MOLECULAR BIOTECHNOLOGY (SQG3213)

OVERVIEW

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BIOTECHNOLOGY

- The study of tools from living things
- The study of techniques based on living system (plant, animal or microbes) to make product / improve other species.
- The application of scientific and engineered principles to processing of material by biological agents
  (eg: microorganisms, plant and animals) to provide good and services.
- *Bios* – "life"
- *Teuchos* – "tool"
- *Logos* – "word", "study of" or "essence"

MOLECULAR BIOTECHNOLOGY

Employs the tools of molecular biology (recombinant DNA, gene cloning) to engineer the genetic information / blueprint of living organism to produce useful, marketable product.

- Describes the molecular basis of technological approaches & processes in biology & medicines.

- Disciplines encompass fundamental science & a number of specialist areas such as genomics & proteomics, drug discovery & development, information bioscience, resource management & regulations.

- Have major impact in health, food, veterinary & agriculture science and is one of science's major growth area.

Table 1: Selected milestones in the timeline of biotechnology

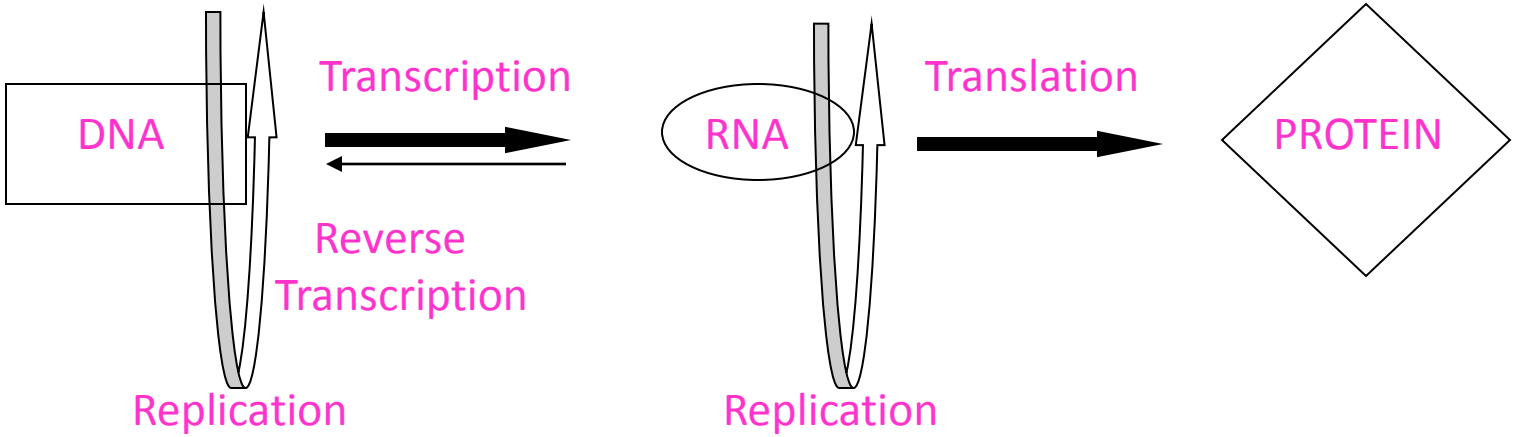
Date	Event
1750 B.C	Sumerians brew beer
1830	Protein discovered
1833	First enzyme isolated
1863	Mendel's discoveries
1919	Term "biotechnology" first used by Hungarian scientist
1935	Geowge W. Beadle. & Edward L. Tatum discovered that each gene codes specifically for a single protein.
1938	Term "molecular biology" arise
1941	Term "genetic engineering" first used by Danish scientists
1944	Avery, MacLeod & McCarty identified DNA as genetic material
1953	Structure of DNA determined by Watson & Crick
1954	Cell culturing techniques developed
1961-66	Genetic code deciphered
1967	First protein synthesized by automation
1973	Recombinant DNA technology established by Cohen & Boyer
1975	Colony hybridization & Southern blotting developed
1976	Sanger, Maxim % Gilbert developed DNA sequencing techniques
1980	U. S. Supreme Court approves the principle of patenting of genetically modified life forms
1983	PCR technique developed; first genetic transformation of plant cells by Ti plasmids accomplished
1984	DNA fingerprinting technique developed
1985	First authorized field test of a genetically engineered plant (tomato); first biotech-engineered interferon drug (Biogen's Intron A and Genentech's Roferon A approved)
1987	First authorized field test of a genetically modified organism – Frostban by Advanced Genetic Sciences
1994	Calgene produced Flavr Savr tomato
1995	First genome of free-living organism completely sequenced *Haemophilus influenzae* (1, 830, 137 nucleotides)
1997	Dolly the sheep cloned by Scottish scientists
2000	First draft of the sequence of the human genome (~3, 300, 000, 000 nucleotides)

