




DNA Genetic Code of Life




Entire Genetic Code of a Bacteria



DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences







Plants of Tomorrow

HC70A, PLSS530, & SAS70A
Winter 2013
Genetic Engineering in Medicine, Agriculture, and Law

Professors Bob Goldberg, Channapatna Prakash, & John Harada

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


Please Turn Off Your Cell Phones!


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
Cloning: Ethical Issues and Future Consequences




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THEMES


1. The Age of DNA, Genomics, Genetic Engineering & Synthetic Organisms
2. Is DNA Part of Our Culture - Some Examples
3. What Do Genes Look Like - DNA Demonstration
4. How Was Modern Genetic Engineering Invented & What Is the Genetic Engineering Process?
5. Why Use Genetic Engineering?
6. How Has Genetic Engineering Affected Our Lives?
7. How Has Genetic Engineering Created New Ethical and Legal Issues?




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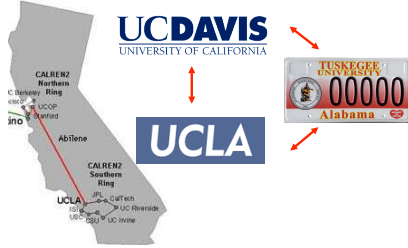


Cloning: Ethical Issues and Future Consequences



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The Long Distance Connection!
HC70A, SAS70A, & PLSS530
Winter 2013




UC DAVIS
 UNIVERSITY OF CALIFORNIA


UCLA

TUSKEGEE UNIVERSITY
 Alabama


A Model For Cross-Campus Interactive Learning




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Genetic Engineering and DNA in the News...

November 9, 2012
In Girl's Last Hope, Altered Immune Cells Beat Leukemia

NATURE | NEWS
 DNA-swap technology almost ready for fertility clinic
 Blood-donor transfer could reduce the risk of childhood disease.

AUGUST 2, 2012 | BY HANNI FAKHOURY
Court Battles Over Warrantless DNA Collection Heating Up

FDA expected to approve Genetically Modified Salmon ..and Politics
 ADVANTAGE SALMON | JANUARY 3, 2013 | BY MARK WACHTEL | Subscribe

NOVEMBER 7, 2012, 9:21 AM
California Votes No on 37: Flawed Proposition on Food Labeling

DNA is Part of Our Culture!!



"It's In Our DNA!"



Not Surprising Because We Live in The Age of DNA!




Genetic Engineering Is Manipulating DNA!



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






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What Do Your DNA Look Like?


Have You Ever Seen or Touched Your Genes or DNA?


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DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



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We Live in the Era of....

- Genes & DNA
- Genomics & Whole Genome Sequencing
- Genetic Engineering of Microbes, Plants, & Animals
- A \$200B Medical and Agricultural Biotechnology Industry Using Genetic Engineering Technology and Proprietary Gene Patents, and Processes
- Synthetic Microbes Made Using Genetic Engineering by Man
- Personalized Genomes and Ability to Identify Any Individual or Disease Using DNA
- Stem Cells, Mammalian Reproduction, & Cloning


And the **INTEGRATION** of These Technologies!!




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DNA Fingerprinting



Cloning: Ethical Issues and Future Consequences



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This Is the 40th Anniversary of Genetic Engineering's Invention

Proc. Nat. Acad. Sci. USA
Vol. 26, No. 11, pp. 3240-3244 November 1973

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 16, 1973

It is Not a New Technology...In Fact, 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




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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!



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Plants of Tomorrow

- From New Medicines
- To Understanding the Basis of Human Disease and Providing Novel Treatments
- To Personalized Genomes and Medicine Geared To Specific Individuals
- To Novel Ways To Identify Individuals
- To More Sustainable Crops
- To Creating Synthetic Organisms For Industrial Purposes
- To the Sequence of the Human Genome & 50,000 Year-Old Fossil Genomes
- To Unraveling the Mysteries of ALL Cellular Processes!
- To Ultimately - Immortality?



