Bioscience Week 2009

September 14-18, 2009
What is Biotechnology?

- Technology based on biology
- The term was coined in 1919 by Karl Ereky, an Hungarian engineer
- At that time, the term meant all the lines of work by which products are produced from raw materials with the aid of living organisms
- A common misconception is that biotechnology refers only to recombinant DNA (rDNA) work or “genetic engineering”
- Biotechnology is not new; man has been manipulating living things to solve problems and improve his way of life
  - Modification of native plants to improve food crops (artificial selection, hybridization)
  - Animals were selectively bred
  - Microorganisms used to make beverages, cheese, bread
What is Biotechnology?

- Before 1970, the term was primarily used in agriculture
- With the development of recombinant DNA techniques, it started to be used to refer to laboratory-based techniques to satisfy food and health demands
- Modern biotechnology was initiated in mid 1980 when the United States Supreme Court ruled that a genetically-modified microorganism could be patented in the case of Diamond vs. Chakrabarty
  - With the development of a bacterium derived from the Pseudomonas genus that was capable of breaking down crude oil, proposed to use in treating oil spills
- Usage of the word biotechnology has come to mean
  - “all parts of an industry that knowingly create, develop, and market a variety of products through the willful manipulation, on a molecular level, of life forms or utilization of knowledge pertaining to living systems”
- The “United Nations Convention on Biological Diversity” defines biotechnology as:
  - “Any technological application that uses biological systems, dead organisms, or derivatives thereof, to make or modify products or processes for specific use.”
Biotechnology is an interdisciplinary science

...it is also an applied science with a desired outcome
Biotechnology has numerous applications

- Making medicines in large quantities
  - Safe human therapeutic proteins

- Improving the quantity and quality of agricultural crops and livestock
  - Engineering new plants for pest or herbicide resistance

- Removing pollution from soil and water
  - Oil eating bacteria
Biotechnology is an old field with crucial discoveries through time

- Prior to 1800s: microorganisms used to make cheese, beverages and bread
- 1865: Mendel investigated how traits are passed from generation to generation
- 1869: Meischer isolated DNA from the nuclei of white blood cells
- 1902: Sutton coined the term "gene" and proposed that chromosomes carry genes
- 1910: Morgan proved that genes are carried on chromosomes
- 1944: Avery, McLeod & McCarty demonstrate that DNA is the genetic material
- 1953: Watson & Crick determined the double helix structure of DNA
- 1957-1960: how DNA functions to make protein; DNA polymerase discovery; isolation of m-RNA
- 1971: discovery of restriction enzymes
- 1973: Cohen produced first recombinant DNA organism
- 1974: foreign genes can be expressed in bacteria
- 1977: human proteins expressed in microorganisms (somatostatin, human growth hormone)
- 1978: Nobel Prize awarded to Arber, Nathans & Smith for the discovery of restriction enzymes
- 1978: genetic engineering techniques used to produce human insulin in E. coli
- 1985: development of PCR (polymerase chain reaction) technology
- 1988: NIH institutes funding mechanism for biotechnology training
- 1997: cloning of first mammal (Dolly)
- 2003: complete human genome sequence
Modern Biotechnology is the result of crucial discoveries made during the last century

- Specifically the discovery of recombinant DNA technology

Discovering the nature of the genetic material  
Understanding the pathway to produce proteins

Leading to a new era of Genetic Engineering
What is Genetic Engineering?

- Is the artificial manipulation and alteration of the genetic material of an organism to allow it to produce endogenous proteins with different properties or to produce entirely different proteins.
- DNA molecules from different sources are combined and inserted in host organisms.
- Host produces the desired protein in large quantities.
- Hosts can be different types of cell systems: bacterial or mammalian.
Traditional Medicines

Aspirin (180.2 Da)
Ibuprofen (206.3 Da)
Paclitaxel (853.9 Da)

Biopharmaceuticals

Insulin (5808 Da)
Filgrastim (18,800 Da)
Etanercept (150,000 Da)

Manufacturing a biopharmaceutical is complex
It starts with the drug substance...

- **Insert** gene into DNA vector
- **Transfer** into host cell
- **Express** desired protein
- **Grow** cells in bioreactors
- **Extract, Purify, Dilute**

...and ends in the manufacturing of the drug product

Formulation

Labeling and packaging

Filling and inspecting
...to fulfill the needs of our patients

Enjoy the Bioscience Week 2009