

Current Trends in Biotechnology

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Outline of the Presentation

- 1 Basic Concepts
- 2 Benefits and Risks
- 3 Bioinformatics
- 4 Moral and Ethical Issues
- 5 Take home message

*The global train of biotechnology has
left the station. It is picking up speed.*

-- Arthur Kornberg

Moore's Law: Computer power
doubles every 18 months

Venter's Law: Biotechnology will
outstrip Moore's Law

Biotechnology

is a set of scientific tools
using living organisms or their parts
to produce useful products.

Genetic Engineering

refers to techniques that permit
artificially moving genes from
one organism to another, often from
one species to another, to produce
new or novel organisms.

Agricultural Biotechnology

Benefits

Food Security
- higher yields
- better quality
Environment
Better Health

Risks

Environment
Health Hazards

Agricultural Biotechnology Food Security

Products developed at BIOTECH-UPLB:

- bioorganic fertilizers
- soil inoculants
- animal vaccines
- diagnostic kits
- enzymes

Agricultural Biotechnology Food Security

- planting of Bt corn
- genetic engineering experiments on rice (IRRI and PhilRice)
- genetic engineering experiments on 5 crops (IPB-UPLB)

Agricultural Biotechnology Food Security

- delayed ripening of mango and papaya
- banana resistant to bunchy top virus
- papaya resistant to ring spot virus
- corn resistant to corn borer
- coconut with modified coconut oil

Agricultural Biotechnology Food Security

Why is food security important?

- 10% of Earthmen are malnourished.
- 8 million Filipinos are malnourished

Benefits to the Environment

- Reduced pesticide usage
- Reduced tillage
- Save forests

***Silent Spring* by Rachel Carson**

describes how pesticides contaminate the natural world, accumulate in our bodies and possibly cause disease.

In ***Our Stolen Future* by Theo Colburn, Dianne Dumanoski and John Myers** explain how pesticides disrupt hormonal systems resulting in: infertility and neurological disorders.

Pesticides: its Hazardous Effects on the Benguet Farmers and the Environment

by **Dr. Charles Cheng**, medical director of Baguio Filipino Chinese General Hospital, notes the **link between the use of pesticides to the number of cancer cases** admitted in the hospital.

Pesticides: its Hazardous Effects on the Benguet Farmers and the Environment

Of the 2000 pesticide users (farmers) in Benguet:

- 50% experience skin problems;
- 39% body malaise;
- 38% dry and sore throat, and whitish spots on tongue (sign of leukoplakia.);
- 28% chest pains;
- 24.5% loss of appetite;
- 15% unbearable headache followed by vomiting;
- 13.5% uncontrollable saliva flow;
- 11% uncontrollable sweating and urination; and profuse bleeding for women, miscarriages and still birth, cancers of the blood, gastrointestinal tract, et.al.

Biotechnologies for the 21st Century

Diagnosics	Gene analysis Integrated therapies Expression analysis
Immuno therapy	Therapeutic vaccines for cancer & infectious diseases
Genomics	Explosion of new targets for drug discovery
Pharmaco-genomics	Customization of medicine Rational patient selection for clinical trials
Proteomics	High throughput validation of gene products
Gene therapy	DNA RNA direct transfer anti sense vector mediated ribozymes live virus RNA ligands
Cell-based therapies	Nervous system repair Tissue regeneration Immune reconstitution

Predictions

In 10 Years:

- Genetic testing for 25 common conditions
- Doctors begin practicing genetic medicine
- Gene therapy successful for some conditions

Predictions

In 20 Years

- Gene-based designer drugs for common diseases such as diabetes and high BP
- Cancer therapy will be targeted to molecular fingerprint of the tumor
- Genetic diagnosis and treatment of mental illness

Predictions

In 30 years

Genes involved in aging
fully catalogued
Complete genomic sequencing
of individual will be routine

Predictions

In 40 years

Individualized preventive
medicine available and
largely effective
Average life expectancy of
90 years

Potential Risks to Environment

Gene Flow – modified crops
can spread their novel genes and
such altered organisms might
become hard to manage.

Short Term Effect

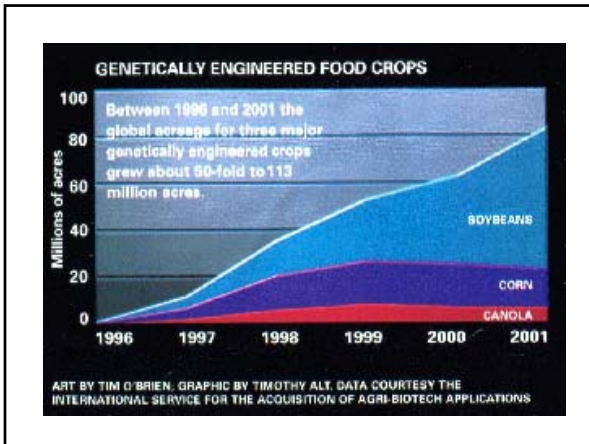
Engineered crops may
hasten insects' resistance to
Bt toxins.

