



# Introduction to Biotechnology



# What is Biotechnology?

Biotechnology is the manipulation of living organisms and organic material to serve human needs.

Examples?

Yeast is bread making and alcohol

# Biotechnology Industry

- **Research is conducted by small companies, large corporations, and public universities.**



# Biotechnology Industry

- **Funding comes from a variety of sources:**
  - **Public (government)**
  - **Private (companies and foundations)**
- **Since 2005, the Texas Emerging Technology Fund has invested \$287.5 million in more than 100 biotech deals**

# Biotechnology Industry

- **Focuses on a variety of research areas including:**
  - **Health/medicine**
  - **Food science**
  - **Environmental science**
  - **Agriscience**

# Impact of Biotechnology

- **Genetically modified organisms (GMOs) are consumed by millions of people (especially Americans) EVERY DAY.**
  - **Almost 56% of all soybean plantings worldwide are genetically engineered (much higher in the US)**



# Impact of Biotechnology

- **Genetically modified crops were produced on more than 167 million acres in 18 countries in 2003, a 15% increase from 2002**
  - **The US was the largest single producer with more than 60% of the total acreage in production.**



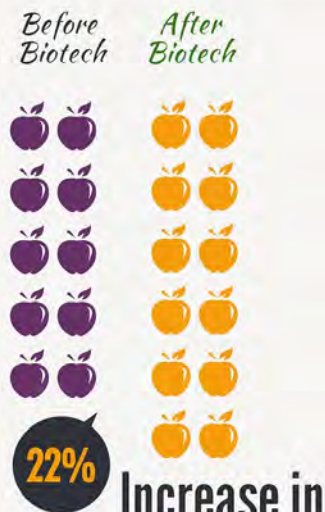
# Impact of Biotechnology

## IMPACTS OF BIOTECH

The latest PLOS ONE metastudy looked at the impacts of biotechnology. We dove in.



Reduction in Pesticides



Increase in Yields



Increase in Farmer Income

[FOODINSIGHT.ORG/FACTS](http://FOODINSIGHT.ORG/FACTS)

# Impact of Biotechnology

## Texas Biotech Headlines

Fortune 1000 company **NBTY** opens state-of-the-art vitamin manufacturing plant in San Antonio

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**Allergan** installs new production line at Waco pharmaceutical plant, expands facility and local workforce

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San Antonio-based **HVHC, Inc.**, the nation's largest U.S. optical company, invests \$25 million for a new manufacturing and distribution center in San Antonio and expands HQ

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**HVHC INC.**  
A FORTUNE 1000 COMPANY

Texas ranks **#2** for employment of life and physical scientists nationwide



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Texas is home to the nation's largest biodiesel plant and ranks **#1** for U.S. biodiesel production

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Texas public institutions award over 66,000 biotech-related degrees from 2009 -2013

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Texas A&M partners with **GlaxoSmithKline** to build \$91 million flu vaccine manufacturing plant



See Page 14

Germany-based prosthetics firm, **Ottobock**, relocates its North American headquarters to Austin

See Page 9

**ottobock.**

Number of biotech workers in Texas: **92,022**

**\$1.3 billion**

Amount invested by venture capital firms 2008 to 2013 in 82 biotech and 79 medical device deals in Texas.

(PricewaterhouseCoopers/National Venture Capital Assn. MoneyTree Report, Data: Thomson Reuters)



**BIOTECH BOOM ON "THIRD COAST"  
PROVES EVERYTHING'S BIGGER IN TEXAS**

# Impact of Biotechnology

## Top Life Sciences Companies in Texas

Selected firms with corporate management, research, or manufacturing facilities in the state



Sources: D&B, US FDA, company websites

## Top Texas-Based Biotechnology Firms (by Global Revenues)

- Kimberly-Clark**  
Respiratory healthcare products  
HQ: Irving  
Sales: \$12.1 billion
- Celanese**  
EVA polymer-based medical care products  
HQ: Irving  
Sales: \$6.5 billion
- KCI**  
Wound care medical devices  
HQ: San Antonio  
Sales: \$734.9 million
- Greatbatch**  
Medical device technologies  
HQ: Frisco  
Sales: \$663.9 million
- Alcon**  
Ophthalmics devices and medicine  
HQ: Fort Worth  
Sales: \$593 million

