

Introduction to Biotechnology

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Lecture outline

- What is biotechnology
- History of Biotechnology
- Success of Biotechnology from time to time
- Some important developments in Biotechnology
- Ethical issues in Biotechnology

Definition

- the science of altering genetic and reproductive processes in plants and animals.
- The simple addition, deletion, or manipulation of a single trait in an organism to create a desired change.

Two areas

- genetic engineering
- embryo transfer

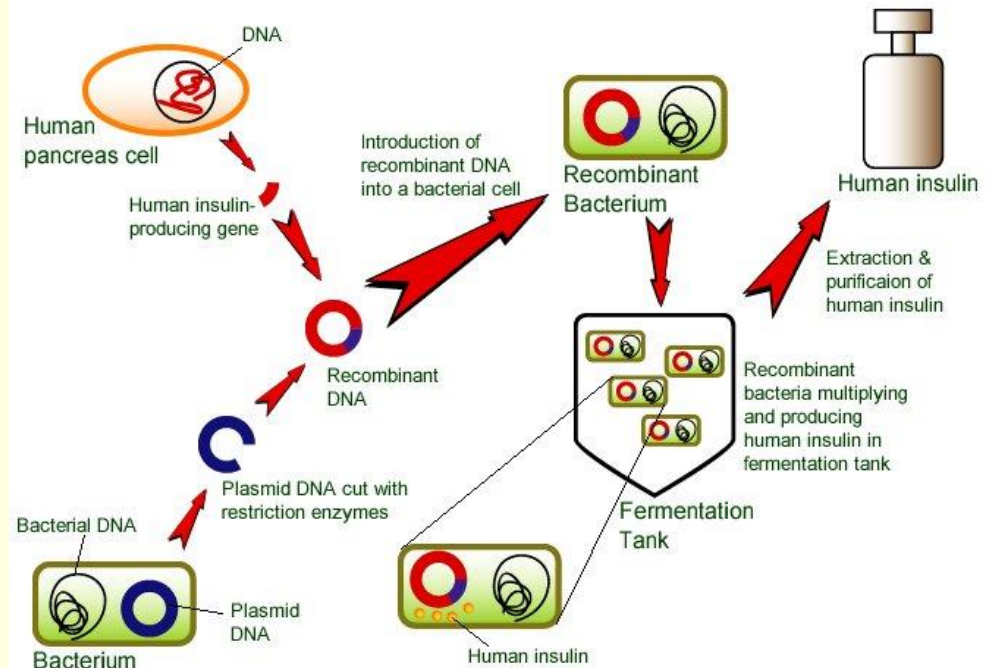
Genetic engineering (The drug insulin produced in 1986)

Recombinant DNA becomes useful when the artificial DNA is reproduced and multiplied. For example, the human gene insulin could be placed in bacteria.

The new bacteria contains recombinant DNA and therefore is called recombinant bacteria.

The bacteria will then produce insulin in large amount for the treatment of diabetes.

Human Insulin Production



Biotechnology

- involves taking a tiny bit of DNA containing the desired gene from one organism and splicing it into the DNA strand of another organism.

Biotechnology

- purpose - to have the recipient organism take on the characteristic controlled by the transferred gene....for its benefit

Examples

- disease resistant animals
- growth regulators
- new drugs and vaccines

Environmental Cleanup

Some modified microorganisms can be used to extract minerals from the environment or degrade potentially toxic waste materials. The process is called: Bioremediation.

Biofuels make use of crops such as corn and soybeans to replace fossil fuels.

Examples

- specify size and sex of animals.
- organism that “eats” oil used in the Persian Gulf



Gulf oil spillage

Genetic Engineering Benefits

- **Genetic material can be shared across scientific kingdoms.**
- **Bacteria engineered to produce human proteins.**
- **Potential is virtually endless.**

Mid eighties

- In the mid-eighties and early-nineties, it has become possible to transform (genetically modify) plants and animals that are important for food production.
"Transgenic" animals and plants, including cows, sheep, tomatoes, tobacco, potato, and cotton have now been obtained.
- Genes introduced may make the organism more resistant to disease, may influence the rate of fruit ripening, or may increase productivity.

