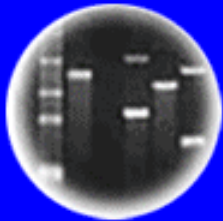


DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

HC70A & SAS70A Winter 2011 Genetic Engineering in Medicine, Agriculture, and Law

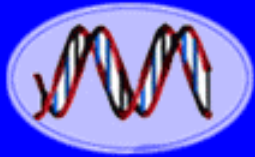
Professors Bob Goldberg & John Harada

Lecture 1-Part Two

**The Age of DNA-What is Genetic
Engineering?**

UCLA

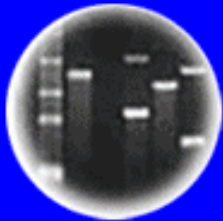
UCDAVIS
UNIVERSITY OF CALIFORNIA



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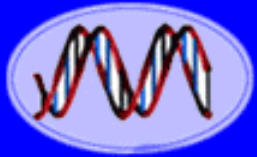
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THEMES

1. The Age of DNA, Genomics, Genetic Engineering & Synthetic Organisms
2. What Do Genes Look Like - DNA Demonstration
3. DNA Into Your Home
4. How Was Modern Genetic Engineering "Invented?"
5. What Is Genetic Engineering & How Has It Affected Our Lives?
6. What Can Be Done With Genetic Engineering?
7. What Does Genetic Engineering Tell Us About Genetic Processes?
8. What Is the Scientific Method?
9. Genetic Engineering - Anything New?
10. Classical vs. 21st Century Genetic Engineering - Demonstration
11. Era of Genomics, Genetic Engineering, & Synthetic Life - Impact on Humankind?

Part 1

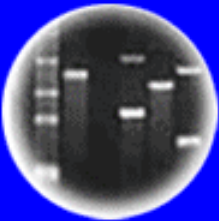
Part 2



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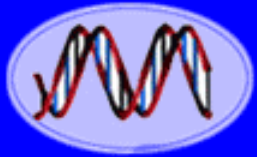


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Last Lecture -- Age of DNA & Genetic Engineering

Today's Class -- What ARE Genes & How Do They Work? PART ONE

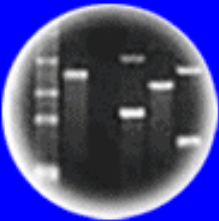
Demonstration Bacterial "Cloning" & Gel Electrophoresis



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Cloning: Ethical Issues
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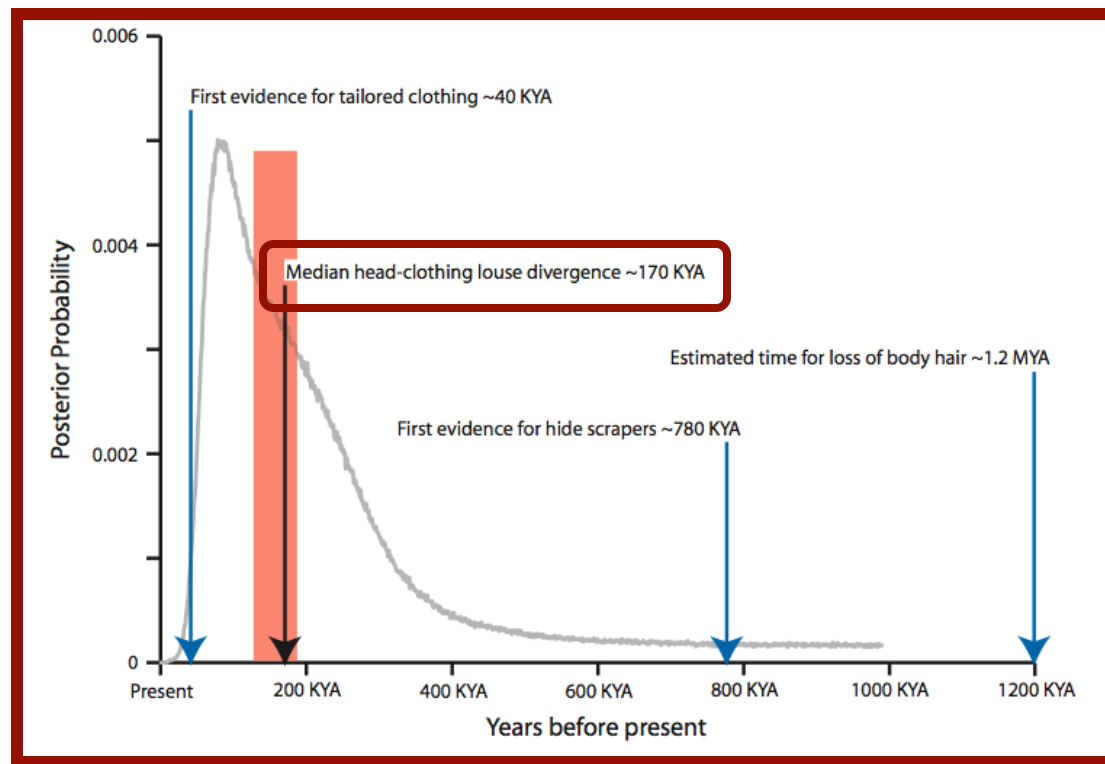
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DNA in the News!

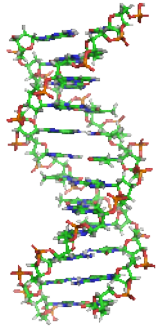
Lice DNA Study Shows Humans First Wore Clothes 170,000 Years Ago

Origin of Clothing Lice Indicates Early Clothing Use by Anatomically Modern Humans in Africa

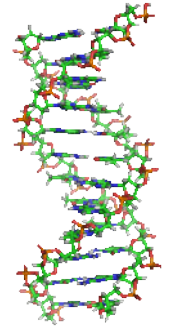
Journal of Molecular Biology and Evolution, January, 2011, 28, 29-32



From Gene Divergence in Head and Clothing Lice

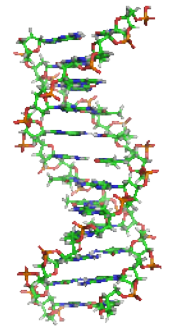
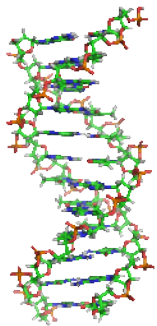


**Recall: We Live in the
The Age of DNA!**



**Genetic Engineering Is
Manipulating DNA!**

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





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?