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We Are Now in 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

Genetic Engineering 2.0
40 Years After the Invention of Genetic Engineering



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 a

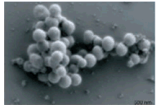

May 15, 2011

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


Genetic Engineering 2.0


Creating Life: Synthetic Microbes

J. Craig Venter


60 Minutes-December 2010




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Question One

Are You Uncomfortable With Creating Microbes With Synthetic Genomes?


a. Yes
b. No




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Cloning: Ethical Issues and Future Consequences



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Question Two

Are You Uncomfortable With Genetic Engineering?


a. Yes
b. No



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



RESEARCH ARTICLE


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

A Draft Sequence of the Neandertal Genome

From a 45,000 Year-Old Bone

Wilma

Female
Red Hair
Pale Skin
Freckles




How Know What Wilma Looked Like?


Reconstruction by Hennis & Koenig; Photograph by Joe Nickols

For the first time, a Neandertal female genome from the past is 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.

DNA Sequences Can Be Used To Specify Eye Color



AAATGGT



Yo...It's In the DNA!

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Plants of Tomorrow


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

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

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

Nature, October 27, 2011

LETTER Ancient DNA Can Be Studied to Find the Source of Major Epidemics From 100s of Years Ago!

doi:10.1038/nature10549

A draft genome of *Yersinia pestis* from victims of the Black Death

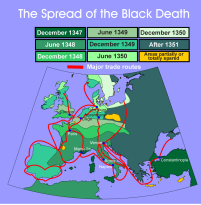
The Power of DNA and Genetic Engineering!

Kirsten I. Bos¹, Verena J. Schuenemann^{2*}, G. Brian Golding³, Hernán A. Burbano⁴, Nicholas Waglechner⁵, Brian K. Coombes⁶, Joseph B. McPhee⁷, Sharon N. DeWitte^{6,7}, Matthias Meyer⁸, Sarah Schmedes⁹, James Wood⁶, David J. D. Earn^{3,10}, D. Ann Herrig¹¹, Peter Bauer¹², Hendrik N. Poinar^{1,13} & Johannes Krause^{1,12}



1347-1351

The Spread of the Black Death

December 1347	June 1348	December 1350
Spain 1348	Germany 1349	Italy 1350
December 1348	June 1350	March 1351



Rat Blood


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

Scientific American, August, 2012

New Life for Ancient DNA

Bring a Mammoth Back to Life?

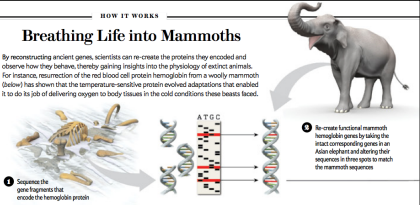
Biotechnology reveals how the woolly mammoths survived the cold and other mysteries of extinct creatures

By Kevin L. Campbell and Michael Hoffner

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 (left) 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 Sequences the gene fragments that encode the hemoglobin protein

2 Re-creates functional mammoth hemoglobin genes by joining the exact corresponding genes in an Abopeptide and identifying their sequences in three spots to match the mammoth sequences

Vol 456 | 20 November 2008 | doi:10.1038/nature07446

nature


Nature, November 2008

LETTERS

Sequencing the nuclear genome of the extinct woolly mammoth

Think About Bringing a Woolly Mammoth Back to Life!

Webb Miller¹, Daniela I. Drautz¹, Aakrosh Ratan¹, Barbara Pusey¹, Ji Qi¹, Arthur M. Lesk¹, Lynn P. Tomsho¹, Michael D. Packard¹, Fangqing Zhao¹, Andrei Sher¹, Alexei Tikhonov¹, Brian Raney¹, Nick Patterson¹, Kerstin Lindblad-Toh², Eric S. Lander³, James R. Knight⁴, Gerard P. Izzyk⁴, Karin M. Fredrikson¹, Timothy T. Harkins¹, Sharon Sheridan¹, Tom Pringle⁵ & Stephan C. Schuster¹




Fossil Hair For DNA 200,000 Years Old

Cloning an Animal - Now Routine!

