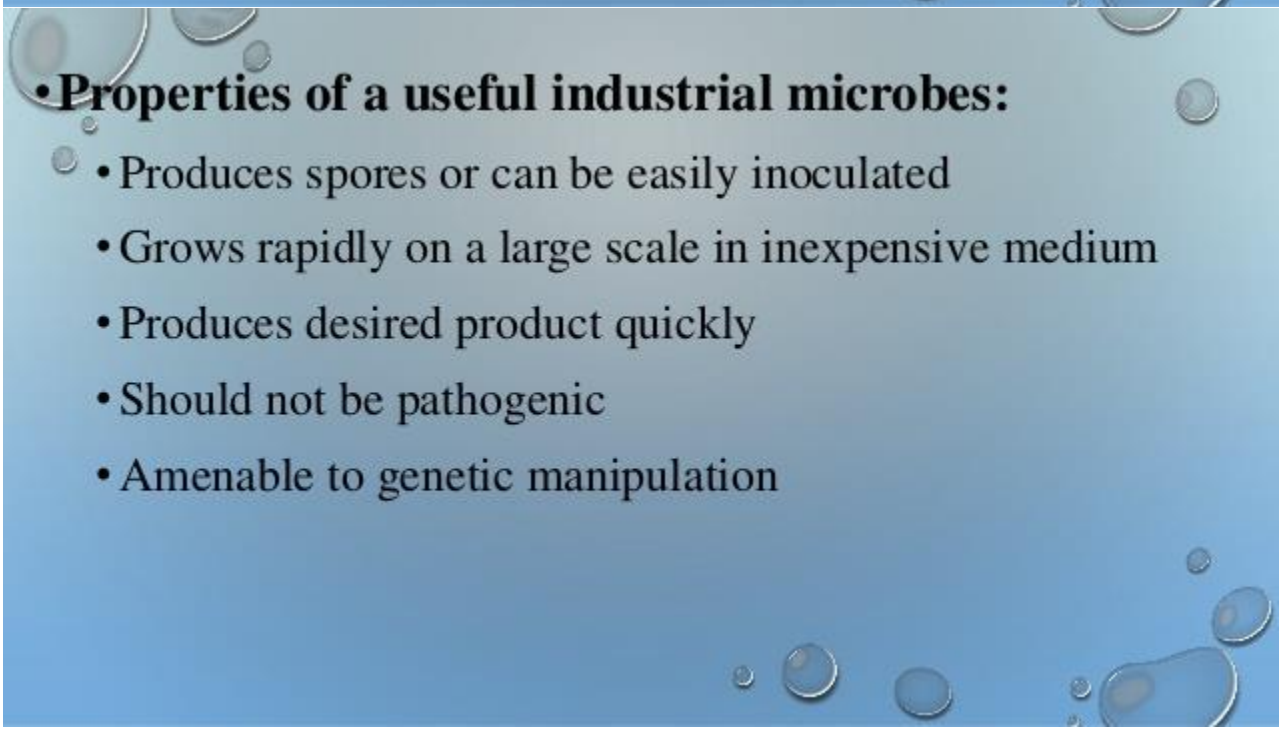
Industrial microbiology

- 



• Natural fermentation

- Micro-organisms found in the soil to improve agricultural productivity. Men use naturally occurring organisms to develop biofertilizers and bio-pesticides to assist plant growth and control weeds, pests, and diseases.
- Micro-organisms that live in the soil actually help plants to absorb more nutrients. Plants and these friendly microbes are involved in "nutrient recycling". The microbes help the plant to "take up" essential energy sources. In return, plants donate their waste by-products for the microbes to use for food. Scientists use these friendly micro-organisms to develop biofertilizers.

Bio-pesticides

Microorganisms found in the soil are all not so friendly to plants. These pathogens can cause disease or damage the plant. As scientists developed biological "tools," which use these disease-causing microbes to control weeds and pests naturally.

Bioinsecticides

Microbiology can also help in developing alternative controls to synthetic insecticides to fight against insect pests. Micro-organisms in the soil that will attack fungi, viruses or bacteria, which cause root diseases. Formulas for coatings on the seed (inoculants) which carry these beneficial organisms can be developed to protect the plant during the critical seedling stage.