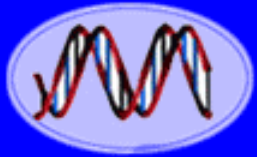
- a. Watson
- b. Crick
- c. Wilkins
- d. Franklin
- e. Gosling
- f. Chargaff

Note: Nobel Prize Rules Allow Only Three People To Share a Prize

1/11/11 - Continuation of Lecture #1

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

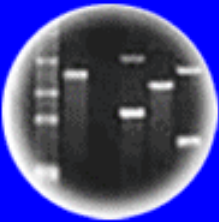
- Synthetic Chromosomes & Microbes
- Recombinant Plasmids & Bacteria
- GlowFish, GloMice, GloMonkey, GloPlant
- Mighty Mice and Giant Fish
- Insect Resistant Crops
- Novel Fly Body Plans (e.g., eye on leg)
- Engineered Humans



DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting

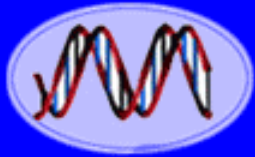


Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

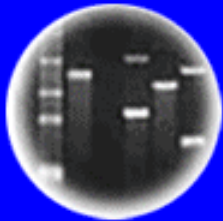




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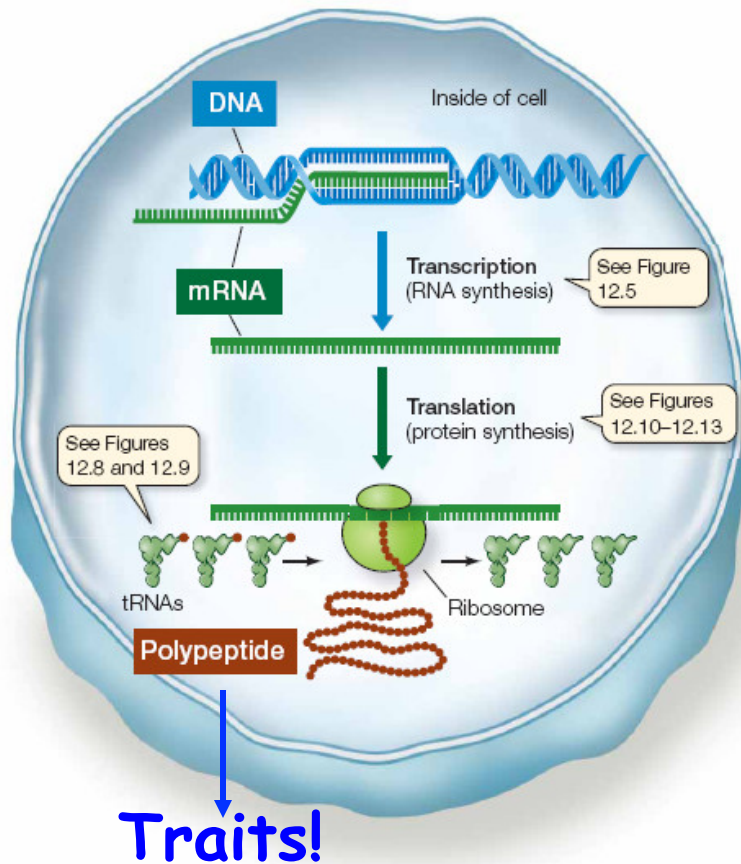
What Do These **Genetic Engineering** Experiments "Say" About the Unity of Genetic and Biological Processes?

What is the Hypothesis?

What are the Predictions?

What Experiment(s) to Test Predictions?

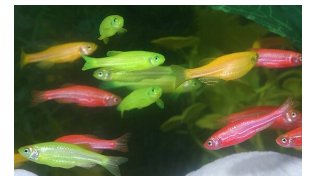
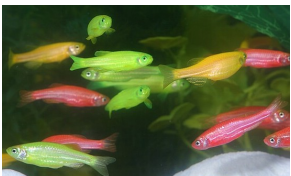
What Can We Infer FROM These Genetic Engineering Experiments About How Genes “Work” and Genetic Processes in All living Organisms?



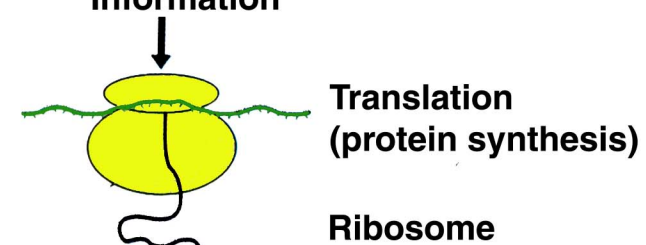
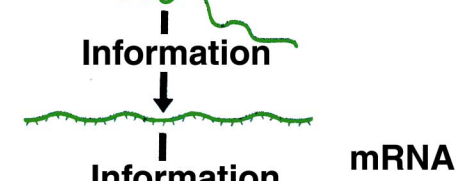
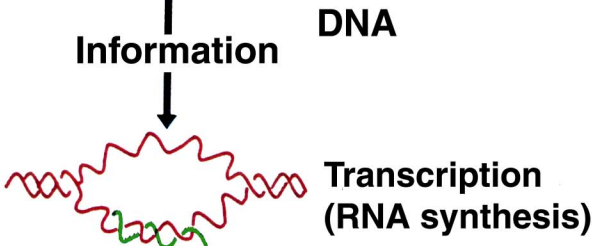
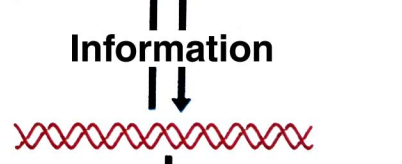
1. *Genes Can Work Independently of Other*
2. *Basic Genetic Processes Are Universal (Replication & DNA to RNA to Protein)*
4. *Basic Genetic Processes Can Be Used to Engineer or Transfer Genes From One Organism to Another and Transfer Them Stably Generation After Generation*

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.*
- 5. 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.*



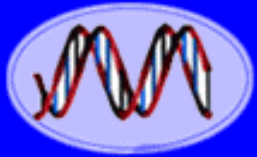
Translating The Genetic Code Into Proteins is a Conserved Process



*Can Intervene
in This Process in
Cells*

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

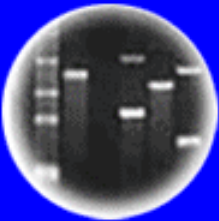
*All Organisms Use
The SAME Processes
And "RULES" to
Generate Traits!! And
The SAME Molecules
& Chemistry!!*



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DNA Fingerprinting



Cloning: Ethical Issues
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HOW IS SCIENCE CARRIED OUT?

