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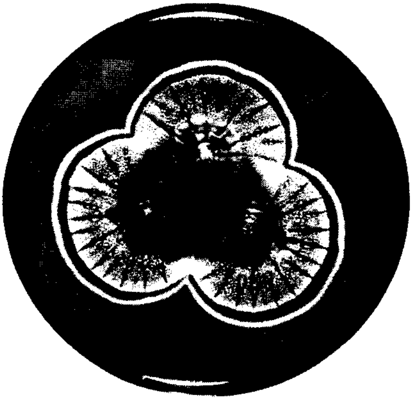
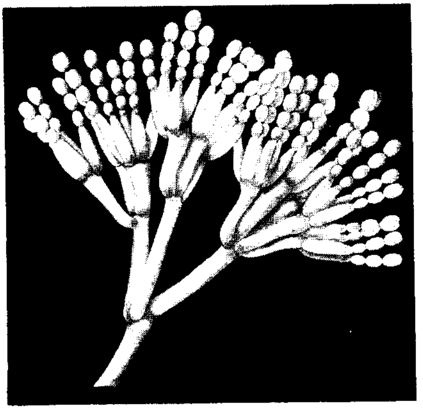
Micro-organisms

ALMOST every phase of life is influenced in some way by a micro-organism or by a microbial process. Bacteria, molds, and yeasts are common micro-organisms. No less vital are the algae, protozoa, and viruses. Most micro-organisms are microscopic. They occur almost everywhere in air, water, and soil. Some cause diseases of man, animals, and plants, but most are harmless or helpful. Micro-organisms form diverse chemical products through growth and cell activity, according to the type of micro-organism, the nature and amount of the nutrient it has, and the conditions under which growth takes place. The organism *Clostridium botulinum* may grow and produce the poisonous botulinus toxin in underheated nonacid foods. Acid-forming bacteria ferment milk curd to various cheeses, shredded cabbage to sauerkraut, cucumbers to pickles, and plant materials to silage. The prime benefit of micro-organisms is in soil building. The continuous reduction of dead animal and plant tissue by microbial growth to more simple chemical substances improves the tilth, fertility, and water-holding capacity of soil. Another contribution to agriculture is the fixation of nitrogen by bacteria that grow symbiotically in the roots of legumes.

Scientists have studied micro-organisms since the early 1900's. Microbiologists and other specialists collect, describe, and classify the micro-organisms and their products. They seek to explain the nature of microbial enzymes in relation to the chemical reactions of the living cell. They look for ways to control microbial activities, especially food spoilage and disease. Scientists learned to grow selected micro-organisms in pure culture under defined conditions as to nutrients and environment. This led to the development of industrial fermentation, one of the most important areas of science to benefit mankind during the past century. Hundreds of species of micro-organisms ferment agricultural materials, directly or indirectly, into chemicals, foods, feed supplements, drugs, vitamins, and antibiotics. Carbohydrate-converting micro-organisms were first used to leaven bread, make alcoholic beverages, and produce vinegar and fermented foods. Since 1900 or so, many new industrial fermentations designed to obtain specific chemical products by use of micro-organisms have been developed. The manufacture of citric acid by *Aspergillus niger* is the most important mold fermentation, aside from penicillin. Ethyl alcohol, produced by yeast from sugars, is the best



Growing colonies of Penicillium chrysogenum isolated from a moldy cantaloup. This is the parent of all present-day cultures used to make penicillin.