## Key Texas Biotechnology Rankings

- No. 1 nationally for biodiesel production
- No. 1 for U.S. agricultural sciences doctorates
- No. 2 in life and physical scientists employment nationwide
- No. 3 for U.S. biological/biomedical sciences and life science doctorates
- No. 3 in U.S. science, engineering, and health doctorate holders
- No. 5 for U.S. health sciences doctorates

## Texas Attracts Biotechnology Investment from around the World

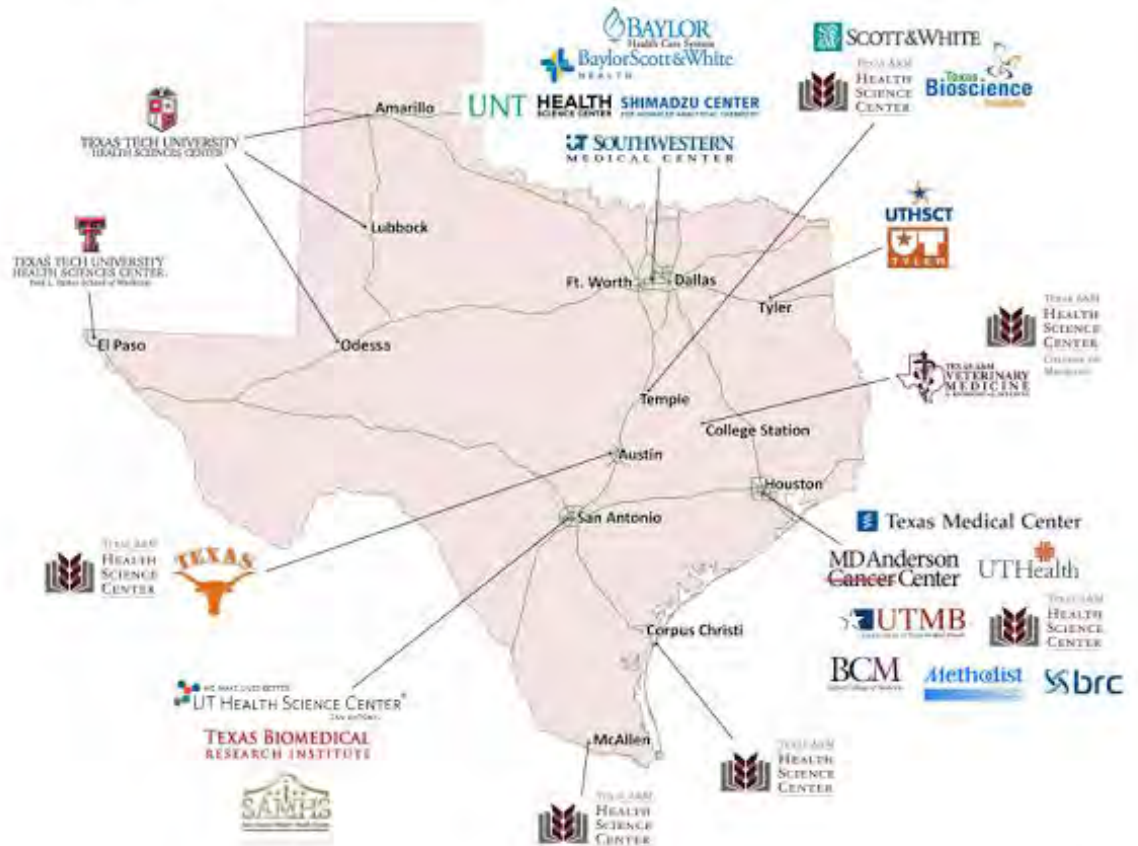
- Selected foreign services companies with biotechnology-related operations in Texas:
- Denmark**  
ALK-Abelló: Round Rock
  - France**  
Essilor: Dallas  
Virbac: Fort Worth
  - Germany**  
Ottobock: Austin
  - Japan**  
Fujirebio: Seguin  
Hitachi: Dallas  
Rigaku: Austin
  - The Netherlands**  
Philips: Arlington, Houston  
Royal Dutch Shell: Houston
  - Singapore**  
Flextronics: Irving
  - Spain**  
Grifols: San Marcos, Statewide locations
  - Switzerland**  
Galderma: Fort Worth  
Lonza: Houston  
Novartis: Fort Worth, Houston  
Orthofix: Lewisville
  - United Kingdom**  
Smith & Nephew: Fort Worth

