COURSE TITLE: FOOD AND INDUSTRIAL MICROBIOLOGY
COURSE NO. - DTM-321: CREDIT HRS-3 (2+1)

Microbial production of industrial products

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Microbial technology refers to the use of microbes to obtain a product or service of economic value. It is also called as Fermentation.

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

Industrial product:

1. Beverages
2. Antibiotics
3. Amino Acids
4. Organic acids
5. Vitamins
6. Enzymes
7. Organic solvants
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	**Fungai**
▪ Acetobacter cerevisiae	Cyberlindnera mrakii
▪ Lactobacillus bucheri	*Pichia fermentans*
▪ *actobacillus hilgardii*	
▪ Lactobacillus kunkeei	

Antibiotics produced by microbes are regarded was 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 Streptomycin (e.g. Tetracycline, Streptomycin, Actinomycin D) and by filamentous fungi (e.g. Penicillin, Cephalosporin)

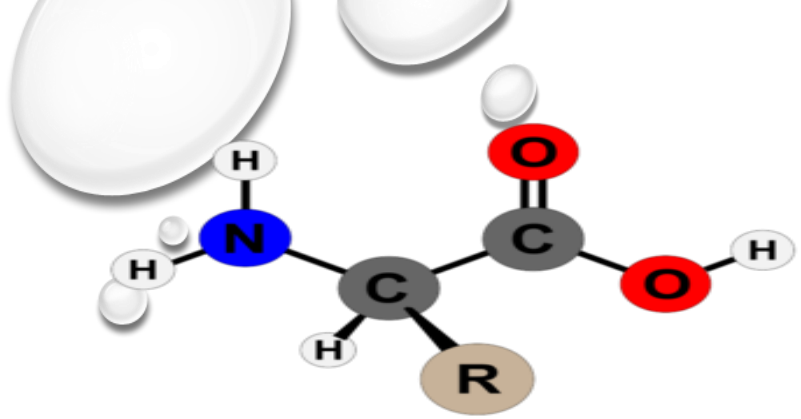
Microbes are also used for the commercial and industrial production of certain organic acids. These compounds can be produced directly from glucose (e.g. gluconic acid) or formed as end products from pyruvate or ethanol.

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.

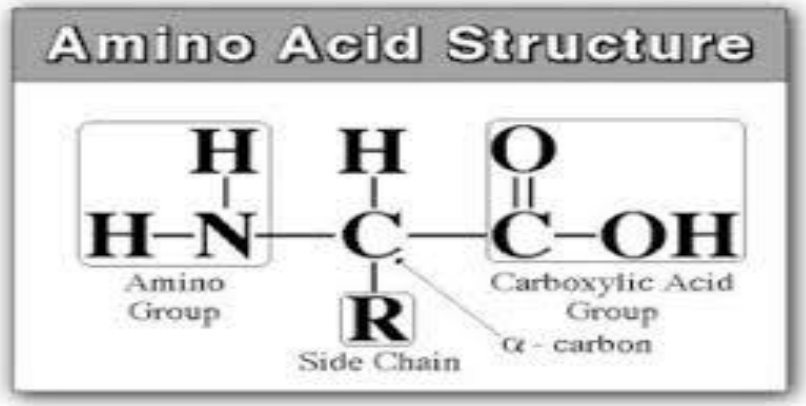
Organic Acid Producing Bacteria

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

Organic acid produced	Name of microbe
Citric Acid	*Aspergillus niger*
Lactic Acid	*Lactobacillus spp.*
Ascorbic acid	*Acetobacter xylinum or Acetobacter suboxydans*
Itaconic acid	*Aspergillus itoconicus and Aspergillus terreus*
Acetic acid	*Acetobacter aceti*



Amino acid



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.

