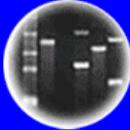


DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

HC70 & SAS70A Spring 2017 Genetic Engineering in Medicine, Agriculture, and Law

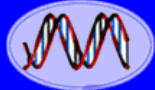
**Professors Bob Goldberg
& John Harada**

Lecture 1 The Age of DNA: What Is Genetic Engineering-Part One

Please Turn Off Your Cell Phones!!

UCLA

UC DAVIS
UNIVERSITY OF CALIFORNIA



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DNA Fingerprinting



Cloning: Ethical Issues
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Plants of Tomorrow

LECTURE THEMES

1. What is a GMO?
2. GMOs in the News!
3. What is Genetic Engineering?
4. What Do Genes Look Like - DNA Demonstration
5. How Was Modern Genetic Engineering Invented & What Is the Genetic Engineering Process?
6. Why Use Genetic Engineering?
7. How Has Genetic Engineering Affected Our Lives?
8. How Has Genetic Engineering Created New Ethical and Legal Issues?
9. Genetic Engineering in Medicine, Agriculture, Law, & Society - Some Examples



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The Long Distance Connection!

HC70A & SAS70A

Spring 2017



*A Model For Cross-Campus
Interactive Learning*

Just Say
No To
GMO

The Politics of...

GMOs

NO 37
ON
STOP THE DECEPTIVE
FOOD LABELING SCHEME



US rethinks crop regulation

Committee begins study to guide oversight of gene-edited organisms.

Congress Passes GMO Food Labeling Bill

**The world's first GMO apple will not
turn brown, but is it safe?**

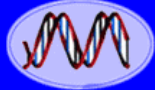
**FDA, EPA approve 3 types
of genetically engineered
potatoes**



**Genetic Details of Controversial
"3-Parent Baby" Revealed**

Justices Back Monsanto on Biotech Seed Planting

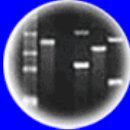
Human Gene Editing Receives Science Panel's Support



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Genetic Engineering in the News.. Medicine

In Girl's Last Hope, Altered Immune Cells Beat Leukemia

British Lawmakers Approve 'Three-Parent' In-Vitro Fertilization



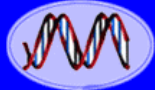
Gene therapy trial 'cures children'

Chinese scientists genetically modify human embryos



UCLA researcher pioneers gene therapy cure for 'Bubble Baby' disease

UK scientists apply for licence to edit genes in human embryos



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Genetic Engineering in the News.. Agriculture

Super-muscly pigs created by small genetic tweak

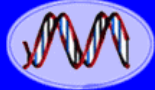
Genetically Modified Salmon Is Safe To Eat, FDA Says

Gene-Altered Apples and Potatoes Are Safe, F.D.A. Says

Congress Passes GMO Food Labeling Bill

US FDA Approves GE Pink Pineapple

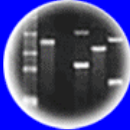
SCIENTISTS DEVELOP GM CITRUS WITH ENHANCED RESISTANCE TO GREENING



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DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

Genetic Engineering in the News.. The Law

DNA Test Frees Man After 34 Years In Prison

Supreme Court OKs DNA swab of people under arrest

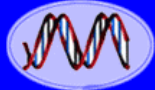
Supreme Court Supports Monsanto in Seed-Replication Case

Los Angeles diners being duped by widespread sushi scam, UCLA study claims

Harvard and M.I.T. Scientists Win Gene-Editing Patent Fight

Supreme Court Free-Speech Decision Clobbers GMO Food-Labeling Activists

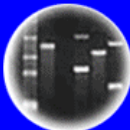
Justices, 9-0, Bar Patenting Human Genes



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Plants of Tomorrow

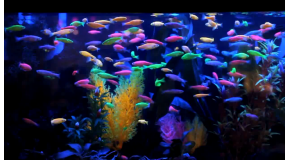
What's a GMO???



So.....What's a GMO?



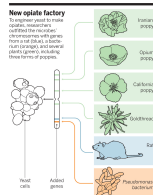
*A Genetically Engineered Bacteria
Synthesizing
Human Insulin Used as a Drug to
Treat Diabetics?*



*A Genetically Engineered GloFish
Used as a Pet?*



*A Genetically Engineered Pig
With Double Muscles For Leaner
& More Meat*



*A Genetically Engineered Yeast
That Synthesizes Opiates For
Medicine?*

What's a GMO?



*A Bacteria With a Genome Synthesized
in a Laboratory?*



*A Yeast With Chromosomes
Synthesized in a Laboratory?*



*A Genetically Engineered Bacteria
Making Blue Dye For Jeans?*



*A Genetically Engineered Goat
Making a Human Anti-Clotting Drug?*

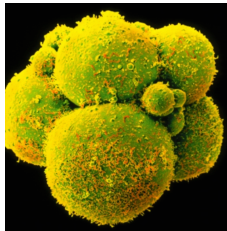
What's a GMO?



A Genetically Engineered Salmon That Grows Faster Than Non-Engineered Salmon & Has Been Approved by the FDA For Human Consumption?



A Genetically Engineered Person With a Gene That They Weren't Born With That "Cures" a Lethal Genetic Disease?

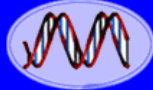


A Human Embryo With a Defective Blood Disease Gene That Was "Edited" and Engineered to Be Normal?



Crops That Are Grown For For Human & Animal Consumption?

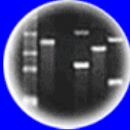
So.....What's a GMO?



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Plants of Tomorrow

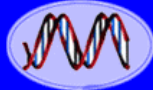


What is Genetic Engineering?

Directed Change of an Organism's Genetic Blueprint or DNA!!



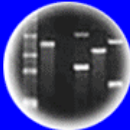
ge·net·ic en·gi·neer·ing
jə'nedik ɛnʒi'ni(e)riŋg/
noun
noun: genetic engineering
the deliberate modification of the characteristics of an organism by manipulating its genetic material.



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Entire Genetic Code
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DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

Genetic Engineering is a TECHNIQUE!

1. Classical Breeding By Selective Mating (Thousands of Years)
2. Insertion of New Genes Into An Organism's Chromosomes (50 Years)
3. Editing Existing Genes Like A "Word Program" (1-2 Years)

Breeding or DNA Manipulation - They Are the SAME

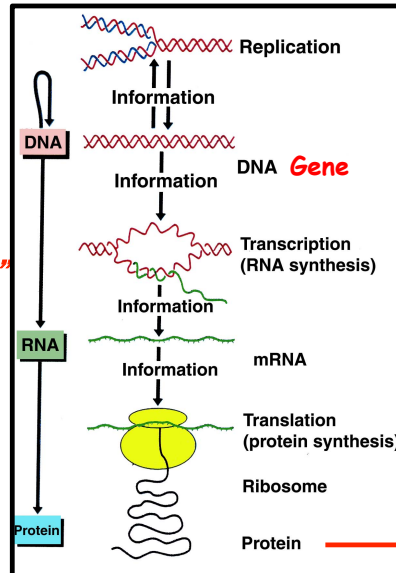
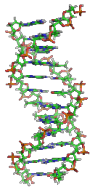
&

Called *Gene Manipulation*
WHAT IS A GMO???

Genes & DNA Obey the Same Rules Using *Either* Classical or Molecular DNA Engineering Approaches!! *BOTH* Produce GMOs!

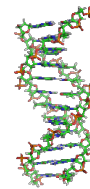
Can Intervene in This Process in Cells

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!!

Coat Color Trait



An Essential HC70A Theme!



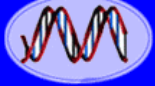
We Live in The Age of Genetic Engineering!

