




Use of Microbes in Industry



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○ Properties of useful industrial microorganism:

- Produces spores or can be easily inoculated
 - Grows rapidly on a large scale in inexpensive medium
 - Produces desired product quickly
 - Should not be pathogenic
 - Amenable to genetic manipulation
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▶ **Industrial product:**

- 1. Beverages**
- 2. Antibiotics**
- 3. Organic acids**
- 4. Amino Acids**
- 5. Enzymes**
- 6. Vitamins**
- 7. Organic solvents**
- 8. Single Cell Protein (SCP)**
- 9. Steroids**
- 10. Vaccines**
- 11. Pharmaceutical Drugs**
- 12. Dairy products**



Beverages



- ▶ Microbes especially yeast have been used from time immemorial for the production of beverages like **wine, beer, whiskey, brandy or rum**. For this purpose, the yeast *Saccharomyces cerevisiae* is used for fermenting **malted cereals and fruit juices** to produce **ethanol**.

Wine producing bacteria

- *Acetobacter cerevisiae*
- *Lactobacillus bucheri*
- *actobacillus hilgardii*
- *Lactobacillus kunkeei*

Fungai

- Cyberlindnera mrakii*
- Pichia fermentans*



Antibiotic

- ▶ **Antibiotics** produced by microbes are regarded as one of the **most significant discoveries of the twentieth century** and have made major contributions towards the welfare of human society.
- ▶ Many antibiotics are produced by **microorganisms**, predominantly by **Actinomycetes** in the genus **Streptomyces** (e.g. **Tetracycline, Streptomycin, Actinomycin D**) and by **filamentous fungi** (e.g. **Penicillin, Cephalosporin**)