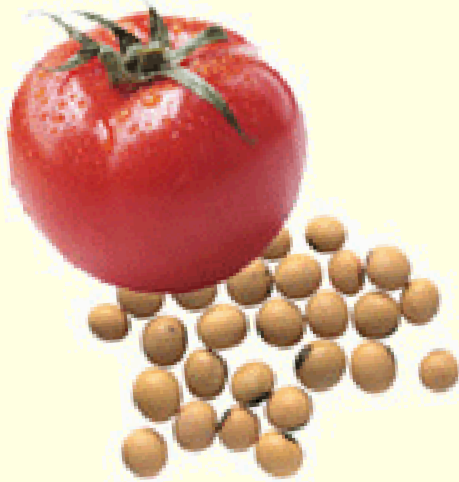
Modern biotechnology

- Expression of **human genes** such as that coding for insulin, but have since been extended to mammalian, microbial, and plant genes.
- Also, the spectrum of "**bioreactors**" (organisms used for production) recently has been broadened to include a variety of animals and plants

Transgenic Organisms

- **Organisms altered by genetic engineering that express a “novel” trait not normally found in the species**
- **genetic material changed by other than random natural breeding.**
- **gene transfer-moving a gene from one organism to another.**
- **these require skill and knowledge to be carried out properly.**

Biotechnology in research and industry?



<-Extended shelf-life tomato (Flavr-Savr)

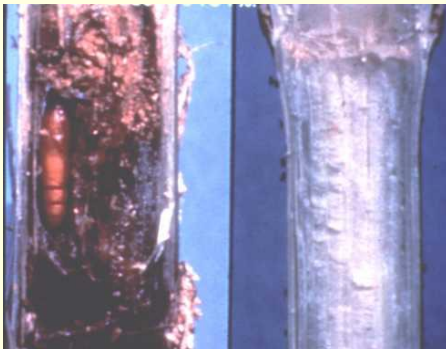
<- Herbicide resistant soybean

Agriculture Transgenics On the Market



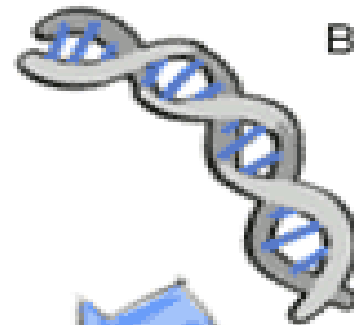
Insect resistant cotton – Bt toxin
kills the cotton boll worm

transgene = Bt protein



Insect resistant corn – Bt toxin
kills the European corn borer

transgene = Bt protein



Bt Gene is
inserted
into crop



Crop is infected by
European corn borer



Pest dies when feeding on
any plant part

Herbicide resistant crops



soybean, corn, canola, sugarbeet, lettuce, strawberry, alfalfa, potato.

transgene = modified EPSP synthase



Virus resistance - papaya
resistant to papaya ring spot virus

transgene = virus coat protein

Biotechnology in Industry



***Biotech chymosin**; the enzyme
used to curdle milk products
**transgene = genetically engineered
enzyme***



***bST**; bovin somatotropin; used to
increase milk production
**transgene = genetically engineered
enzyme***

Biotechnology in Agriculture



Golden Rice – increased Vitamin A content

transgene = three pathway enzymes



Sunflower – white mold resistance

transgene = oxalate oxidase from wheat



Turfgrass – herbicide resistance; slower growing (= reduced mowing)



Bio Steel – spider silk expressed in goats; used to make soft-body bullet proof vests (Nexia)

Human Applications of Biotechnology

- **Pharmaceutical products**

New solutions to old problems

- **Disease diagnosis**

Determine what disease you have or may get

- **Gene therapy**

Correcting disease by introducing a corrective gene

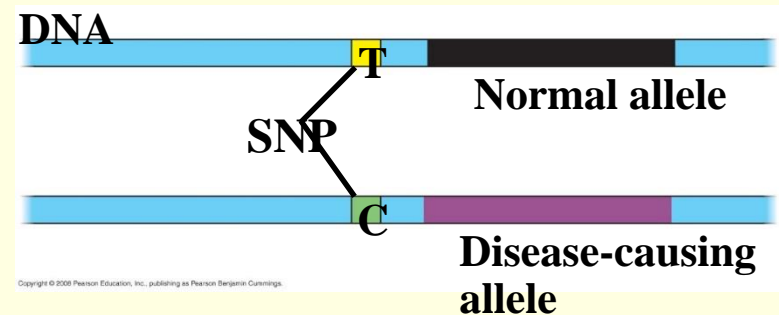
Examples of benefits from Biotechnology and Genetic engineering