Genetic Engineering Is Manipulating DNA! ALL GMOs Have Engineered Genes




**By Classical Breeding or in a Test Tube
It's All the Same!**

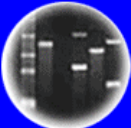





DNA
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Entire Genetic Code
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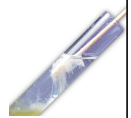
DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences

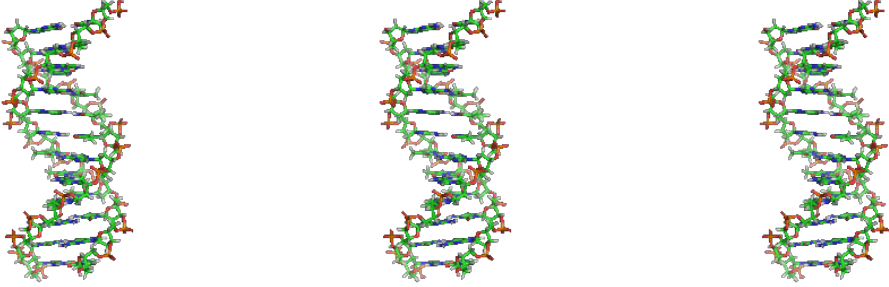


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What Does Your DNA Look Like?

Have You Ever Seen or Touched Your Genes?



Genetic Engineering Has Been in the News For Over FORTY Years!!! (From NY Times Archives)

Gene Transplants Seen Helping Farmers and Doctors

By VICTOR K. MCELHENY MAY 20, 1974

Debate on Shifting Genes Nearing a Critical Phase

By BOYCE RENSBERGER MAY 16, 1976

Scientists Report Using Bacteria To Produce the Gene for Insulin; Bacteria Used to Make Insulin Gene

By HAROLD M. SCHMECK Jr. Special to The New York Times (); May 24, 1977

Substance Usually Made in Brain Grown in Bacteria

By HAROLD M. SCHMECK JR. NOV. 3, 1977



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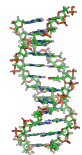
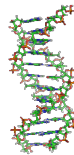
Cloning: Ethical Issues and Future Consequences



Plants of Tomorrow

How Was Genetic Engineering Using DNA Invented?

& How Did It Lead To Remarkable Advances In Medicine, Agriculture, & Law?




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DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



Plants of Tomorrow

The Idea That DNA From Different Species Could Be Recombined Occurred - 46 Years Ago!

1972

Paul Berg (1926-) creates first recombinant DNA molecules

Paul Berg assembled the first DNA molecules that combined genes from different organisms. Results of his experiments, published in 1972, represented crucial steps in the subsequent development of recombinant genetic engineering. By stepwise methods such as he devised, individual genes could be isolated and inserted into mammalian cells or into such rapidly growing organisms as bacteria. The genes themselves could then be studied, and their protein products expressed and even manufactured in quantity.

The prospect of recombinant DNA emerged from a series of advances in biochemistry—most especially, from discoveries of new enzymes. Particularly important were the restriction enzymes that act as “scissors” to cut molecules of DNA at specific points. Similarly, ligases are enzymes that forge covalent bonds. The discovery of DNA ligase provided a kind of chemical soldering that could restore DNA after a foreign gene was spliced into it. These and other enzymes, captured from nature, could be used as tools in genetic engineering.

In creating hybrid DNA molecules, Berg employed the much-studied SV40 monkey virus and a bacterial virus known as the λ (or lambda) bacteriophage. The SV40 virus has few genes, lacks a protein coat, and is convenient to work with. The λ bacteriophage normally invades a type of *E. coli*, where it replicates according to the nutritional environment. The DNA of both viruses takes the form of closed loops. Berg's original idea was to open the SV40 DNA, and splice into it genes snipped out of the bacteriophage. The virus could then replicate in cells, as in nature, and the products of the bacteriophage genes could also be expressed.

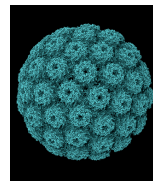
In Berg's cut-and-splice method he created, in the DNA of both viruses, what came to be known as “sticky ends.” Restriction enzymes were first used to open the circular units of DNA of phage and virus. In separate operations, types of terminal transferase (another enzyme) were used to add complementary DNA bases (adenine and thymine) to the ends of the molecules. When both kinds of DNA were incubated together, the ends would anneal naturally. Addition of DNA ligase would seal the plasmid. In succeeding with a series of enzymatic reactions, Berg wrote that his methods “are general and offer an approach for conveniently joining any two DNA molecules together.”

Potential dangers of recombinant genetic engineering emerged even before Berg published his landmark paper. Although the SV40 virus was thought to be innocuous in humans, the prospect of an altered form of the virus spreading through such a common bacterial agent as *E. coli* caused Berg to defer part of his research program. He did not insert the recombinant virus into bacterial cells as he originally planned. (With bacterial and animal genes, Herbert Boyer and Stanley Cohen took this step shortly.) A professor at Stanford University, in 1974 Berg published a widely discussed letter on the potential dangers of recombinant DNA research. Subsequently, a moratorium on research in 1975 provided time for regulations to be devised and put into effect in 1976.

In 1980 Paul Berg shared the Nobel Prize in Chemistry with Walter Gilbert and Frederick Sanger, for “his fundamental studies of the biochemistry of nucleic acids, with particular emphasis on DNA and RNA.”



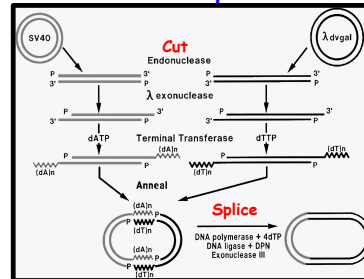
Simian Virus 40



λ Bacteriophage



“Cut & Splice”



Proc. Natl. Acad. Sci. USA, 69, 10, 3139-3140, October 1972

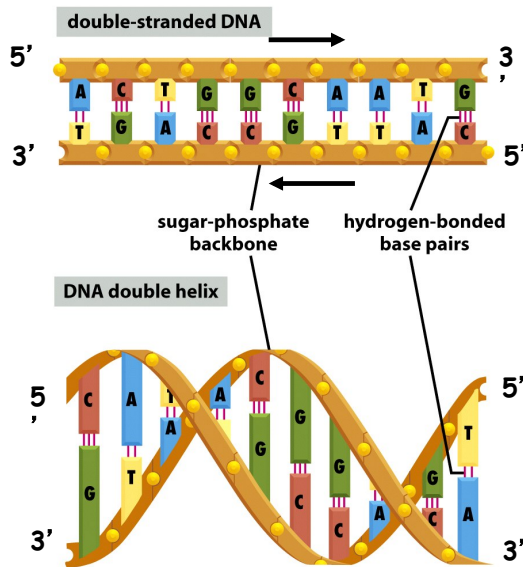
Biochemical Method for Inserting New Genetic Information into DNA of Simian Virus 40: Circular SV40 DNA Molecules Containing Lambda Phage Genes and the Galactose Operon of *Escherichia coli*
(Genetically hybrid DNA joining/acid transformation/genetic transfer)
DAVID A. JACKSON*, ROBERT H. FIMONSHI, AND PAUL BERG

In Test Tube Only!



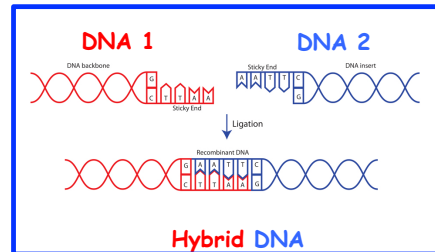


Major HCTOA Concept - Complementary Bases of the DNA Double Helix Allows Two DNAs to be Spliced Together & Form a Hybrid

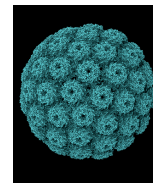


Complementary Strands

A=T and G=C (Four Bases)



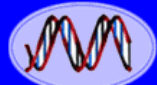
Simian Virus 40



λ Bacteriophage



Major Genetic Engineering Concept!!



DNA Genetic Code of Life



Entire Genetic Code of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



Plants of Tomorrow

Modern Genetic Engineering of Organisms Was Invented a Year Later & Caused a Revolution in Biology - 45 Years Ago!

Proc. Nat. Acad. Sci. USA
Vol. 70, No. 11, pp. 3240-3244

November 1973

This is the 45th Anniversary of Genetic Engineering's Origins

Construction of Biologically Functional Bacterial Plasmids *In Vitro*

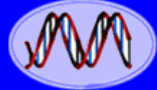
(R factor/restriction enzyme/transformation/endonuclease/antibiotic resistance)

STANLEY N. COHEN*, ANNIE C. Y. CHANG*, HERBERT W. BOYER†, AND ROBERT B. HELLING‡

* Department of Medicine, Stanford University School of Medicine, Stanford, California 94305; and † Department of Microbiology, University of California at San Francisco, San Francisco, Calif. 94122

Communicated by Norman Davidson, July 18, 1973

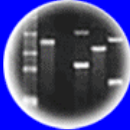
It is Not a New Technology..... To Those of Us Who Have Done This Our Entire Careers, It is an OLD technology!!