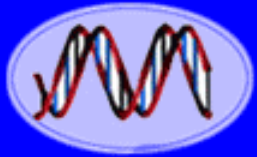
SCIENTIFIC
KNOWLEDGE IS
OBTAINED BY A
PRECISE & SPECIFIC
PROCESS



philipmarin.info



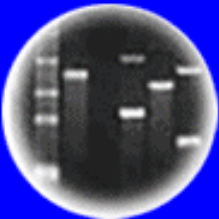
ppppt.com



DNA
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Entire Genetic Code
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DNA Fingerprinting



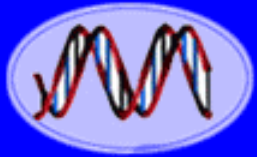
Cloning: Ethical Issues
and Future Consequences



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The Scientific Method

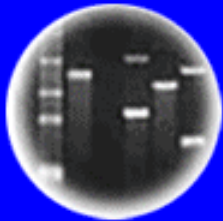
- What are the Observations?
- What is Your Hypothesis to Explain the Observations?
- What are the Predictions?
 - How Test Hypothesis?
- What are the Experimental Data?
 - Have the Data Been Verified & Peer Reviewed?



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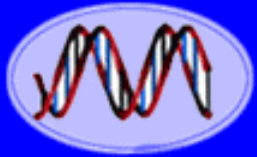
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Science is **NOT** "Hocus Pocus"
or Based on Opinions and Beliefs

• 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

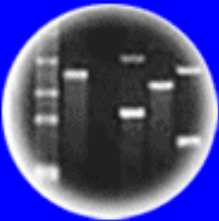
What Are the Data!!!!



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Cloning: Ethical Issues
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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!

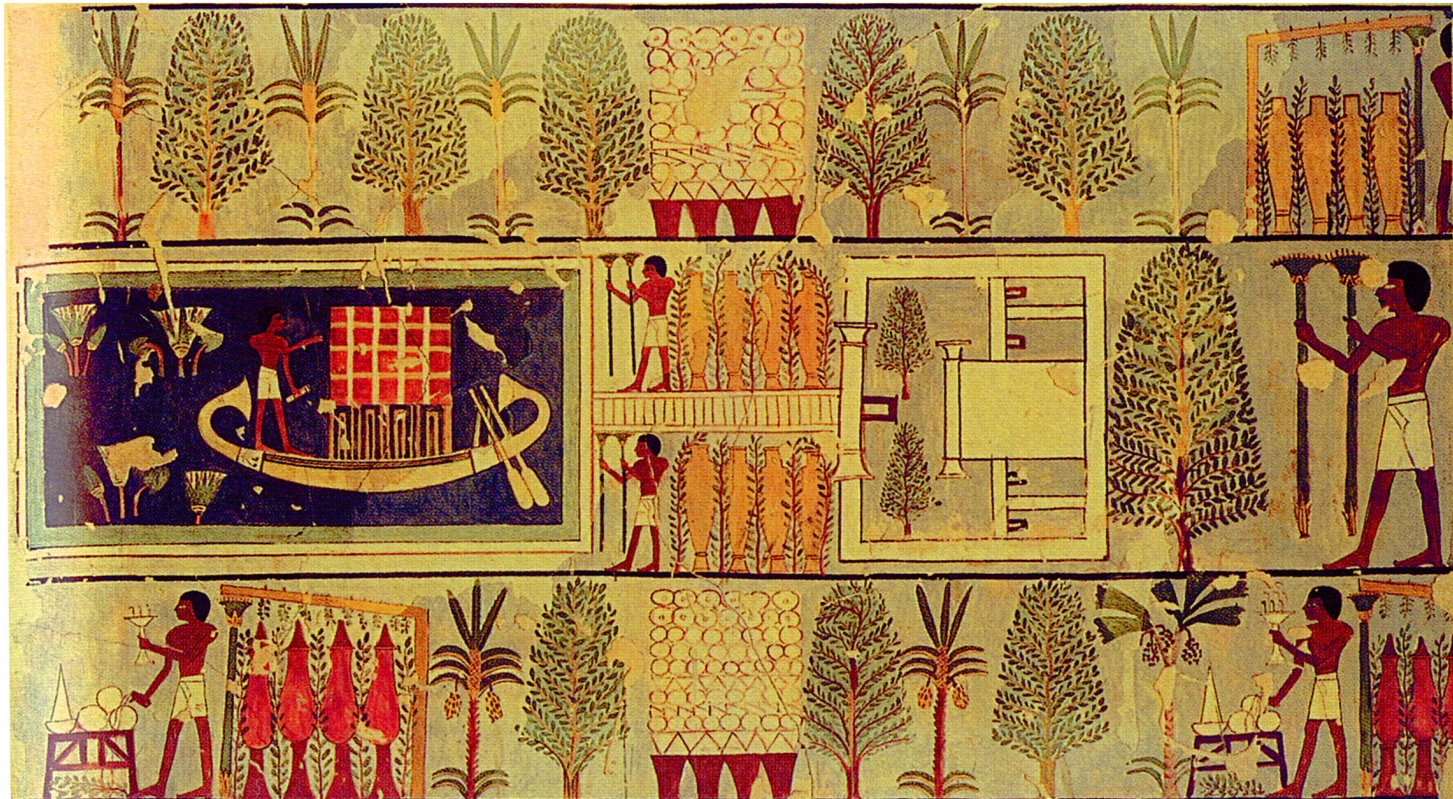
Is Genetic Engineering a New Technology?

- a. Yes**
- b. No**

There is Nothing New About Genetic Engineering!