Donor Nucleus
A donor cell is taken from a sheep's udder. These two cells are fused using an electric shock.

Egg Cell
The nucleus of the egg cell is removed. An egg cell is taken from an adult female sheep. The fused cell begins dividing normally.

Embryo
The embryo is placed in the uterus of a foster mother.

Cloned Lamb
The embryo develops normally into a lamb—Baby.

Bring Back the Dead?

Left sidebar:
 DNA Genetic Code of Life
 Entire Genetic Code of a Bacterium
 DNA Fingerprinting
 Cloning: Ethical Issues and Future Consequences
 Plants of Tomorrow

PNAS November 11, 2008

Production of healthy cloned mice from bodies frozen at -20°C for 16 years *Think of the possibilities!*

Sayaka Wakayama*, Hiroshi Ohta*, Takafusa Hikiuchi*, Eiji Mizutani*, Takamasa Iwaku*, Osami Kanagawa*, and Teruhiko Wakayama*
*RIKEN Center for Developmental Biology, 2-23-3 Matsuyama-4-chome, Kobe, 650-8047, Japan; *Yokai University School of Medicine, Tokyo 108-8441, Japan; and *RIKEN Research Center for Allergy and Immunology, 1-3-22, Yatsushiro-cho, Tsuyama-shi, Yamaguchi, 739-0262, Japan

How Know a Clone or Genetically Identical Individual - DNA!

Clone of Dead Mouse

Frozen Dead Mouse

Survival Rates:
 Genotype: 12, 8, 4, 0
 Survival: 100%, 100%, 100%, 100%

Resurrecting the Extinct

60 Minutes, January, 2010

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

DNA Fingerprinting

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Using DNA Fingerprints to Identify Individuals & Genes

RESEARCH METHOD

1. A white A restriction enzyme cuts the DNA fragment in two at its recognition sequence.

2. A white B restriction enzyme cuts the DNA fragment in two at its recognition sequence.

3. The fragments are separated by gel electrophoresis.

4. The fragments are stained with ethidium bromide and viewed under UV light.

5. The gel shows the DNA patterns of the members of the family.

What is YOUR DNA Fingerprint?

Left sidebar:
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Lineages of Ancient Mummies Such As King Tut Can Be Determined Using DNA Fingerprinting!

Genealogical Chart:
 GREAT GRANDPARENTS: Tutankhamun (1323-1325), Amenhotep III (1370-1390)
 GRANDPARENTS: Tutankhamun (1323-1325), Amenhotep III (1370-1390)
 PARENTS: Tutankhamun (1323-1325), Amenhotep III (1370-1390)
 KING TUT AND WIFE: Tutankhamun (1323-1325), Neferiti (1323-1325)
 CHILDREN: Tutankhamun (1323-1325), Amenhotep III (1370-1390)

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DNA Fingerprints Used to Verify Remains of Russian Royal Family

	Number of repeats
STR-1	15, 16, 15, 16
STR-2	8, 8, 7, 10
STR-3	3, 5, 7, 7
STR-4	12, 13, 12, 12
STR-5	32, 36, 11, 32

Tsarina Alexandra Tsar Nicholas II

Genomic identification in the historical case of the Nicholas II royal family **PNAS, March, 2009**

Mystery solved: The Identification of the Two Missing Romanov Children Using DNA Analysis **PLOS, March, 2009**

DNA Can Also Be Used To Uncover Consumer Fraud and Identify Poached Wildlife

Tests Reveal Mislabeling of Fish
By ELIZABETH 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.

\$11,250 IN FINES FOR ILLEGAL MOOSE HUNT AND COVER UP
November 16, 2010

Four western Ontario men have been convicted of charges related to illegal moose hunting.

