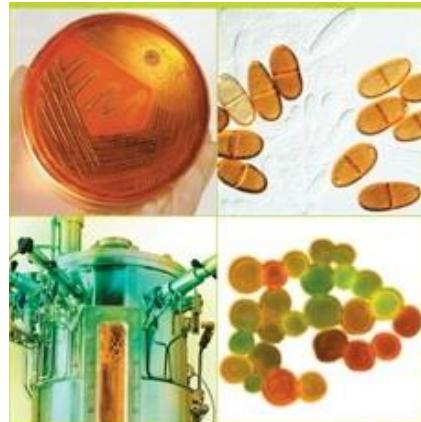


# MICROBES IN INDUSTRY

## INDUSTRIAL PROCESS – USING MICROBES

- Yeast and bacteria are used in producing medicines
- Microbes are used in food production and they play significant roles in food spoilage and contamination
- Many Agriculture processes use microbes such as
  - Bacteria are used to digest grasses and other fodder
  - to make silage, a feed material that can be stored for use during winter months
  - A bacterial compound is used to increase digestion efficiency in dairy cattle
  - Microbes are being used as insecticides for crops
  - Microbes are used as pesticides, herbicides, and fungicides
- Microbes are used to help clean up oil spills by oxidizing the hydrocarbons
- Microbes are used as biocatalysts for production of organic acids, steroid hormones, antibiotics, precious metal recovery and bioleaching of metals to recover minerals from low grade ores.
- Manufacture of Biofuels and other energy products is done using microbes
- Microbes are in many probiotic products (consumables containing microbes that are believed to offer health benefits)
- Microbes are used in clean up operations for pollution
- Wastewater Treatment uses microbes
- Bacterial ice nucleation proteins are used in snow manufacture



## INDUSTRIAL PRODUCTS – Microbes are used in the production of many products

Most antibiotics are made by microbes. Recombinant microbes are being used to make pharmaceutical products and some vaccines. Microbes are used as pesticides and can be sprayed on plants or recombined into the plant's genome to kill many pests.

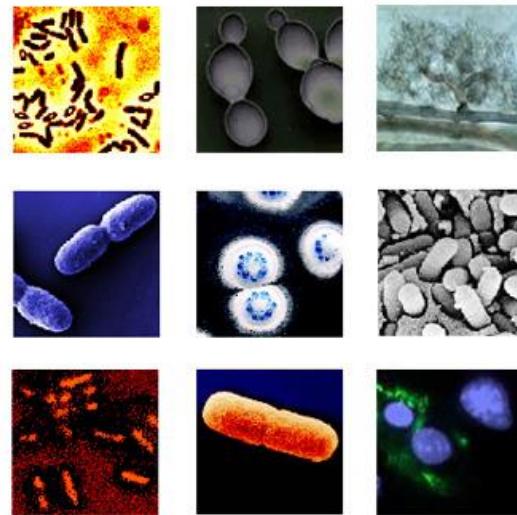
### Therapeutic agents

- Antibiotics
- Hormones: insulin, human growth hormone, somatostatin, interferons
- Epidermal growth factor
- Insulin
- Platelet-derived growth factor
- Proinsulin
- Fibroblast growth factor
- Blood coagulating factors
- Transgenic plants and animals



## Commercial pharmacological and biotech products

- Vitamins
- Amino acids
- Nucleic acids
- Antibiotics
- Alkaloids
- Steroids
- Non-Steroid Hormones/cell regulators (cytokines):
  - Epidermal growth factor
  - Proinsulin
  - Insulin
  - Human growth hormone
  - Somatostatin
  - Interferons
  - Platelet-derived growth factor
  - Fibroblast growth factor
  - Tumor Necrosis Factor
- Blood coagulating factors
- Transgenic plants and animals
- restriction enzymes
- vaccine antigens
- cytokines – interferons, interleukins, and other cytokines
- monoclonal antibodies
- Plasmids
- Enzymes
- Other enzymes (e.g. ligase, DNA polymerases etc.) for use in molecular biological research



## OTHER INDUSTRIAL APPLICATION OF MICROBES

### Samples of Organic Chemicals made commercially by microbes

- 2,3, butanediol; buttery taste
- Enzymes
- Organic acids such as citric, lactic, ascorbic (vitamin C), acetic for use in both as foods and in industrial chemical processes.
- Polysaccharides
- Poly-beta hydroxybutyric acid
- Methane
- Hydrogen
- Biological pesticides

### Other Industries use microbes in the manufacture of:

- Bio Sensors – to measure pollutants and sensors
- Electronics
- Jet fuel
- Paper Production
- Paints
- Textiles and Leather Goods
- Metals and concretes



- Petroleum
- Biodegradable plastics

**Bioremediation** – The use of microbes to remove pollutants from the environment

**The principles involved include**

- (1) isolate microbes that can **degrade** or eat a particular pollutant
- (2) to provide the conditions whereby it can do this to eliminate that pollutant.