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

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

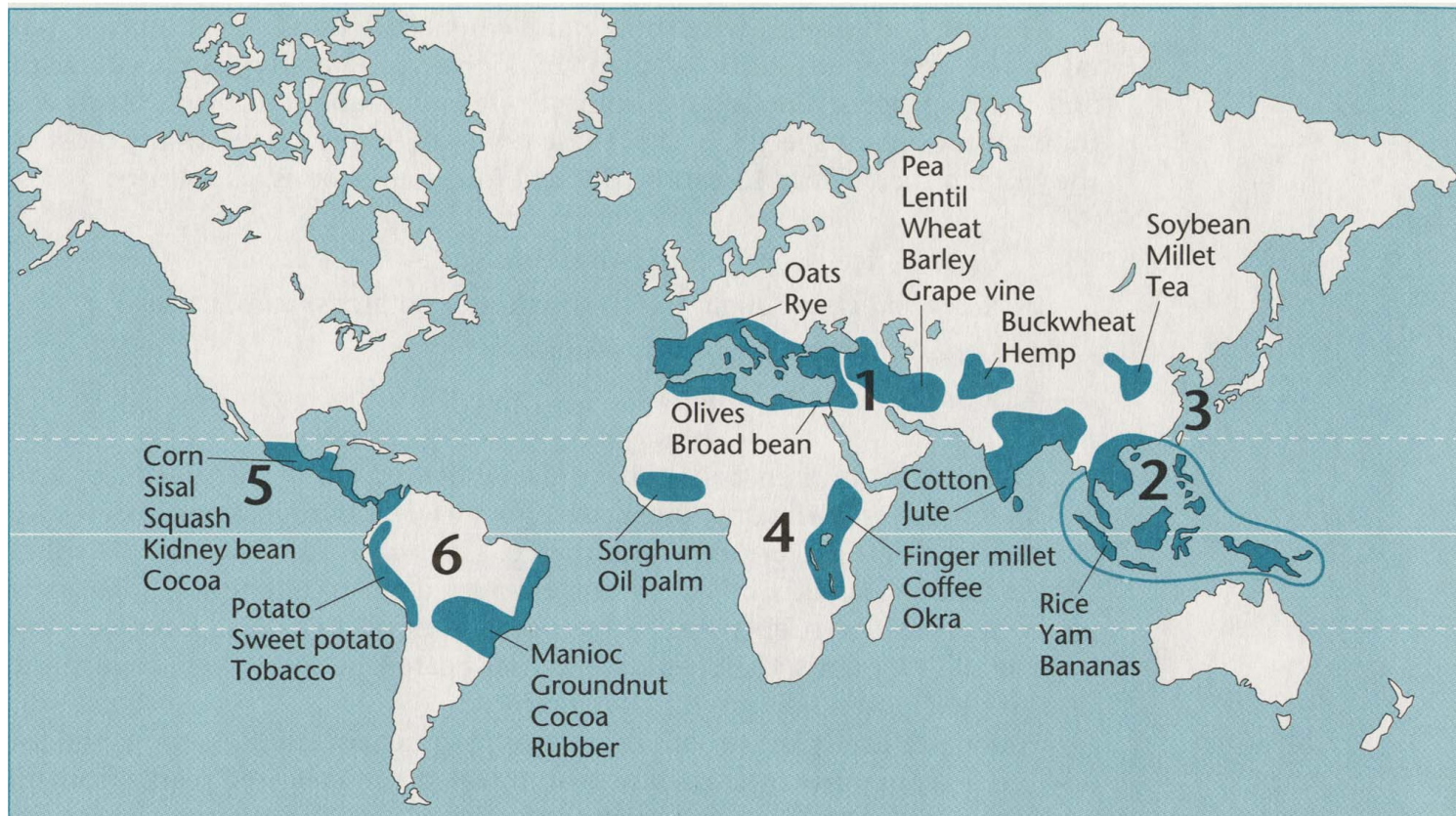


Genetic Engineering is Not New

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)*

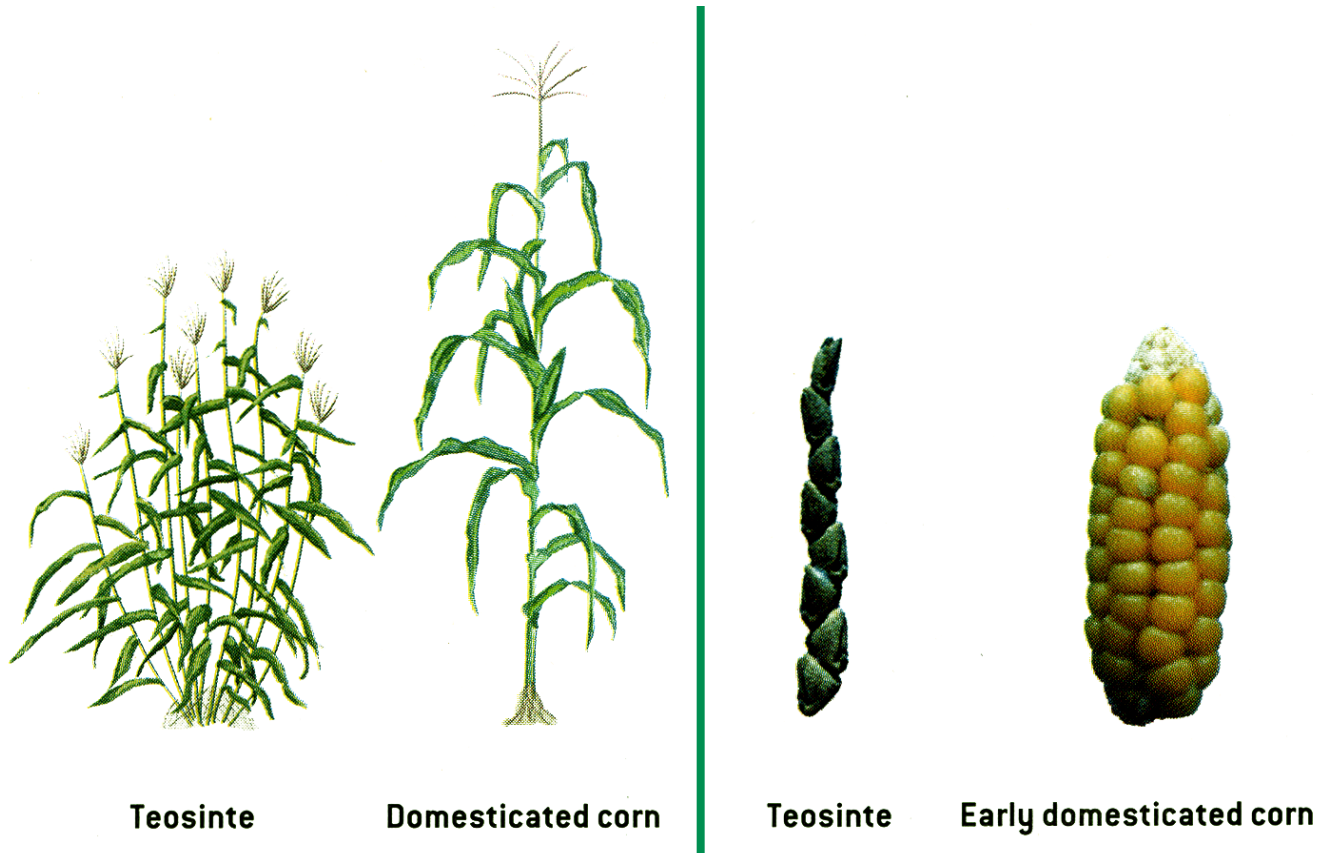
*Tomatoes Were Engineered From Small Wild Relatives
Because of Mutations in Fruit Size Genes!*



*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!