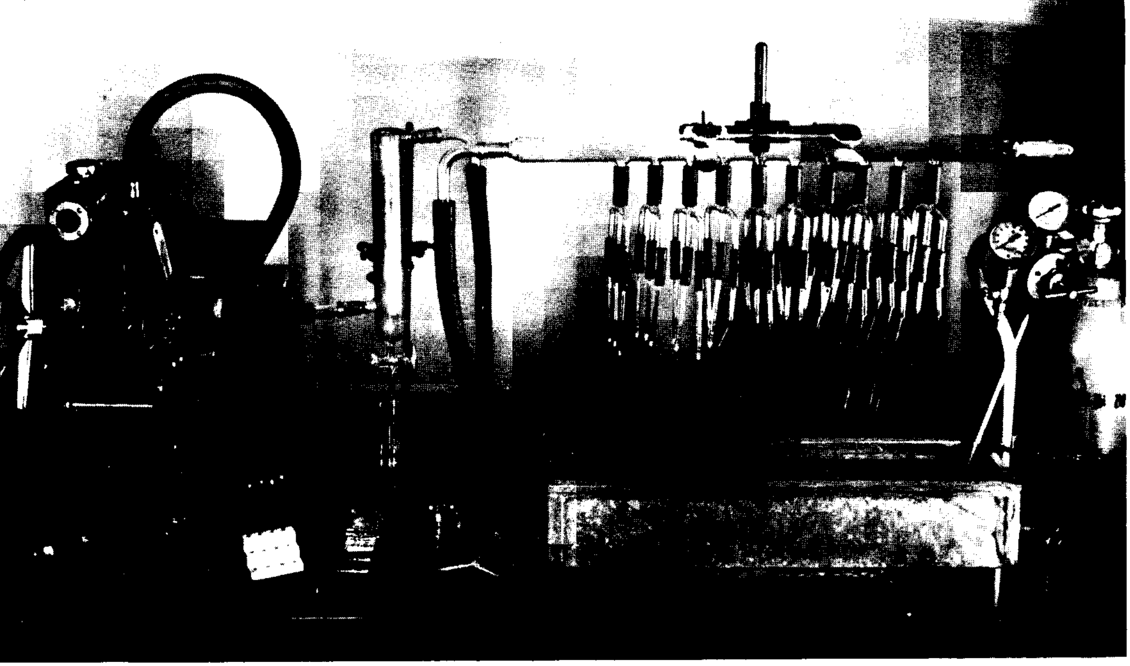


Characteristic structure, greatly enlarged, of Penicillium chrysogenum stalk showing chains of spores which can initiate new growth.

known chemical made in large volume. Many serious diseases are practically nonexistent today or are held in check with the products of microbial fermentation—antibiotics, antitoxins, vaccines, and cortical hormones.

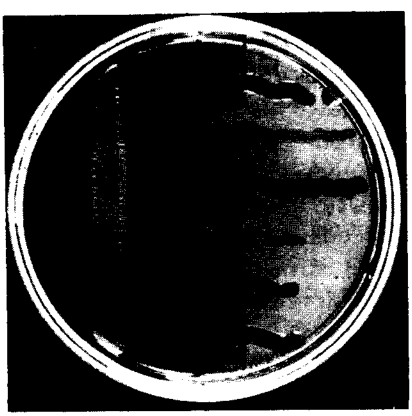
The antibiotics deserve special comment. Penicillin, produced by species of molds, was first discovered in 1928 by Alexander Fleming, a British mycologist. It remained undeveloped for many years. Actually, the urgent medical needs of the Second World War provided the necessary impetus and financial support required for the rapid development of Dr. Fleming's basic finding. An appeal to the United States Department of Agriculture for assistance in developing a production process with his strain of the fungus *Penicillium* was answered by scientists of the Northern Regional Research Laboratory. The discovery by a staff member of a more productive mold, *Penicillium chrysogenum,* on a cantaloup, and the development of a process for growing it in deep-tank culture set the stage for the present antibiotic industry. Tests made with thousands of microbial cultures obtained from soil samples and other sources throughout the world have resulted in the discovery of several hundred new antibiotics. A few are outstanding for combating the disease-producing micro-organisms of man, animals, and plants. Some have proved useful as feed supplements to promote better health and growth of animals. The value of all antibiotics produced in 1961 was about 350 million dollars.

Riboflavin (vitamin B_2) is produced by two fungal species, *Eremothecium ashbyii* and *Ashbya gossypii.* Both are pathogenic to plants. Vitamin B_{12}, the most potent yet discovered, is made by