Health Effects

Allergens might be
introduced into foods.

How Safe Are GMOs?

- National Academy of Sciences (US)
- Royal Society of London
- Third World Academy of Sciences
- Brazilian Academy of Sciences
- Chinese Academy of Sciences
- Indian National Science Academy
- Mexican Academy of Sciences
- National Academy of Science and Technology (Philippines)



Bioinformatics

- Means for analyzing, comparing, graphically displaying, modeling, storing, systemizing, searching, and ultimately distributing biological information, which includes sequences, structures, function, and phylogeny
- Thus may be defined as a discipline that generates computational tools, databases, and methods to support genomic and postgenomic research
- Comprises the study of DNA structure and function, gene and protein expression, protein production, structure and function, genetic regulatory systems, and clinical applications

Knowledge Base in Biology - 1

- As genetic information is being made as computerized databases and their sizes are steadily growing, molecular biologists need computational tools to store and retrieve cognate information such as bibliographic or biological information from the databases, to analyze the sequence patterns they contain and to extract the biological knowledge the sequences have
- There is a strong need for mathematical methods and computational techniques for challenging computational tasks such as predicting the three-dimensional structure of the molecules the sequences represent, and to construct the evolutionary trees from the sequence data

Knowledge Base in Biology - 2

- These tools will also be used to learn basic facts about biology, such as which sequences of DNA are used to code proteins for greater understanding of genes and how they influences diseases
- The demanding challenge here is to determine how the digital language of the chromosomes is being converted into the 3-dimensional and sometimes 4-dimensional languages of living and breathing organisms

Information Technology in Biology

- Performing all the above-mentioned tasks manually is nearly impossible without the use of computers due to the massive volumes of biological data and the preciseness of works involved
- Bioinformatics deals with designing and deploying efficient software tools for accomplishing these tasks in a fast and precise manner

Software and Hardware Advancements in Biology

- Recent advances include improved DNA sequencing methods, new approaches to identify protein structure, and revolutionary methods to monitor the expression of many genes in parallel
- Genomics has triggered the development of high-throughput instrumentation for DNA sequencing, DNA arrays, genotyping, proteomics, etc.
- These instruments have catalyzed a new type of science for biology termed **discovery science**.

Genomes - Discovery Science

- Discovery science defines all the elements in a biological system
- In the era of automated DNA sequencing and dynamic advances in DNA sequence analysis, the attention of many researchers is now shifting away from the study of single genes or small gene clusters to whole genome analyses
- Knowing the complete sequence of a genome is only the first step in understanding how the information contained within the genes is transcribed and ultimately translated into functional proteins

System Biology - 1

- Two types of biological information:
 - 1 information of genes and proteins, which are the molecular machines of life
 - 2 information of the regulatory networks that coordinate and specify the expression patterns of the genes and proteins

System Biology - 2

- All biological information is hierarchical: DNA \triangle mRNA \triangle protein
- These pathways form informational networks, which in turn becomes cells. Now cells form networks of cells. A host of individuals forms population and a variety of populations becomes ecologies

System Biology - 3

- The challenge is for researchers and scientists to create tools and mechanisms to capture and integrate these different levels of biological information and integrate it towards gaining insight of their functionings
- A paradigm shift leads to the view that the major challenges for biology and medicine in this new century will be the study of complex systems and the approach necessary for studying these biological complexities

Bioinformatics - Conclusion

“As it becomes imperative for biologists to seek the help of information technology professionals to accomplish the ever growing computational requirements of a host of exciting and needy biological problems, the synergy between modern biology and computer science needs to blossom in the days to come.”

The Moral Issue

(courtesy of Bishop Jesus Varela)

1. Anti Global Environmentalism

- > introduction of any 1st World technology is always eyed with suspicion
- > influence of Marxist propaganda in 3rd World cultures has had an adverse effect on attitudes toward capitalistic multinationals
- > an exaggerated reverence for the environment as if it were a sacred reality superior to man

The Moral Issue

(courtesy of Bishop Jesus Varela)

2. Scientific Utilitarianism

> a deification of science and technology as if they hold the ultimate answer to all human problems

> every human act is judged by its practical and material usefulness

> use, overuse, and abuse of nature as long as the material well-being of man is served

An alternative ethical framework

(courtesy of Bishop Jesus Varela)

Christian Environmentalism, which advocates

- 1 CUSTODY – preserving the integrity of nature
- 2 STEWARDSHIP – responsible use of material things for the good of the human being and society
- 3 RIGHT ORDERING – establishing criteria for the exercise of Custody and Stewardship

• Guidelines include:

- a. Sustainable development
- b. Cost-benefit analysis
- c. Keeping science at the service of man, not vice-versa

Take Home Message

Biotechnology is in its infancy.

Growth is fast and furious.

Inflame the minds of people about its potential.

Benefits of Biotechnology

For More Information

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