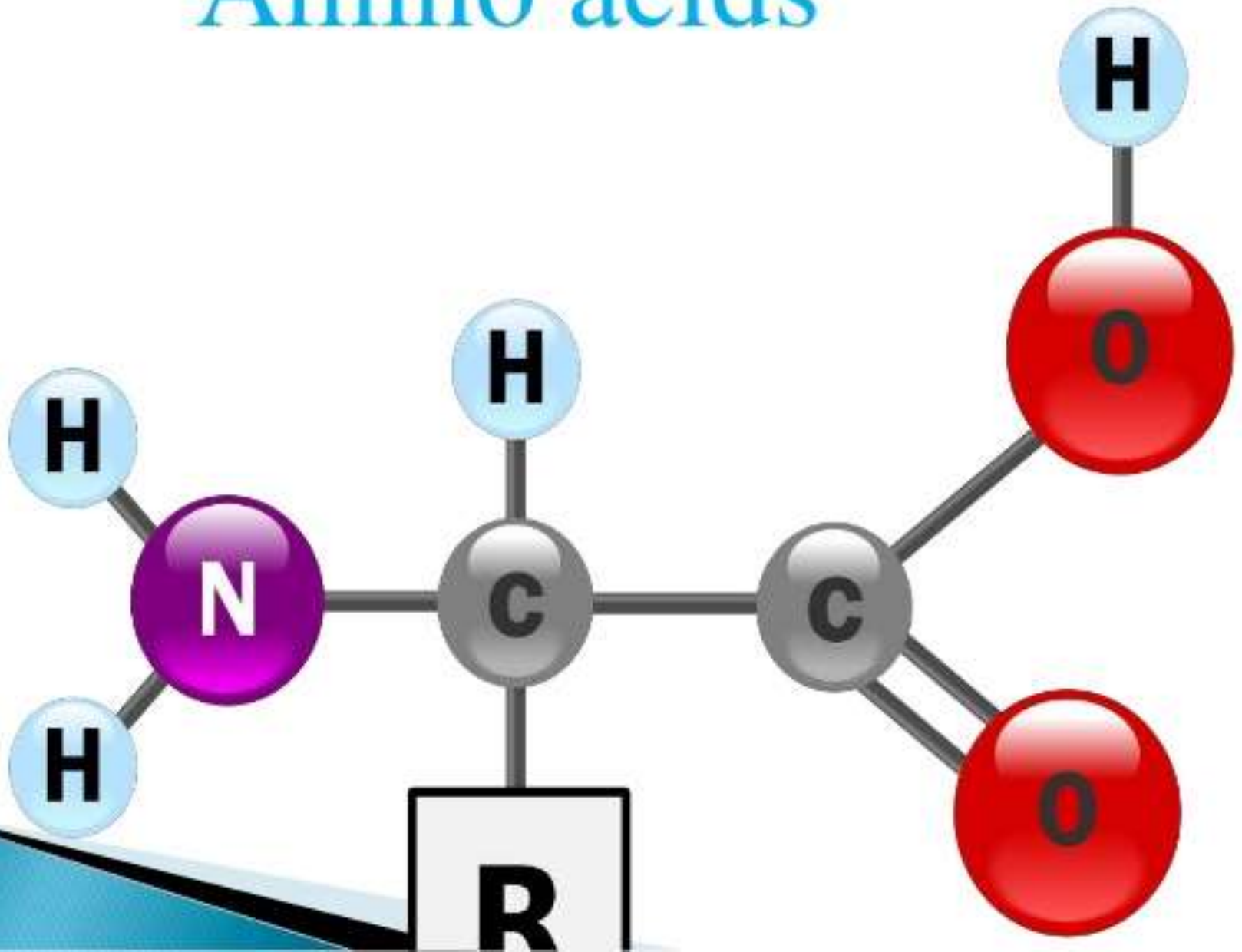
Organic acid


- ▶ Microbes are also used for the commercial and industrial production of certain **organic acids**. These compounds can be produced directly from **glucose** (e.g. **gluconic acid**) or formed as **end products** from **pyruvate or ethanol**.
- ▶ Examples of acids producing microorganisms are *Aspergillus Niger* (a fungus) of **Citric acid**, *Acetobacter acute* (a bacterium) of **Acetic Acid**, *Lactobacillus* (a bacterium) of lactic acid and many others.

Organic acid Producing bacteria:

1. Butyric acid –*salmonella enteritidis*
2. Formic acid –*salmonella*
3. Formic,
propionic and –*campylobacter*
acetic acid
- 4 .buffered propionic acid- *E.coli*
- 5 .butric acid- *E.coli*
- 6 .organic acid mixture- *coliform*
- 7.Malic acid- *E.coli*

Amino acids

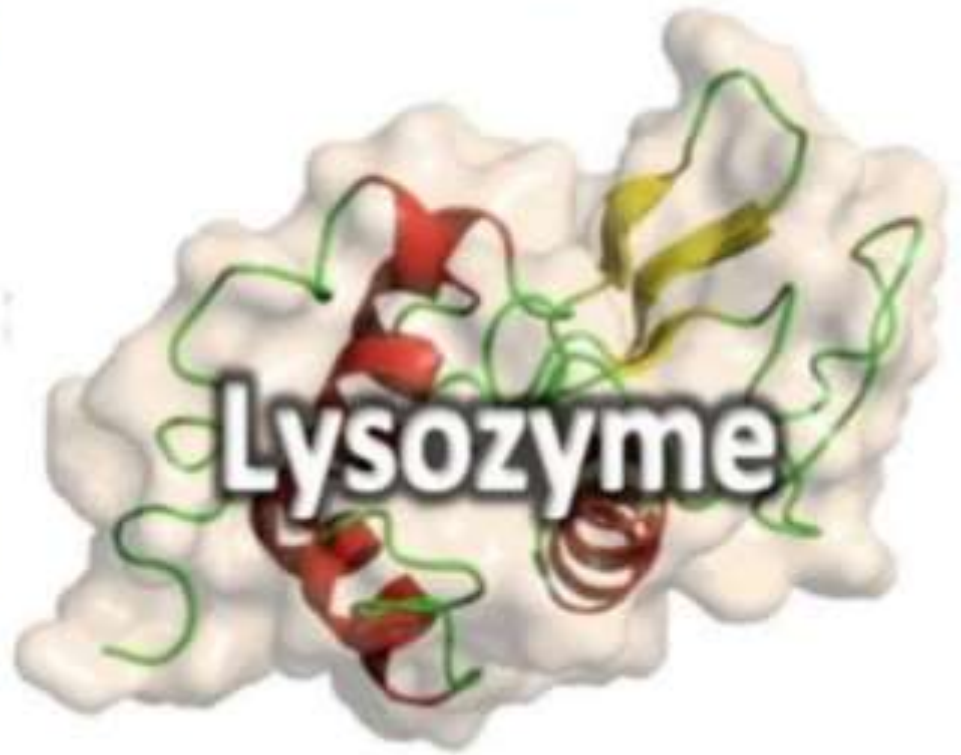
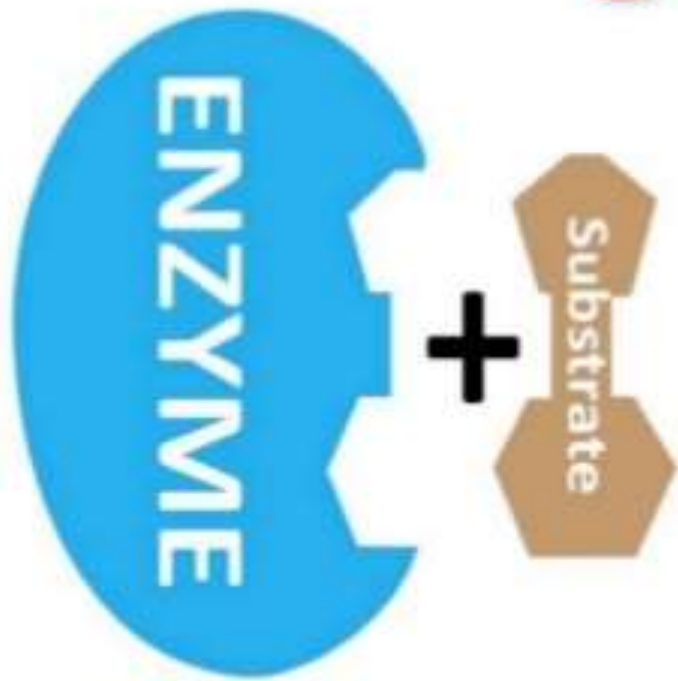



