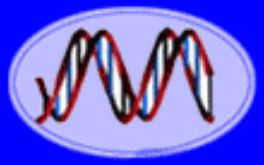

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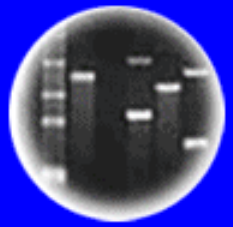

DNA Fingerprinting

Cloning: Ethical Issues
and Future Consequences

Plants of Tomorrow

HC70A, PLSS530, & SAS70A
Winter 2012
Genetic Engineering in Medicine, Agriculture, and Law

Professors Bob Goldberg, Channapatna Prakash, & John Harada

Lecture 2
The Age of DNA: What Is Genetic Engineering-Part Two

UCLA

TUSKEGEE UNIVERSITY

UCDAVIS
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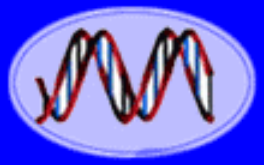

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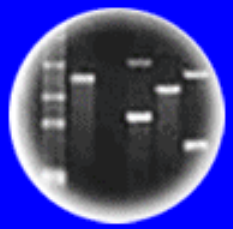

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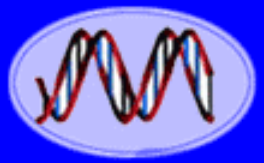
THEMES

1. The Double Helix – Who Gets the Nobel Prize?
2. The Age of DNA, Genomics, Genetic Engineering & Synthetic Organisms
3. Origins of Genetic Engineering-Revisited
4. What is the Significance of Genetic Engineering & What is the Purpose of Cloning Genes??
5. How Has Genetic Engineering Affected Our Lives and Raised New Legal and Ethical Issues??
6. Spectacular Examples of Genetic Engineering 1.0 - What Can Be Done?
7. What Does Genetic Engineering Tell Us About Basic Genetic Processes?
8. Genetic Engineering - Anything New?
9. Classical vs. 21st Century Genetic Engineering - Demonstration
10. Era of Genomics - Impact For Genetic Engineering Future?
11. What Is the Scientific Method & How is Science Carried Out?



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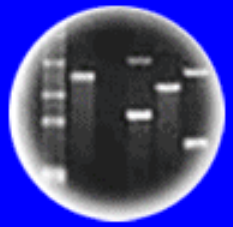

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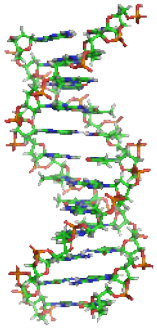
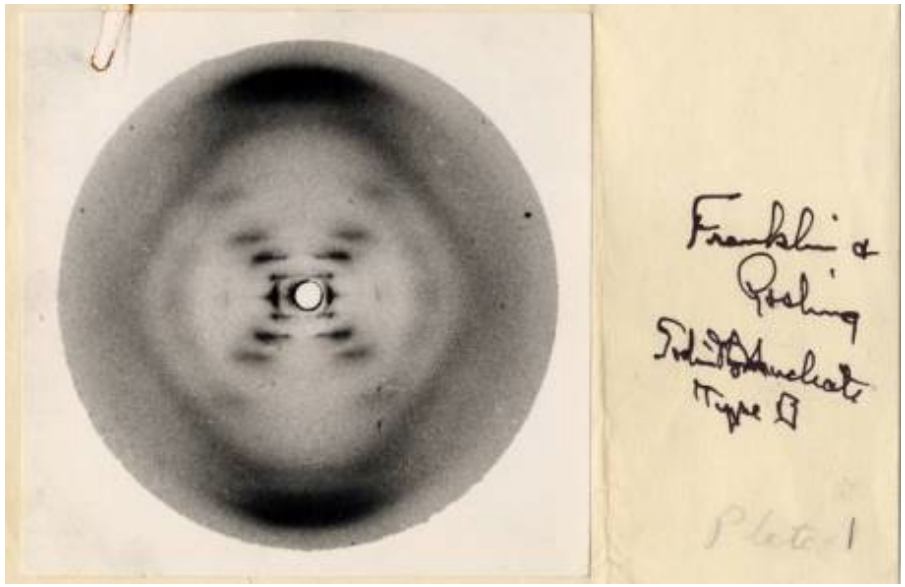
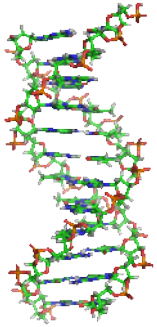
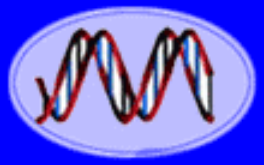
Reflections on The *"Race For the Double Helix"* Film









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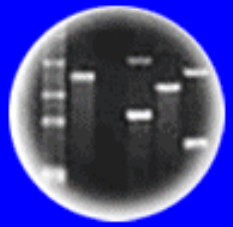

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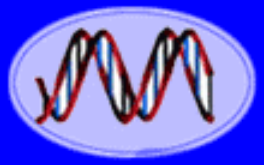
If You Were on the Nobel Prize Committee, Who Would Be Your Choice(s) For Being Awarded the Nobel Prize For Discovering the Structure of DNA?

a. Watson
b. Crick
c. Wilkins
d. Franklin
e. Gosling
f. Chargaff

<u>Note</u>: Nobel Prize Rules Allow Only <u>Three</u> People To Share a Prize



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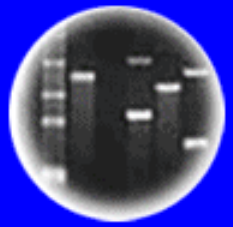

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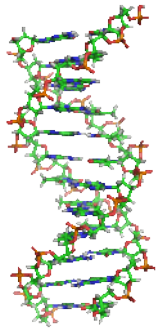
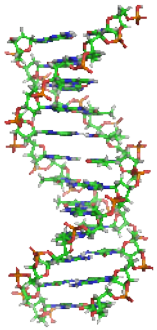
Last Lecture - Age of DNA & Genetic Engineering: Part One

Today's Class – Age of DNA & Genetic Engineering: Part Two

Genetic Engineering - Anything New?

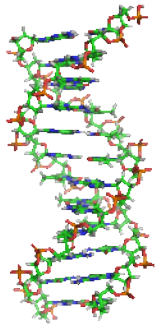
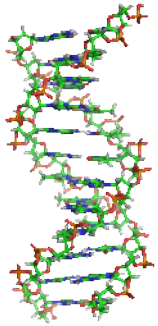
Demonstration
Flying Vegetables!

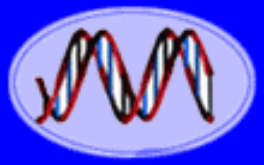
Recall: We Live in the The Age of DNA!

Genetic Engineering Is Manipulating DNA!

Understanding Genetic Engineering Requires a Basic Understanding of Genes And How They Work

The Origins of Genetic Engineering
1973



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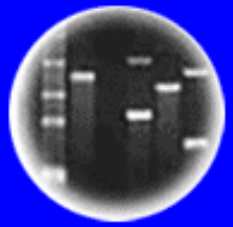

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Cloning: Ethical Issues
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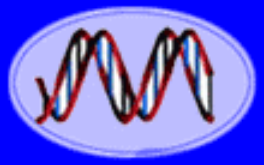
What is Genetic Engineering?
&
What Does It Do?



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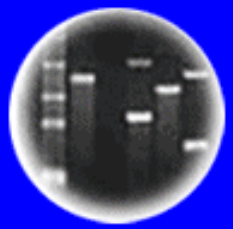

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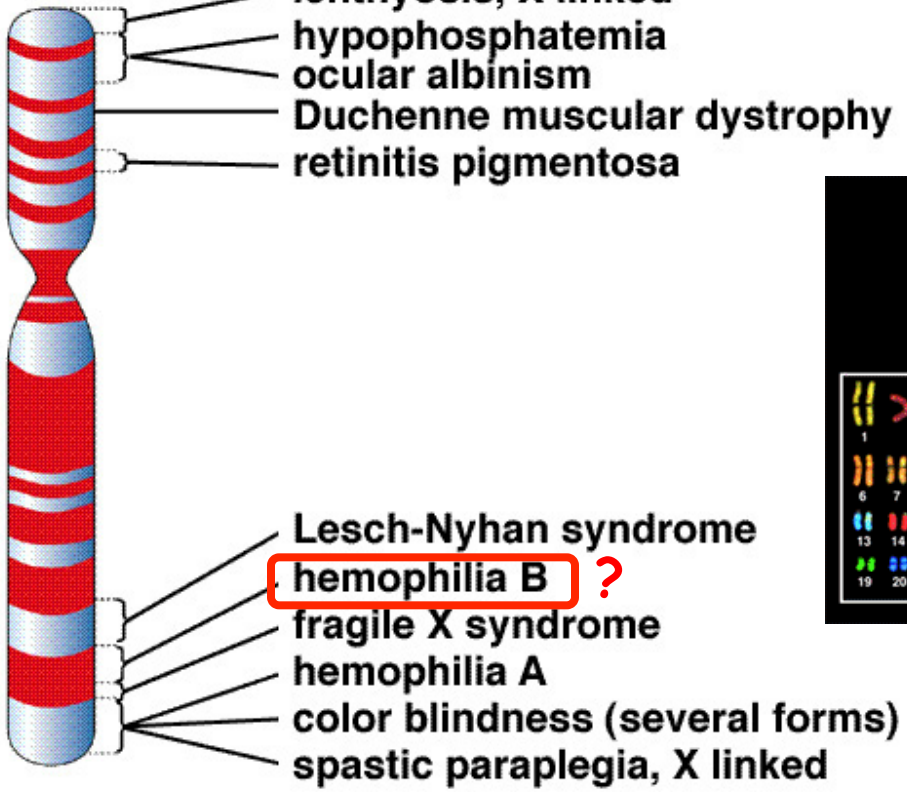
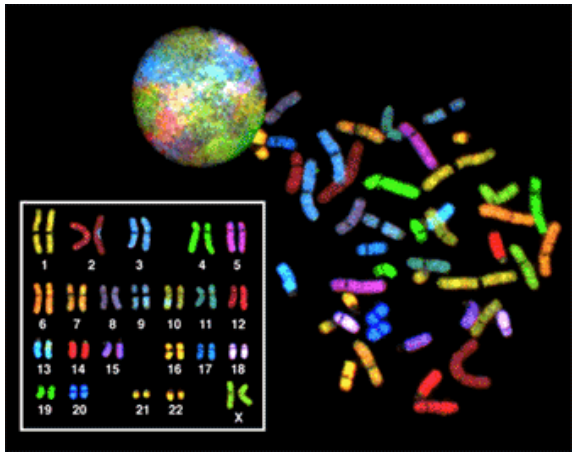
Genomes & Chromosomes Contain Thousands of Genes

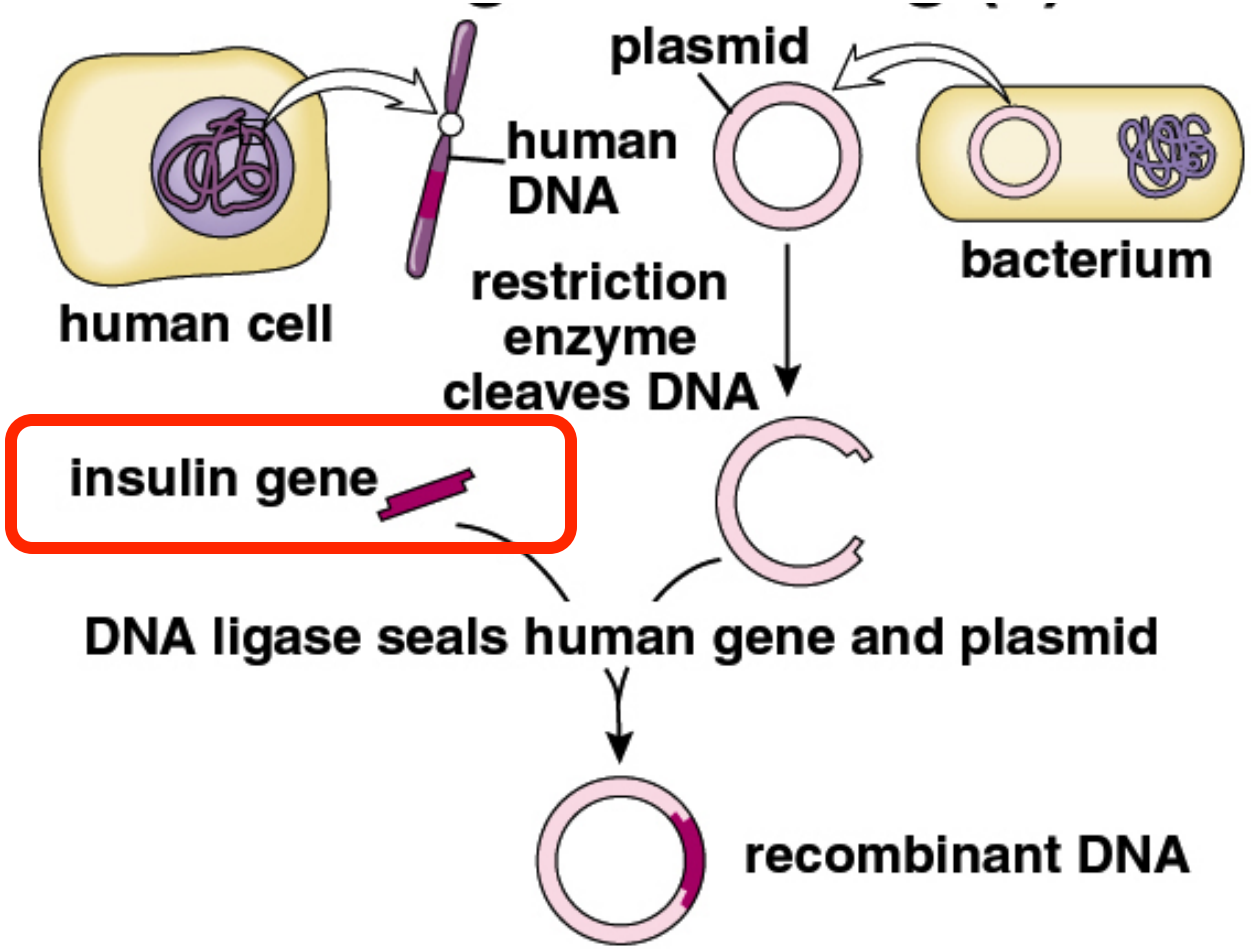
Map of chromosome X





How Can a Single Gene Be Studied?