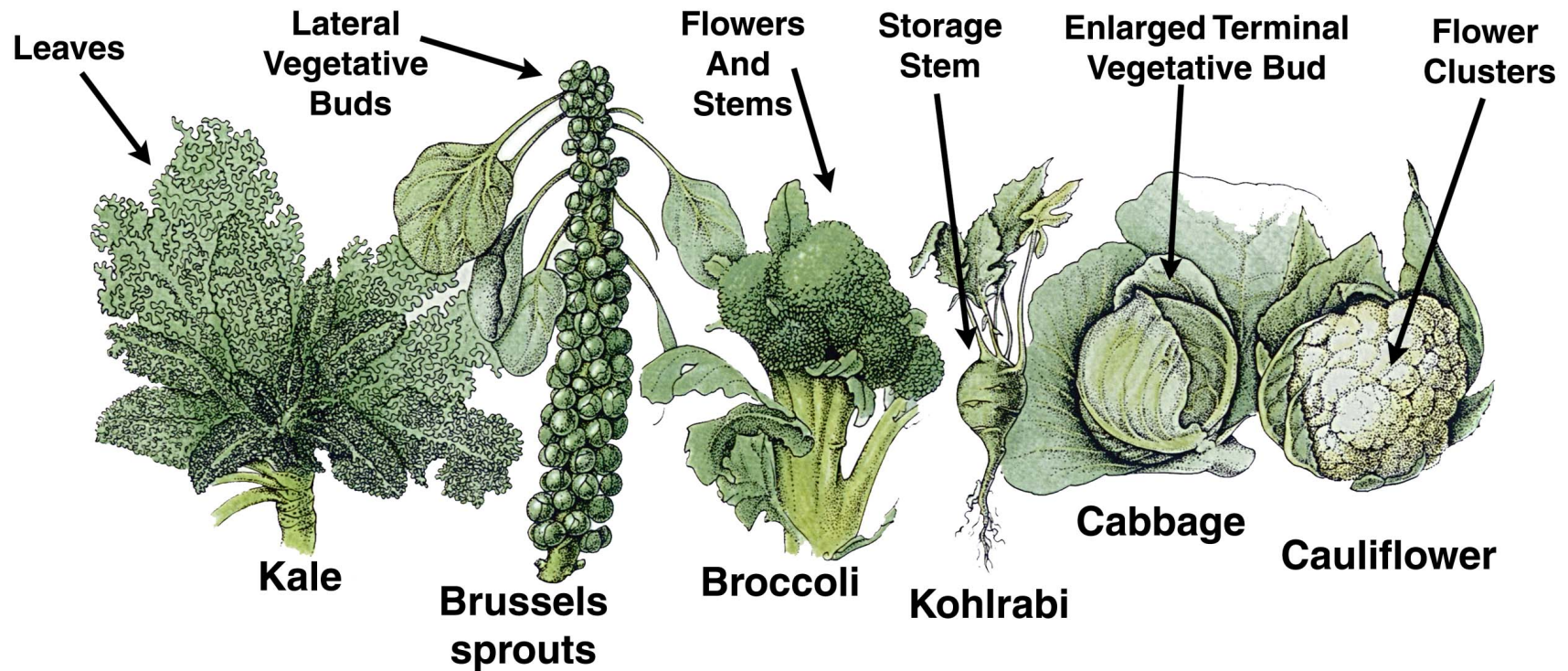
Engineering Teosinte Into Domesticated Corn



Note: Architecture and Fruit (cob) Size

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

**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



GENOMICS

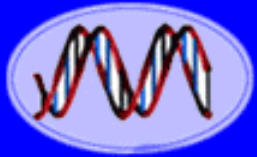
The dog has its day

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!

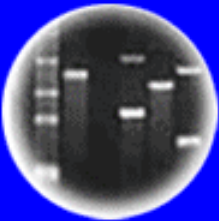
Canine DNA
Forensic Testing



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Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

The Problem With Breeding the "Old Fashioned Way"

Cannot Predict Results!

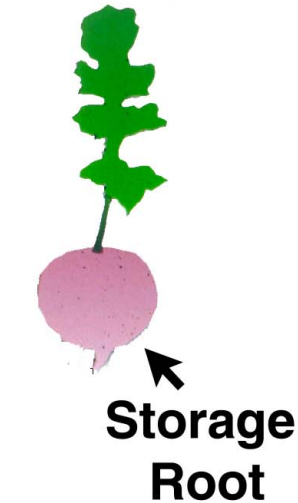
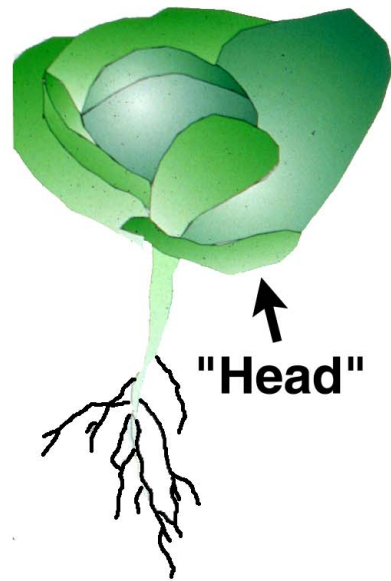


The Problem With Breeding the "Old Fashioned Way"

Engineering A Novel Crop By "Wide" Breeding

Cabbage (*Brassica*)

Radish (*Raphanus*)



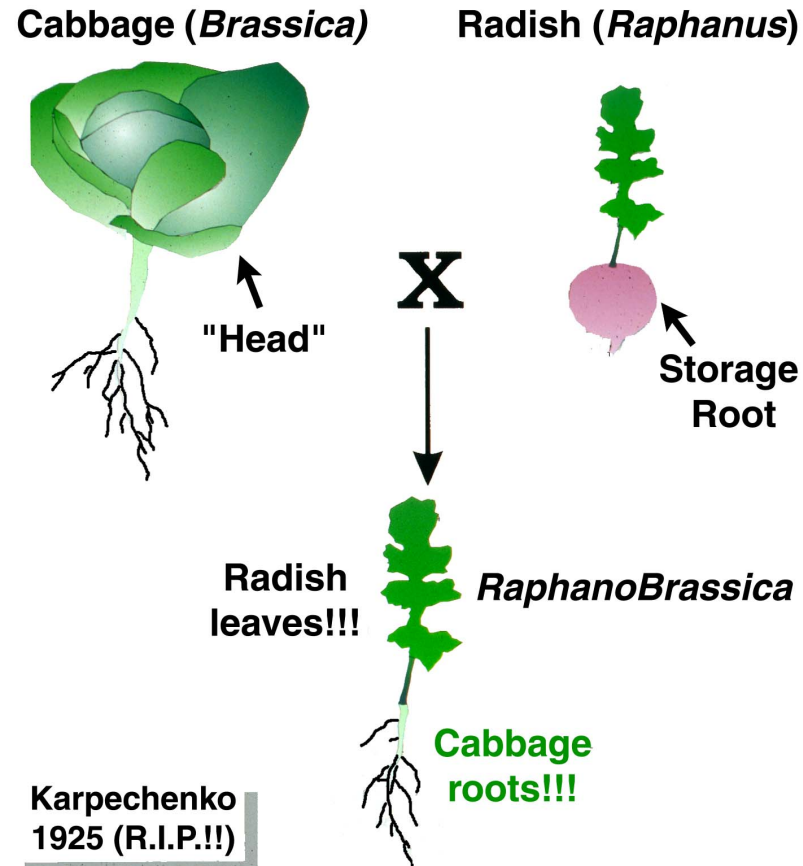
X



???

