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Role of Bacteria in Industries:

1. Fiber retting:

Retting is a process by which commercial plant fibers like jute, flax, hemp etc. are separated by the bacterial decomposition of pectin substances that hold the fibers together. In anaerobic retting, fibrous plant body immersed in water tanks where butyric acid bacteria (*Clostridium butylicum*) decompose the middle lamella and separate the fibers. In dew retting, periodic sprinkling of water is done and *Pseudomonas fluorescens* does the retting process.

2. Leather industry (Tannery):

In leather industry, removal of hairs, fats and other tissues from rawhide is done by bacteria. The cleaned hides are then tanned to prepare leather.

3. Curing:

It is the removal of bitterness and to give unique flavor and aroma in tea, coffee, tobacco and coca, e.g., *Bacillus megatherium*, *Micrococcus candidans*.

4. Dairy Products:

A variety of dairy products are prepared due to fermentation of milk. Lactic acid bacteria convert lactose (milk sugar) to lactic acid which helps in curdling of milk protein casein. Mixed Fermentation of milk by lactic acid bacteria and yeasts produce kefir and kumiss (mild alcoholic beverage). Large holes of Swiss

cheese are formed due to release of large amount of CO₂ by *Propionibacterium sharmanii*.

Pasteurization:

It is the heating of milk at 62.8 C for 30 min or 71.6°C for 15 sec. and sudden cooling at 4-5°C to kill the non-spore forming bacteria. It is used for preservation of milk.

Dairy Products	Bacteria involved
1. Curd	<i>Streptococcus lactis, Lactobacillus etc.</i>
2. Butter	<i>Streptococcus lactis</i>
3. Butter milk	<i>Streptococcus lactis, S. cremoris.</i>
4. Yoghurt	<i>Lactobacillus bulgaricus, Streptococcus thermophilus</i>
5. Cheese	<i>Lactobacillus lactis</i>

5. Bioleaching or bio-mining:

Bacteria are used to recover metals like nickel, lead, zinc, copper etc. from low grade ores which otherwise can't be economical. Precious metals like Gold and silver obtained through bioleaching of pyrite ore and iron sulfide respectively.

6. Production of lactic acid, acetic acid, acetone, butanol, N-butanol, alcohol, glycerol etc.

Fermentation Products	Bacteria involved	Use
1. Lactic acid	<i>Lactobacillus delbruki, L. lactii</i>	In food industry, preservatives, tanning, in plastics, decalcifying skins.
2. Acetic acid	<i>Acetobactor aceti</i>	Production of Vinegar.
3. Acetone and Butanol	<i>Clostridium acetobutylicum</i>	manufacture of explosive, photographic films, industrial solvents.
4. Streptokinase	<i>Streptococcus</i>	remove clots from blood vessels.
5. Alcohol	<i>Klebsiella pneumoniae</i> <i>Zymomonas mobilis</i> <i>Sarcina ventriculi</i>	in alcoholic beverages, gasohol (liquid fuel) solvent of dyes, lubricants, Pesticides, resins and manufacture of synthetic fibers.
6. Glycerol	<i>Lactobacillus brevis</i>	In medicals, D-fructose, synthesis, in food industry for its sweetness and high solubility.

7. Biodegradable plastics are prepared from the PHB (Poly β-hydroxybutyrate) that act as reserve fatty acid in bacteria.

8. Production of Antibiotics:

Antibiotics are the biochemicals (secondary metabolites) produced by microorganisms and are capable of inhibiting the growth of pathogenic microorganisms. The phenomenon of growth inhibition by antibiotics is called antibiosis. Alexander Flemming (1929) discovered the first commercial antibiotic penicillin from *Penicillium notatum* (a fungus). But, Waksman (1942) coined the term of antibiotics. At present, about 7,000 antibiotics have been discovered. Some of them produced by bacteria are as follows.

Ernest Chain and Howard Florey established the antibiotic potential of penicillin. At present, about 7000 antibiotics are known and every year about 300 new antibiotics are discovered. Some of them produced by bacteria are as follows.

9. Production of Vaccines:

A vaccine is a suspension of killed, or living but inactivated bacteria which, when inoculated into the body, act as antigen causing development of antibodies that render the body immune or at least, resistant to infection by bacterium. It was with *Bacillus anthracis* that the first systematic vaccination was conducted.

9. Thermostable Enzyme.

A thermostable DNA polymerase called Taq polymerase is isolated from a bacterium *Thermus aquaticus* which is used in PCR (polymerase chain Reaction) for amplification of gene of interest.

Table 11.4. Antibiotic and Bacteria

	Antibiotic	Bacteria	Range of action
1.	Bacitracin	<i>Bacillus subtilis</i>	Gram ⁺ bacteria
2.	Polymyxin B	<i>Bacillus polymyxa</i>	M. tuberculosis Gram ⁻ bacteria
3.	Streptomycin	<i>Bacillus griesus</i>	Gram ⁺ bacteria
4.	Chloramphenicol (Chloromycetin)	<i>Streptomyces venezuelae</i>	Broad spectrum
5.	Chlortetracycline (Aureomycin)	<i>S. aureofaciens</i>	Broad spectrum (Aureomycin)
6.	Erythromycin.	<i>S. erythraeus</i>	Rickettsias
7.	Griesofulvin	<i>S. griesus</i>	Pathogenic fungi
8.	Kanamycin	<i>S. kanamyceticus</i>	mycobacterium tuberculosis
9.	Neomycin	<i>S. fradiae</i>	Gram ⁺ bacteria
10.	Terramycin (Oxytetracycline)	<i>S. rimosus</i>	Broad spectrum

10. Transgenic Bacteria:

These are genetically engineered bacteria whose normal genome has been altered by introduction of a foreign gene (transgene). Transgenic *Escherichia coli* are cultured to extract human insulin.

11. SCP (Single cell protein):

It is the production of microbial biomass (e.g. bacterium, yeast) on a commercial scale in a fermentor, dried and sold as alternate sources of proteins for human and animal nutrition.

The common SCP obtained from Bacteria is *Methylophilus methylotrophus*, *Rhodospseudomonas capsulata* etc.