Any Human Gene Can Be Separated From Other Genes and Cloned in Bacteria Using Recombinant DNA Methods!



Genetic Engineering Means……

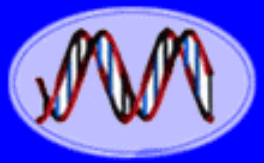
1. Specific DNA Fragment or Gene Can Be Isolated From Any Cell or Organism
2. DNA Segments of Any Kind From Any Organism Can Be Combined
3. Isolated Genes Can Be Re-Inserted Into the Chromosomes of Any Organism and Made to Work
4. Genes and Genomes Can Be Synthesized and Made To Work in Any Organism

There Are No Genetic Limits. All Biological Organisms Use the Same Genetic Rules. The Implications Are Enormous!!

What is the Purpose of Cloning Genes From a Genome?

1. PURIFY Individual Genes From the Genome (e.g.,one of 25,000 human genes)
2. AMPLIFY the Gene to Obtain Enough DNA For Study
3. Use the Cloned Gene To:
   a) Study Gene Structure & Function (THE Major Use!)
   b) Use to Convert Cells Into Factories To Make Drugs and Pharmaceuticals
   c) Use to Diagnose Genetic Diseases
   d) Use to Identify Individuals (e.g., paternity, forensics)
   e) Use to Correct Genetic Disease
   f) Use to Engineer New Crops and Farm Animals
   g) Synthesize New Genomes and Many Other Uses

Genetic Engineering Has Lead to New Knowledge About How Cells and Genes Function and Has Lead to Applications That Have Improved Our Lives!!



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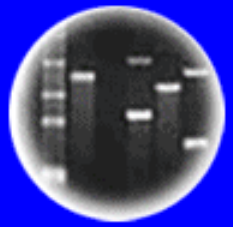

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What Can Be Done With Genetic Engineering?

A Few Examples of Genetic Engineering 1.0

Using a Jellyfish Gene to Make Animals and Plants Glow!!!!

Green Fluorescence Protein (GFP)

Nobel Prize in Chemistry – 2008 – Shimomura, Chalfie, & Tsien

Engineering a "GloFish"……

Zebrafish - Danio rerio

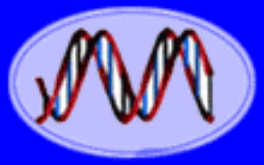
…….Using Genetic Engineering To Insert A Jellyfish Gene into a Zebrafish Egg!

A "GloFish" Embryo!!

Zebrafish - *Danio rerio*

Genetically Engineered "GloFish!!"

Note Different Fluorescing Colors – Due to Different Jellyfish Genes



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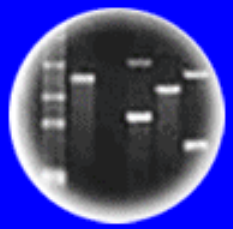

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GloFish Are Not Sold In California

- Cal. Fish and Game Code § 15007 (2007)

Regulation Makes it illegal to spawn, cultivate, or incubate any transgenic fish in the state controlled waters of the Pacific Ocean.

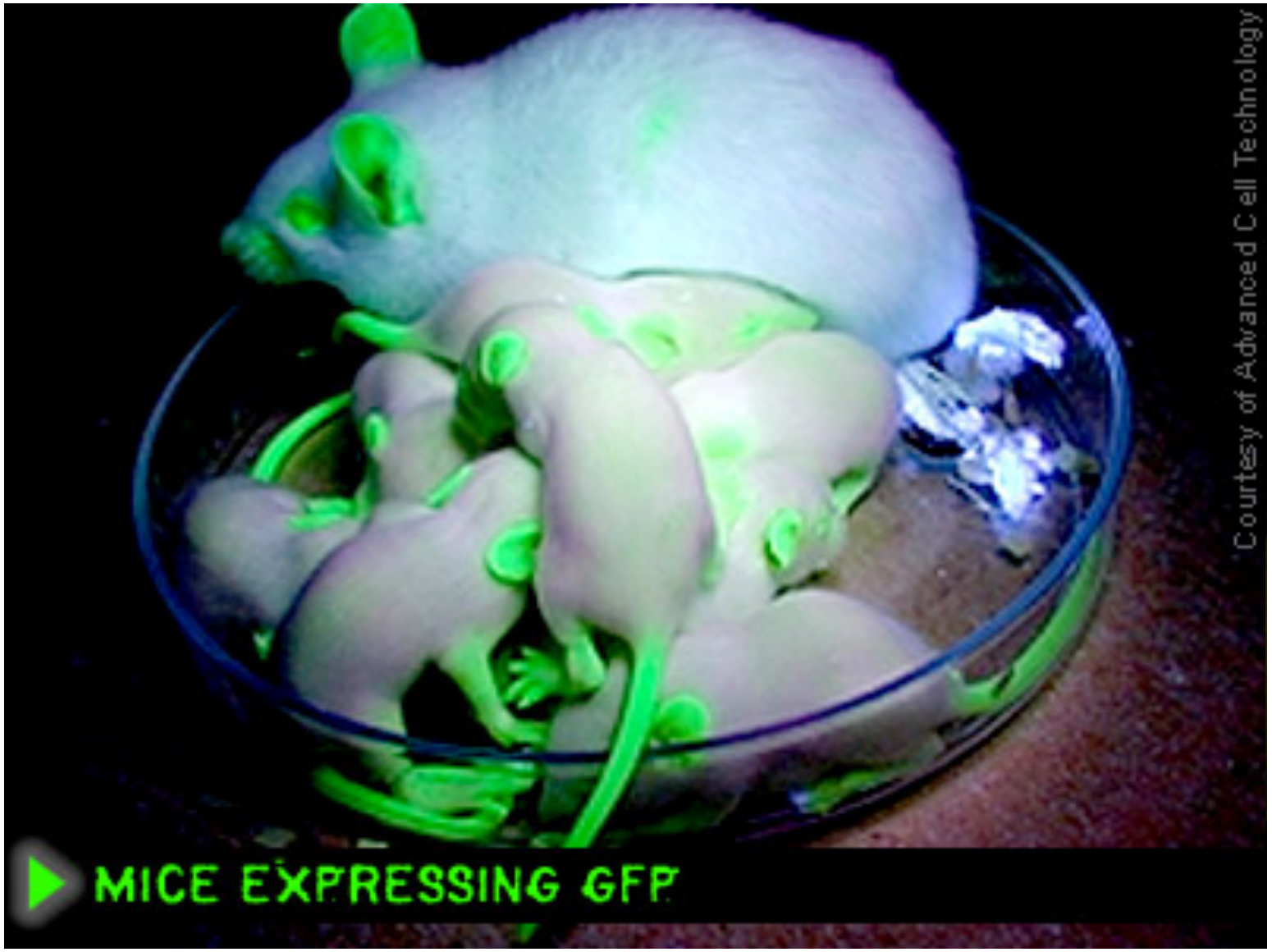
- Title 14, Section 671.1 CA Code of Regulations (2003)

Regulation. Movement of live transgenic aquatic animals from facilities is prohibited unless specifically permitted by the Department. Release of transgenic aquatic animals or their progeny into waters of the state is prohibited.

Genetic Engineering & the Law!!

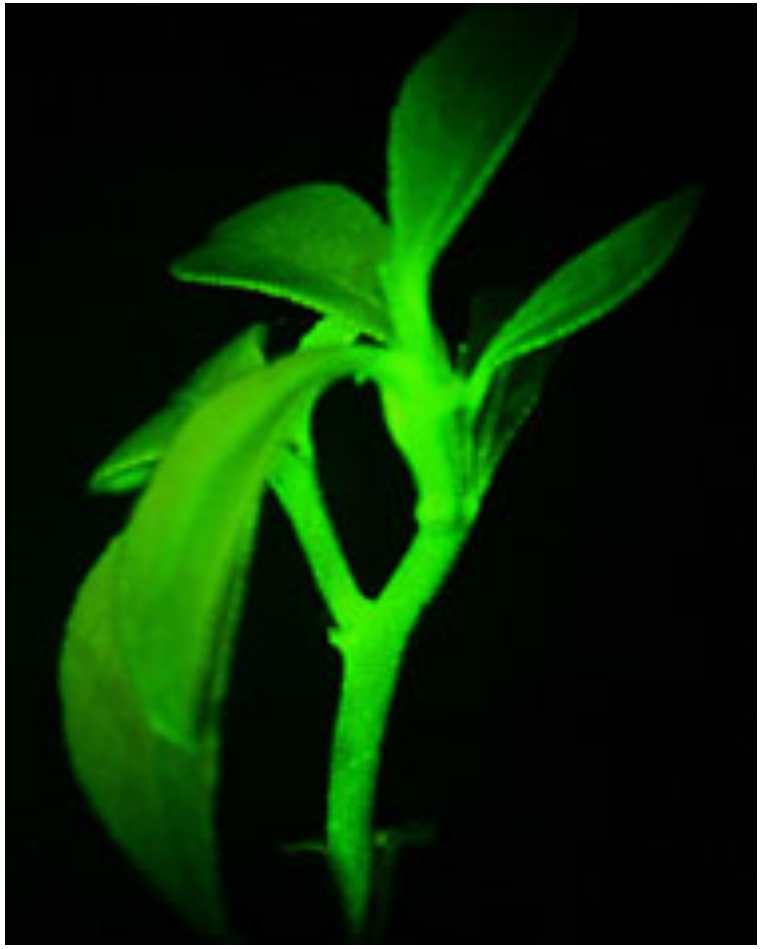
How About a GloFly!

What About "GloMice!!!"

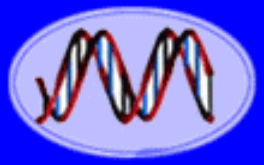


And Glo Monkeys, Cats and Pigs s Well!!

Engineering a GloPlant With the Same Jellyfish Gene!!!



What are the Philosophical and Biological Implications of These Experiments?



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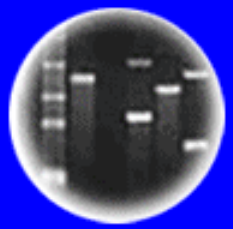

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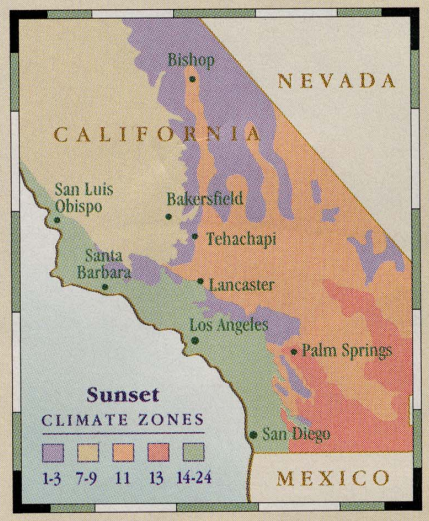
What About Inserting Bacterial Genes Into Plants To Produce a Result With Significant Applications??