Karpechenko
1925

Engineering A Novel Crop By "Wide" Breeding



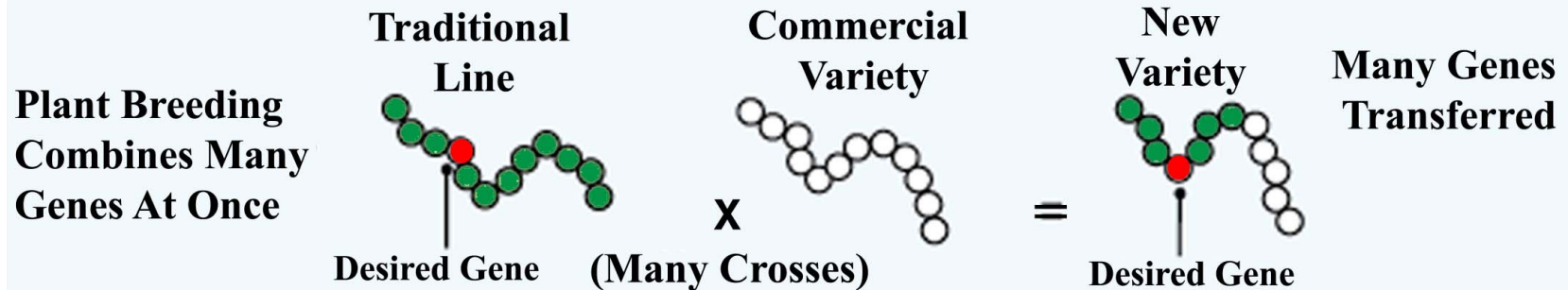
*Results Show the Unpredictability of Classical Breeding Approaches
Compare With the Modern Genetic Engineering Examples Shown Previously*

Genetic Engineering is a Technique!

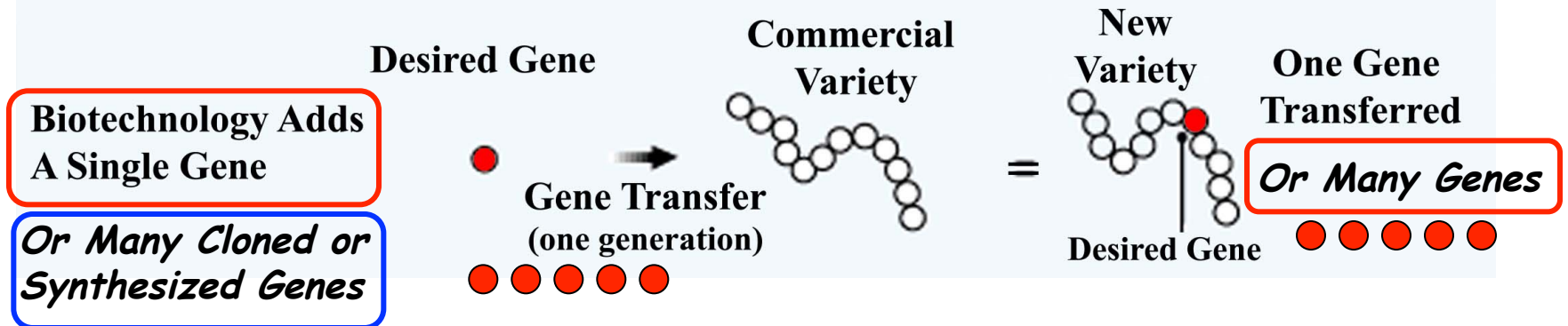
**How Do Classical Genetic Engineering
Methods Differ From Those Using
DNA and 21st Century Technologies?**

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 Severe Ethical Issues With Humans
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

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

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

Gene + Chromosome =
Genome

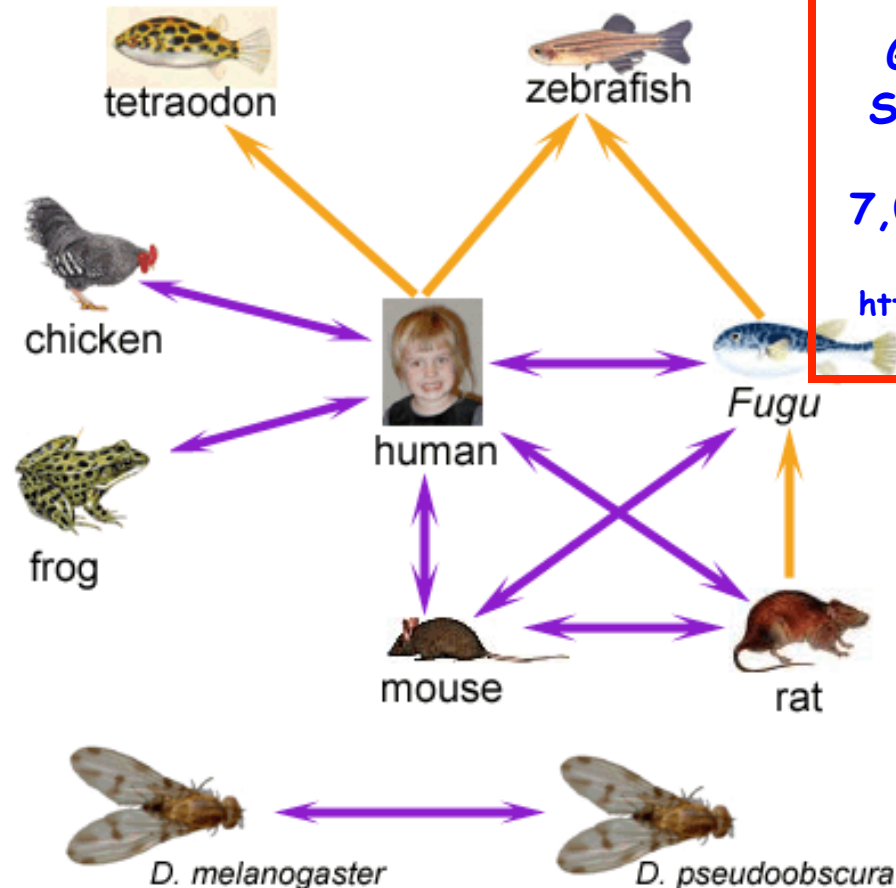
(Winkler, 1920)