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Cloning: Ethical Issues and Future Consequences



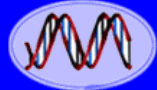
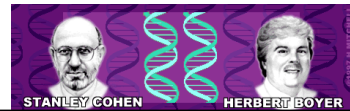
Plants of Tomorrow

Modern Genetic Engineering Was Invented With An Unexpected "Eureka" Moment Dealing With Two Unrelated Areas of Study Related To Bacterial Defense Systems:

1. The Mechanism of Bacterial Antibiotic Resistance To Fight Off "Predators"
2. How Novel Enzymes Protect Bacteria From Destruction By Viruses "Cut" DNA Into Pieces



TIME, March, 1981



DNA Genetic Code of Life



Entire Genetic Code of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



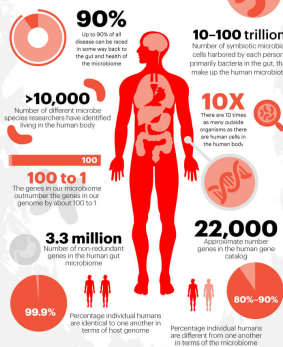
Plants of Tomorrow

Bacterial Cells Are Everywhere!

Human Bacterial Diseases

Disease	Pathogen	Prevention
Tooth decay	<i>Streptococcus mutans</i>	Regular dental hygiene
Lyme disease	<i>Borrelia burgdorferi</i>	Protection from tick bites
Tetanus	<i>Clostridium tetani</i>	Current tetanus vaccination
Tuberculosis	<i>Mycobacterium tuberculosis</i>	Vaccination
Salmonella food poisoning	<i>Salmonella enteritidis</i>	Proper food-handling practices
Pneumonia	<i>Streptococcus pneumoniae</i>	Maintaining good health
Cholera	<i>Vibrio cholerae</i>	Clean water supplies

The Importance of the MICROBIOME by the Numbers



DNA Genetic Code of Life

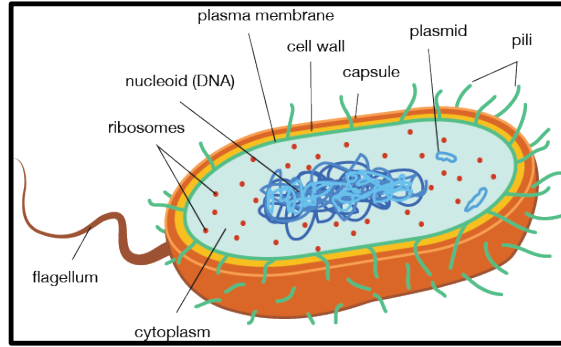
Entire Genetic Code of a Bacteria

DNA Fingerprinting

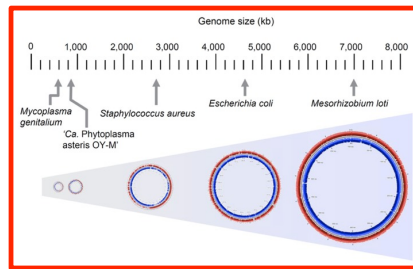
Cloning: Ethical Issues and Future Consequences

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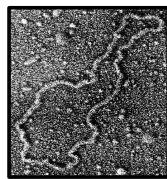
A Typical Bacterial Cell



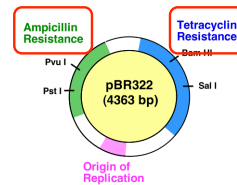
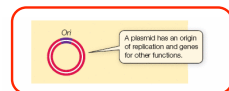
Bacterial Chromosomes Are Circular & Contain 500 to 7500 Genes



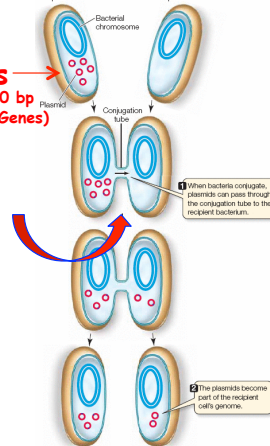
Bacteria Also Contain Plasmids - Circular Self-Replicating DNA Molecules - That Carry Antibiotic Resistance Genes



Plasmids
2,000 to 150,000 bp
(One to Several Genes)

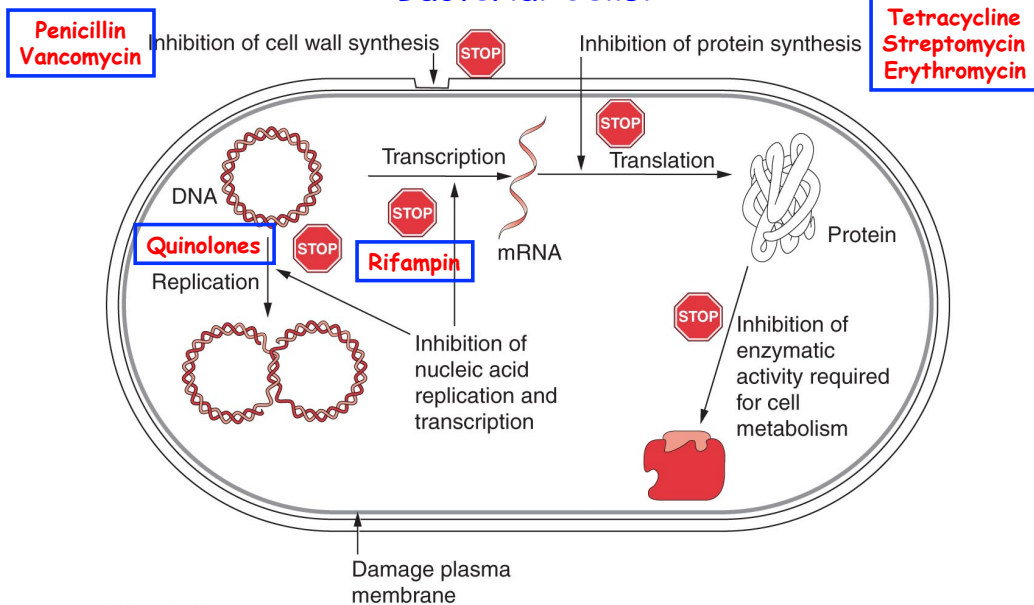


Small Plasmids Move From Cell to Cell Spreading Antibiotic Resistance Genes in Bacterial Populations!



Plasmids Defend Bacteria Against Antibiotics! (The "Workhorses" or Vectors for Genetic Engineering)

Microorganisms Produce Antibiotics To Protect Themselves Against Predators (Cellular "Warfare") - How Do Antibiotics Kill Bacterial Cells?



Plasmid Antibiotic Resistance Genes Allow Bacteria to "Fight Off" the Effects of Antibiotics & Select For Genetically Engineered Organisms!

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Genetic Code of Life

Entire Genetic Code
of a Bacteria

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and Future Consequences

Plants of Tomorrow

Restriction Enzymes Are Proteins That "Cut" DNA Into Pieces

"Killer" Virus

Enzymes?

1 A restriction enzyme cleaves the incoming phage DNA at restriction sites.

2 Other enzymes degrade the phage DNA into smaller fragments.

3 Methyl groups at the restriction sites block the restriction enzyme and protect the bacterial DNA from being cleaved.

Bacterial host cell

Host DNA

Herb Boyer

Restriction Enzymes Protect Bacteria From "Killer" Viruses!