André Gauthier Jr. and André Gauthier Sr., both of Châteauguay, a municipality of Cardinal and Steeve B. Krizek of St. George, were each fined \$1,000 for obstructing a Ministry of Natural Resources conservation officer and Gauthier Sr. and Krizek were each fined \$500 for illegally processing a moose. Gauthier Sr. was also fined \$200 for illegally processing a wolf pelt, \$1,200 for having one moose without a license and \$500 for failing to immediately attach a game tag to a harvested animal. Gauthier Sr. was fined \$500 for only a hunting license but no moose to consume also.

DNA Fingerprints Can Also Be Used To Trace the Source of Illegal Drugs

U.S. JUSTICE DEPARTMENT
DRUG ENFORCEMENT ADMINISTRATION

Identifying Victims of 9/11 by DNA Fingerprinting

300 Pounds of Unidentified Remains Left

Identified 1126 of 2756 9/11 Victims

8 of 19 Terrorists

Newsweek, January 12, 2009

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? **Ancestry**
Discover your connections to over 695 world populations in 4 easy steps

23andMe
NAVIGENICS
IDENTIGENE
HOMEDNA
The New Standard in Home DNA Testing
HomeDNA Home Paternity Testing System **Immigration**

DNA Has Impacted the Law in Dramatic Ways

Combined DNA Index System of DNA Profiles

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

NDIS Statistics
National DNA Index System
| CODIS Home Page | FBI Home Page |

November 2012

Offender Profiles 10,043,800
Arrestee Profiles 1,307,300
Forensic Profiles 461,390
Database "Hits" 195,600 assisting 187,700 investigations

What Are State Laws?
California Proposition 69

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!!

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

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Plants of Tomorrow

Question Three

Should every individual who is arrested for a crime be required to have their DNA fingerprinted and deposited in a National Criminal DNA database (CODIS)?

- Yes
- No

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Entire Genetic Code of a Bacteria

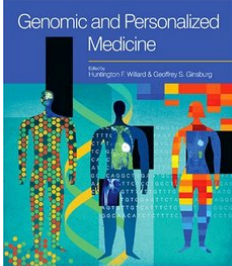

DNA Fingerprinting

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DNA Is Leading to a New Era in Personalized Medicine

Genomic and Personalized Medicine





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

What Are the Problems & Laws That Govern Direct To Consumer DNA Tests?

23andMe

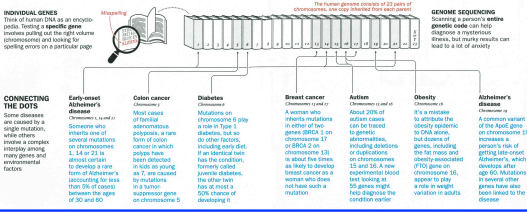
And Before Birth!!!



NEW genetic tests can point to risks—but not always sure

Decoding Disease

Genetic testing can detect more than 2,000 medical conditions for the same \$500 or so. Scientists have the ability to search all 21,000 or so genes at once for mutations that could increase the risk of disease. The price for this is \$2500 and rising fast.



CONNECTING THE DOTS
Some diseases are caused by a single mutation, while others involve a complex interplay among many genes and environmental factors.

- Early-onset Alzheimer's disease:** Chromosomes 1 and 7. Someone who inherits one of several mutations on chromosome 14, or a mutation on chromosome 7, are caused by mutations in a tumor suppressor gene on chromosome 17, and 21.
- Colon cancer:** Most cases of colorectal adenocarcinoma, a form of cancer in which cells have been mutated in an ongoing manner.
- Diabetes:** Mutations on chromosome 6 play a role in Type 1 diabetes, but an as yet unknown mutation, including one on chromosome 11, has the condition. Family history, juvenile diabetes, the other form of diabetes, and the other form of diabetes, which has been linked to a mutation on chromosome 6.
- Breast cancer:** Chromosomes 1 and 17. A mutation in either of two genes, BRCA 1 or BRCA 2 on chromosome 17, or mutations on chromosomes 13, 17, and 22, is about five times as likely to develop as the other form of breast cancer.
- Asthma:** Chromosomes 1 and 2. About 25% of asthma cases can be traced to genetic mutations, including mutations on chromosomes 13, 15, and 16. A new mutation on chromosome 16, which appears to play a role in asthma, has been linked to the disease.
- Obesity:** Chromosome 2. It's a mutation that affects the ability of the body to burn energy. It increases a person's risk of getting sick with Alzheimer's, which is linked to the gene.
- Alzheimer's disease:** Chromosome 21. A mutation on chromosome 21, which appears to play a role in Alzheimer's, has been linked to the disease.