**Top Ten Texas Institutions  
for Biomedical R&D**  
by FY 2013 Expenditures

Institution	Total R&D (Millions)
Univ. of Texas (UT) M.D. Anderson Cancer	\$670.5
Baylor College of Medicine-Houston	\$481.8
UT Southwestern Medical Ctr. at Dallas	\$404.3
UT Health Science Center (HSC) at Houston	\$220.1
Texas A&M University	\$201.6
UT Health Science Center at San Antonio	\$156.4
UT Medical Branch (UTMB) at Galveston	\$144.7
The University of Texas at Austin	\$80.9
Texas A&M Health Science Center	\$75.4
Texas Tech University Health Science Ctr.	\$61.0
<b>TOTAL</b>	<b>\$2,496.7</b>

Source: Texas Higher Education Coordinating Board

**Texas Medical Schools & Selected Medical Research Centers**



**Texas Places Four Research  
Medical Schools in Top 100**

In 2014, U.S. News & World Report ranked the nation's top 100 research medical schools. Texas landed four schools on the list:



# Historical Development of Biotechnology

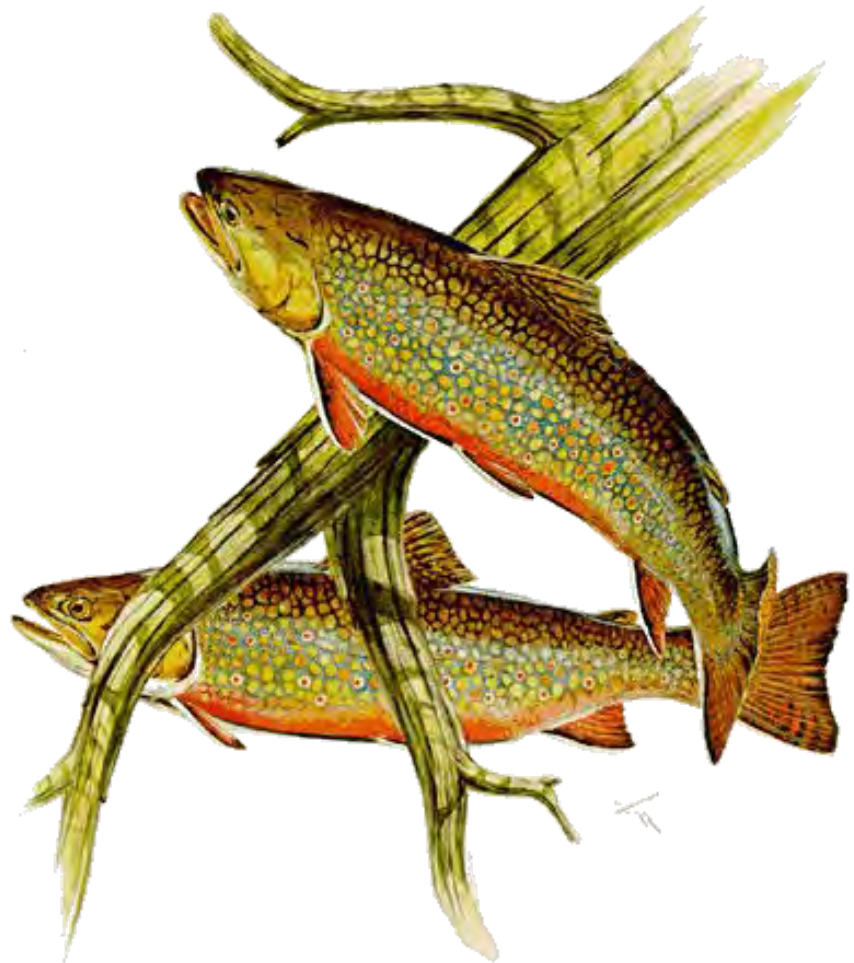


# 1750 B.C.

- **Origins of “biotechnology” emerge in methods of food production and plant and animal breeding**
  - **Use of bacteria to produce cheese (food preservation)**
  - **Use of natural enzymes in yogurt**
  - **Use of yeast to produce bread**
  - **Use of fermentation for producing wine and beer**

# 1869

- **DNA is discovered in trout sperm by German Miescher**