DNA
Genetic Code of Life

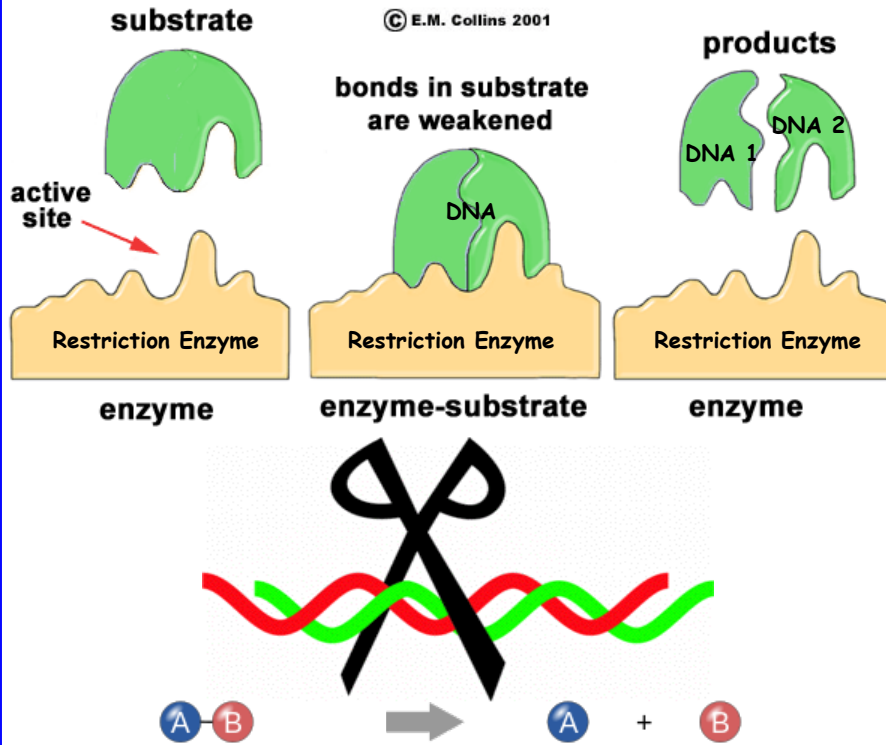
Entire Genetic Code of a Bacteria

DNA Fingerprinting

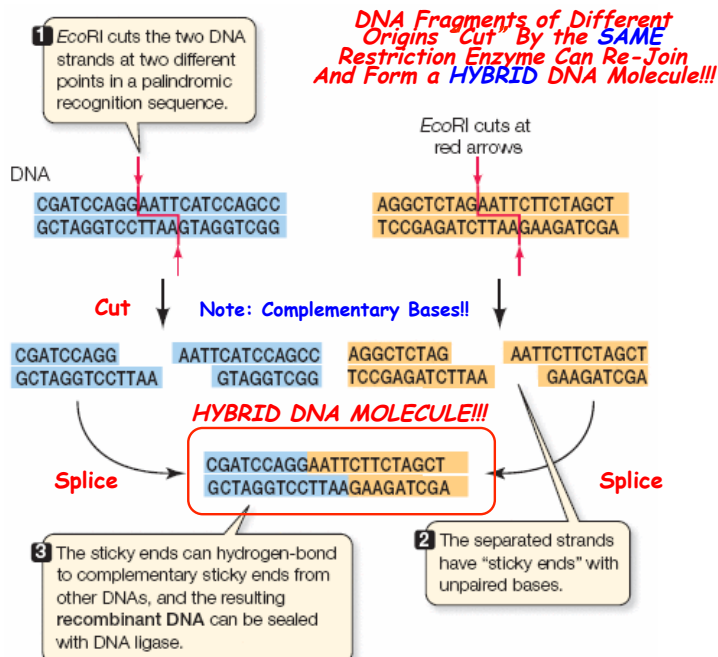
Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

Enzymes Are Proteins That Catalyze or Facilitate Chemical Reactions



Restriction Enzymes Are Proteins That "Cut" DNA Into Pieces At Specific Sequences



The "Scissors" For Genetic Engineering

DNA
Genetic Code of Life

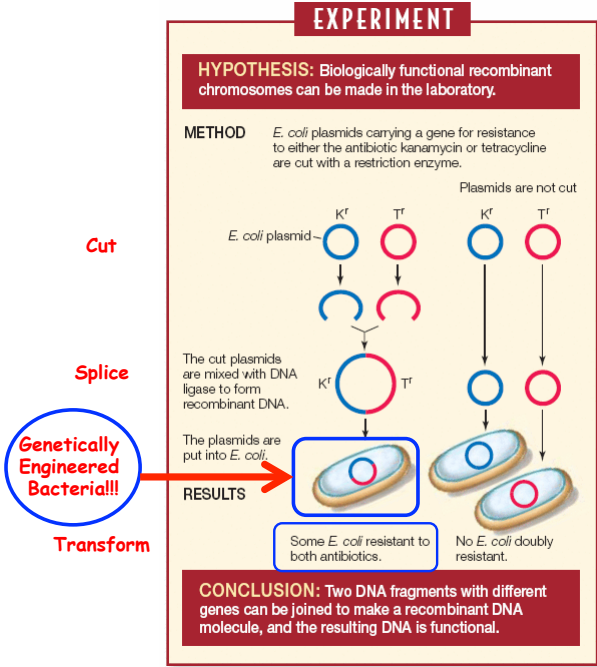
Entire Genetic Code of a Bacteria

DNA Fingerprinting

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

Genetic Engineering Technology Can Combine DNA (Genes) From Different Sources Leading to New Gene Combinations!!



Cohen-Boyer Experiment
One of Your Discussion Articles For Next Week

DNA
Genetic Code of Life

Entire Genetic Code of a Bacteria

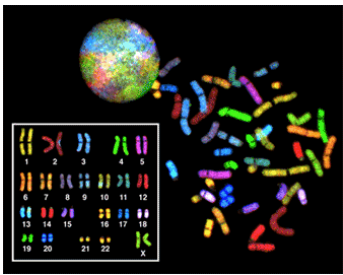
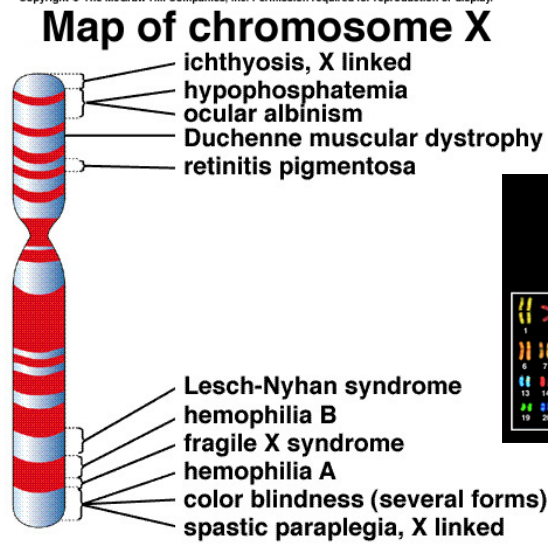
DNA Fingerprinting

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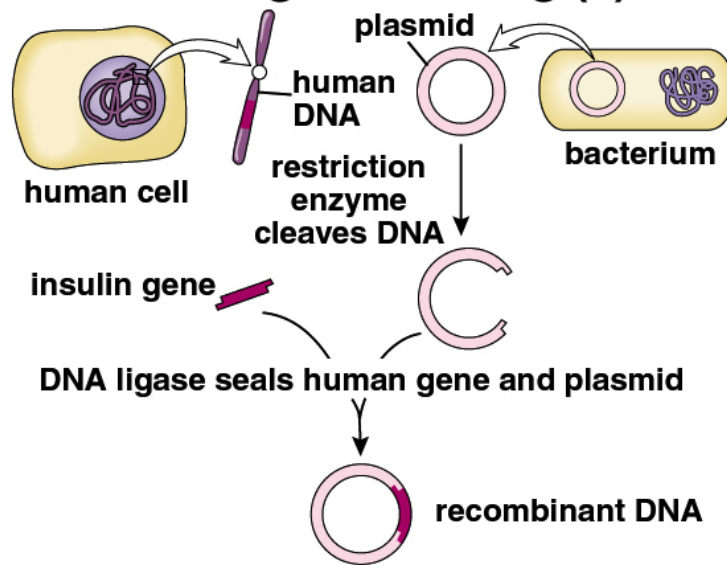
"Why" Clone Genes - Simply Put... Genomes & Chromosomes Contain Thousands of Genes

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How Can a Single Gene Be Studied?

For Example.... The Human Insulin Gene Can Be Separated From Other Human Genes and Transferred to a Bacterial Cell Using Recombinant DNA Methods!



And Used to Treat Diabetes!



-  DNA Genetic Code of Life
-  Entire Genetic Code of a Bacteria
-  DNA Fingerprinting
-  Cloning: Ethical Issues and Future Consequences
-  Plants of Tomorrow

Any Gene Can Be Isolated & Transferred to Any Organism Using Genetic Engineering!!