GENOME SEQUENCING
Sequencing a person's entire genetic code can help diagnose a mysterious illness, but many results can lead to a lot of anxiety.

Made Possible Because of Genetic Engineering...

Walmart Personalized DNA Test!



Disease Genes

What are the Scientific, Legal, Ethical, & Privacy Issues??

Vertical Sidebar:

- DNA Genetic Code of Life
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Your Complete Genome Can Now Be Decoded and Sequenced Very Inexpensively (\$5,000)!!

Genome of DNA Pioneer Is Deciphered
By NICHOLAS WADE
Published: May 31, 2007

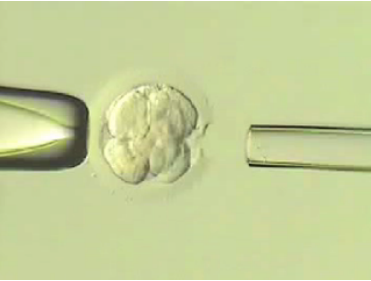
PRENATAL DIAGNOSIS ~10% of DNA in Maternal Plasma is From the Fetus
Maternal Plasma DNA Sequencing Reveals the Genome-Wide Genetic and Mutational Profile of the Fetus
Science Translational Medicine, December 8, 2010

knomeDISCOVERY
\$4,998 /whole genome 30x
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!

Determining the Genetic Identity of a Human Embryo Before Implantation!



Prenatal Genetic Diagnosis (PGD)

Your Complete Genome Can Now Be Decoded and Sequenced For \$1,000!

Science Moves At Warp Speed

"Scientists Always Overestimate What Can Be Done in a Short Time and Always Underestimate What Can Be Done Over Longer Periods of Time!"

THE WALL STREET JOURNAL
U.S. NEWS | JANUARY 11, 2012
Soon, \$1,000 Will Map Your Genes
By RON WINSLOW AND SHIRLEY S. WANG



SAN FRANCISCO—The quest to harness the power of DNA to develop personalized medicine is on the threshold of a major milestone: the \$1,000 genome sequencing.

Life Technologies Corp., a Carlsbad, Calif., genomic company, plans to introduce Tondar, a machine it says will be able to map an individual's entire genetic makeup for \$1,000 by the end of this year. Moreover, the machine and accompanying microchip technology, both developed by the company's Ion Torrent unit, will deliver the information in a day, the company says.

Sequencing DNA
If Life Technologies delivers on the claim, it would likely make the company the first among a group of rivals racing to produce a \$1,000 gene map. The current cheapest sequencing costs about \$3,000 and takes a week.

The goal, triggered in part by an initiative launched by the U.S. government's National Human Genome Research Institute in 2004, already has resulted in a dramatic cost reduction in sequencing all three billion units of DNA, known as base-pairs, that make up the human genetic code.

Scientists say that breaking the \$1,000 barrier—roughly the price of an MRI test—will accelerate an already fast-moving transformation in genetic discovery and drug development.

Question Five

Should parents that carry a gene for a genetic disease be required to test their children to determine whether they are carriers or have the disease?

a. Yes
b. No

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Question Six

Should Individuals Be Told That They Have a Genetic Disease Even Though There is No Treatment or Cure?

a. Yes
b. No

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DNA and Genetic Engineering Has Also Lead To Novel Crops and New Medicines to Treat Disease!!





Rice seed yields blood protein PNAS, October, 2011
Human serum albumin from transgenic rice could ease shortages of donated blood.




Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

Question Seven

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

a. yes
b. no

Cloning: Ethical Issues and Future Consequences

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Question Eight

Should Genetically Modified Foods Be Labeled?

a. Yes
b. No

Cloning: Ethical Issues and Future Consequences

Plants of Tomorrow

How Was Genetic Engineering Invented? & How Did It Lead To Remarkable Advances With DNA?

Genetic Engineering 1.0

Proc. Natl. Acad. Sci. USA, Vol. 76, 12, pp. 388-391, November 1979

Construction of Biologically Functional Bacterial Plasmids In Vitro
(A Recombination-Free System for the Construction of Recombinant Plasmids)

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(Communicated by Arthur Kornberg, July 30, 1979)

Cloning: Ethical Issues and Future Consequences

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Genetic Engineering Started in a Hawaii Delicatessen 40 Years Ago....

With An Unexpected "Eureka" Moment Dealing With Two Unrelated Areas of Study:

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



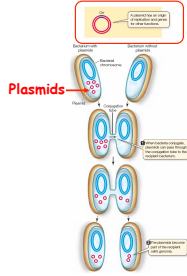
TIME, March, 1981



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Plasmids Are Circular Self-Replicating DNA Molecules in Bacterial Cells That Carry Antibiotic Resistance Genes



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

Plasmids Defend Bacteria Against Antibiotics!

Stanley Cohen

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Plasmids Are Circular Self-Relicating DNA Molecules in Bacterial Cells That Carry Antibiotic Resistance Genes

Plasmids are circular self-replicating DNA molecules found in bacterial cells. They often carry genes for antibiotic resistance. The diagram shows *E. coli* cells and a petri dish with colonies. A scale bar indicates 5,000 bp.

E. coli in Gut

5,000 bp

5,000 bp

1 cm

Plasmid

Bacterial chromosome

Genetic Code of Life

Entire Genetic Code of a Bacterium

DNA Fingerprinting

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Restriction Enzymes Are Proteins That "Cut" DNA Into Pieces

"Killer" Virus

- 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.

Enzymes?

Restriction Enzymes Protect Bacteria From "Killer" Viruses!

Herb Boyer

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Enzymes Are Proteins That Catalyze or Facilitate Chemical Reactions

substrate

active site

Restriction Enzyme

enzyme

bonds in substrate are weakened

Restriction Enzyme

enzyme-substrate

products

DNA 1

DNA 2

Restriction Enzyme

enzyme

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

DNA Fragments of Different Origins "Cut" By the SAME Restriction Enzyme Can Re-join And Form a HYBRID DNA Molecule!!!

EcoRI cuts at red arrows

1 EcoRI cuts the two DNA strands at two different points in a palindromic recognition sequence.

2 The separated strands have "sticky ends" with unpaired bases.

3 The sticky ends can hydrogen-bond to complementary sticky ends from other DNAs, and the resulting recombinant DNA can be sealed with DNA ligase.

HYBRID DNA MOLECULE!!!

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

EXPERIMENT

HYPOTHESIS: Biologically functional recombinant chromosomes can be made in the laboratory.

METHOD: *E. coli* plasmids carrying a gene for resistance to the antibiotic tetracycline or tetracycline are cut with a restriction enzyme. Plasmids are not cut.

RESULTS: Some *E. coli* resistant to both antibiotics. No *E. coli* doubly resistant.

CONCLUSION: Two DNA fragments with different genes can be joined to make a recombinant DNA molecule, and the resulting DNA is functional.

Genetically Engineered Bacteria!!!

Cohen-Boyer Experiment

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Any Gene Can Be Isolated Using Recombinant DNA