GARDEN | GUIDE

SUNSET

WHAT TO DO IN YOUR GARDEN IN SEPTEMBER

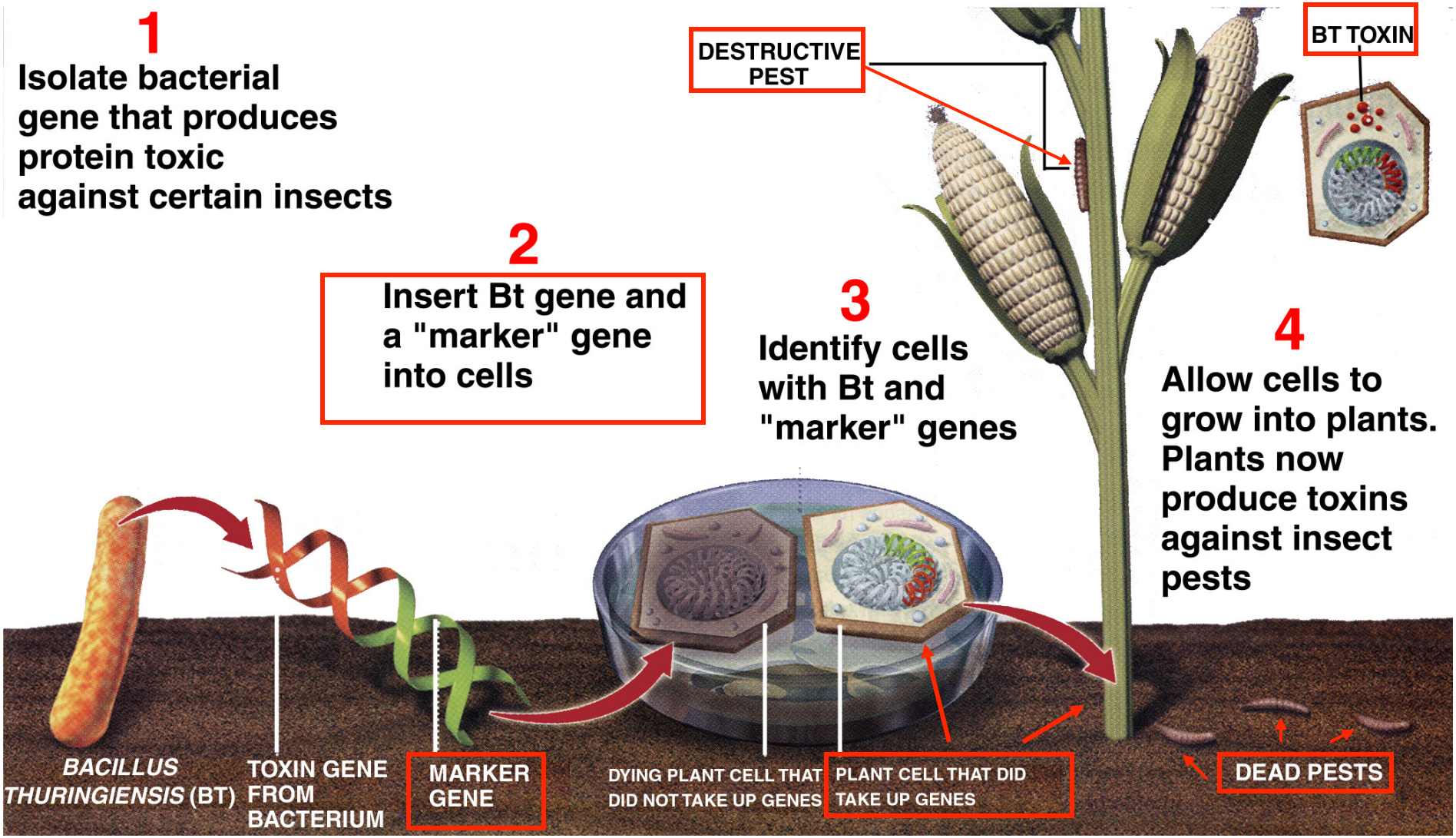
Southern California Checklist



DEBRA LAMBERT

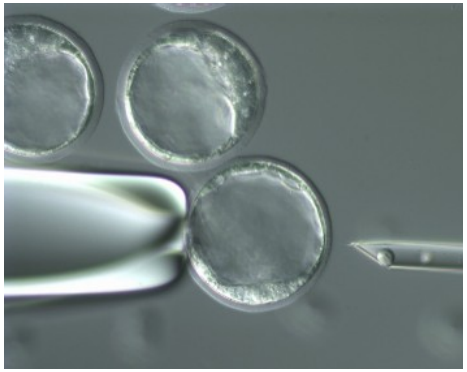
✔ PROTECT CABBAGE CROPS. The minute you plant a brassica, squadrons of cabbage white butterflies seem to descend on it to lay their eggs. The easiest way to thwart them is to cover your cabbage crops with row covers right from the start. The next best option is spraying with *Bacillus thuringiensis* to kill the young caterpillar larvae. ◆

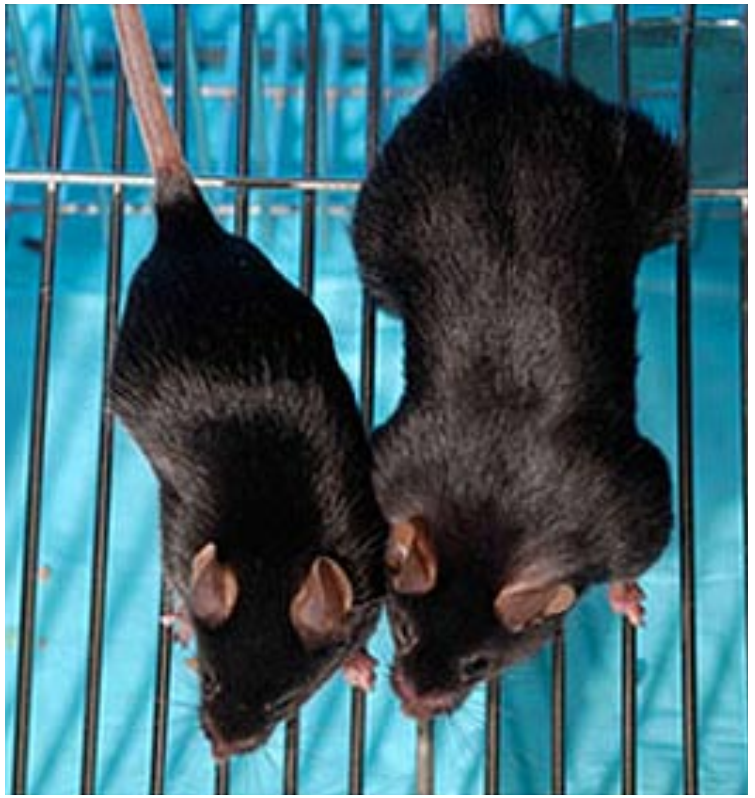
How to Make an Insect-Resistant Plant



Genetic Engineering a Plant to Resist Worms!

Engineering "Mighty Mouse" With a Rat Growth Hormone Gene





How About a Giant Fish?

GENETIC ENGINEERING

Genetically-modified salmon are closer than ever to a dinner plate near you

The super salmon are (almost) here. The Food and Drug Administration has reportedly finished its evaluation of the environmental impacts of the first fish genetically engineered (GE) for human consumption.

THE WALL STREET JOURNAL.
WSJ.com

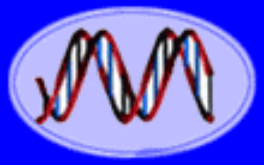
BUSINESS | SEPTEMBER 21, 2010

Gene-Altered Fish Closer to Approval

By GAUTAM NAIK

FDA faces opposition over genetically engineered salmon

A group of eight senators is asking the FDA to cease consideration of the fish as food, and is threatening to pull funding for the study if the agency does not comply.



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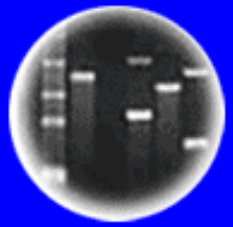

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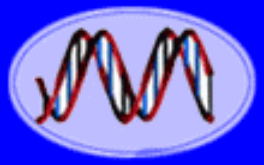
Question One

Have you ever eaten genetically engineered food?

a.yes

b.no



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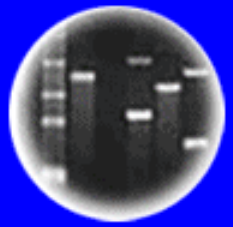

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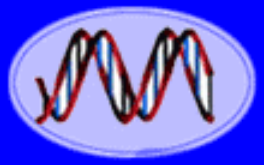
Question Two

Would you eat food obtained from genetically modified plants and animals?

a. yes
b. no



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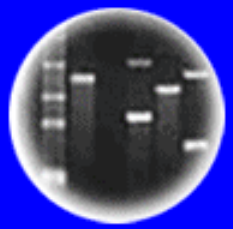

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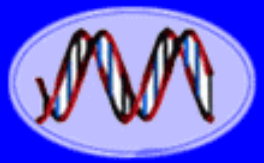
Question Three

Should Genetically Modified Food Be Labeled?

a. yes
b. no



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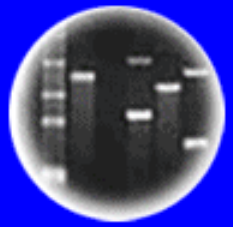

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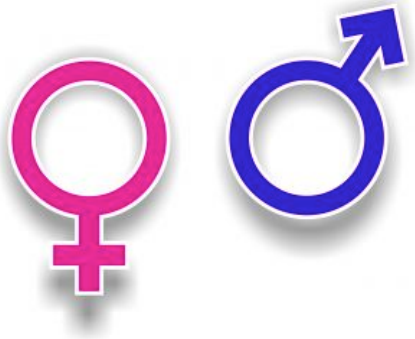
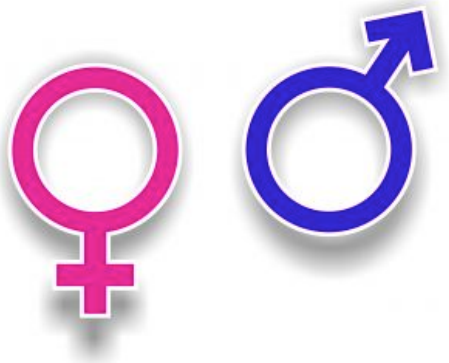
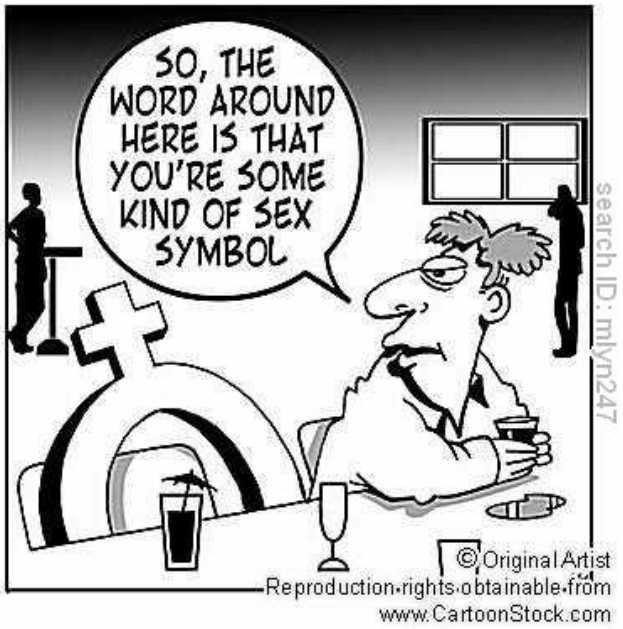
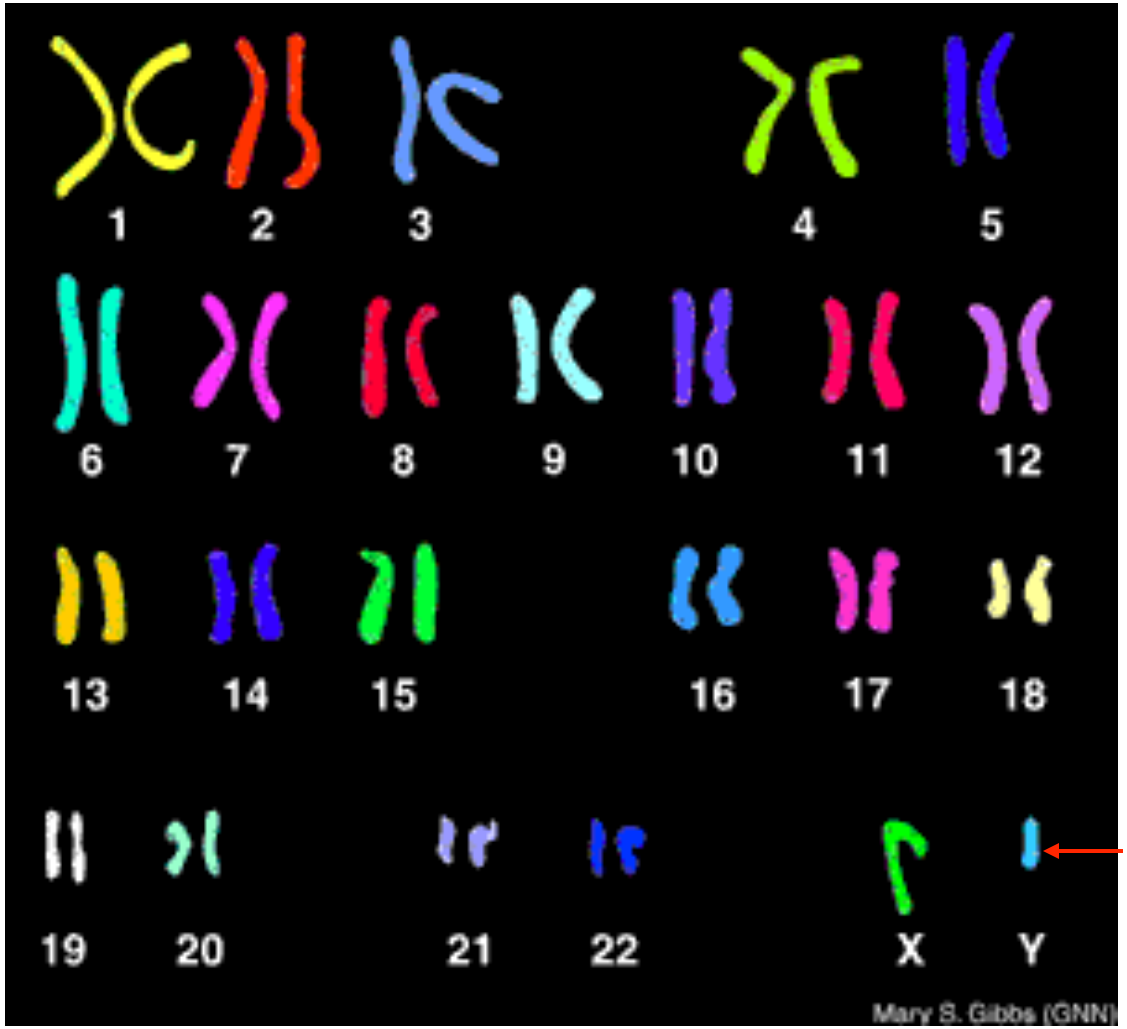




How About Changing The Sex Of An Organism?



