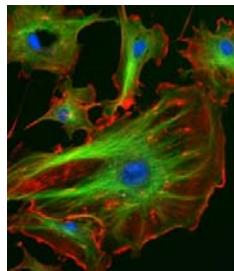


# Lecture 1: Introduction & Overview

**Genes & Society  
LSM3201 / GEK 1527**

The ‘scientificisation’ of the humanities,  
and the humanization of the sciences  
—we should have this two-way flow.

-Catherine Lim  
(author & political commentator)





# Learning Objectives & Outcomes

- Introduce the fundamental concepts and broad themes of genetics and biotechnology.
- Provide sufficient knowledge to ensure students of diverse background can appreciate the significance of past, present and future developments of genetics on societies.

**Empowering you with knowledge for decision-making in near future:**

- In an inter-disciplinary workforce
- As a public stakeholder (or even a legislator)
- As an individual requiring to make a personal decision (usually health/medical condition)
- A deeper and better understanding of who you are biologically (why you are what you are) and to accept or come to terms but yet not limited by your genetic make-up.



# Linking Genes with Society

- **GENES**

- I. From Nature to Concepts
- II. From Concepts to Techniques
- III. From Techniques to Applications
- IV. From Applications to Implications



- **SOCIETY**

- Medical / Public health
- Legal / Forensic
- Historical / Archaeological
- Industries
- Environment
- Agriculture & Animal Husbandry
- Biological warfare (Bioterrorism)
- Art and Entertainment
- Ethical, Legal, & Social Implications (ELSI)
- Various academic disciplines (Computational Science, Chemistry, Physics, Engineering, Law, Social Science, Politics, Religion, Business, Arts etc).
- Personal



# Overview of Concepts

Learn from Nature and Ourselves (from the world around us)

Principles of Hereditary, Chromosomal Dynamics & Aberrations, DNA structure & Replication, Transcription & Translation, Organization and Control of Genetic Materials in Different Organisms, Mutations & Epigenetics



Development of Tools and Technology (within the laboratory)

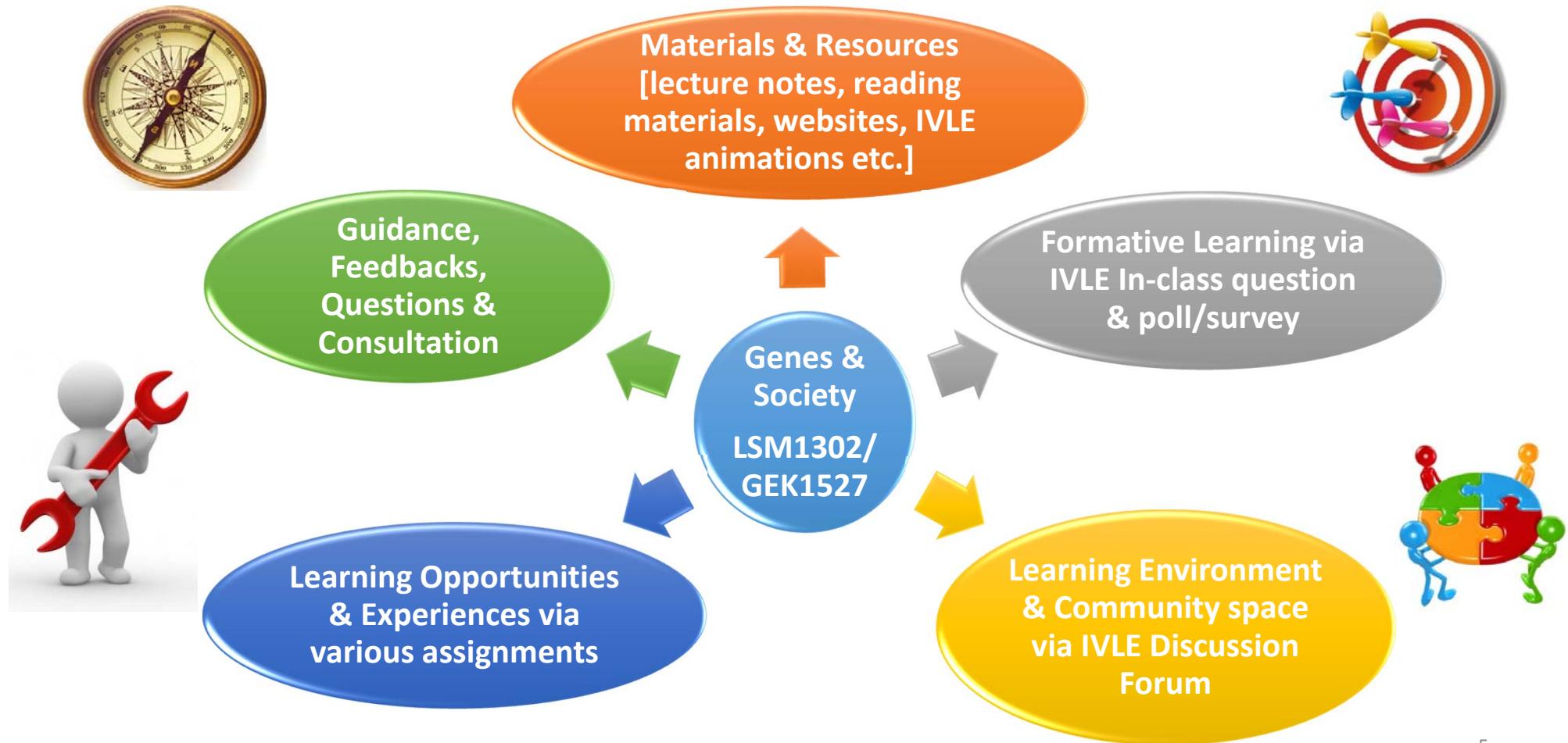
Use of Restriction Enzyme, Mapping, Cloning, Southern Blotting, PCR and DNA fingerprinting, Sequencing of DNA and Genome