GENETIC BASIS OF LIVING THINGS

- DNA – genetic material of life

  - function through **CENTRAL DOGMA**

Central Dogma of Molecular Biology
Concept of information flow progresses from DNA to RNA to protein but not the reverse.



The central dogma of molecular biology

- “New” dogma – take into account the fact that an organism’s environment impacts when & how some of its genes are expressed & also that more than 1 protein can be produced by a single gene.

- Modern science – able to create gene by working backward from its protein product.

THE BASIC PRINCIPLE OF GENETIC MANIPULATION

- Not all traits can be genetically manipulated.
- Underlying concept:

  P = G + E

  P=phenotype, G=genotype,

  E=environment

- To change phenotype, genes coding the trait may be changed, environment may be changed, or **both** factors may be changed.
- Changing genotype – permanent.
- Changing phenotype – temporary.

WHAT IS GENETIC ENGINEERING?

Defined as

Transfer of genes from one organism to any other, circumventing the sexual process.

WHAT IS A GENETICALLY MODIFIED PRODUCT?

- A product of manufactured by recombinant DNA technology, where genetic manipulation of cells is required, referred to as GMO (genetically modified organism) or Transgenic organism / product.

- Consist of modified DNA from the same or and other species.

- Differ from biology product – different in characteristics / control than standard chemically synthesized pharmaceuticals.

- Examples:

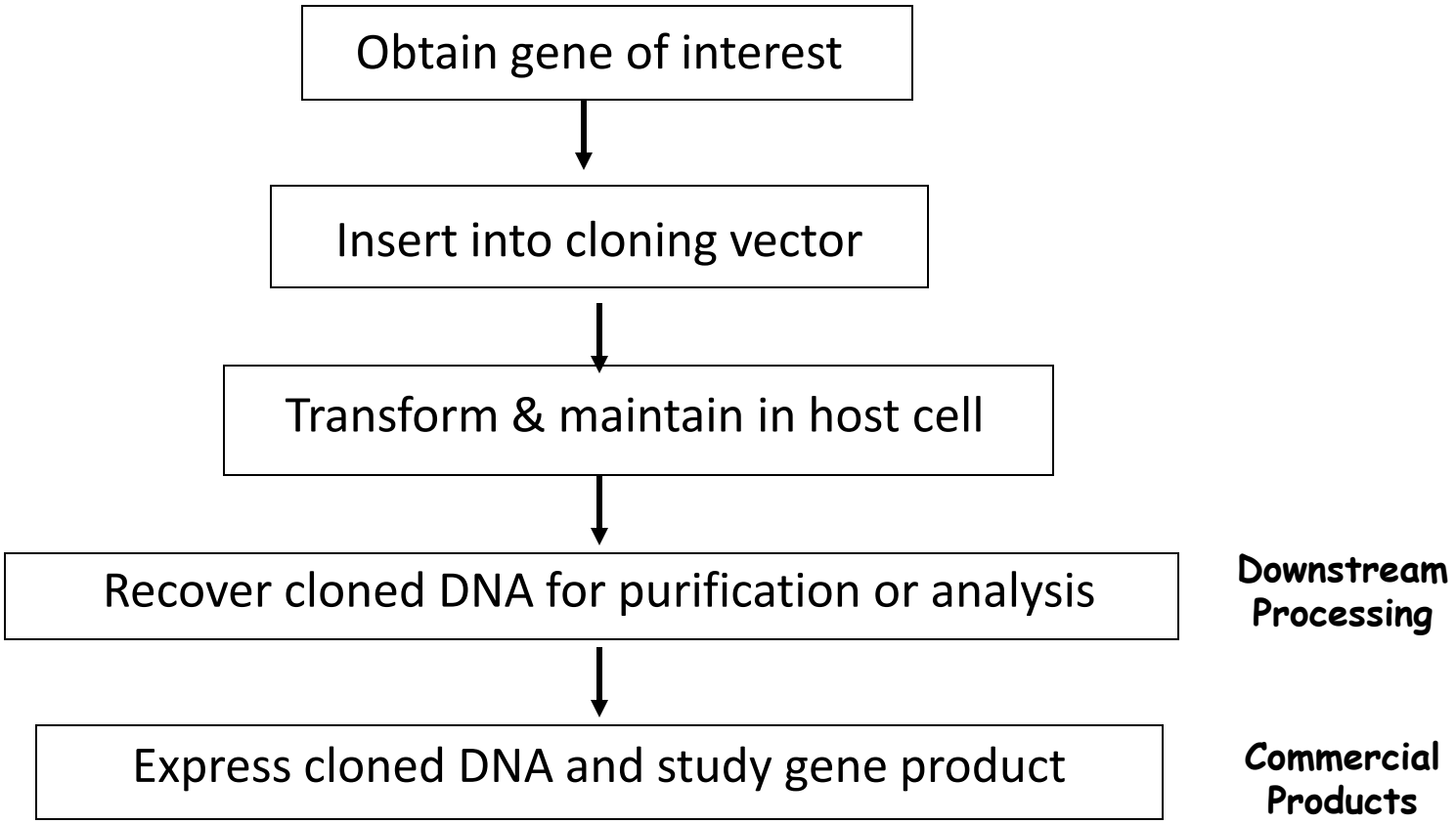
1. Genetically modified products
- - expected to be commercially available within next decade.
- - engineered for input trait & output trait.
- - eg: Monsanto's Roundup®, Mycogens's high oleic sunflower.