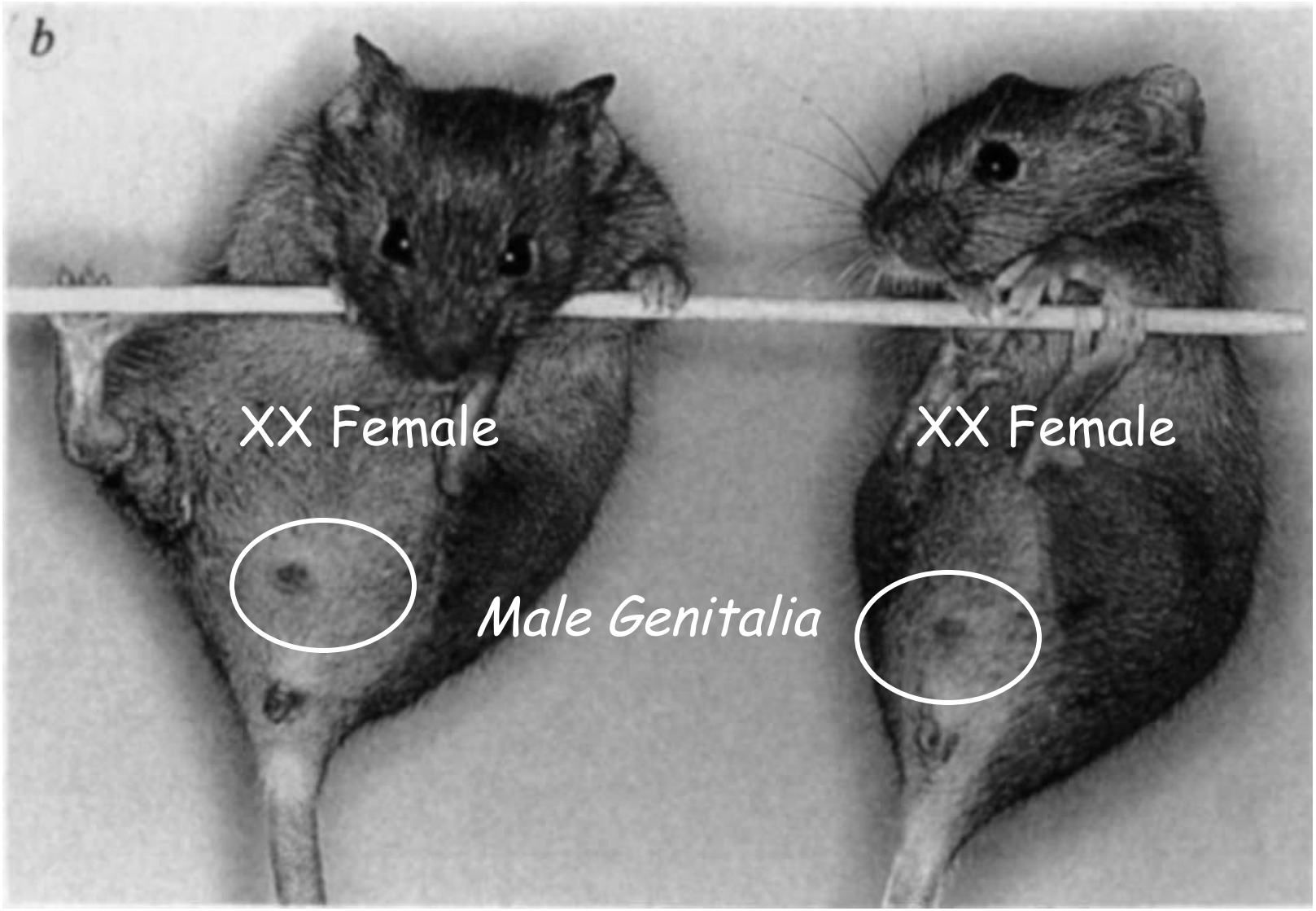
Males and Females Differ By the Presence or Absence Of the Y Chromosome (simplistically!!)



Male SRY Gene (Sex Determining Region Y)

The Human SRY Gene For Maleness Can……

…..Turn a Female Mouse Into a Male!!!!

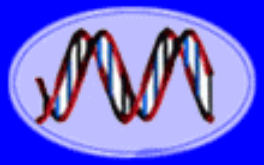


What Does This Experiment "Say" About Human & Mice Genes?

What Are the Conclusions of This Experiment?

- *Ground State of Mammalian Development is FEMALE!*
- *ONE Gene Switches Development From Male to Female!*
- *Eve Had a Y Chromosome and LOST the SRY Gene!!*

"So the LORD God caused a deep sleep to fall upon the man, and while he slept took one of his ribs and closed up its place with flesh; and the rib which the LORD God had taken from the man he made into a woman and brought her to the man. Then the man said, "This at last is bone of my bones and flesh of my flesh; she shall be called Woman, because she was taken out of Man." *Genesis, Chapter 2*



DNA
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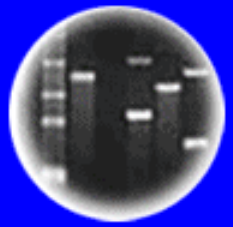
Entire Genetic Code of a Bacteria



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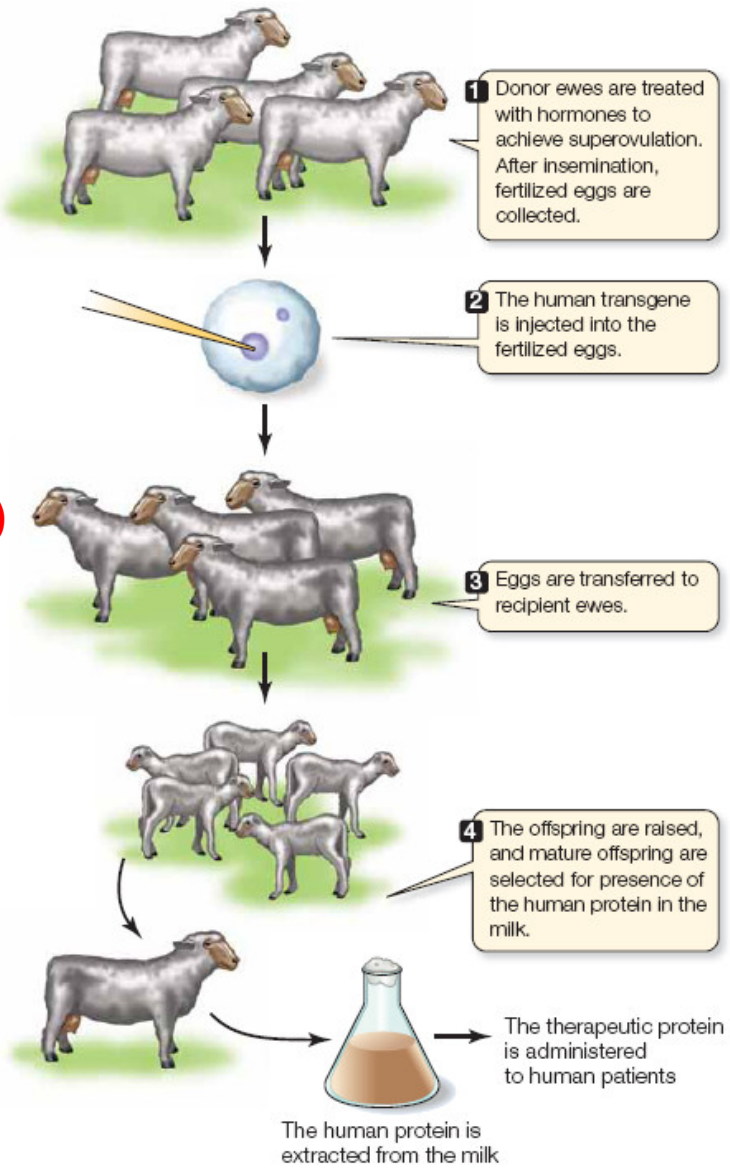
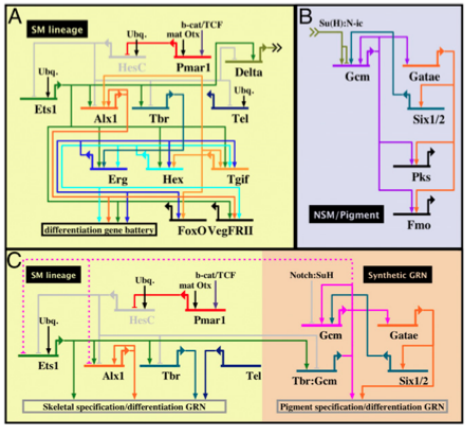
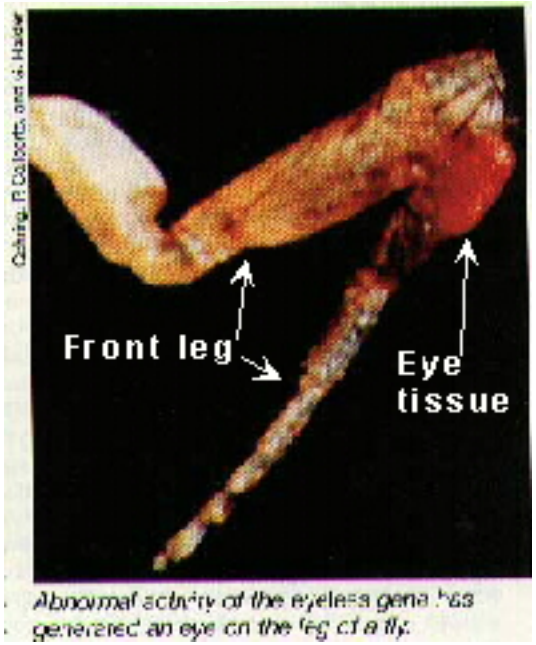
Engineering Goats to Make Specific Human Proteins That Can Be Used to Treat Diseases

Making TPA (Tissue Plasminogen Activator) in Goat Milk to Treat Heart Patients

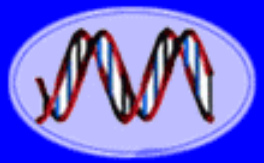


Using Genetic Engineering to Change Body Architecture-Engineering Eyes on a Fly's Leg With a Single Gene!





Abnormal activity of the eyeless gene has generated an eye on the leg of a fly.



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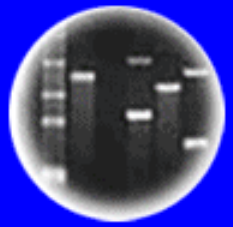

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How About Genetically Engineered Humans?

Even Humans Have Been Genetically Engineered!!

Treatment for Blood Disease Is Gene Therapy Landmark

By NICHOLAS WADE
Published: December 10, 2011

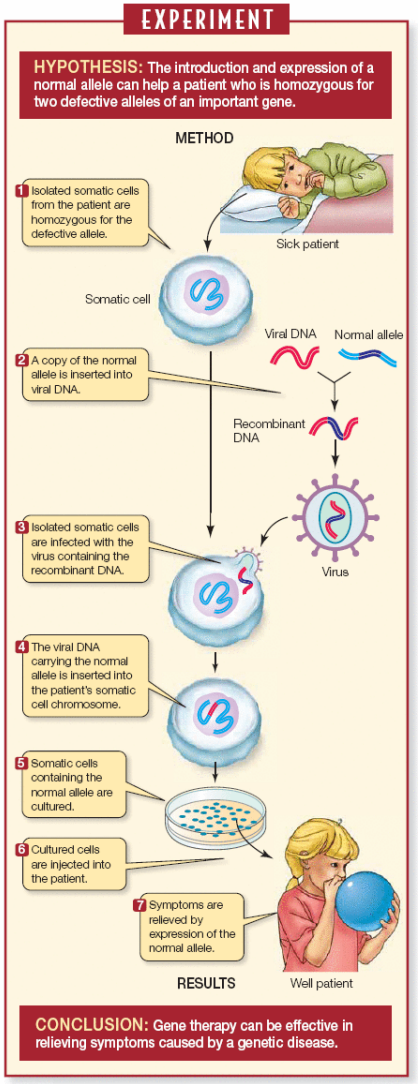
Gene therapy for red–green colour blindness in adult primates Nature, October, 2009

Gene Therapy Helps Blind Children See

By Jocelyn Kaiser
*Science*NOW Daily News
24 October 2009

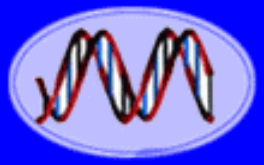
Humans Have Been Genetically Engineered To Cure a Lethal Genetic Disease (SCID)

The Age of Human Genetic Engineering Began Almost Twenty Years Ago Treating Severe Combined Immunodeficiency Disease (SCID) With Normal ADA Genes!!!



Several Teenagers Are Alive Because They Have Been Engineered With an ADA Gene That They Were Not Born With!!!

Adenosine Deaminase Gene (ADA)



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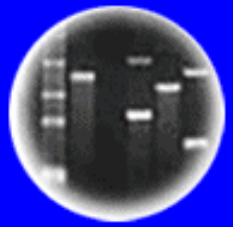

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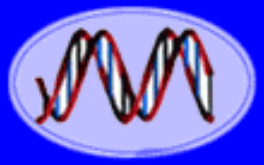
What Can We Infer From These Genetic Engineering Experiments About How Genes "Work" and Genetic Processes in All Living Organisms?

What is the Hypothesis?

What are the Predictions?

What Experiment(s) to Test These Predictions?