- ▶ **Amino acids** such as **Lysine and Glutamic acid** are used in the food industry as nutritional supplements in bread products and as flavor enhancing compounds such as **Monosodium Glutamate (MSG)**.
 - ▶ Amino acids are generally synthesized as **primary metabolites by microbes**. However, when the rate and amount of synthesis of some amino acids **exceed the cell's need** for protein synthesis, then **cell excrete them** into the surrounding medium.
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Amino acid producing bacteria

- 1.L-alanine - *cornycbacterium dismutans*
E.coli, pseudomonas dacunhae
- 2.L-arginine - *serratia marcescens*
Bacillus subtilis
- 3.L-aspartic acid- *E.coli*
- 4.N-Carbamyl-D-amino acids- *Bacillus sp.*

Enzymes!



- ▶ Many microbes synthesize and excrete **large quantities** of enzymes into the **surrounding medium**. Using this feature of these tiny organisms, many enzymes have been produced commercially. These include **Amylase, Cellulase, Protease, Lipase, Pectinase, Streptokinase**, and many others.
 - ▶ Enzymes are extensively used in **food processing and preservation, washing powders, leather industry, paper industry** and in scientific research.
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Enzyme produced	Name of Microbe	Uses
Amylase	<i>Aspergillus oryzae, A.niger, Bacillus subtilis</i>	Production of alcohol, removal of starch, preparation of glucose syrups
Cellulase	<i>Aspergillus niger</i>	Alcohol and glucose production
Invertase	<i>Saccharomyces cerevisiae</i>	Sucrose inversion, in confectionaries
Pectinase	<i>Aspergillus spp.</i>	Clarification of fruit juices, alcohol production
Glucose oxidase	<i>Aspergillus niger</i>	Antioxidant in prepared foods

VITAMINS



- ▶ Vitamins are some organic compounds which are capable of performing many **life-sustaining functions** inside our body. These compounds cannot be synthesized by humans, and therefore they have to be supplied in **small amounts in the diet**.
- ▶ **Microbes** are capable of synthesizing the vitamins and hence they can be successfully used for the commercial production of many of the **vitamins** e.g. **thiamine, riboflavin, pyridoxine, folic acid, pantothenic acid, biotin, vitamin b12, ascorbic acid, beta-carotene (pro-vitamin A), ergosterol (provitamin D)**

- ▶ **Vitamin B12** produced by *Propionibacterium freudenreichii*, *Pseudomonas denitrificans*, *Bacillus megaterium* and *Streptomyces olivaceus*, *p.shermanii* and etc
- ▶ **Riboflavin** produced by *Ashbya gossypii* and *Eremothecium ashbyii*, *clostridium buytilcum*, *mycocandida riboflavina*, *candida flareri* and etc,.
- ▶ **β- Carotene** is a pro vitamin produced by *Blakeslea trispora*, *Phycomyces blakesleeanus* and *Choanephora cucurbitarum*.
- ▶ *Blakeslea trispora* commenly used for high yield production.

Organic solvents



SOLVENTS

- ▶ **Organic solvents** such as **ethanol**, **acetone**, **butanol**, and **glycerol** are some very important chemicals that are widely used in **petrochemical industries**. These chemicals can be commercially produced by using **microbes** and **low-cost raw materials** (e.g. wood, cellulose, starch).
- ▶ Yeast (*Saccharomyces cerevisiae*) is used for commercial production of ethanol.

- ▶ Acidic acid- *acteobacter*
- ▶ Citric acid- *aspergillus niger*
- ▶ Fumaric acid- *rhizopus nigricans*
- ▶ Gluconic acid- *aspergillus niger*
- ▶ Itaconic acid- *aspergillus terreus*
- ▶ Koji acid- *aspergillus flavus*
- ▶ Lactic acid- *lactobacillus*

Dairy product



Microbes are used in dairy industry to make dairy product such as curd, yogurt,cheese,kefir , kumies,bread and various types of milk product.

Saccharomyces cerevisiae,
Streptococcus sp,
penicillium roqueforti,
p.camemberti,
streptococcus thermophilus,
lactobacillus bulgaricus,
Lactobacillus sp,candida sp.