Industrial wastes polluting our environment

The ones colored **red** are carcinogenic/toxic,

- Gasoline
- Lead
- DDT
- **Phenol**
- **Chloroform**
- **Carbon tetrachloride**
- **Motor oils**
- **Raw petroleum**
- **Benzene**

**Pulp and Paper Industry** – use microbes to degrade pollutants

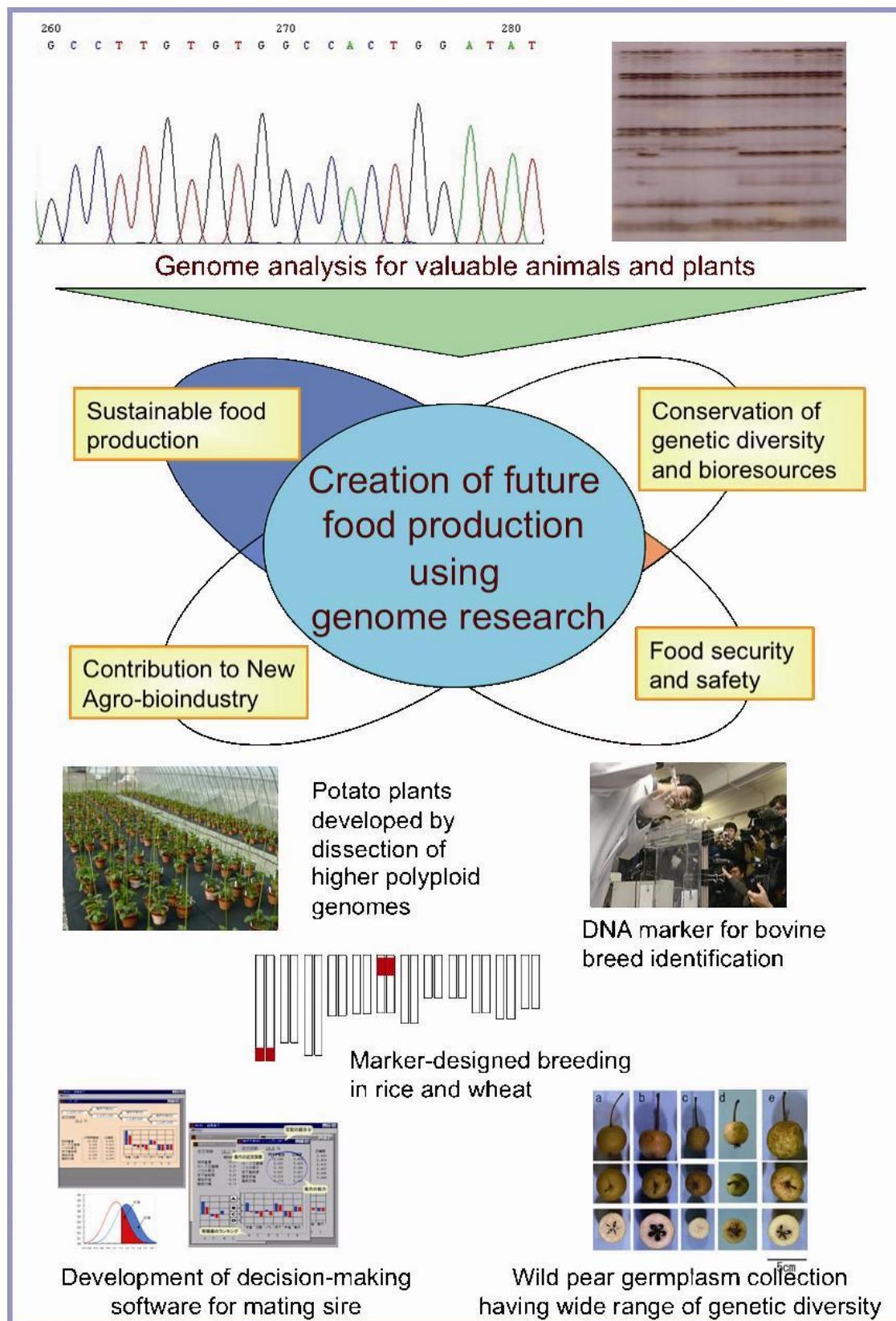
The pulp and paper industry are largest among most polluting industries. Conventionally the process of paper manufacturing was purely chemical and mechanical. A large quantity of lignocellulosic material is processed every year that results in more pollutional load on to the environment. But as the research focuses to reduce this environmental pollution load by limiting the chemical use, new options emerged from degrading capabilities of microbes & their enzymes and then various chemical process were replaced by biotechnological ones. The use of enzymes in the pulp and paper industry has grown rapidly in the biotechnology scientific era. Many applications of enzymes in the pulp and paper industry are still unknown and are in the preliminary stage of development.