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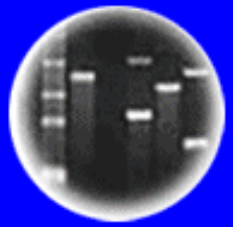

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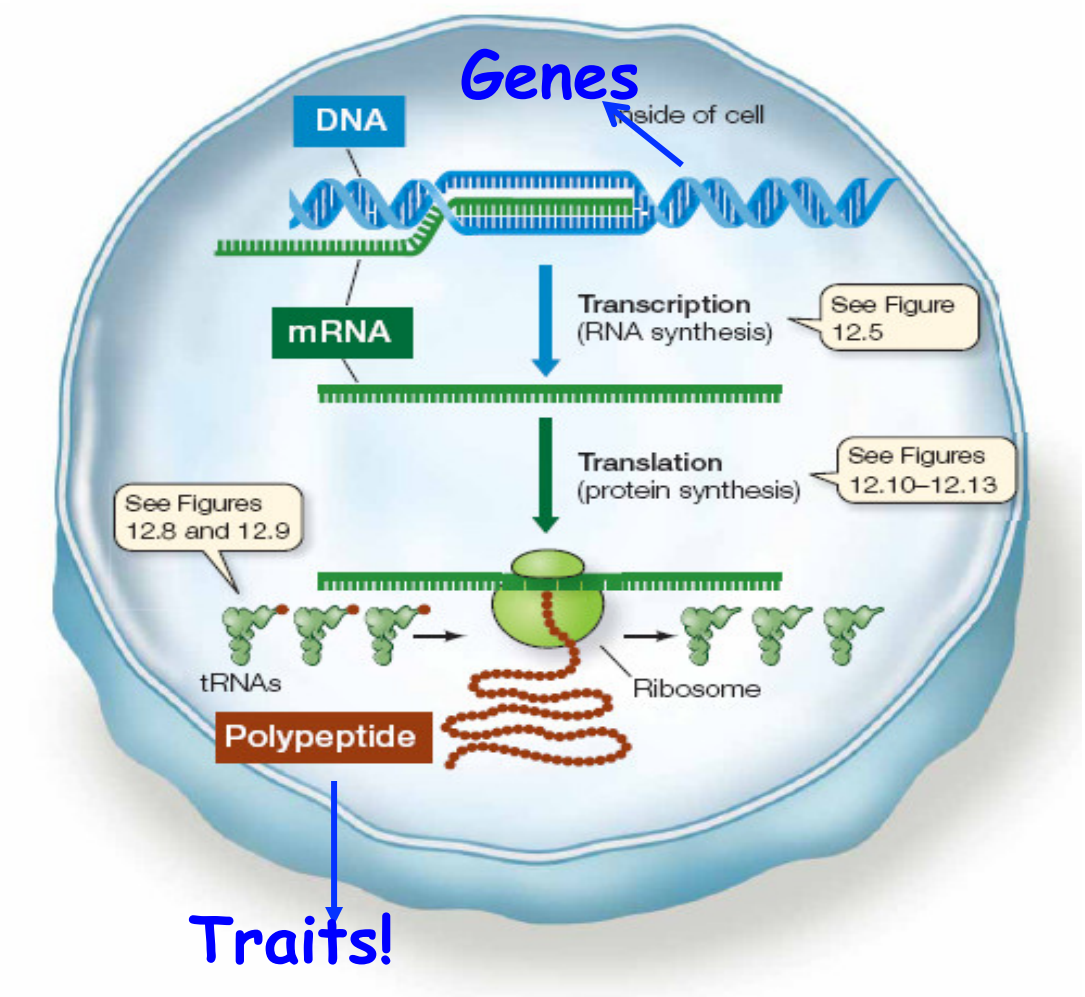
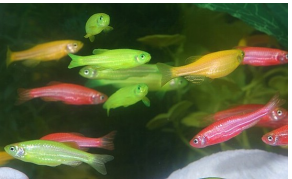


Observations and Inferences From the GloGene Experiments

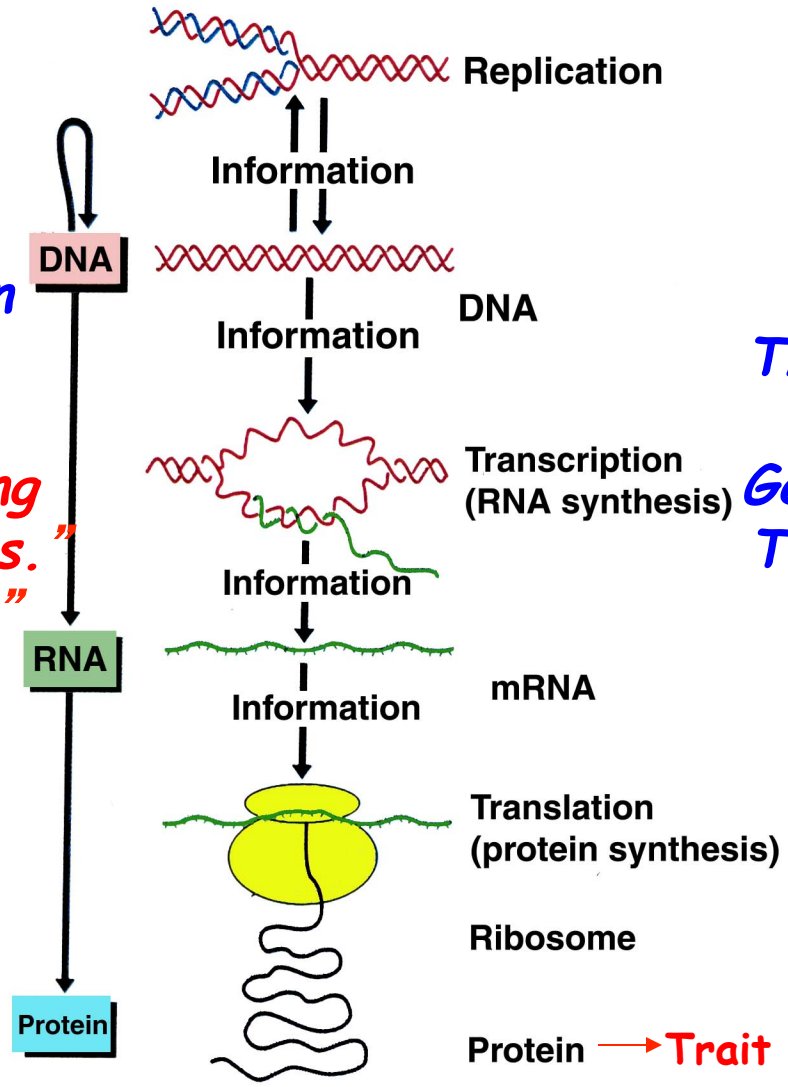
1. *Genes Can Work Independently of Each Other - The Jellyfish Fluorescence Gene Works Perfectly in a Variety of Organisms*

2. *Basic Genetic Processes Are Universal (Replication & DNA to RNA to Protein) - The Jellyfish Gene Directs the Production of Fluorescence Protein That Glows in the Cells of a Variety of Organisms.*

3. *Basic Genetic Processes Can Be Used to Engineer or Transfer Genes From One Organism to Another and Transfer Them Stably Generation After Generation - The Jellyfish Gene Can Be Used To Engineer a Variety of Organisms That Glow and That Are Inherited Generation After Generation.*



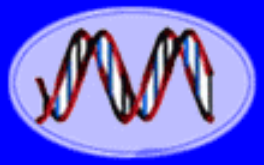
Translating The Genetic Code Into Proteins is a Conserved Process



Can Intervene in This Process in Cells

Genetic Engineering Is not "Hocus Pocus." It Uses "Natural" Cell Processes!!!!

All Organisms Use The SAME Processes And "RULES" to Generate Traits!! And The SAME Molecules & Chemistry!!



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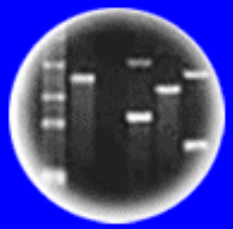

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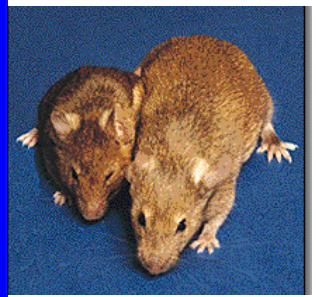
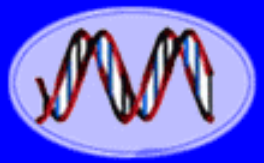
Age of DNA - There Are NO Genetic Limitations to What Can Be Done Using Genetic Engineering

- Synthetic Chromosomes & Microbes (GE 2.0)
- Recombinant Plasmids & Bacteria
- GlowFish, GloMice, GloMonkey, GloPlant
- Mighty Mice and Giant Fish
- Insect Resistant Crops
- Novel Fly Body Plans (e.g., eye on leg)
- Engineered Humans

GE 1.0





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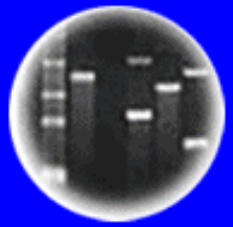

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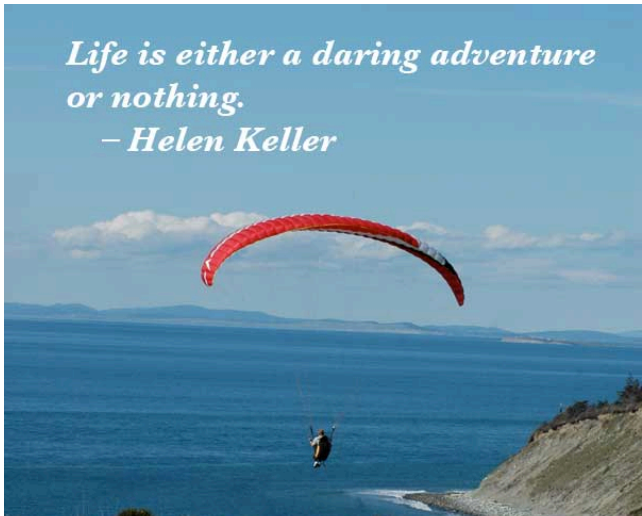
We Are Only Limited By Our Ingenuity and Our "Fear" of the Unknown

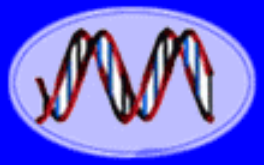


Genetic Engineering Has Affected Our Lives In Many Ways

1. Basic Understanding of Living Processes and Ourselves
2. Basic Understanding of Genes and Their Functions
3. The Era of Genomics and the Sequence of the Human Genome and Those of Other Organisms
4. Basic Understanding of Human Diseases Such as Cancer and Novel New Treatments
5. A Multibillion Dollar Biotechnology Industry
6. New Legal Issues Such as Genetic Privacy, Forensics, and Patents on Genes and Genetically Engineered Organisms
7. An New Understanding of Human Origins and the Diversity of Human Populations (e.g., where we come from)
8. New Understanding of the Evolutionary Relationships Between Organisms
9. Ability to Sequence the Genomes of Extinct Organisms
10. New Ethical Issues in "How Far" We Should Go in Using Genetic Engineering Technology
11. And Much, Much More!

Genetic Engineering Technology Has Led to Many New Legal and Ethical Issues

1. Patenting Genes, Cells, & Living Organisms?
2. Regulating Experimentation on DNA, Cells, Transgenic Organisms ("GMOs")?
3. Regulating the Release of Genetically Modified Organisms into the Environment?
4. Labeling of Genetically Modified Foods?
5. Genetic Testing: DNA Databases, Newborn Genetic Screening, Genetic Privacy, Involuntary or Voluntary Testing?
6. Genetic Discrimination?
7. Genetic Enhancement and Eugenics: Right to Enhance Your Child?
8. Gender Selection and Prenatal Diagnosis of Genetic Diseases?
9. Gene Therapy: Correcting Human Genetic Diseases?
10. Human Cloning and Genetic Improvement?
11. Gene Testing Companies (e.g., 23andMe): Liability?
12. Synthetic Genomes: Constructing New Organisms?



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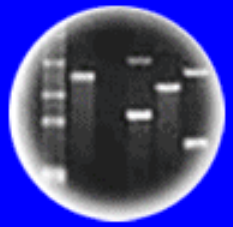

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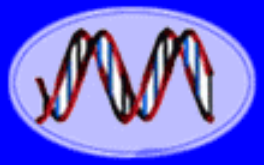
Question Four

Should We Be Able To Patent Human Disease Genes For Genetic Testing?

a. yes
b. no



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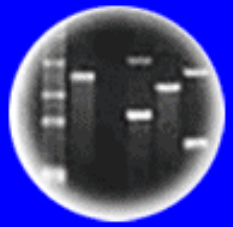

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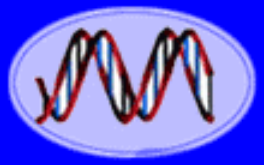
Question Five

Would You Use DNA Tests To Make Sure That Your In Vitro Fertilized Embryos Did Not Have a Familial Disease Gene (e.g, Cystic Fibrosis)?

a. yes
b. no



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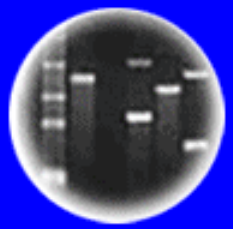

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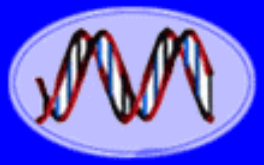
Question Six

Would You Use a Genetically Engineered Drug?

a. yes
b. no



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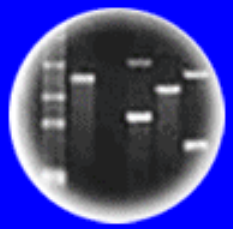

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December 26, 2011

Debate Persists on Deadly Flu Made Airborne

By DENISE GRADY and DONALD G. McNEIL Jr.