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

160 Eukaryotic &
1400 Prokaryotic
Genomes Have Been
Sequenced as of 2010
&
7,000 Genome Projects
Ongoing!
[http://www.genomesonline.org/
cgi-bin/GOLD/bin/gold.cgi](http://www.genomesonline.org/cgi-bin/GOLD/bin/gold.cgi)

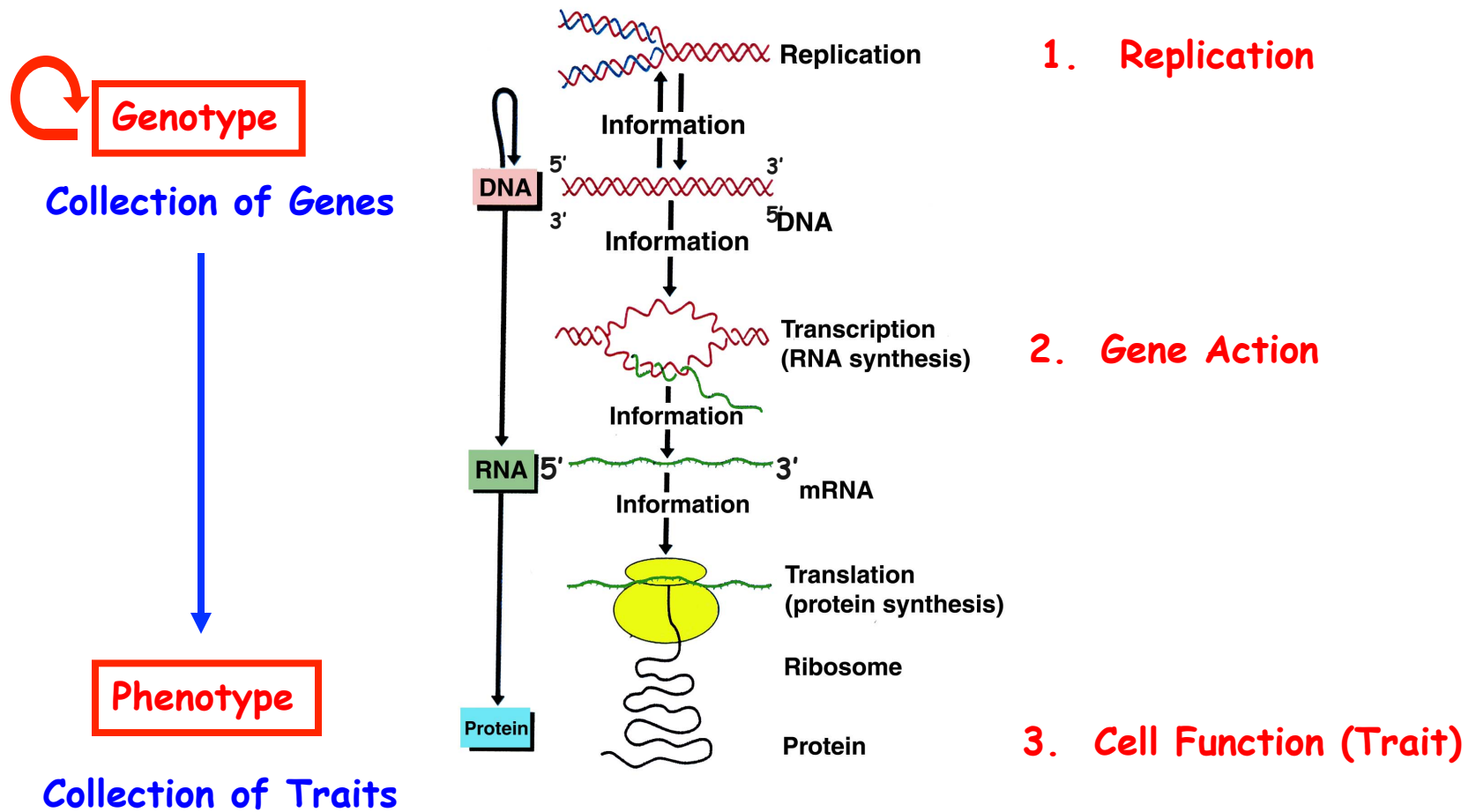
The Future is
Unlimited!



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

Begin Lecture #2

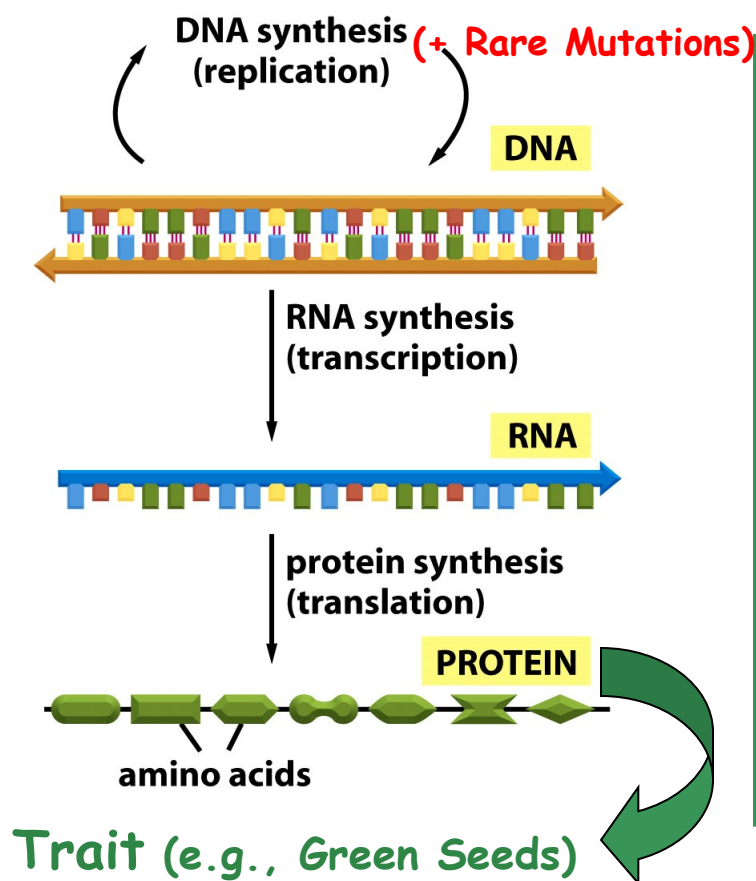
What Are the Functions of a Gene?



Genetic Engineering Alters Cell Function By Changing the Genotype
How is this Demonstrated Experimentally?

Design an Experiment!