# 1919

- **The word “biotechnology” is first used by a Hungarian agricultural engineer.**



# 1940's-1950's

- **Widespread work is undertaken to investigate the structure and function of DNA**



# 1980



- **The U.S. Supreme Court approves the patenting of genetically altered organisms.**

# 1980's-1990's

- **A variety of GMO's and biotechnology techniques are introduced in fields from agriculture to medicine**
  - **Recombinant DNA technology-extracts DNA from one organism for use in another, allowing more rapid and specific improvements in plants and animals**
  - **Plant Tissue Culture-gains widespread acceptance as a method to quickly and cheaply produce genetically identical plants**

# 1990's

- **First transgenic organisms (GMO's) are introduced in widespread agricultural production, particularly in the area of crops.**
  - **Bt corn and soybeans are introduced offering “natural” insect resistance by the introduction of a gene from the bacterium *Baccillus thuringensis***

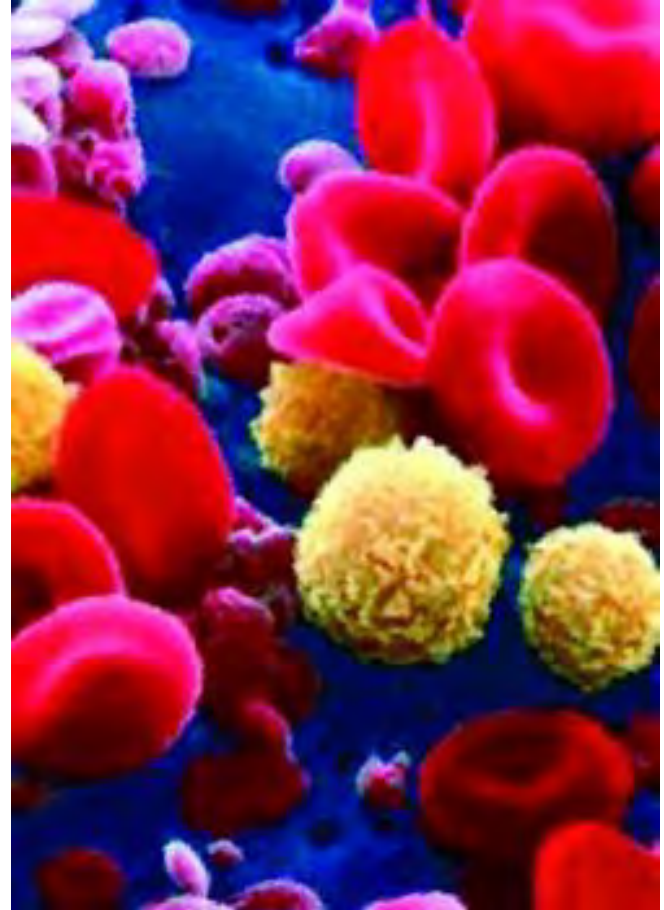
# 1997

- **Dolly is the first animal cloned from diploid cells is produced in Scotland**



# Late 1990's-Early 2000's

- **Human cloning is outlawed in the U.S. and the first concerns over the use of human stem cells in research begin to arise.**