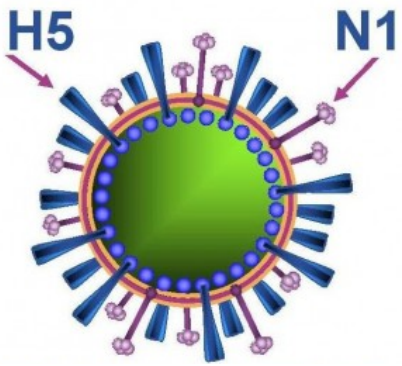
The young scientist, normally calm and measured, seemed edgy when he stopped by his boss's office.

"You are not going to believe this one," he told Ron Fouchier, a virologist at the Erasmus Medical Center in Rotterdam. "I think we have an airborne H5N1 virus."

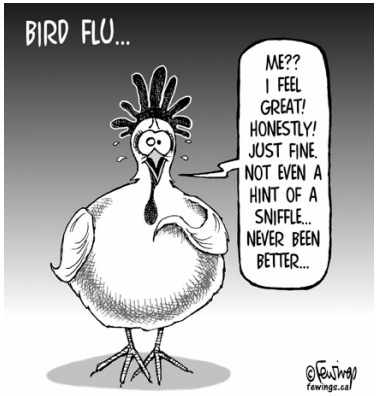
Studies of deadly H5N1 bird flu mutations test scientific ethics

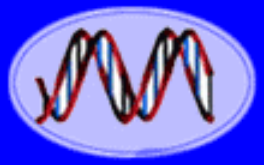
Dutch scientists have created a version of the deadly H5N1 bird flu that's easily transmitted. In an unprecedented move, a U.S. board asks that some details of the research not be published.

Question Eight



Publish?
a. yes
b. no





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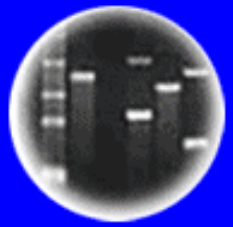

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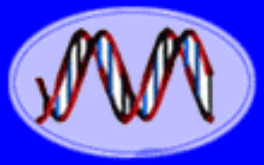
Question Nine

Is Genetic Engineering a New Technology?

a. yes
b. no



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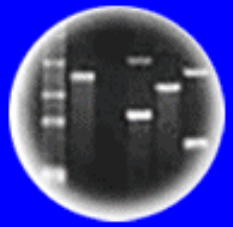

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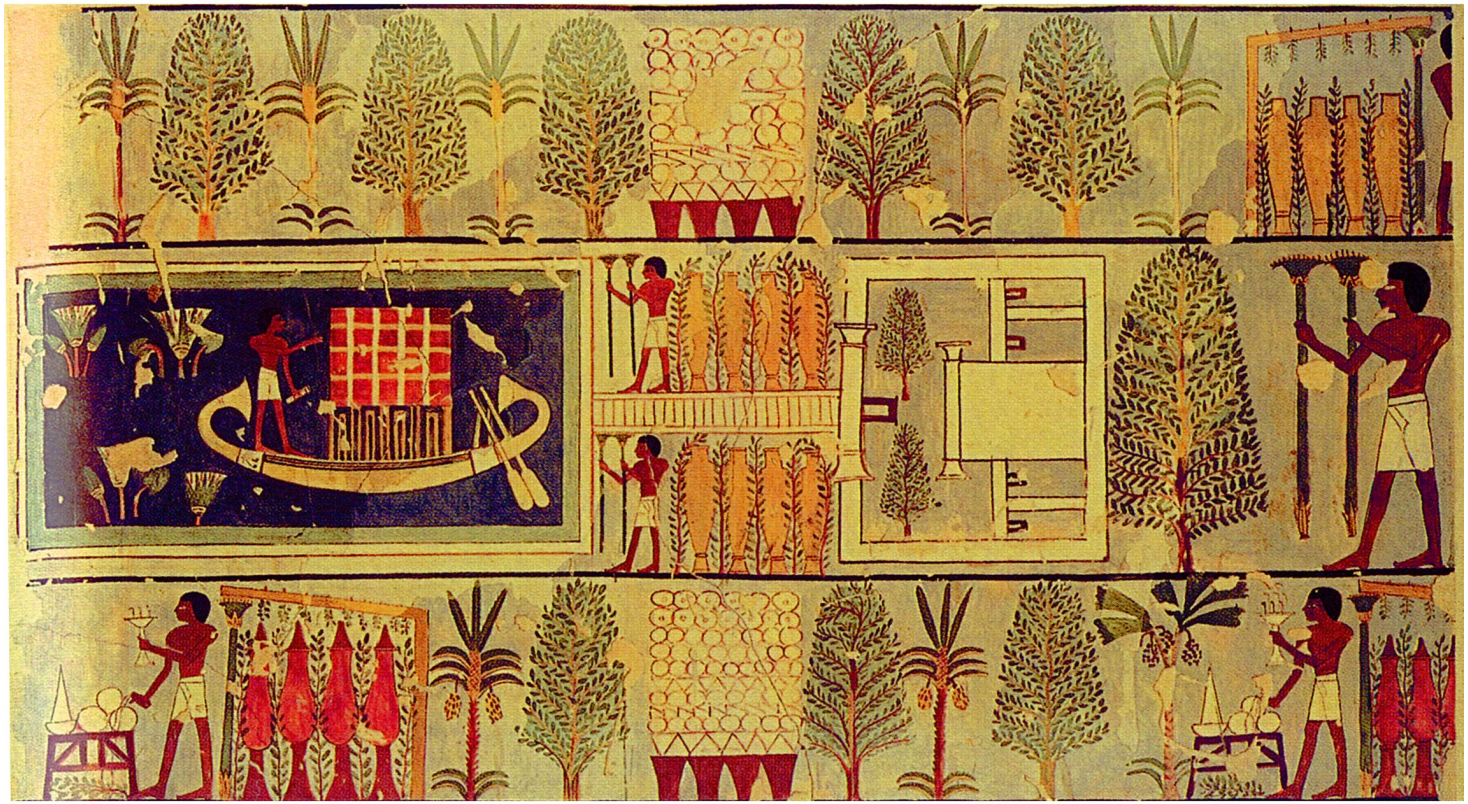
There is Nothing New About Genetic Engineering!

Manipulating Genes IS Manipulating Genes No Matter What Technology or Processes Are Used!!

This is Genetic Engineeering 1.0!!

Breeding And Cultivation Of Plants Have Taken Place Over Thousand Of Years

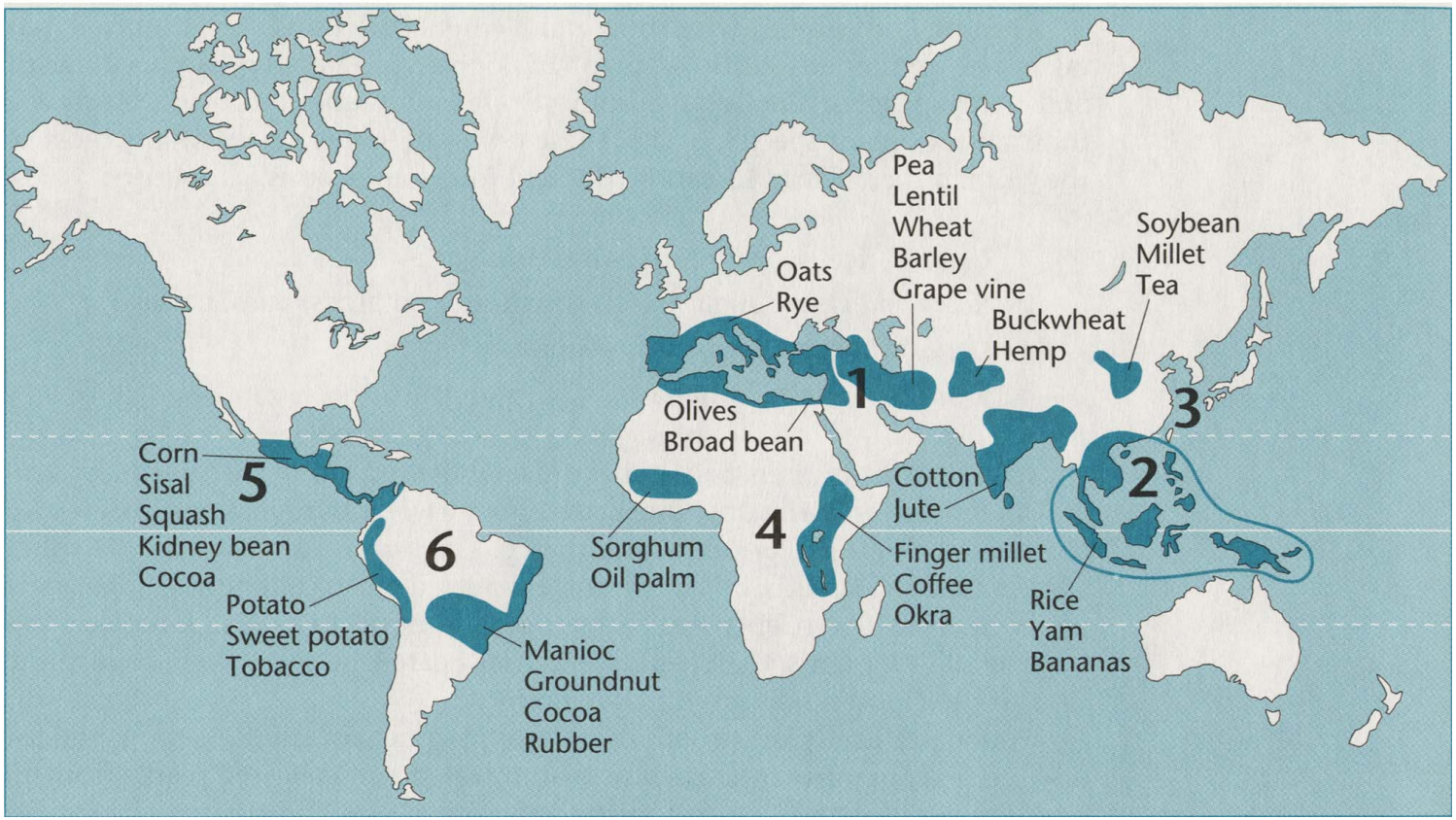


Genetic Engineering is Not New

Crops of Egypt 400 B.C.

Most Major Crops Were Engineered From Wild Relatives by Early "Bioengineers" Over 10,000 Years Ago!!

Regions Where Major Crops Were Established



Breeding Involves Gene Manipulation Using EXISTING Genetic Variability!

Breeding Uses Natural Genetic Variability of Genes As Raw Material - Variability Generated by Mutations

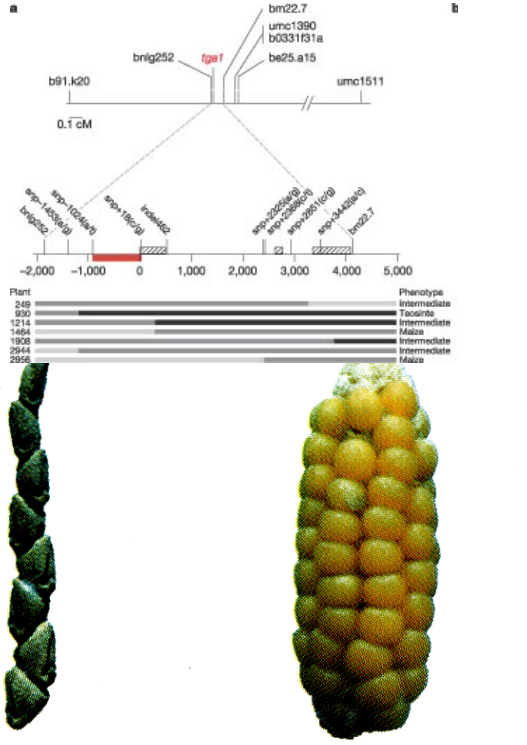
Mutations in a Gene That Change Its Chemical Sequence & Slightly Alters Its Function (e.g., fruit size, color)

Tomatoes Were Engineered From Small Wild Relatives Because of Mutations in Fruit Size Genes!

The Early Tomato "Bioengineers" Selected For Large Fruit Size Because it Provided More Food!

What They Were Selecting Was a Different Form (Allele) of a Fruit Size Gene!