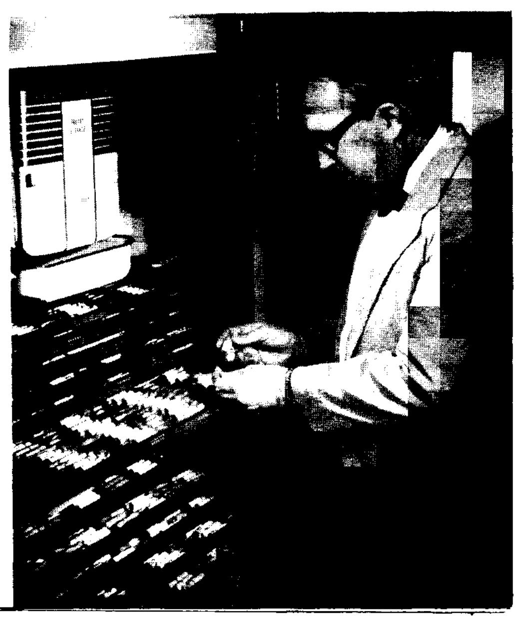


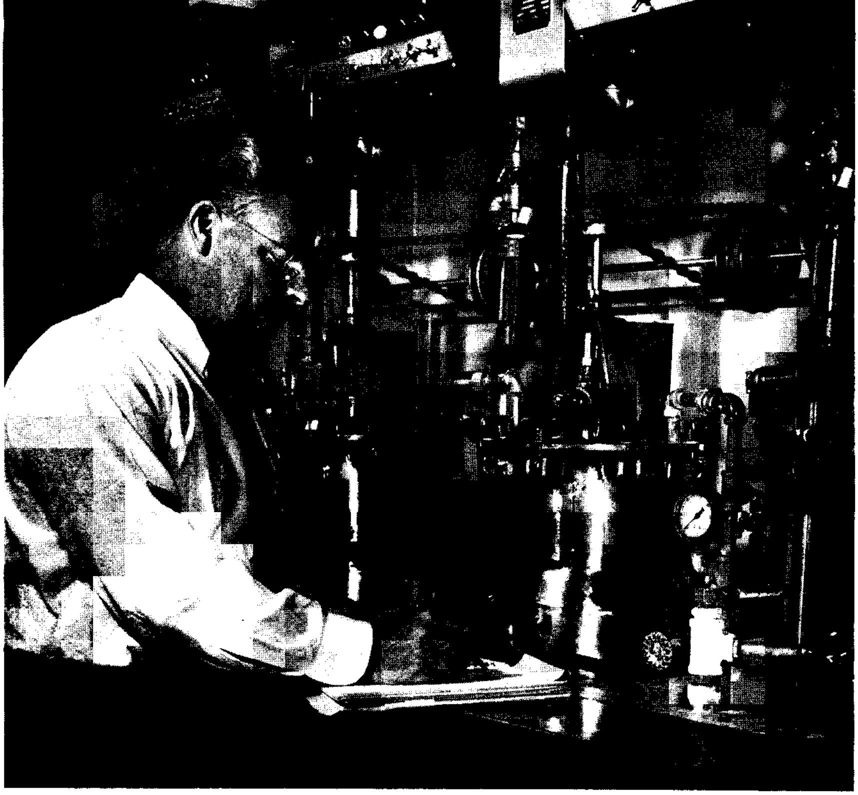
This is the apparatus used to freeze-dry micro-organisms for the culture collection at the Northern Utilization Research and Development Division, Peoria. The four small tubes (left-center foreground) contain cells of micro-organisms and blood serum. They are lowered into a pan containing dry ice, and the air is exhausted from them. When serum and cells are frozen and dry, the tops of the tubes are heated until the glass becomes molten, and the tubes are pulled off. This operation seals the tubes. This method, developed by Department scientists, keeps cells of bacteria, molds, and yeasts alive as long as 20 years.

Antibiotic produced by a species of Streptomyces. Vertical growth (left) is shown to inhibit adjacent growth of five different plant disease bacteria growing in horizontal lines at right. The sixth (bottom) micro-organism is unaffected by the antibiotic. This technique is used in searching for antibiotic-producing micro-organisms.



Dr. C. W. Hesseltine, a mycologist, examines the collection of several thousand cultures of bacteria, molds, and yeasts at the Northern Regional Research Laboratory in Peoria, Ill. The cultures are used in research and the development of processes for the conversion of agricultural products to new chemicals.





Dr. Harlow H. Hall and some of the equipment used at the Northern Regional Research Laboratory for developing fermentations to manufacture new products from agricultural materials.

several species of *Streptomyces,* as well as by the propionic acid-forming bacteria. A fermentation process, worked out by the Northern Regional Research Laboratory, produces beta-carotene, which is a precursor of vitamin A. This fermentation product is in demand as a supplement for animal feeds and for drugs and foods. The micro-organism used is the fungus *Blakeslea trispora,* commonly found on pumpkin, squash, and cucumber plant blossoms. One of the newest uses of micro-organisms in agriculture is to combat insects. Bacteria and molds that cause disease in a particularly destructive insect are spread through infested areas to induce plagues of the insect itself. Still another new use for micro-organisms is the production of plant growth hormones. One of them is gibberellic acid, a chemical that speeds up plant growth and the formation of blossoms and seeds. Industrial fermentation continues to be a fruitful area for research and development. More and more products from American farms are being converted to new products because of our knowledge of the action of micro-organisms. *(Harlow H. Hall* and *John L. Etchells)*