Medical Applications

Identification of human genes in which mutation plays a role in genetic diseases

Single nucleotide polymorphisms (SNPs) are useful genetic markers

These are single base-pair sites that vary in a population

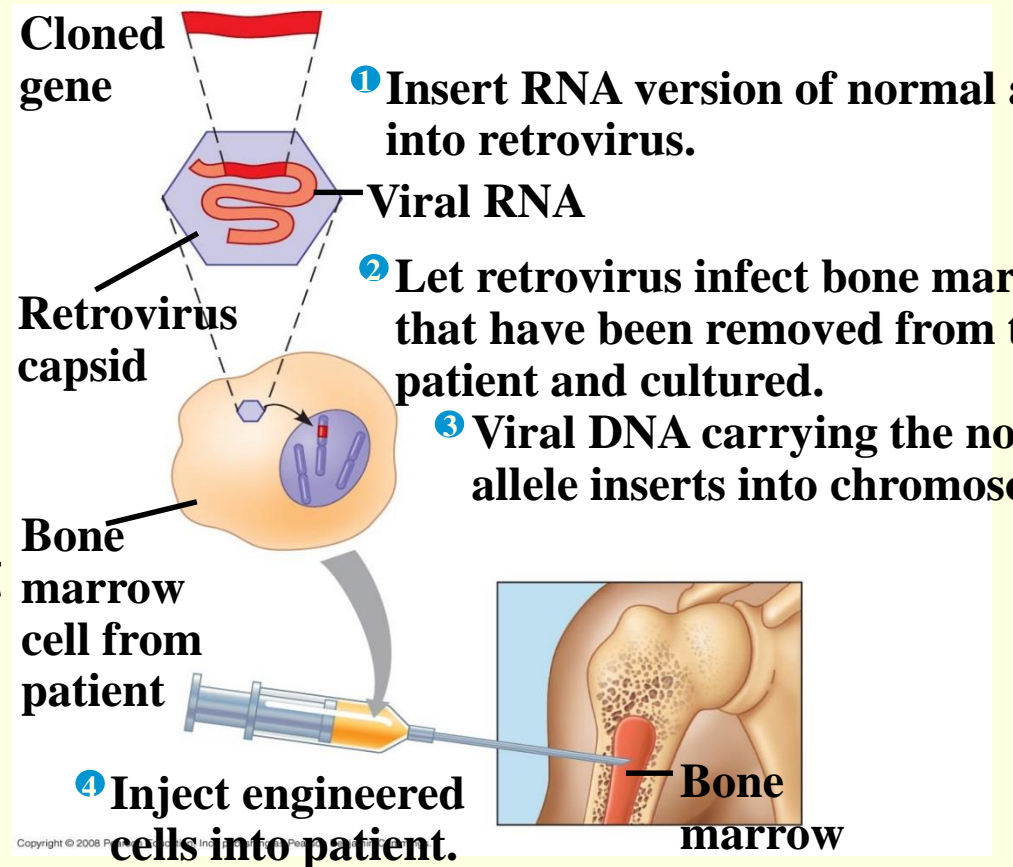


Human Gene Therapy

Gene therapy is the alteration of an afflicted individual's genes

Viruses, are used for delivery of genes into specific types of cells, for example bone marrow

It may be difficult to target cells.



Biotechnology in environment



Bioremediation - cleanup contaminated sites; uses microbes designed to degrade the pollution.



Indicator bacteria - contamination can be detected in the environment.

Transgenic Plants Serving Human Health

Needs: Edible Vaccines

- They Work like any vaccine
- A transgenic plant with a pathogen protein gene is developed e.g, Potato, banana, and tomato are targets
- Humans eat the plant and
- The body produces antibodies against pathogen protein. Thus
- Humans are “*immunized*” against the pathogen
- Examples:
 - Diarrhea
 - Hepatitis B
 - Measles



Biotechnology in crop improvement

Breeding- Crossing two Individuals from the same species produces a new, improved variety;

not a biotechnology procedure



**Transformation-
Adding a gene from another species; the *essential*
biotechnology procedure to
produce transgenics.**



Opposition to “Biotech”

- **people fear.**
- **production of new uncontrollable disease.**
- **freak animals.**
- **long term adverse effects of environment from products.**

Limitations in the Biotechnology field

Production of new uncontrollable and biological weapons.

Strange animals.

Long term adverse effects on environment from products.



Slow Progress

- lack of money for research
- government regulations
- environmental groups filing lawsuits to stop research and testing

Slow Progress

- many farmers don't support genetic engineering because they feel we already have surplus production





■ Issues and Ethics

Ethics and Biotech

- Ethics: a set of principles that guide human actions
- Bioethics: the area of ethics that deals with the life sciences
- Religion: a system of beliefs and practices that an individual chooses to follow

Religion and Biotechnology

- Common fact that God created life

Ethics and the Future of Biotech

- Developments are limited by advancements in science and by ethical rules.
- Some of the progress are considered morally unacceptable exp. Cloning

Social, ethical, and legal issues have no simple solutions

The ability to analyze the genomes of individual humans raises a host of pressing questions about the privacy of genetic information, limitations on the use of genetic testing, the patenting of DNA sequences, society's view of older people, the training of physicians, and the extent to which the human genetic engineer should seek to engineer himself or herself.