Engineering Teosinte Into Domesticated Corn



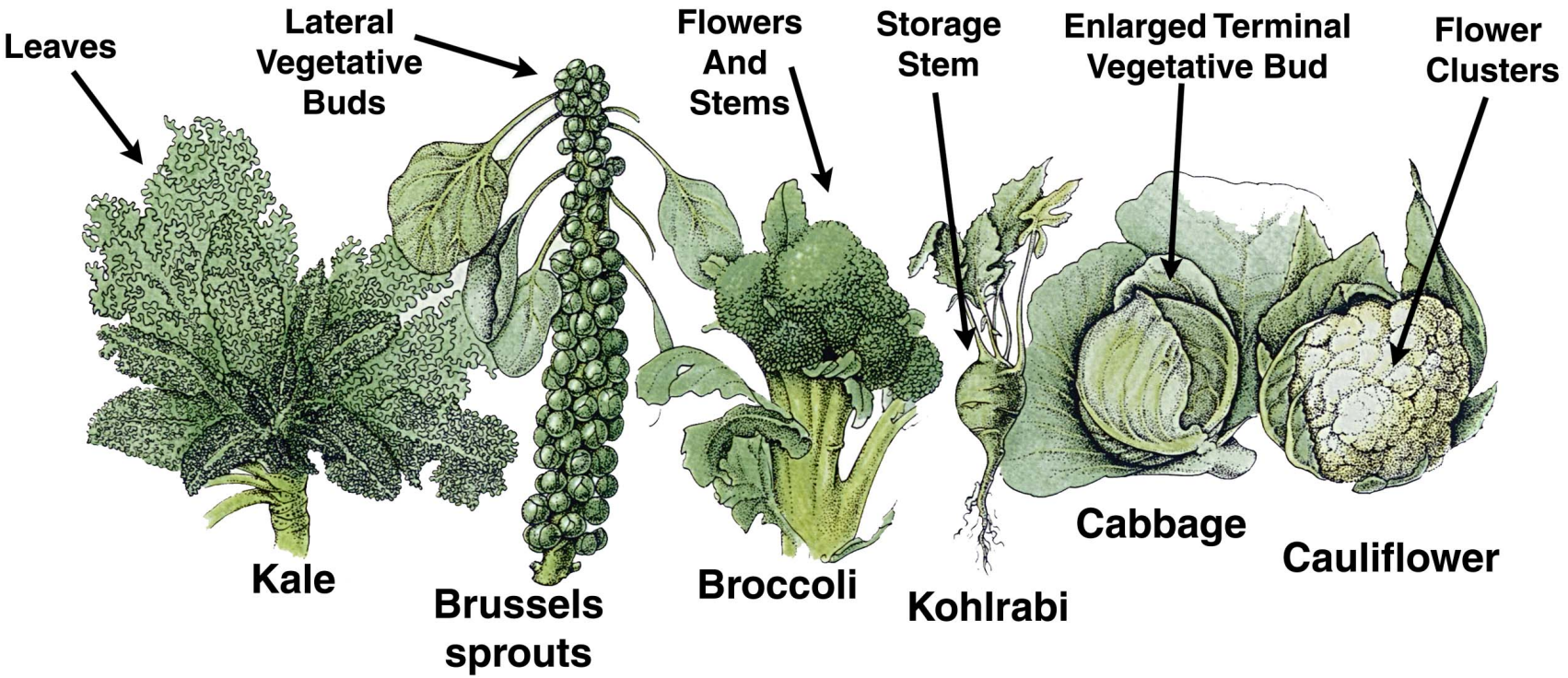
Teosinte Domesticated corn Teosinte Early domesticated corn

Note: Architecture and Fruit (cob) Size

Only Five Genes Cause These Plants to Differ & We Now Know What They Are

How Does This Differ From Putting an Eye on a Fly's Leg?

Breeders Have Selected For Variability In Plant Control Genes To Generate Novel Crops

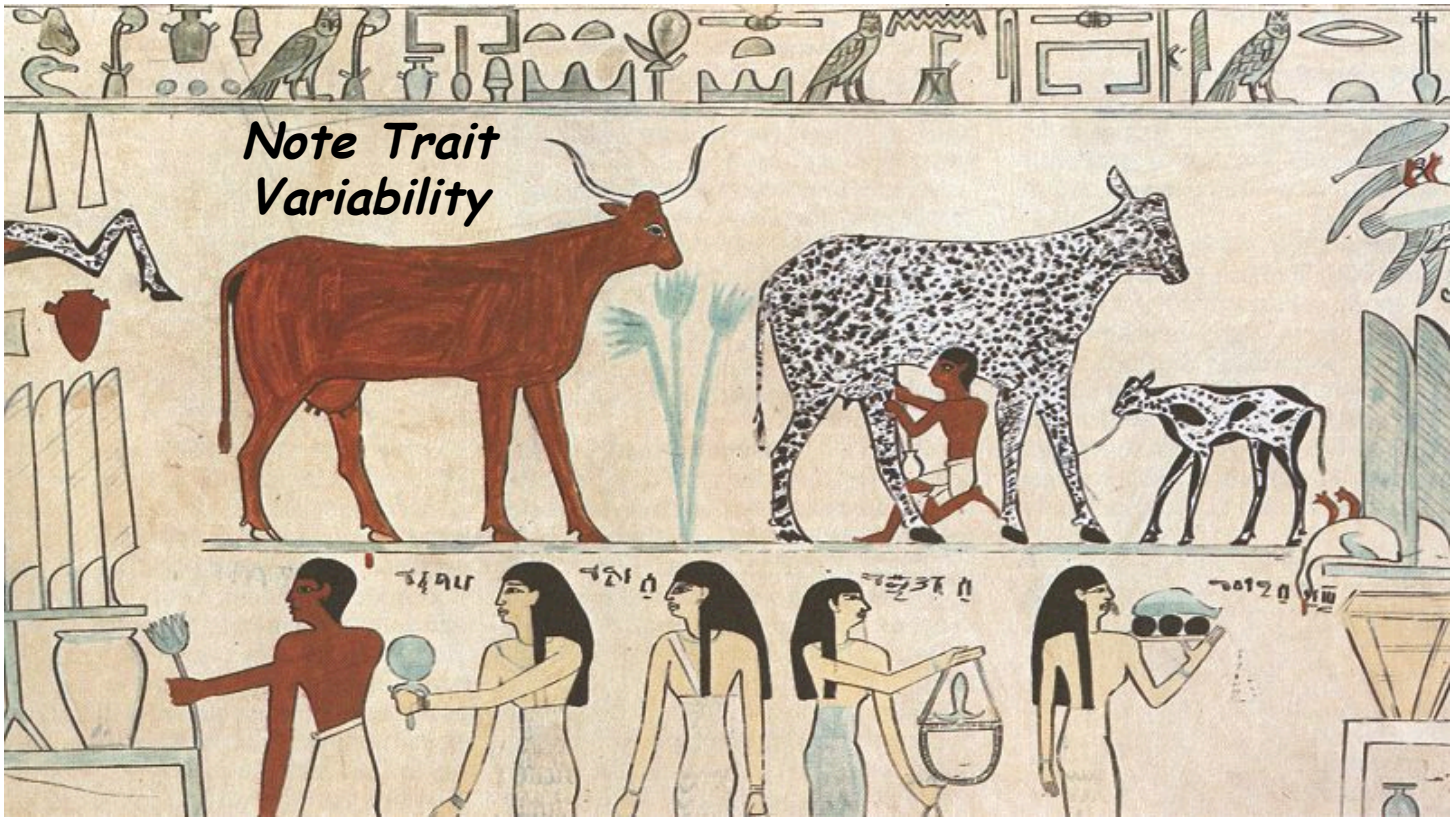


How Are These Plants Related?

Engineered For Regulatory Genes!! Genes That Have Been Identified!!

Farm Animals Were Also "Engineered" By Breeding Wild Relatives

Cattle Breeding in Egypt 4,000 Years Ago!



Manipulating Existing Genetic Variability Brought About By Chance Mutations!

Even Domesticated Pets Were "Engineered" By Breeding Wild Relatives

Vol 438|8 December 2005 nature

Nature, December 2005

NEWS & VIEWS

C. COLLINS/CORBIS

GENOMICS

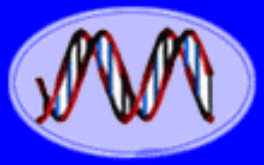
The dog has its day

Hans Ellegren

Domestication and selective breeding have transformed wolves into the diversity of dogs we see today. The sequence of the genome of one breed adds to our understanding of mammalian biology and genome evolution.

The Dog Genome Has Been Sequenced!


DELI



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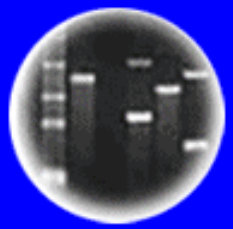

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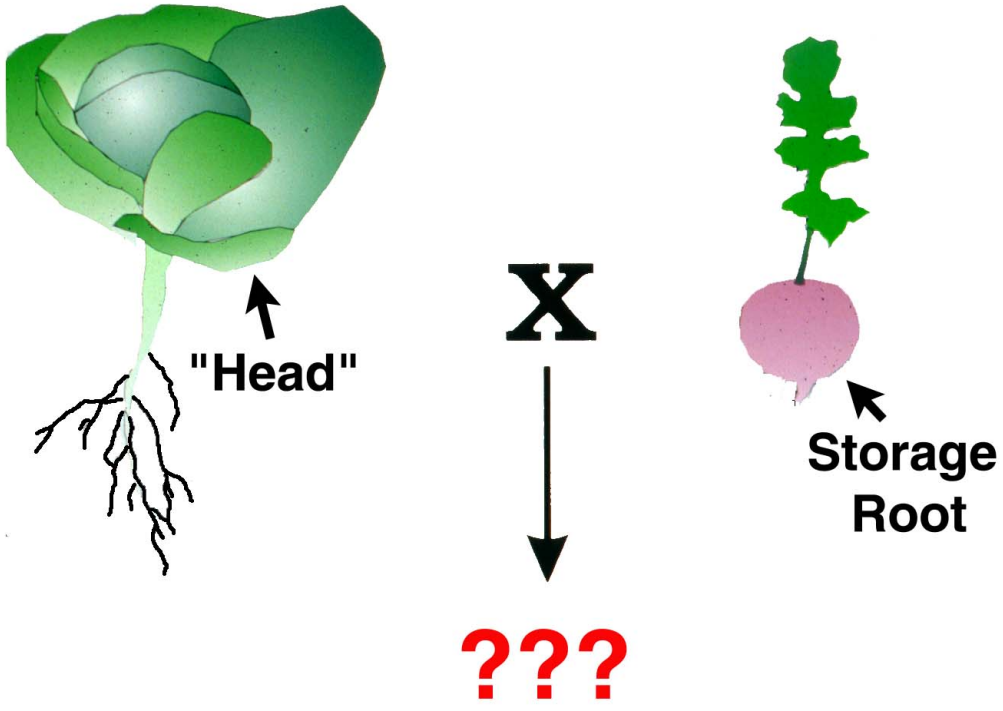
The Problem With Breeding the "Old Fashioned Way"

Cannot Predict Results!

The Problem With Breeding the "Old Fashioned Way"

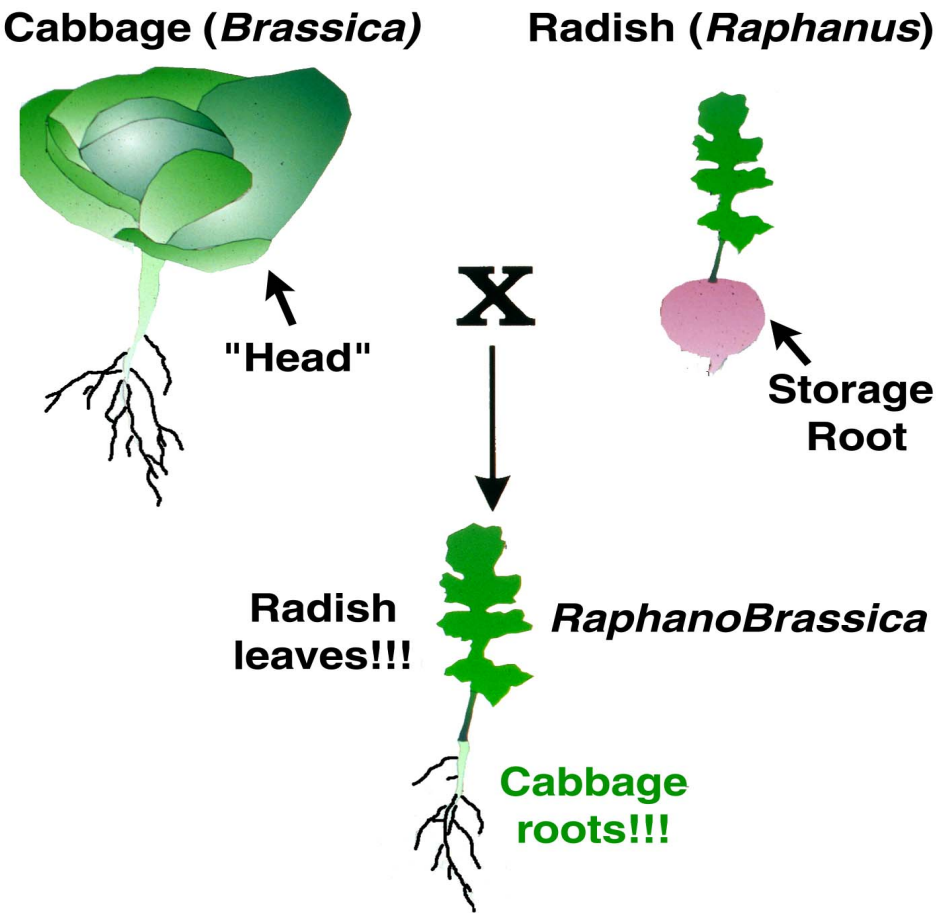
Engineering A Novel Crop By "Wide" Breeding

Cabbage (*Brassica*) Radish (*Raphanus*)

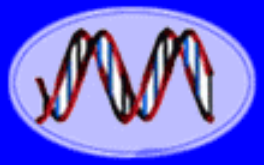


Karpechenko, G.D., 1928. *Polyploid hybrids of Raphanus sativus L. X Brassica oleracea L.* Zeitschrift für induktive Abstammungs- und Vererbungslehre 48, 1-85.