Donor DNA

Restriction enzyme sites

1

2

Recombinant vector with insert 1 or 2

Bacterial genome

Transformation

Replication, amplification, and cell division

Clone of donor fragment 1

Clone of donor fragment 2

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

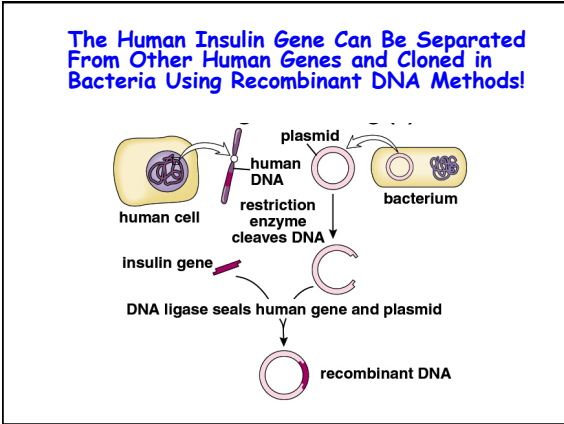
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Leading to a **REVOLUTION** in Technology and Making it Possible For the First Time to Isolate, Manipulate, and Study Genes

DNA Genetic Code of Life

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There Are Now No Limits to What Can Be Done With Genetic Engineering!

The Genes of Any Organism Can Be Isolated, Combined With Those of Another Organism, and Made to Function Normally in New Cellular Environments!

For Example: Jellyfish Genes in Monkeys, Bacterial Genes in Plants, Human Genes in Bacteria, etc., etc., etc., etc.

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What is Genetic Engineering? & What Does It Do?

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Genomes & Chromosomes Contain Thousands of Genes

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Map of chromosome X

ichthyosis, X linked
hypophosphatemia
ocular albinism
Duchenne muscular dystrophy
retinitis pigmentosa

Lesch-Nyhan syndrome
hemophilia B
fragile X syndrome
hemophilia A
color blindness (several forms)
spastic paraplegia, X linked

How Can a Single Gene Be Studied?

The Era Of 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**
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!!

"Why" Clone Genes From An Organism's 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 Led to New Knowledge About How Cells and Genes Function and Has Led to Applications That Have Improved Our Lives!!

The Age of DNA & 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 (e.g., sequence of mammalian genomes, including mouse, human, dog, cat, chimpanzee)
9. Ability to Sequence the Genomes of Extinct Organisms
10. New Ethical Issues in "How Far" We Should Go in Using Genetic Engineering Technology

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?



Question Nine

Would You Use DNA Tests To Select the Gender of In Vitro Fertilized Embryos?

- a. Yes
- b. No



Question Ten

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

- a. Yes
- b. No



HC70A Winter 2013
Genetic Engineering in Medicine,
Agriculture, and Law
Professor Bob Goldberg

Class Announcements
1/8/13

HC70A Winter 2013 (UCLA)
**Genetic Engineering in Medicine,
 Agriculture, and Law**

Teaching Fellows
Eden Maloney
Reece Fenning
Mike Lyons

Course Administrator
Jennifer Kwan

SAS70A Winter 2013 (UC Davis)
**Genetic Engineering in Medicine,
 Agriculture, and Law**

UC Davis
Professor John Harada
TA - Alex Olson

UCDAVIS
 UNIVERSITY OF CALIFORNIA

PLSS530 Winter 2013 (Tuskegee)
Biotechnology

Tuskegee
Professor Channapatna Prakash

HC70A - A Unique Class!
A Unique Way To Teach & Learn Science

MAJOR

YEAR IN SCHOOL

Long-Distance Learning & Much, Much More.....Details in Syllabus & We'll Discuss on Thursday

Discussion Tomorrow

- **Genetic Engineering Then & Now Scientific & Political History**
- **Read Popular Press Articles Handed Out Today & Textbook Chapters 1 & 3.1 (pgs. 59-66)**
- **Be Prepared for a Discussion of the History & Science of Genetic Engineering Providing the Foundation**

Discussion Instructions

- **Come PREPARED!!!!**
- **Read Articles Carefully Prior to Discussion**
- **What's the Question, the Approach, the Results, the Conclusions?**
- **Study Each Figure/Experiment/Legend-Ask The Same Questions!**
- **Read Relevant Parts of Text That Relate to Concepts Covered in Articles**
- **Read Articles ACTIVELY - Look Up Unknown Words/Concepts - Ask Yourself Questions Along the Way - What Does This Mean?!**

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Stop Part One!!