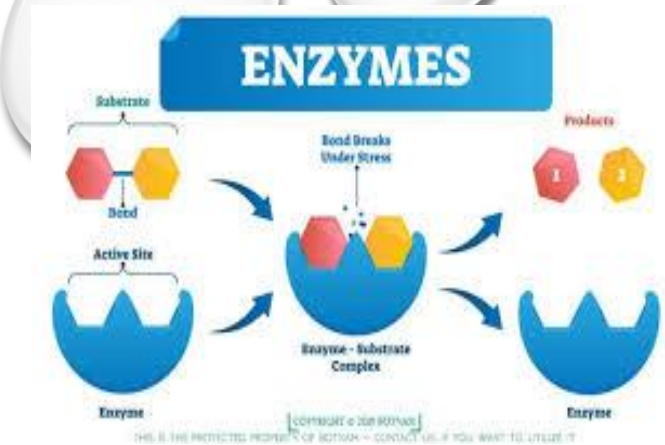
Amino acid producing bacteria

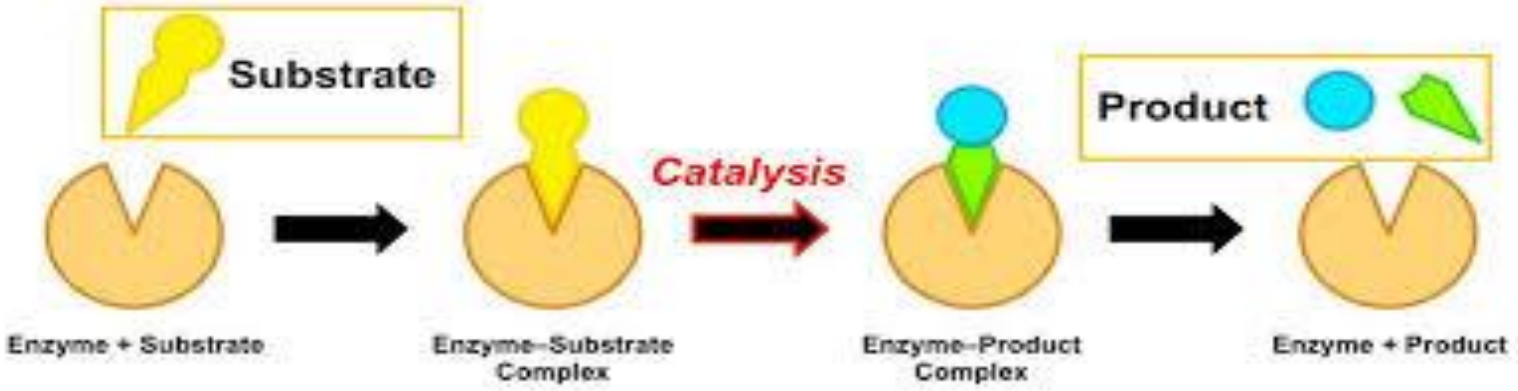
1.L-alanine - *cornycbacterium dismutans*
E.coli, pseudomonas dacunhae

2.L-arginine - *serratia marcescens*
Bacillus subtilis

3.L-aspartic acid- *E.coli*

4.N-Carbamyl-D-amino acids- *Bacillus sp.*





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.

- Lipase, protease – *serrtia*
  bacillis sp
- Protease *-xanthomonase*
  candida humicola
- Lipase *-pseudomonas*
- Amylase *-aeromonas hydrophila*
  alteromonas haloplantktins

Enzyme produced	Name of Microbe	Uses
Amylase	*Aspergillus oryzae, A.niger, Bacillus subtilis*	Production of alcohol, removal of starch, preparation of glucose syrups
Cellulase	*Aspergillus niger*	Alcohol and glucose production
Invertase	*Saccharomyces cerevisiae*	Sucrose inversion, in confectionaries
Pectinase	*Aspergillus spp.*	Clarification of fruit juices, alcohol production
Glucose oxidase	*Aspergillus niger*	Antioxidant in prepared foods

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,clostridum buytilcum,mycocandida riboflavina,candida flareri* and etc,.