Paper is manufactured from pulped wood fibers, fillers, pigments and flocculent additives. Fillers such as clays or chalk are added to make the paper opaque. Dyes and pigments, such as titanium dioxide, are added to modify the brightness of the finished product. Improving the retention of these constituents is prime importance during the paper making process

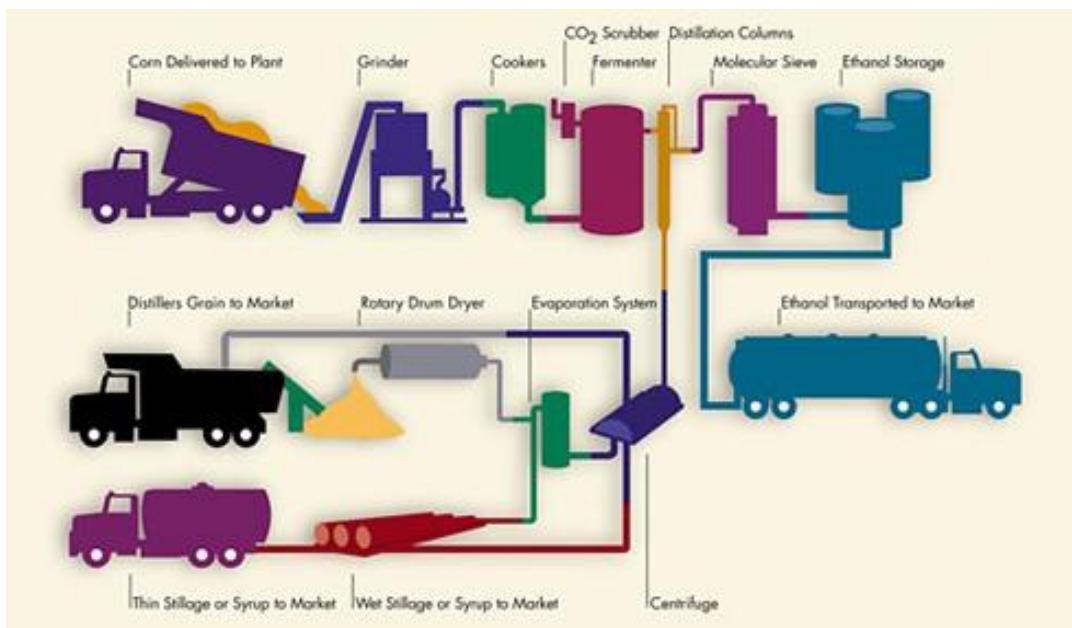


# Example of Using Microbes in Industry

## Biotechnology



## Ethanol Production



In dry milling, the entire starchy grain kernel is first ground into flour, which is referred to in the industry as "meal" and processed without separating out the various component parts of the grain. The meal is slurried with water to form a "mash." Enzymes are added to the mash to convert the starch to dextrose, a simple sugar. Ammonia is added for pH control and as a nutrient to the yeast.

The mash is processed in a high-temperature cooker to reduce bacteria levels ahead of fermentation. The mash is cooled and transferred to fermenters where yeast is added and the conversion of sugar to ethanol and carbon dioxide ( $\text{CO}_2$ ) begins.

The fermentation process generally takes about 40 to 50 hours. During this part of the process, the mash is agitated and kept cool to facilitate the activity of the yeast. After fermentation, the resulting "beer" is transferred to distillation columns where the ethanol is separated from the remaining "stillage." The ethanol is concentrated to 190 proof using conventional distillation and then is dehydrated to approximately 200 proof in a molecular sieve system.

The anhydrous ethanol is then blended with about 5% denaturant (such as natural gasoline) to render it undrinkable and thus not subject to beverage alcohol tax. It is then ready for shipment to gasoline terminals or retailers.

The stillage is sent through a centrifuge that separates the coarse grain from the solubles. The solubles are then concentrated to about 30% solids by evaporation, resulting in Condensed Distillers Solubles (CDS) or "syrup." The coarse grain and the syrup are then dried together to produce dried distillers grains with solubles (DDGS), a high quality, nutritious livestock feed.