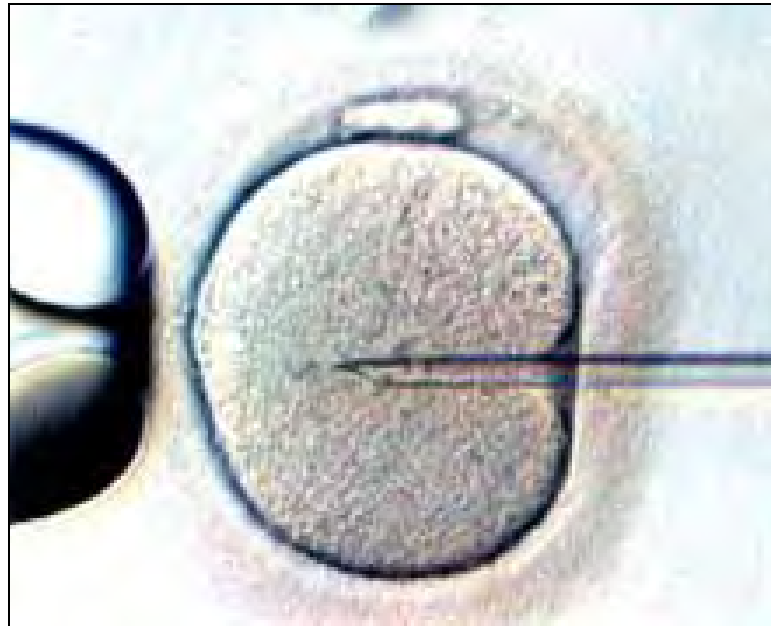


# **Biotechnology and Agriscience**

- **There has been increased activity and research between different agricultural areas with common research techniques and goals**
  - **Plant Science**
  - **Animal Science**
  - **Environmental Science**
  - **Health/Agri-Medicine**

# Animal Science

- **Increased use of methods of in vitro fertilization and artificial insemination improve selected breed programs**





# Environmental Science

- **Use of biotechnology techniques in environmental science for cleaning contaminants and protecting endangered species**
  - **Bioremediation-use of natural organisms to clean contaminants**

# Pioneers in Biotechnology



# Antony van Leeuwenhoek

- 1675
- Discovers bacteria using a simple microscope



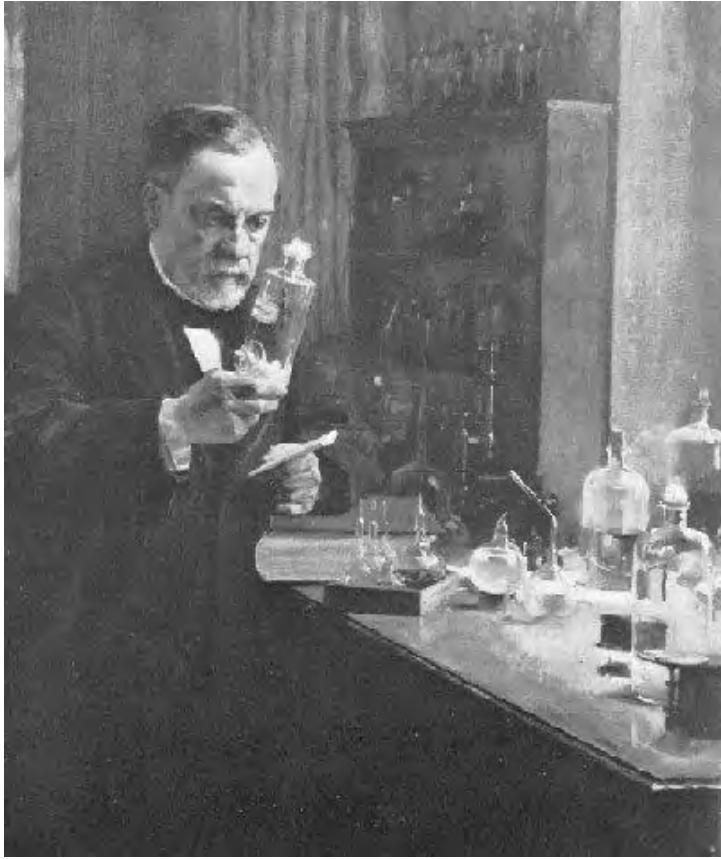
# Gregor Mendel

- 1863
- Austrian monk who conducted the first genetics experiments using pea plants in the mid 1800s.
- Often considered the founder of genetics.