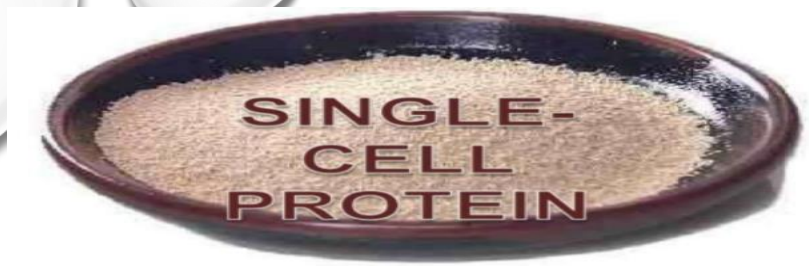
- **β– Carotene** is a pro vitamin produced by *Blakeslea trispora, Phycomyces blakesleeanus and Choanephora cucurbitarum.*
- *Blakeslea trispora commenly* used for high yield production.

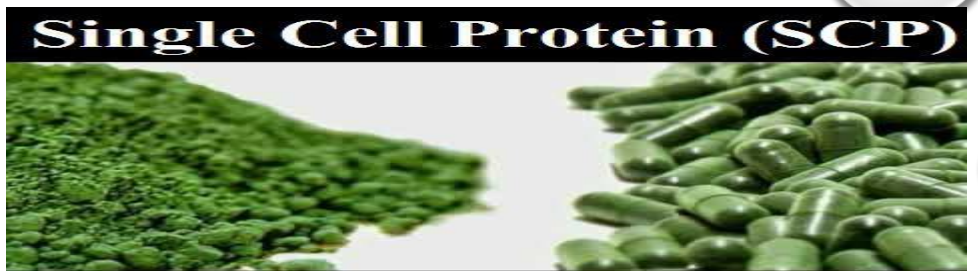
Organic solvents

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*





What is single cell protein?

The term "single cell protein" refers to the total protein extracted from the pure culture of microorganisms (e.g. yeast, algae, fillamentous fungi, bacteria.) SCP are dried cells of microorganisms which can be used as dietary protein supplement. They are used as animal feed & can be used for human feed as protein supplement. Also called 'Novel Food' & 'Minifood'. It is also known as Microbial protein. 60-80% dry cell weight; contains nucleic acids, fats, CHO, vitamins and minerals

Single Cell Protein (SCP) can serve as an alternate source of energy when a larger portion of the world is suffering from hunger and malnutrition. Single cell proteins are microbial cells that are rich in protein content and can be used as protein supplements for humans and animals.

Microbes like Spirulina can be grown easily on materials like waste water from potato processing plants (containing starch), straw, molasses, animal manure, and even sewage, to produce large quantities and can serve as food rich in protein, minerals, fats, carbohydrate, and vitamins.

Steroids

These are a very important group of chemicals, which are used as anti-inflammatory drugs and as hormones such as estrogens and progesterone, which are used in oral contraceptives.

Steroids are widely distributed in animals, plants, and fungi like yeasts. But, producing steroids from animal sources or chemically synthesizing them is difficult, but microorganisms can synthesize steroids from sterols or from related, easily obtained compounds.

Mostly mycobacterium sp are used frequently.

Steroids Producing Microorganisms

- *Fusarium moniliforme, Phycomyceblakesleeanus.*
- *Aspergillus ochraceus, Aspergillus fumigatus, Rhizopus nigrican,*
- *Penicillium raistricki,*
- *Streptomyces roseochromogenes,*
- *Bacillus thermoglucosidasius,*
- *Cochliobolus lunatus,*
- *Bacillus megaterium,*

Pharmaceutical drugs

Many pharmaceutical drugs are also produced by microbes e.g. Cyclosporin A, that is used as an immunosuppressive agent in organ-transplant patients, is produced by the fungus *Trichoderma polysporum*.

Immunosuppressant cyclosporin A. Statins produced by the yeast Monascus purpureus have been commercialized as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for the synthesis of cholesterol.

Dairy Products

Microbes are used in dairy industry to make dairy product such as curd, yogurt, cheese, kefir , kumiss, bread and various types of milk product. *Saccharomyces cerevisiae*, Streptococcus sp, *Penicillium roqueforti*, *P. camemberti*, *Streptococcus thermophilus*, *Lactobacillus bulgaricus*, Lactobacillus sp, Candida sp.

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

THANK YOU