2. Transgenic plant
- - enhance fruit ripening & yield; insect, herbicide & viral
- resistance.
- - eg: tomato, rice, tobacco, cotton, papaya, maize, etc.

3. Transgenic animals
- - engineering growth hormone, cloning animal & transgenic fish.
- - eg: Dolly the sheep, Atlantic salmon.

4. Gene therapy
- - correcting genetic disorder.
- - through replacement therapy targeted gene repair.
- - use continuously producing cells for manipulation.
- - target hereditary diseases.

BASIC STEPS IN GENETIC ENGINEERING PROCEDURE



Summary of general steps in recombinant DNA research.

1. Obtain DNA of interest by isolation & cutting out specific sequence.

2. Transgene inserted into cloning vector & ligated – DNA construct.

3. Transfer construct into & maintained in a host cell via transformation.

4. Identify incorporated foreign DNA + host cells & isolate.

5. Cloned DNA can be manipulated.

BENEFITS OF BIOTECHNOLOGY

- Health – new & better antibiotics, drugs & vaccines, diagnosis of disease, gene therapy.
- Nutrition – production of more nutritious foods.
- Agriculture – increased crop & livestock production, disease resistance, better pesticides.
- Energy – production of fuels from renewable resources, cleaner fuels.
- Chemicals – production methods that produce less pollution.
- Environment – bioremediation of pollution.

BIOTECHNOLOGY AND SOCIETY

- Some concerns over:
  - Potential to cause harm to individuals or the environment
    - E.g.: Spread of toxin or cancer-causing genes to benign organisms
  - Spread of antibiotic resistance genes to pathogen
  - Spread of herbicide-resistance genes to weed plant
  - Not able to “recall” microorganisms after their release to the environment.
  - Morality of genetic engineering of humans.
  - Knowledge of predisposition to disease may influence personal decisions or availability of health insurance.
  - Patenting genetic material and living organisms.
  - Deliberate misuse – biological warfare, terrorism.

References:

- Bernard R. Glick. (2008) Molecular Biotechnology: Principles & Applications of Recombinant DNA - John Wiley & Sons, Inc., USA.
- Acquaah, G. (2004) Understanding Biotechnology: An Integrated and Cyber-Based Approach. Pearson, Prentice Hall, New Jersey.