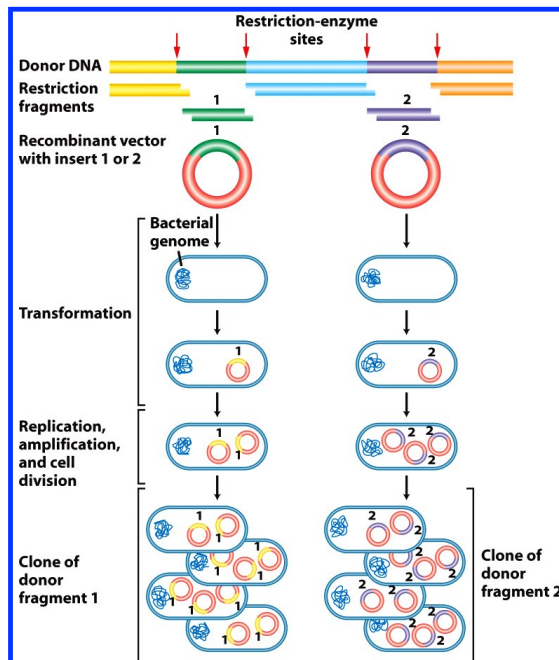


Figure 20-4
Introduction to Genetic Analysis, Ninth Edition
© 2008 W.H. Freeman and Company

“Why” Clone Genes From An Organism’s Genome? An Essential HC70A Concept!

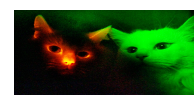
- 1. PURIFY Individual Genes From the Genome (e.g., One of 25,000 Human Genes)**
- 2. AMPLIFY The Gene to Obtain Enough DNA For Study**
- 3. Use the Cloned Gene To:**
 - a) Study Gene Structure & Function (THE Major Use!)
 - b) Use to Convert Cells Into Factories To Make Drugs and Pharmaceuticals
 - 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

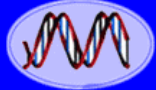
Genetic Engineering Has Lead to New Knowledge About How Cells and Genes Function and Has Lead to Applications That Have Improved Our Lives!!

Recombinant DNA Manipulation Means.....

- 1. Specific DNA/Genes Can Be Isolated From Any Organism**
- 2. DNA Segments of Any Kind From Any Organism Can Be Combined (Genetic Engineering!!!!!!)**
- 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!!

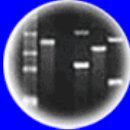




DNA
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Entire Genetic Code
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DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

Genetic Engineering.....

**Is the Most Revolutionary Technology in
Biology to Have Been
Invented in Human History!**

**Has Generated the Vast Majority of
New Biological Knowledge Over the
Past 40 Years From Experiments in
Biology Laboratories Around the Globe**

Has Changed Our Lives Dramatically!

AndHas 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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A Few Examples of 21st Century DNA Applications That Have Affected Society and Knowledge About Ourselves

Essential HC70A Concept: They Could Not Have Been Developed Without the Invention of Genetic Engineering!!!

Which You Will Learn the Basis of in HC70A!




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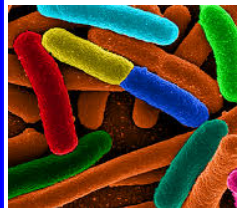


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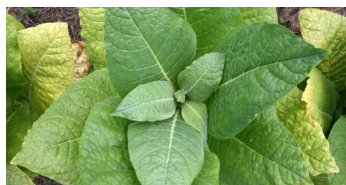
Genetic Engineering Has Been A Major Source of Drugs To Treat Human and Animal Diseases Over the Past 30 Years!



Bacteria



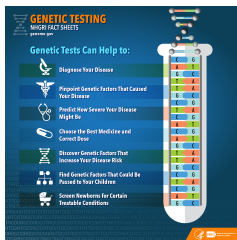
Crops



Livestock



DNA Can Be Used To Test For Hundreds of Disease Genes and Human Traits and Generate Personalized Gene Profiles



And Before Birth!!!



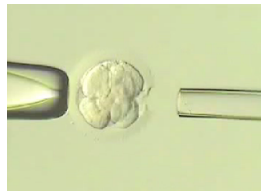
Made Possible Because of Genetic Engineering!

Determining the Genetic Identity of a Human Embryo Before Implantation!



Prenatal Genetic Diagnosis (PGD)

Fertility Clinics Scan for the Strongest Embryo



DNA Testing Into the Home - Fast & Inexpensive DNA Testing Kits!

MedicalLegalTesting.com
 Accurate DNA Identification Tests To Meet Requirements Of The Civil Court System
 (800) 456-9913

Paternity

DNA Tribes Genetic Ancestry Analysis
 What's Your Tribe?
 Discover your connections to over 695 world populations in 4 easy steps.

Ancestry



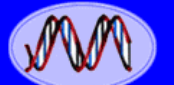
HOMEDNA Home | About | Products | Register Your Test Kit | FAQ | Contact | Results

The New Standard in Home DNA Testing

Featuring our exclusive HomeSuab™ 4-Step process

HomeDNA Home Paternity Testing System

Immigration



DNA Genetic Code of Life



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Cloning: Ethical Issues and Future Consequences



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....And Has Lead To a New Set of Ethical Issues & Controversies

F.D.A. Orders Genetic Testing Firm to Stop Selling DNA Analysis Service

Poking Holes in Genetic Privacy

I Had My DNA Picture Taken, With Varying Results

Why You Shouldn't Trust Newfangled Gene Tests

DIRECT-TO-CONSUMER GENETIC TESTS

Misleading Test Results Are Further Complicated by Deceptive Marketing and Other Questionable Practices

Contradictory Risk Predictions for Prostate Cancer and Hypertension

Gender	Age	Condition	Company 1	Company 2	Company 3	Company 4
Male	48	Prostate cancer	Average	Average	Below average	Above average
		Hypertension	Average	Below average	Above average	Not tested

Source: GAO.



.... And a Major New Report by The National Academy of Sciences



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Cloning: Ethical Issues and Future Consequences



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Your Complete Genome Can Now Be Decoded and Sequenced Very Inexpensively (\$1,000)!!

Genome of DNA Pioneer Is Deciphered

By NICHOLAS WADE
Published: May 31, 2007

DNA sequencer raises doctors' hopes for personalized medicine

The device could accelerate the use of genetic information in everyday medical care, physicians hope, improving diagnoses and treatments.

PRENATAL DIAGNOSIS ~10% of DNA in Maternal Plasma is From the Fetus

Maternal Plasma DNA Sequencing Reveals the Genome-Wide Genetic and Mutational Profile of the Fetus

Science Translational Medicine, December 8, 2010



\$4,998

/whole genome 30x

knomeDISCOVERY

Sequencing & in-depth interpretation

Genome-Wide Detection of Single-Nucleotide and Copy-Number Variations of a Single Human Cell

Science, December 20, 2012

The Era of Personalized Genomes is Here!



Genetic Engineering Has Led to the Era of Human Gene Engineering - Using Gene Therapy to Cure Lethal Genetic Diseases

In Girl's Last Hope, Altered Immune Cells Beat Leukemia

DNA-swap technology almost ready for fertility clinic

Gene therapy trial 'cures children'

Treatment for Blood Disease Is Gene Therapy Landmark

In A First, An Experimental Drug May Help Boys With Muscular Dystrophy

Immune systems of 'bubble babies' restored by gene therapy, UCLA researchers find

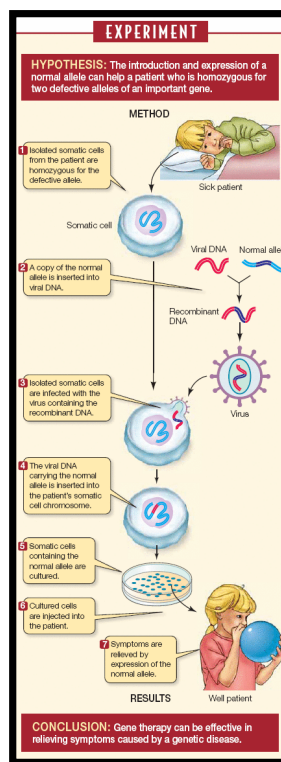
Humans Have Been Genetically Engineered To Cure a Lethal Genetic Disease (SCID) - Human GMOs!