Contribution From Disciplines (Chemistry, Physics, Medicine, Engineering, Computational, Law, Arts, etc)

Application of Tools and Technology (from laboratory back to the world around us)

Benefits to mankind (Applications in microbes, plants, animals and humans); Ethical, Legal & Social Implications (ELSI)

# How You & I can make the best of Genes & Society?

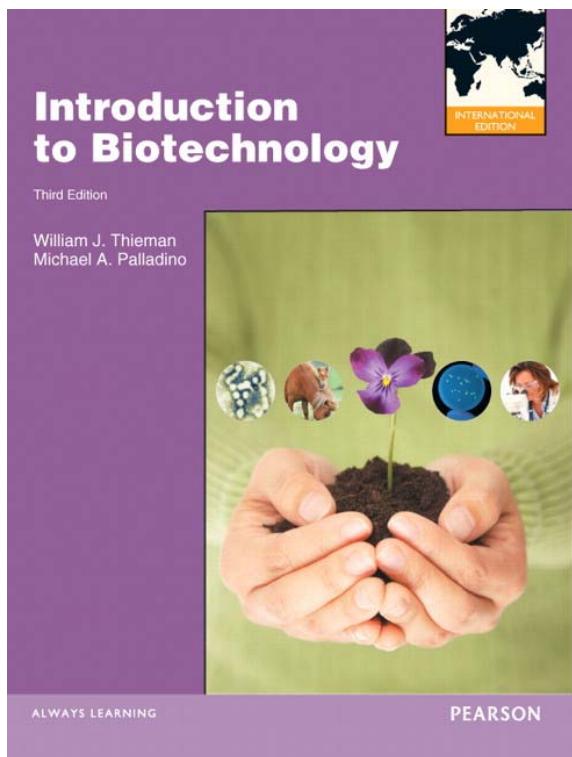


# “ House-keeping” – visit IVLE

- Lecture timetable [SL1 (Mon & Thurs) or SL 2 (Tues & Fri)]
- IVLE Resources for the Module
- Assessment (Individual Effort; No Group Work)
  - **Final Examination (60%): 60 MCQs**
  - **Continuous Assessment (40%) : Multiple Assignments**
    1. IVLE Participation In-Class Questions & surveys
    2. Multiple Short Structured Questions (based on websites & reading assignments to explore diverse genetic-related themes)
    3. Mini Project [Infographic/brochure design to explore communication of genetic-related themes to general public]
    4. Short Essay [to explore ELSI-related themes]
  - Tutorials (whole-class at same time & venue): Assignments & survey questions, IVLE Online MCQs,
- IVLE Forum: Discussion of concepts, issues and ideas related to Genes & Society



# Recommended Resources



Recommended Textbook

DNA-Interactive  
<http://www.dnai.org/>

Home • HHMI's BioInteractive • Explore Short Films

BioInteractive

Free Resources for Science Education

Search by TOPIC RESOURCE TYPE

Send Feedback Help

Short Films

Our series of short films for the classroom brings important scientific advances to life through fascinating stories of discovery.

HHMI BioInteractive  
<https://www.hhmi.org/biointeractive/explore-short-films>

DNA Learning Center Home MORE DNALC SITES: Inside Cancer • Eugenics Archive • DNA from the Beginning • Your Genes, Your Health • NEW! Genes to Cognition Online

DNA Interactive

MENU Timeline Code Manipulation Genome Applications Chronicle

DNA has come a long way. James D. Watson, Nobel Laureate

This site is dedicated to the moment on February 28, 1953, when Jim Watson and Francis Crick discovered the double-helical structure of DNA – and to the scientists who breathed life into that structure.