Gregor Mendel

# Louis Pasteur



- 1870's
- Disproved the notion of spontaneous generation, describing the role of bacteria in spoilage and the scientific basis for fermentation
- Created the rabies vaccine

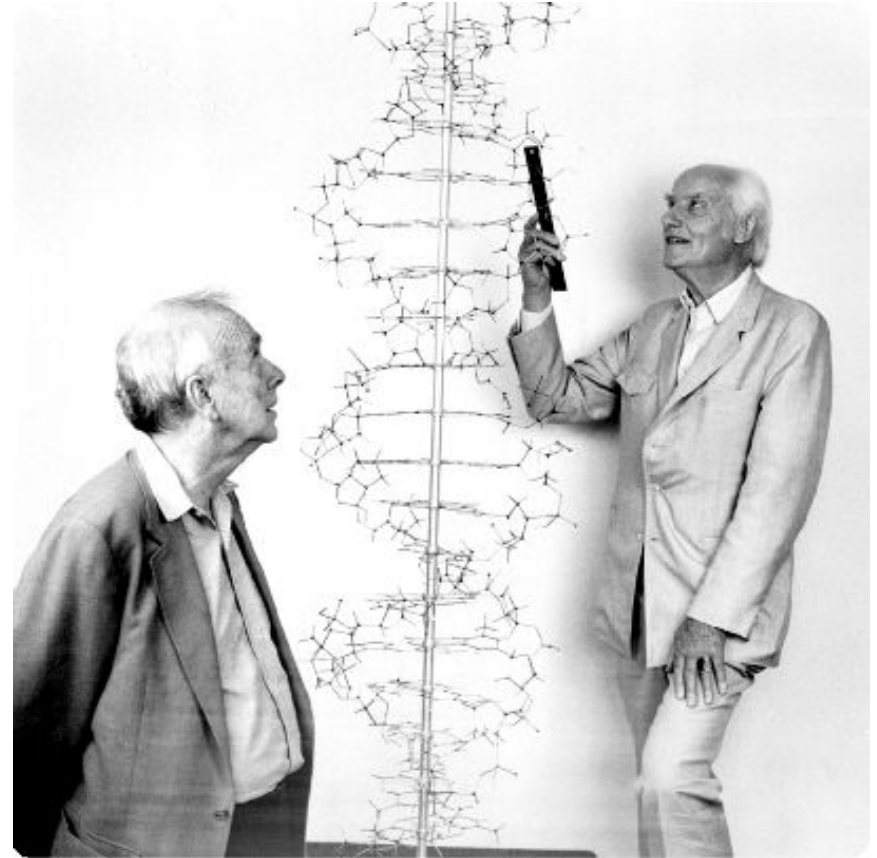
# Robert Hooke

- 1665
- Invented the compound light microscope
- First to observe cells in cork



# James Watson & Francis Crick

- 1953
- Englishmen responsible for the discovery of the double helix structure of DNA using X-ray photographs



# Paul Berg



- **1972**
- **Stanford University scientist who first developed recombinant DNA technology, a method for insertion of genetic material from one organism into another.**



# Pioneers in Biotechnology

Choose your favorite pioneer in biotechnology (or modern scientist) and answer the following questions below. You will submit a short presentation (powerpoint format), before class on Friday (08-26-16). Each student will have 5 minutes maximum to present to the class.

1. Name of scientist
2. Briefly describe the individual's academic background.
3. Describe how their scientific discovery advanced the field of biotechnology.
4. Outline the experiment/method used.
5. Describe whether or not these contributions are still relevant today (if applicable).

You will receive a daily grade based upon the content of your presentation and your presentation skills.

# Interactive DNA Timeline Quiz

Browse the Interactive DNA Timeline (<http://www.dnai.org/timeline/index.html>) to find the answers to the quiz located on the [right](#).

Note answers are due before class Friday (08-26-16) and will be marked for a daily grade.