Gene therapy cures 'bubble boy disease'

31 Jan 2009, 1128 hrs IST, AP

The Age of Human Genetic Engineering Began More Than Twenty Years Ago - SCID Treated With Normal ADA Gene!!!

Several People are Alive Because They Have Been Engineered With an ADA Gene



The new england journal of medicine

established in 1812 january 29, 2009 vol. 360 no. 5

Gene Therapy for Immunodeficiency Due to Adenosine Deaminase Deficiency

Gene Therapy with the Adenosine Deaminase (ADA) Gene





DNA
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DNA Fingerprinting



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The Era of Correcting, or Editing, Defective Genes in the Germline (e.g., Eggs) Has Arrived!!!!

This IS Human Genetic Engineering!




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DNA Fingerprinting



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and Future Consequences



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Don't edit the human germ line

Heritable human genetic modifications pose serious risks, and the therapeutic benefits are tenuous, warn Edward Lanphier, Fyodor Urnov and colleagues.

Scientists Seek Ban on Method of Editing the Human Genome

By NICHOLAS WADE MARCH 19, 2015

A group of leading biologists on Thursday called for a worldwide moratorium on use of a new genome-editing technique that would alter human DNA in a way that can be inherited.



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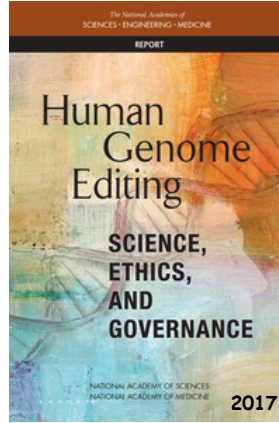
DNA Fingerprinting



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National Academy of Sciences Recommendation!!!!!!

With Stringent Oversight, Heritable Germline Editing Clinical Trials Could One Day Be Permitted for Serious Conditions; Non-Heritable Clinical Trials Should Be Limited to Treating or Preventing Disease or Disability at This Time



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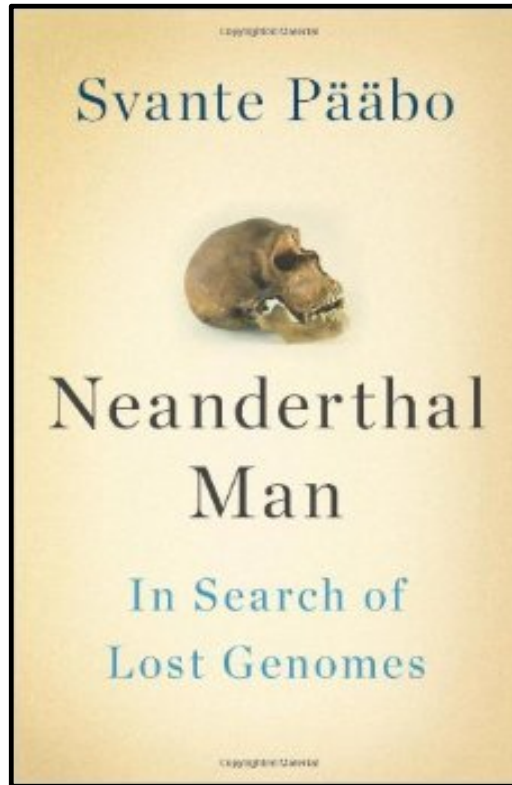
**DNA Can Be Used To Look
Into The Past and Bring
Back the Dead!!**

**Ancient DNA & Technology
Based On Genetic Engineering**



**An Exciting
Field Called
Ancient DNA**

An Excellent Book About "Inventing" the Field of Ancient DNA & the Evolution of Humans

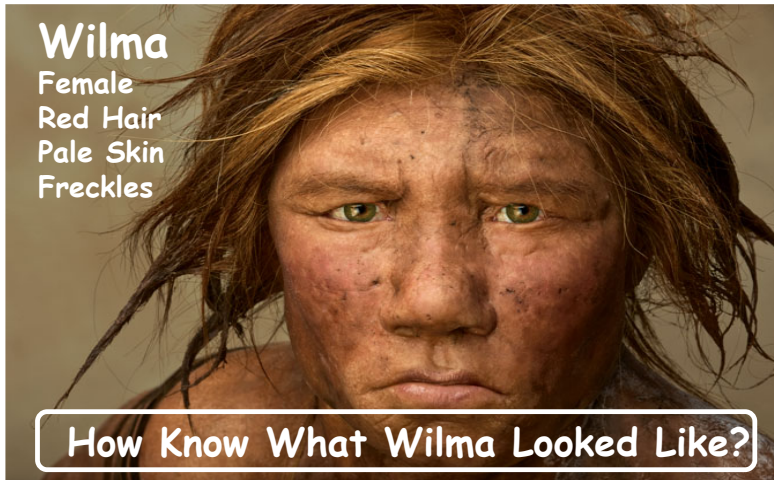


RESEARCH ARTICLE

Science, May 7, 2010 (328, 710-722)

A Draft Sequence of the Neanderthal Genome From a 45,000 Year-Old Bone!

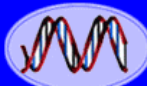
Wilma
Female
Red Hair
Pale Skin
Freckles




How Know What Wilma Looked Like?

Reconstruction by Kennis & Kennis / Photograph by Joe McNally

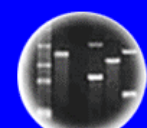
For the first time, a Neanderthal female peers from the past in a reconstruction informed by both fossil anatomy and ancient DNA. At least some of her kind carried a gene for red hair and pale skin.




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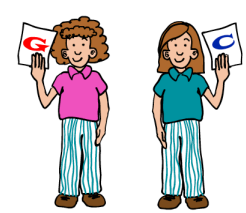


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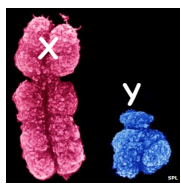
DNA Sequences Can Be Used To Specify Eye Color....



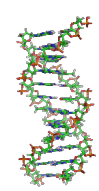
A A T G G T



...As Well As Gender & Several Physical Features



Yo.....It's In the DNA!



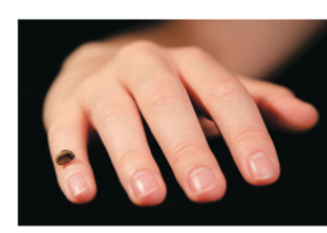
Science, October 12, 2012 (338,222-226)

ANCIENT DNA

A Crystal-Clear View Of an Extinct Girl's Genome

COMPLETE DNA Sequence From 40,000 Year Old Fossil DNA With Accuracy of Sequencing Our Own Genome!!

Had 23 Chromosomes Like "Us" and Split From Human Line Between 150k and 700k Years Ago



Slice of life. This replica of a tiny finger bone from Denisova Cave (right) yielded an entire genome.

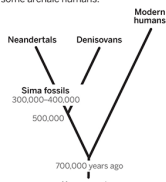
New DNA Analysis Shows Ancient Humans Interbred with Denisovans

Can Demonstrate Interbreeding of Ancient Humans!

A new high-coverage DNA sequencing method reconstructs the full genome of Denisovans--relatives to both Neandertals and humans--from genetic fragments in a single finger bone

Using Ancient DNA to Unravel Human History

Deeper branches
Putting the Sima fossils on the Neanderthal lineage implies an earlier split between modern and some archaic humans.



The Shaping of Modern Human Immune Systems by Multiregional Admixture with Archaic Humans

www.sciencemag.org SCIENCE VOL 334 7 OCTOBER 2011

Comparing 40,000 Year-Old Fossil Genomes to Our Genome Reveals Ancient "Matings" Between Different Human Ancestor Lineages!!



We Have Neanderthal & Denisovan Genes in Our Chromosomes

It's All in the DNA! Nature Reviews | Genetics September, 2011

23andMe

I Have ~3% Neanderthal DNA in My Genome - A Relic of Ancient Migration and Mating Tens of Thousand of Years Ago!

23andMe

How Did I Learn That?

This lab estimates your genome-wide percentage of Neanderthal ancestry

Got Neanderthal DNA?

Your Neanderthal DNA might actually be doing you some good

An estimated 2.6% of your DNA is from Neanderthals.