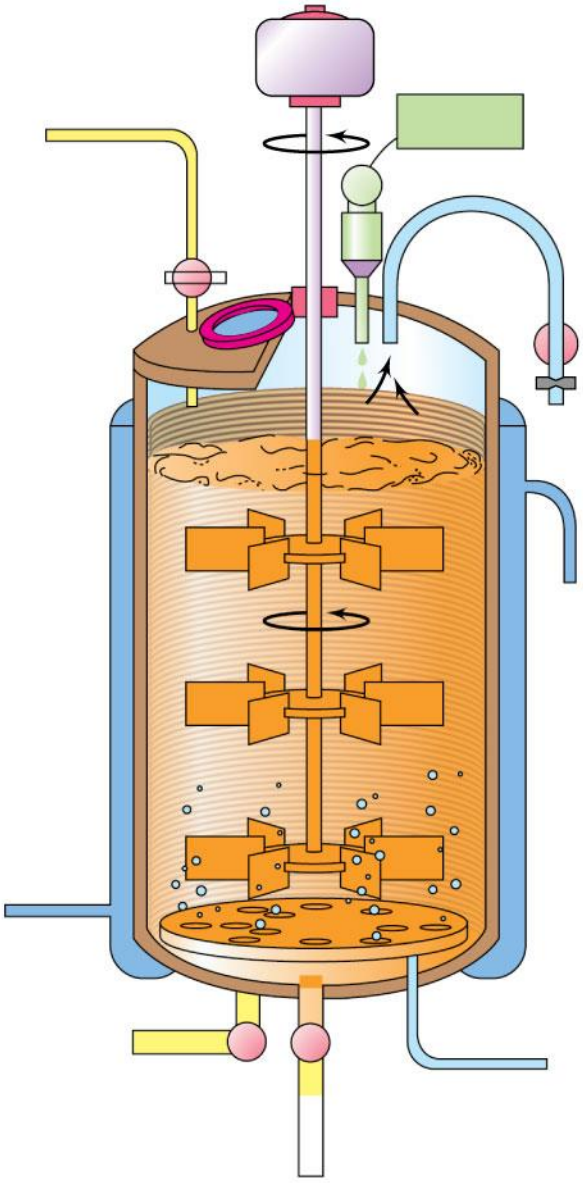
- # Industrial Products and the Microorganisms That Make Them
- **Microbial products of industrial interest include**
  - Microbial cells
  - Enzymes
  - Antibiotics, steroids, alkaloids
  - Food additives
  - *Commodity chemicals*

Inexpensive chemicals produced in bulk include ethanol, citric acid, and many others

- # Production and scale
- *Primary metabolite*
  - Produced during exponential growth
  - Example: alcohol
- *Secondary metabolite*
  - Produced during stationary phase

- *Secondary metabolites*
  - Not essential for growth
  - Formation depends on growth conditions
  - Produced as a group of related compounds
  - Often significantly overproduced
  - Often produced by spore-forming microbes during sporulation
- ***Fermentor* is where the microbiology process takes place (Figure 15.2a and b)**
- **Any large-scale reaction is referred to as a fermentation**
  - **Most are aerobic processes**
- **Fermentors vary in size from 5 to 500,000 liters**
  - **Aerobic and anaerobic fermenters**

- **Large-scale fermenters are almost always stainless steel**



(b)

Antibiotics: Isolation, Yield, and Purification

- Compounds that kill or inhibit the growth of other microbes
- Typically secondary metabolites
- Most antibiotics in clinical use are produced by filamentous fungi or actinomycetes
- Still discovered by laboratory screening
  - Microbes are obtained from nature in pure culture
  - Assayed for products that inhibit growth of test bacteria

Industrial Production of Penicillins and Tetracyclines

- Penicillins are *β-lactam antibiotics*
  - *Natural* and *biosynthetic penicillins*

- *Semisynthetic penicillins*
  - *Broad spectrum* of activity

- Penicillin production is typical of a secondary metabolite
  - Production only begins after near-exhaustion of carbon source

Vitamins and Amino Acids

- Production of vitamins is second only to antibiotics in terms of total pharmaceutical sales

  -Vitamin B_{12} produced exclusively by microorganisms.

  - Deficiency results in *pernicious anemia*
  - Cobalt is present in B_{12}

  -Riboflavin can also be produced by microbes.

- *Amino acids*
  - Used as feed additives in the food industry
  - Used as nutritional supplements in nutraceutical industry
  - Used as starting materials in the chemical industry
  - Examples include
    Glutamic acid (MSG)
    Aspartic acid and phenylalanine
    Aspartame(Nutrasweet)
    Lysine (food additives;

Enzymes as Industrial Products

- Exoenzymes
  - Enzymes that are excreted into the medium instead of being held within the cell; they are extracellular
  - Can digest insoluble polymers such as cellulose, protein, and starch
- Enzymes are useful as industrial catalysts
  - Produce only one stereoisomer
  - High substrate specificity
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Alcoholic Beverages and Biofuels

- Wine
- Brewing and Distilling
- Biofuels

- Most wine is made from grapes
- Wine fermentation occurs in fermentors ranging in size from 200 to 200,000 liters
    - Fermentors are made of oak, cement, glass-lined steel, or stone

Biofuels

- Ethanol Biofuels
  - Ethanol is a major industrial commodity chemical
  - Over 60 billion liters of alcohol are produced yearly from the fermentation of feedstocks
  - Gasohol and E-85
- Petroleum Biofuels
  - Production of butanol
  - Synthesis of petroleum from green algae

Products from Genetically Engineered Microorganisms

- Expressing Mammalian Genes in Bacteria
- Production of Genetically Engineered Somatotropin
- Other Mammalian Proteins and Products
- Genetically Engineered Vaccines
- Mining Genomes
- Engineering Metabolic Pathways