harvesting
HORMONES

Before recombinant DNA technology, drug manufacturers extracted hormones, including insulin and growth hormone, directly from animal or human glands. Human growth hormone (hGH) required a supply of pituitary glands from human cadavers that was difficult to obtain.

"The Position of the Pituitary Gland within the Skull," Armour Laboratories, 1940s
Courtesy National Library of Medicine

The pituitary gland, the size of a chick pea, situated in the center of the brain, secretes nine different hormones, one of which regulates human growth.

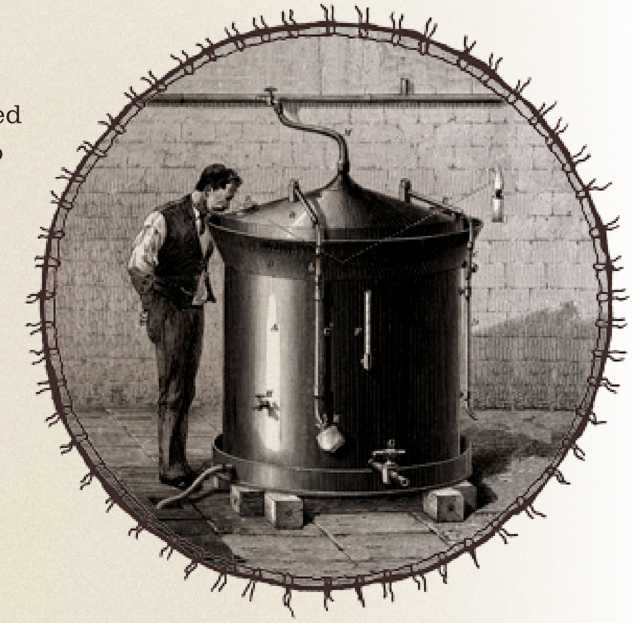
Grinding pancreas glands to extract insulin at Eli Lilly and Company, 1940s
Courtesy National Museum of American History

In the early 1920s, Eli Lilly and Company began mass-producing insulin from the pancreas glands of cows and pigs.

brewing
MYSTERIES

Beer making is an old technology that relies on microorganisms. Brewers, however, barely knew of the existence of microbes, much less the critical role they played in their livelihood. Problems encountered in beer production motivated scientists to study the secrets of this "invisible world."

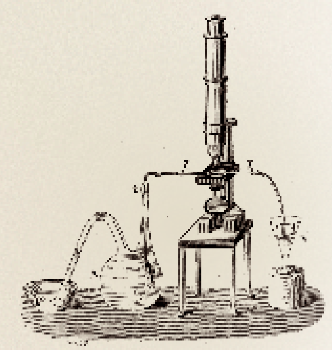
In the mid-19th century, chemist Louis Pasteur worked with French beer makers to discover what was causing their product to spoil. Through his investigation into the "diseases" of beer, Pasteur demonstrated the essential role that yeast, a tiny living organism, played in the fermentation process and identified microorganisms that caused beer to go bad.



Engraving of beer vat designed by Louis Pasteur, about 1880
Courtesy National Library of Medicine

The closed fermentation tank prevented air-borne bacteria from entering and spoiling the brew.

French chemist Louis Pasteur, 1889
Courtesy National Library of Medicine



***Études sur la Bière (Studies on Beer)*, Louis Pasteur, 1876**
Courtesy National Library of Medicine

This illustration from Pasteur's book demonstrates a method for examining the yeast in beer without exposing the sample to contamination from other microorganisms.

This exhibition was developed and produced by the National Library of Medicine, National Institutes of Health and the Smithsonian's National Museum of American History.
Guest curated by Diane Wendt and Mallory Warner, National Museum of American History.
Exhibition design by The Design Minds.

www.nlm.nih.gov/fromdnatobeer

cover illustrations

***Half-Hours with the Microscope*, Edwin Lankester, MD, illustrated by Tuffen West, 1860**
Courtesy National Library of Medicine

from DNA to BEER
Harnessing Nature in Medicine & Industry

U.S. National Library of Medicine

Microbes—tiny organisms too small to be seen with the naked eye—have altered human history. Life forms such as bacteria, yeasts, and molds can cause sickness or restore health, and help produce foods and beverages.

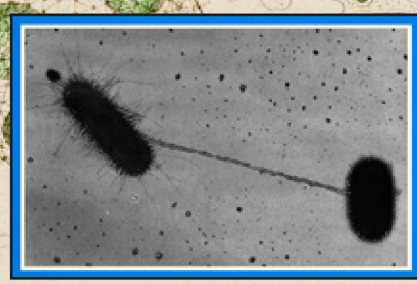
Scientists, in partnership with industry, have developed techniques to harness the powers of these microbes. In recent years, headline-grabbing technologies have used genetically modified bacteria to manufacture new medicines.