Bob Goldberg (you)



2.6%

33rd percentile

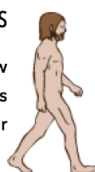
Average European user



2.7%

MODERN HUMANS

Higher brow
Narrower shoulders
Slightly taller



NEANDERTHALS

Heavy eyebrow ridge
Long, low, bigger skull
Prominent nose with developed nasal chambers for cold-air protection



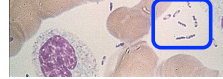
Without Genetic Engineering and DNA Sequencing Technologies This Could Not Have Been Done



A draft genome of *Yersinia pestis* from victims of the Black Death *The Power of DNA and Genetic Engineering!*

Kirsten I. Bos^{1*}, Verena J. Schuenemann^{2*}, G. Brian Golding³, Hernán A. Burbano⁴, Nicholas Waglechner⁵, Brian K. Coombes⁵, Joseph B. McPhee⁵, Sharon N. DeWitte^{6,7}, Matthias Meyer⁴, Sarah Schmedes⁸, James Wood⁹, David J. D. Earn^{5,10}, D. Ann Herring¹¹, Peter Bauer¹², Hendrik N. Poinar^{1,3,5} & Johannes Krause^{2,12}

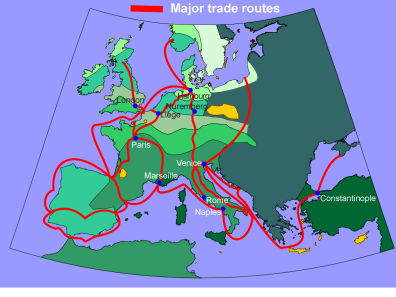
1347-1351



Rat Blood

The Spread of the Black Death

December 1347	June 1349	December 1350
June 1348	December 1349	After 1351
December 1348	June 1350	Areas partially or totally spared



- Killed 30% of Europe's Population
- Killed 100M People in Four Years!
- Population of 450M to 350M
- Took 150 Years to Recover



Think About Bringing a Woolly Mammoth Back to Life!!

Nature, November 2008

Sequencing the nuclear genome of the extinct woolly mammoth

Webb Miller¹, Daniela I. Drautz¹, Aakrosh Ratan¹, Barbara Pusey¹, Ji Qi¹, Arthur M. Lesk¹, Lynn P. Tomsho¹, Michael D. Packard¹, Fangqing Zhao¹, Andrei Sher^{2,3}, Alexei Tikhonov¹, Brian Raney⁴, Nick Patterson⁵, Kerstin Lindblad-Toh⁶, Eric S. Lander³, James R. Knight⁶, Gerard P. Irzyk⁶, Karin M. Fredrikson⁷, Timothy T. Harkins⁷, Sharon Sheridan⁷, Tom Pringle⁸ & Stephan C. Schuster¹

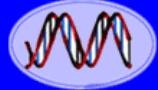


Woolly Mammoth DNA Mutations Piled Up Pre-Extinction

By Gemma Tarlach | March 2, 2017 1:00 pm



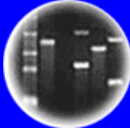
Mammoths are on the march... to their doom? — In this artwork based from the American Museum of Natural History in New York, Credit: Charles R. Knight/AMNH.



DNA Genetic Code of Life



Entire Genetic Code of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



Plants of Tomorrow

Scientific American, August, 2012

EVOLUTIONARY BIOLOGY

New Life for Ancient DNA

Biotechnology reveals how the woolly mammoth survived the cold and other mysteries of extinct creatures
By Kevin L. Campbell and Michael Hofreiter

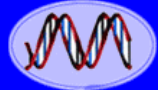
Bring a Mammoth Back to Life? It Could Be Possible Using Genetic Engineering & Cloning

HOW IT WORKS

Breathing Life into Mammoths

By reconstructing ancient genes, scientists can re-create the proteins they encoded and observe how they behave, thereby gaining insights into the physiology of extinct animals. For instance, resurrection of the red blood cell protein hemoglobin from a woolly mammoth (below) has shown that the temperature-sensitive protein evolved adaptations that enabled it to do its job of delivering oxygen to body tissues in the cold conditions these beasts faced.

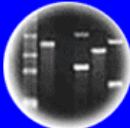
- 1 Sequence the gene fragments that encode the hemoglobin protein
- 2 Re-create functional mammoth hemoglobin genes by taking the intact corresponding genes in an Asian elephant and altering their sequences in three spots to match the mammoth sequences



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The Age of Resurrecting Extinct Animals Is Not Far Away!

Resurrecting the mammoth

Japanese researchers are hoping to clone a mammoth back to life from a frozen carcass

- 1 Preserved cells extracted from frozen mammoth carcass
- 2 Nuclei extracted from mammoth cell
- 3 Egg cells taken from elephant, DNA material is removed
- 4 Mammoth genes are placed inside elephant egg cells
- 5 Egg is placed in elephant womb
- 6 Elephant gives birth to live mammoth, effectively a clone of the frozen carcass that yielded undamaged cells

AFP

Is It Ethical To Bring Back the Dead?



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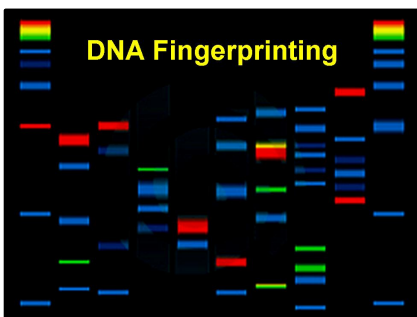


Cloning: Ethical Issues
and Future Consequences



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DNA Can Be Used To Identify Individuals For Paternity, Ancestry, Forensics, Crimes, and Much More...

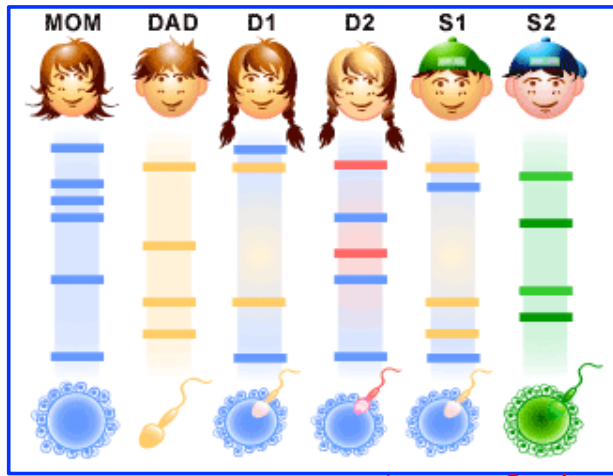


Based on Genetic Engineering

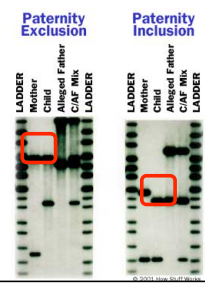
Using DNA Fingerprints to Identify Individuals & Genes They Don't "Lie"

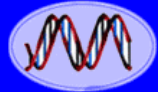
DNA Fingerprints

Sometimes They Reveal Unexpected Results!



What is YOUR DNA Fingerprint?

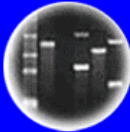




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DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



Plants of Tomorrow

DNA Can Also Be Used To Uncover Consumer Fraud

May 26, 2011

Tests Reveal Mislabeling of Fish

By ELISABETH ROSENTHAL

Scientists aiming their gene sequencers at commercial seafood are discovering rampant labeling fraud in supermarket coolers and restaurant tables: cheap fish is often substituted for expensive fillets, and overfished species are passed off as fish whose numbers are plentiful.



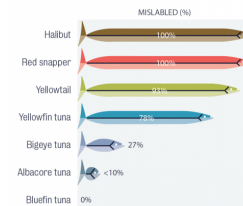
Herbal supplements fail DNA test in New York investigation of store brands

Just 21% of test results verified that DNA from plants listed on labels were what was inside, with only 4% of Walmart products passing test



HIGH RATES OF MISLABELING IN LA SUSHI RESTAURANTS

UCLA researchers used DNA barcoding to assess seafood served in Los Angeles restaurants from 2010 to 2010. They found 41 percent of fish had been mislabeled overall. However, mislabeling was inconsistent across different fish species, as shown below.