Gene Action Leads to Specific Traits



Mendel's Traits

	DOMINANT	RECESSIVE
	Spherical seeds	Wrinkled seeds
	Yellow seeds	Green seeds
	Purple flowers	White flowers
	Inflated pods	Constricted pods
	Green pods	Yellow pods
	Axial flowers	Terminal flowers
	Tall stems (1 m)	Dwarf stems (0.3 m)

Alleles

Mutations Lead to Different Forms of the SAME Gene (Alleles) and Generate Genetic Variability in a Population of Organisms (e.g., round and wrinkled peas)

Genetic Engineering Can Create Infinite Amounts of Genetic Variability NOT Found in Nature

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

Tomato Genetic Diversity

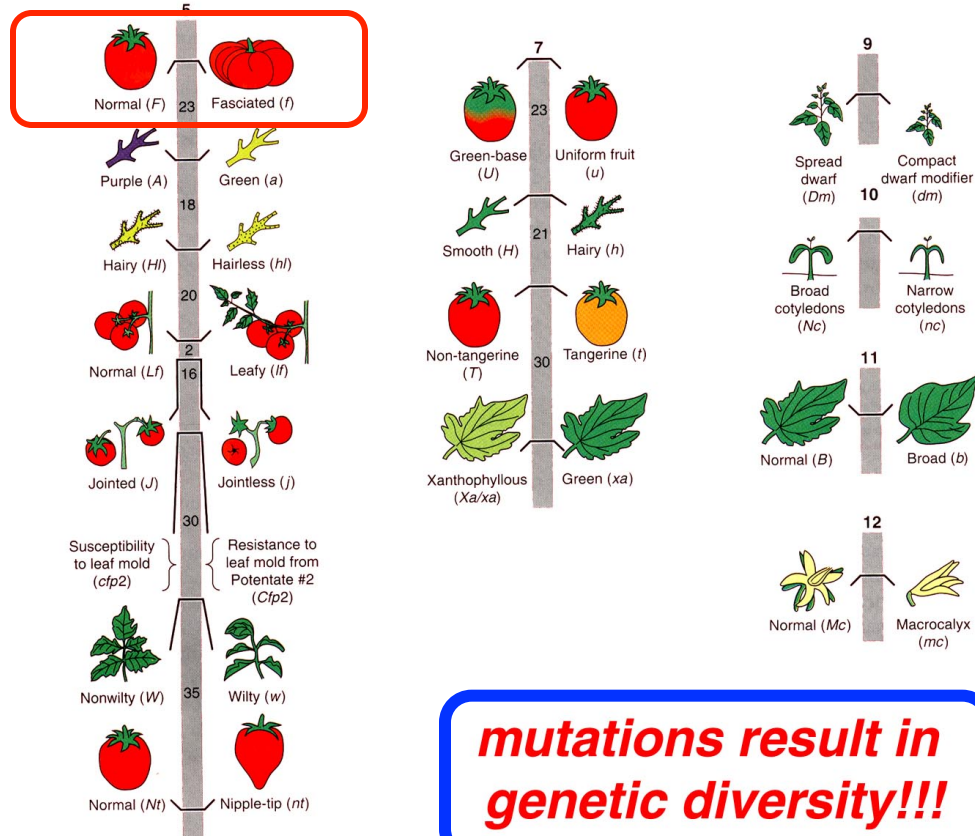
*This
Genetic Variability
Arose Spontaneously
By RARE Mutations*



*Gene Mutations Alter DNA Sequences,
Slightly Change Gene Functions (e.g., fruit size, color),
& Create Alleles -- Different Forms of the Same Gene*

Alleles Reside at the Same Position on a Chromosome

Alleles



Gene Engineering Can Generate New Forms of Alleles of a Gene and, therefore, Results in More Genetic Diversity

mutations result in genetic diversity!!!

Alleles Are Different Forms of the Same Gene That Arise By Mutation & Can be Made in a Laboratory By Modern Genetic Engineering!

How Does the GloFish Experiment Show That Genes Direct the Production of Traits?

What's Your Hypothesis?

Fluorescent transgenic zebrafish were developed by a research team, led by Dr. Z. Gong in Department of Biological Sciences, National University of Singapore.

Fig. 1. The basic procedure to produce transgenic fish. Briefly, fluorescent color genes, originally isolated from a jellyfish and a sea anemone, were microinjected into zebrafish eggs and these foreign genes later become a part of the genetic make-up of injected zebrafish. Thus the fluorescent color acquired by these transgenic zebrafish can be stably transmitted to all future generations. This technology can also be applied to other ornamental fish species.

General Procedure of Generation of Transgenic fish

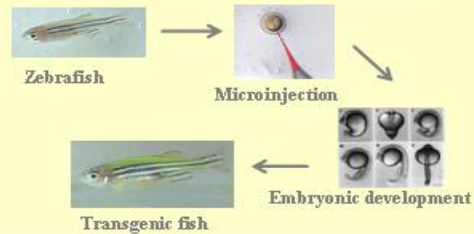


Fig. 2. Florescent transgenic zebrafish in a rainbow array (top to bottom): Red, rfp fish; Orange, rfp/gfp fish; Yellow, yfp fish; Green, gfp fish; and Wild Type fish. The picture on the far left was taken under a daylight and the picture on the left in the dark with a red light.

rfp – red fluorescent protein
yfp – yellow fluorescent protein
gfp – green fluorescent protein

Traits

Phenotypes

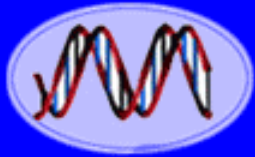
Different Colors!!



Fig. 3. Swimming fluorescent transgenic zebrafish under the daylight (top) and in the dark (bottom, with a uv light)

DESIGN AN EXPERIMENT TO SHOW THAT DNA IS THE GENETIC MATERIAL!!

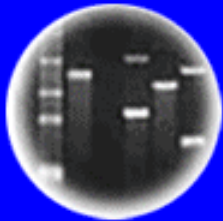
GloFish®



DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting

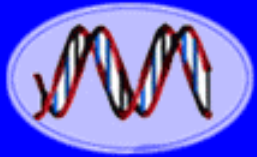


Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

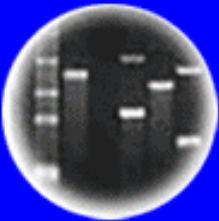
- **What are the Observations?**
- **What is Your Hypothesis to Explain the Observations?**
- **What are the Predictions?**
 - **How Test Hypothesis?**
- **What are the Experimental Data?**
 - **Have the Data Been Verified & Peer Reviewed?**



DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

•Bacterial "Cloning" Experiment

•Gel Electrophoresis and Restriction Enzyme Digestion Demonstration