A glimpse into the past reveals a history of human enterprise that has adapted these tiny organisms for health and profit. This exhibition explores some of the processes, problems, and potential inherent in technologies that use life.

tinkering with DNA

All organisms, from microbes to humans, are governed by the genetic code embedded in their DNA. In the 1970s, scientists inserted a human gene into the genetic material of a common bacterium. This so-called "recombinant" microorganism could now produce the protein encoded by the human gene.

Eager to explore the potential of this recombinant DNA technique, investors joined forces with research scientists to develop industrial applications. Two of the earliest products to reach the market were human insulin, used to treat diabetes, and human growth hormone, used in children with pituitary gland disorders.



E.coli bacteria exchanging genes, *Time*, April 18, 1977

Courtesy Charles C. Brinton Jr. and Judith Carnahan; reprinted in *TIME Magazine*, April 18, 1977, © 1977, Time Inc.

Escherichia coli (E. coli) bacteria are the workhorses of recombinant DNA technology. The ability of bacteria to easily exchange and absorb new pieces of DNA made them good vehicles for genetic engineering techniques.

Protropin, human growth hormone, 1987

Courtesy National Museum of American History

The Food and Drug Administration approved Protropin, human growth hormone made using genetically modified bacteria, for therapeutic use in 1985.

making "YELLOW MAGIC"

Microbes are equipped with defense mechanisms to help ensure their survival. *Penicillium*, the bluish-green mold that grows on stale food, produces a substance that has the power to kill its bacterial competition. Many of these bacteria are also deadly to humans.

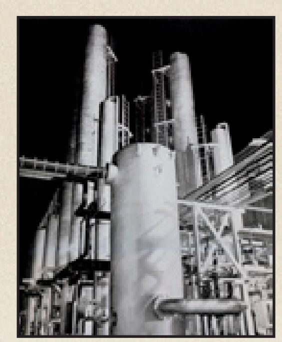
In the years leading into World War II, British scientists established the life-saving potential of *Penicillium's* natural antibiotic. Prompted by the war emergency, the United States government teamed with drug companies to mass-produce penicillin. The ability of the drug to prevent fatal infections among the wounded inspired the nickname "yellow magic."

"The Era of Antibiotics," painted by Robert A. Thom for Parke, Davis & Company, 1950s

Courtesy American Pharmacists Association Foundation

"Thanks to Penicillin … He Will Come Home!" penicillin advertisement, Schenley Laboratories, 1944

Courtesy Schenley Laboratories, Inc.



Penicillin plant from *Yellow Magic: The Story of Penicillin*, by J. D. Ratcliff, 1945

Courtesy Random House

New production methods and facilities transformed American penicillin production into a giant industry.

Terramycin product, Charles Pfizer and Company, early 1960s

Courtesy National Museum of American History

The success of penicillin prompted the development of new antibiotics including many products for treating livestock.

living FACTORIES

Humans and animals have natural defense systems that produce antibodies in the blood to combat bacteria and other harmful substances invading the body. In the late nineteenth century, scientists investigating this immune response in animals developed new methods for treating diseases in humans.

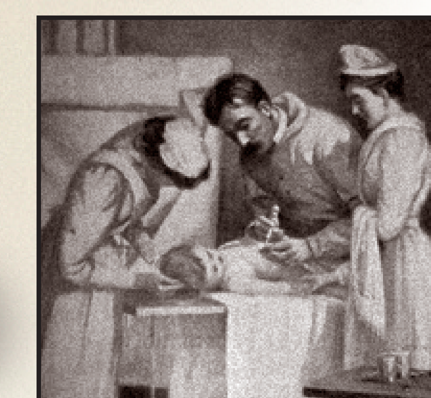
One of these early therapies used blood serum, collected from animals inoculated with toxins from bacteria. The natural protection these animals developed against the toxin could be passed to humans through injections of the serum. In commercial production, horses and other large animals served as living serum factories to grow the so-called "antitoxins" for human use.

Recovering the diphtheria serum from horse blood in Marburg, Germany, by Fritz Gehrke, 1890s

Courtesy National Library of Medicine

Anti-Diphtheritic Serum, Parke, Davis & Company, 1898

Courtesy National Museum of American History



"Injecting Diphtheria Antitoxin," illustration from a Parke Davis publication, 1895

Courtesy The Historical Medical Library of The College of Physicians of Philadelphia

Serum therapy provided an effective cure for diphtheria, an often fatal childhood disease.