Timeline myDNA Register free to join our online teaching community where you can create personalized web pages and use the Lesson Planner tool. These features are only available to DNA members.

Teacher Guide Download 15 lesson plans for use in your room. Plans include objectives, national standards, and more.

DNA NEWS Sad News for 'Depression Gene'

DNA DVD Includes 200 video clips and animations

Learn.Genetics GENETIC SCIENCE LEARNING CENTER

THE HUMAN MICROBIOME ASTROBIOLOGY

GENETICS

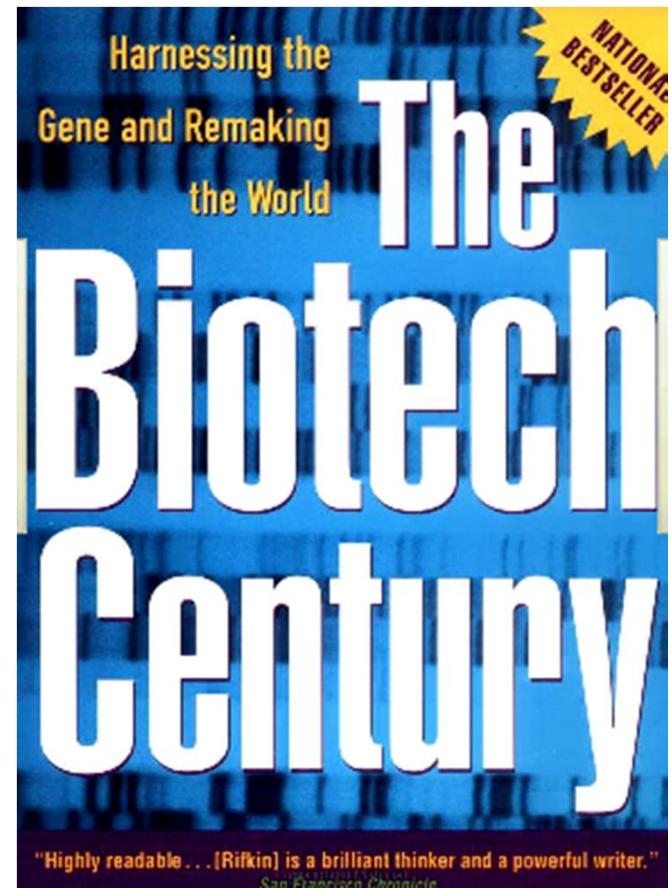
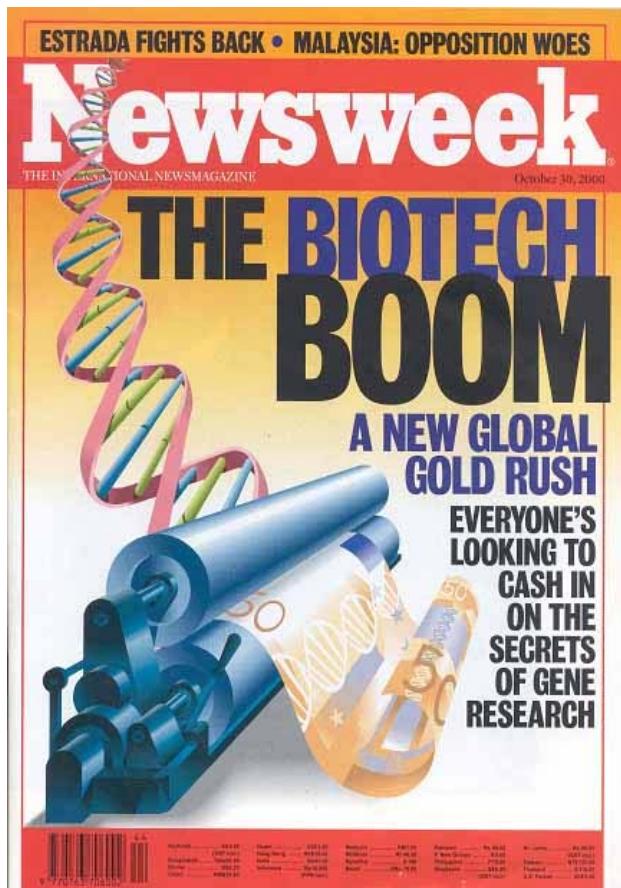
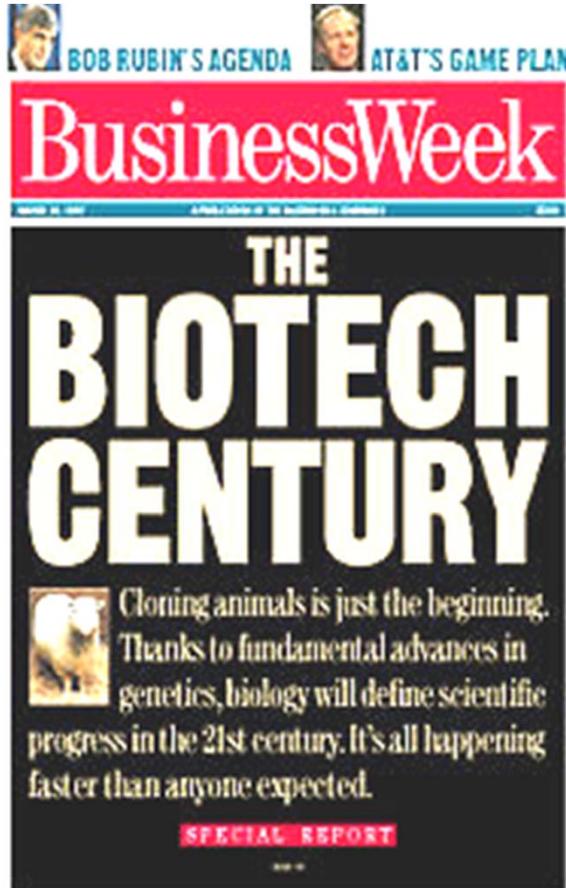
- TOUR OF BASIC GENETICS
- CHARACTERISTICS OF INHERITANCE
- MOLECULES OF INHERITANCE
- GENETIC VARIATION