SOURCE: Daniel A. Whitte, et al., UCLA Department of Ecology and Evolutionary Biology. Graphic reporting by Sarah Chen, Science and Health editor. Graphic by Jason Forester, Daily Brain Trust.



Also Identify Victims of 9/11 And Other Tragedies by DNA Fingerprinting

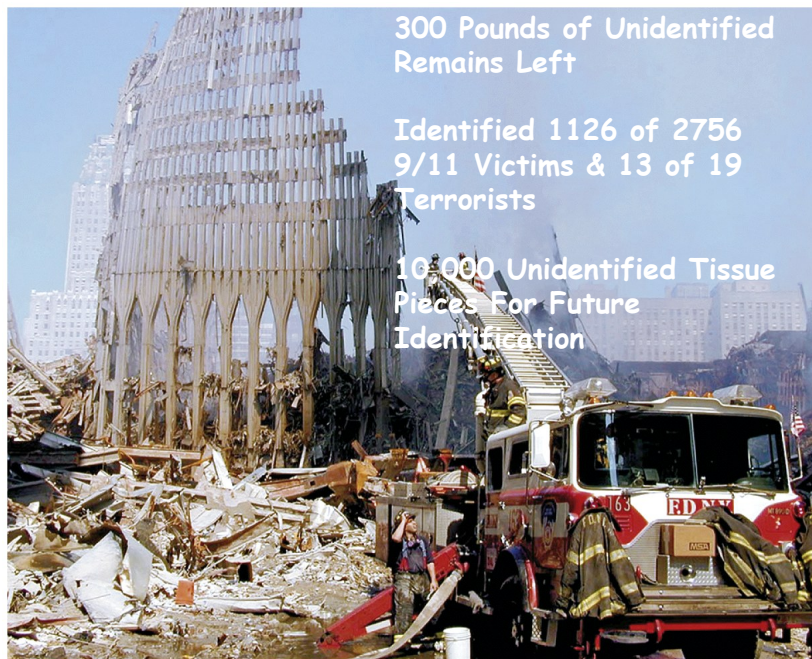


Figure 19-31 Genetics: A Conceptual Approach, Third Edition © 2009 W. H. Freeman and Company

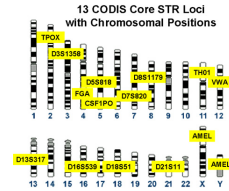
Newsweek, January 12, 2009

DNA Has Impacted the Law in Dramatic Ways

Combined DNA Index System (CODIS) of DNA Profiles

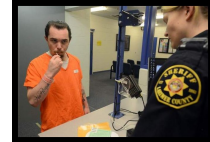


- Convicted Felons
- Suspects Arrested For Felonies
- DNA Samples From Crime Scenes
- Unidentified Human Remains
- Relatives of Missing Persons



January 2017

Offender Profiles	12,732,925	King vs. Maryland SCOTUS 4th Amendment Case
Arrestee Profiles	2,608,768	
Forensic Profiles	752,508	
Database "Hits"	362,144 assisting 347,240 investigations	



FORENSICS

Familial DNA Testing Scores A Win in Serial Killer Case



Proud of their work. A familial DNA search by forensic scientists in California led to the arrest of Lonnie Franklin, the suspected Grim Sleeper killer.

Grim Sleeper Caught By DNA!!

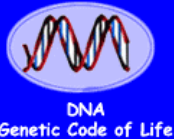
Others Set Free By DNA Evidence

INNOCENCE PROJECT



15th Person Cleared by DNA in Dallas. Charles Chatman was released from state custody Jan. 3 in Dallas, after serving nearly 27 years in prison for a rape he didn't commit. He is the 15th Dallas man to be cleared by DNA testing after being wrongfully convicted. After his hearing, he hugged Judge John Creuzot, who advocated for testing in the case. Innocence Project of Texas Attorney Jeff Blackburn (left) represents Chatman.

- 281 Post-Conviction DNA Exonerations Since 1989
- 17 of 281 People Exonerated Were on Death Row
- Average Time Served Was 13 Years
- Average Age at Time of Wrongful Conviction Was 27
- **75% of Wrongful Convictions Due to Eyewitness Misidentification**
- 50% of Wrongful Convictions Due to Improper Forensic Science, Such As Hair Sample, Shoe Print, & Bite Mark Comparisons



DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting



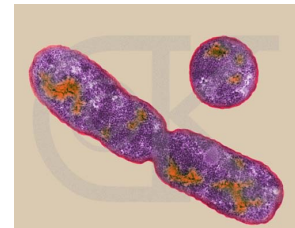
Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

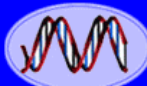


Synthetic Genomes &
Chromosomes
40 Years After the
Invention of Genetic
Engineering



Finally... We Have Entered a
New Era of Genetic Engineering
The Era of Synthetic Biology

Genetic Engineering Can Be Used To
Synthesize and Engineer Entire
Chromosomes From Chemicals and
Create Synthetic Microbes in a
Test Tube



DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting




Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

A Yeast Cell With Chromosomes Synthesized in the Laboratory From A, G, C, & T DNA Bases !!!!





2 JULY 2010 VOL 329 SCIENCE www.sciencemag.org

Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome

May 20, 2010

Researchers Say They Created a 'Synthetic Cell'

By NICHOLAS WADE

The genome pioneer J. Craig Venter has taken another step in his quest to create synthetic life, by synthesizing an

July 14, 2011

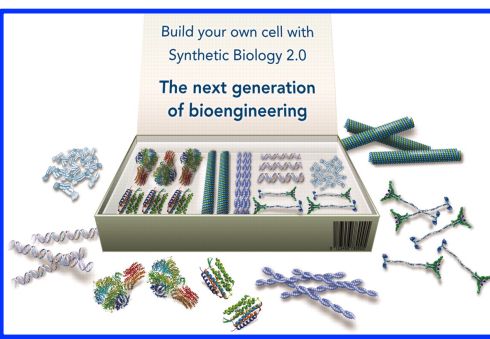
Genetic Code of E. Coli Is Hijacked by Biologists

By NICHOLAS WADE

Science, July 15, 2011

Build your own cell with
Synthetic Biology 2.0

The next generation
of bioengineering




Synthetic Generation of Influenza Vaccine Viruses
for Rapid Response to Pandemics

Sci. Transl. Med., May
15, 2013.

Think of the Possibilities.....

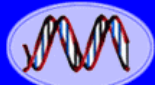
George Church: De-Extinction Is a Good Idea

Reviving mammoths and other extinct creatures is a good idea



Creating Life: Synthetic Microbes J. Craig Venter

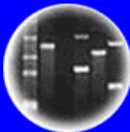
60 Minutes-December 2010



DNA
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Entire Genetic Code
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DNA Fingerprinting

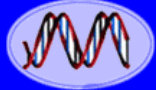


Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

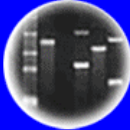
Stop Part One!!



DNA
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DNA Fingerprinting



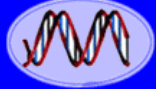
Cloning: Ethical Issues
and Future Consequences



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HC70A Spring 2017 Genetic Engineering in Medicine, Agriculture, and Law Professor Bob Goldberg

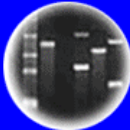
Class Announcements 4/4/17



DNA
Genetic Code of Life



Entire Genetic Code
of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



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HC70A Spring 2017 (UCLA) Genetic Engineering in Medicine, Agriculture, and Law

Discussion Coordinator

William Barshop

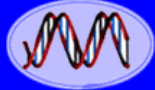
Undergraduate Assistants

Helen Li

Pierce Ford

Course Administrator

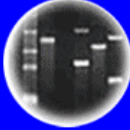
Lauren Bowman



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DNA Fingerprinting



Cloning: Ethical Issues
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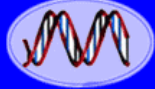
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SAS70A Spring 2017 (UC Davis) Genetic Engineering in Medicine, Agriculture, and Law

UC Davis
Professor John Harada

Teaching Assistant
Leonardo Jo

UC DAVIS
UNIVERSITY OF CALIFORNIA



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of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues
and Future Consequences



Plants of Tomorrow

Discussion Tomorrow

- Your Perceptions of Genetic Engineering & Its Applications
- **Fill Out Survey Handed Out at the End of Class & Hand In Tomorrow in Discussion**
- Be Prepared For a Lively Discussion