Engineering A Novel Crop By "Wide" Breeding



Results Show the Unpredictability of Classical Breeding Approaches!!
Compare With the Modern Genetic Engineering Examples Shown Previously



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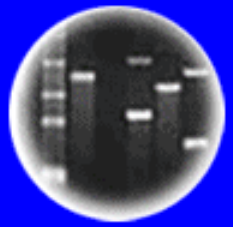

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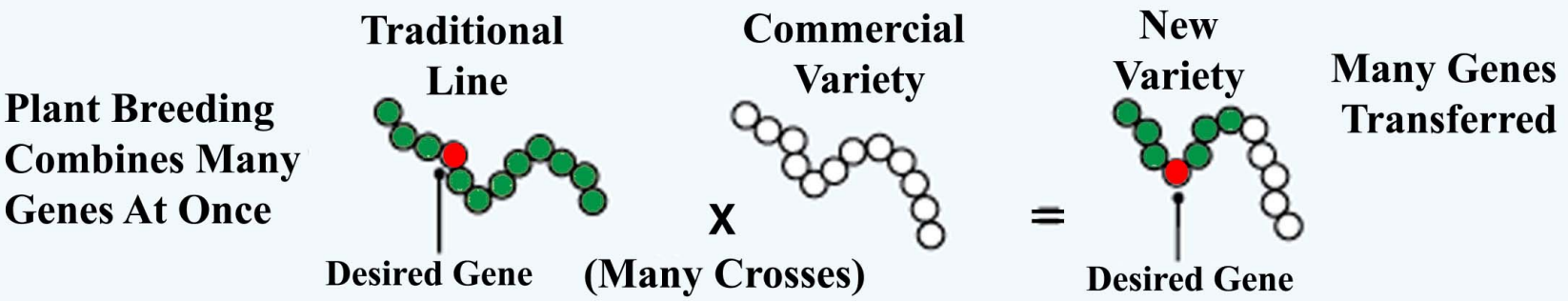
Genetic Engineering is a TECHNIQUE!

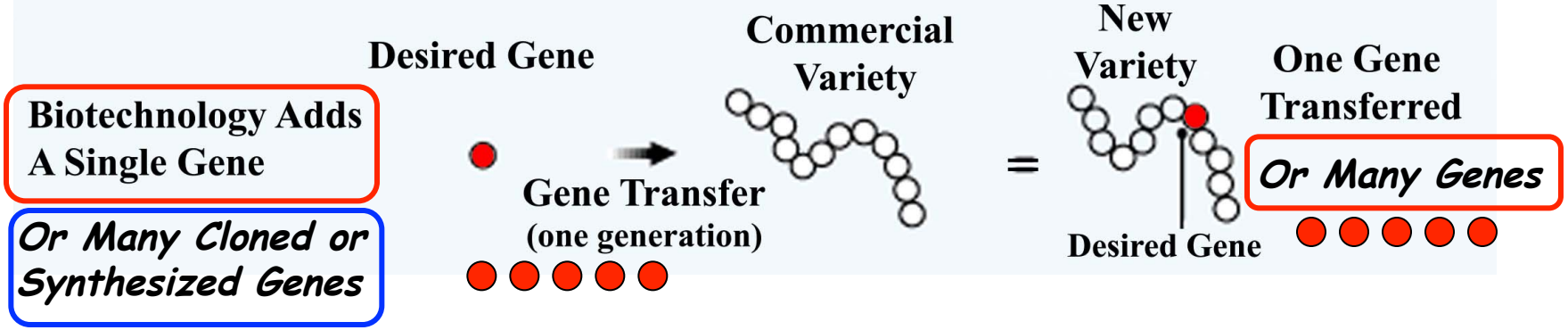
How Do Classical Genetic Engineering Methods Differ From Those Using DNA and 21st Century Technologies?

Classical vs. Molecular Genetic Engineering

TRADITIONAL PLANT BREEDING



PLANT BIOTECHNOLOGY



What Are The Limitations of Classical Breeding/Genetic Engineering?

1. Limited To Genes of Interbreeding Organisms and, Clearly, Severe Ethical Issues With Humans (eugenics)

2. Only Can Make New Combinations of EXISTING Genes - Genes Created By "Natural" Mutations

3. Can't Make Existing Genes "Better" - Just Better or More Useful Combinations of Existing Genes and/or Alleles

4. Takes Time - Limited To Generation Time of Organism - Decades For Some Crop Plants

5. Only Useful For "Obvious" Traits - One's That Can Be Observed or Followed

6. Unpredictable Outcomes (Bringing in Thousands of Genes at Once – Some With Deleterious Consequences)

What Are The Advantages of Using 21st Century Genetic Engineering Methods?

1. Any Gene From Any Organism Can Be Used In Any Organism - There Are No Breeding Barriers (e.g., genes of all sequenced genomes)

2. New Genes Can Be Engineered - Genes That Work Better and/or Produce New Proteins (i.e., create new genetic variability and/or alleles)

3. Existing Genes Can Be Engineered to be Switched On in "Places" That They Are Normally Off - Gene Control or Regulation Altered (e.g., fly eye on leg)

4. Speed - Can Engineer a New Organism in a Generation

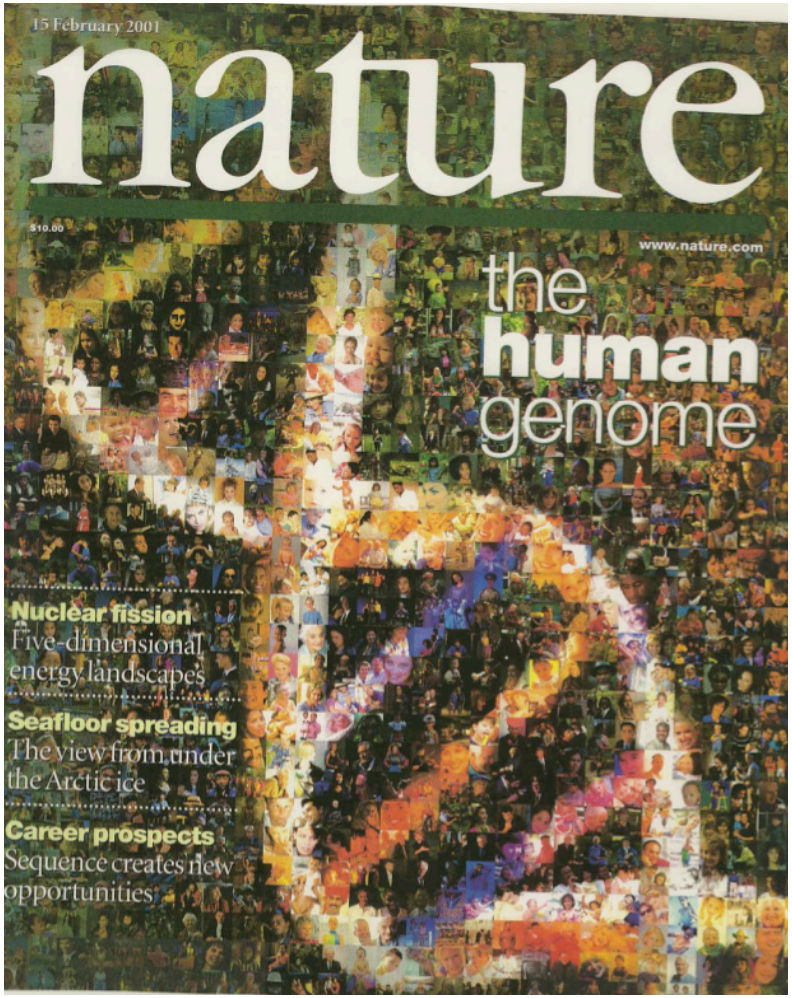
5. Can Change, Alter, Manipulate, Synthesize and/or Control the Genetic Blueprint of Any Organism

6. Very Precise (Working With Known Genes & Proteins)

The Era of 21st Century Genomics Will Provide Access to ALL Genes of Every Organism on the Earth

Gene + Chromosome = Genome

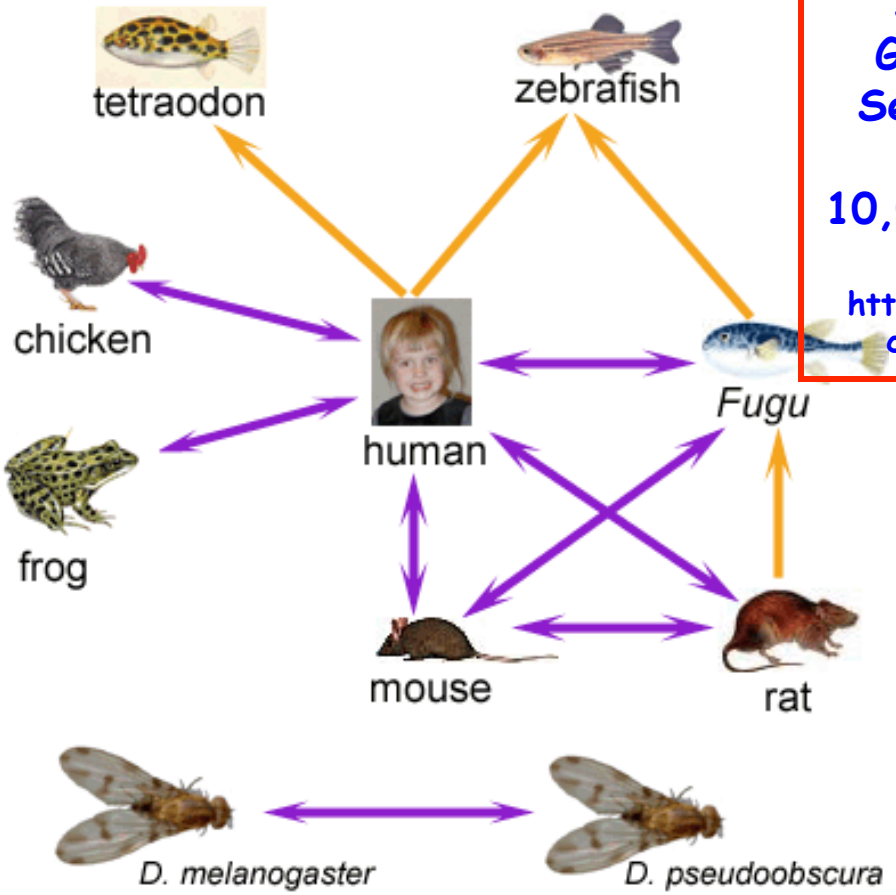
(Winkler, 1920)



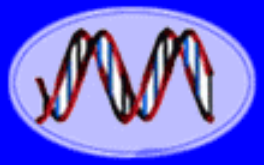
The Genomes of Many Organisms Have Been Sequenced Providing New Knowledge About Our Origins and Cellular Functions

168 Eukaryotic &
3,000 Prokaryotic
Genomes Have Been
Sequenced as of 2011
&
10,000 Genome Projects
Ongoing!
http://www.genomesonline.org/cgi-bin/GOLD/bin/gold.cgi

The Future is Unlimited!



Providing Thousands of New Genes and Proteins To Be Engineered For Practical Applications (e.g., cellulases in termite gut bacteria for biofuel production)



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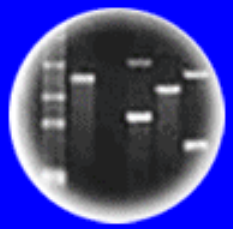

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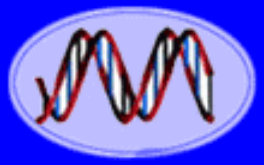
HOW IS SCIENCE CARRIED OUT?

SCIENTIFIC KNOWLEDGE IS OBTAINED BY A PRECISE & SPECIFIC PROCESS



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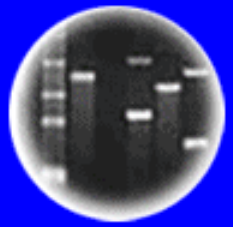

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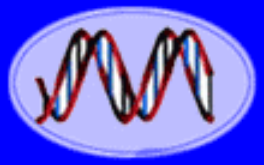
The Scientific Method

- What are the Observations?
- What is Your Hypothesis to Explain the Observations?
- What are the Predictions?
- How Test Hypothesis?
- What are the Experimental Data?
- Have the Data Been Verified & Peer Reviewed?



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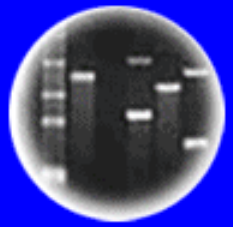

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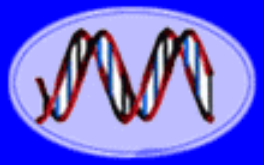
Science is NOT "Hocus Pocus" or Based on Opinions and Beliefs

- Science is Based on Observation, Hypothesis Testing, Rigorous Experimentation, and Verification

- Technology, or the Application of Scientific Knowledge, Has Transformed Dramatically Our Lives and How We Live

What Are the Data!!!!!



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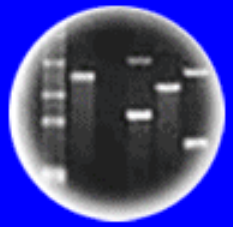

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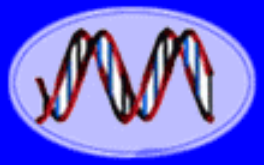
It Has Lead to Civilization and Culture as We Know It!

- Agriculture
- Medicine
- Computers and Automation
- Airplanes, Cars, and Satellites
- Countries and Cities
- Political Systems
- Art and Literature
- Etc., Etc., Etc.

Simply Put:Our Way of Life!



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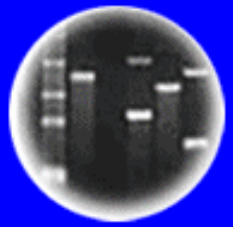

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