CELL BIOLOGY

- AMAZING CELLS
- STEM CELLS
- CLONING

Learn. Genetics  
<http://learn.genetics.utah.edu/>

# 21<sup>st</sup>. Century: The Biotechnology Century FACTS or HYPE?



# Dynamic Bio-cluster in Singapore

In 2000, Singapore also joined the Biotech Bandwagon. Government invested \$5 billion with 1.49 billion spent on biomedical R&D annually.





**Between 2000 and 2010,  
Singapore's biomedical  
manufacturing output  
had quadrupled from S\$6  
billion to S\$23.3 billion  
(5 % national GDP).  
Employment doubled  
from 8.2K to 19K.**

With more than **50** biomedical sciences companies and **30** research institutes, Singapore manufactured over **S\$27 billion** worth of medicines and medical devices for global markets in 2011.

# The Juggernaut Of Science

<http://catherinelim.sg/2010/01/22/the-juggernaut-of-science/>

At no time in its history, has Science created so much unease...

The increasing importance today of the biological sciences such as genetics and neuroscience is not at all surprising, since everything in the end boils down to human behaviour which in turn is explainable in terms of biological processes.

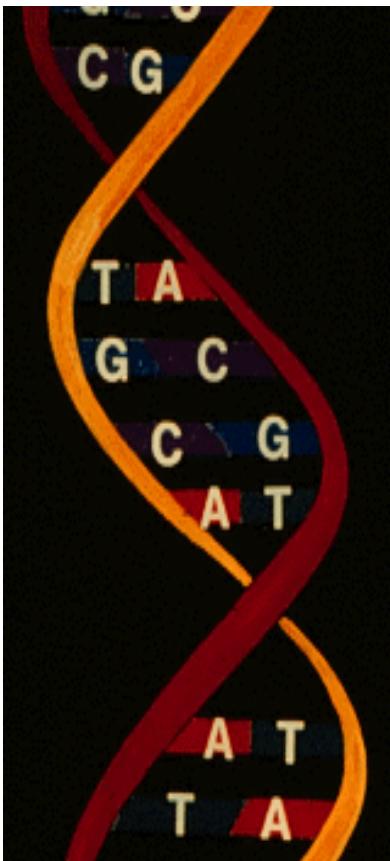


**Catherine Lim**  
**Author & Political  
Commentator**

The dominance of biology is seen in its colonization of other sciences and even the humanities, by attaching its name to theirs: bioengineering, biomechanics, bioeconomics, biomedicine, biogeography, biohistory, bioethics, even bioaesthetics and biotheology.

The most spectacular—and fearful—advancement is therefore in the biological sciences, and it has to do with our sense of who and what we are. Will a human being be cloned eventually? Will Science create new forms of life...a new version of homo sapiens? Will Science be able to extend human life indefinitely, that is give immortality to the human species? How will immortality affect the very structure of society, the way humans relate to each other, their moral and religious beliefs?

# What is *Biotechnology*?



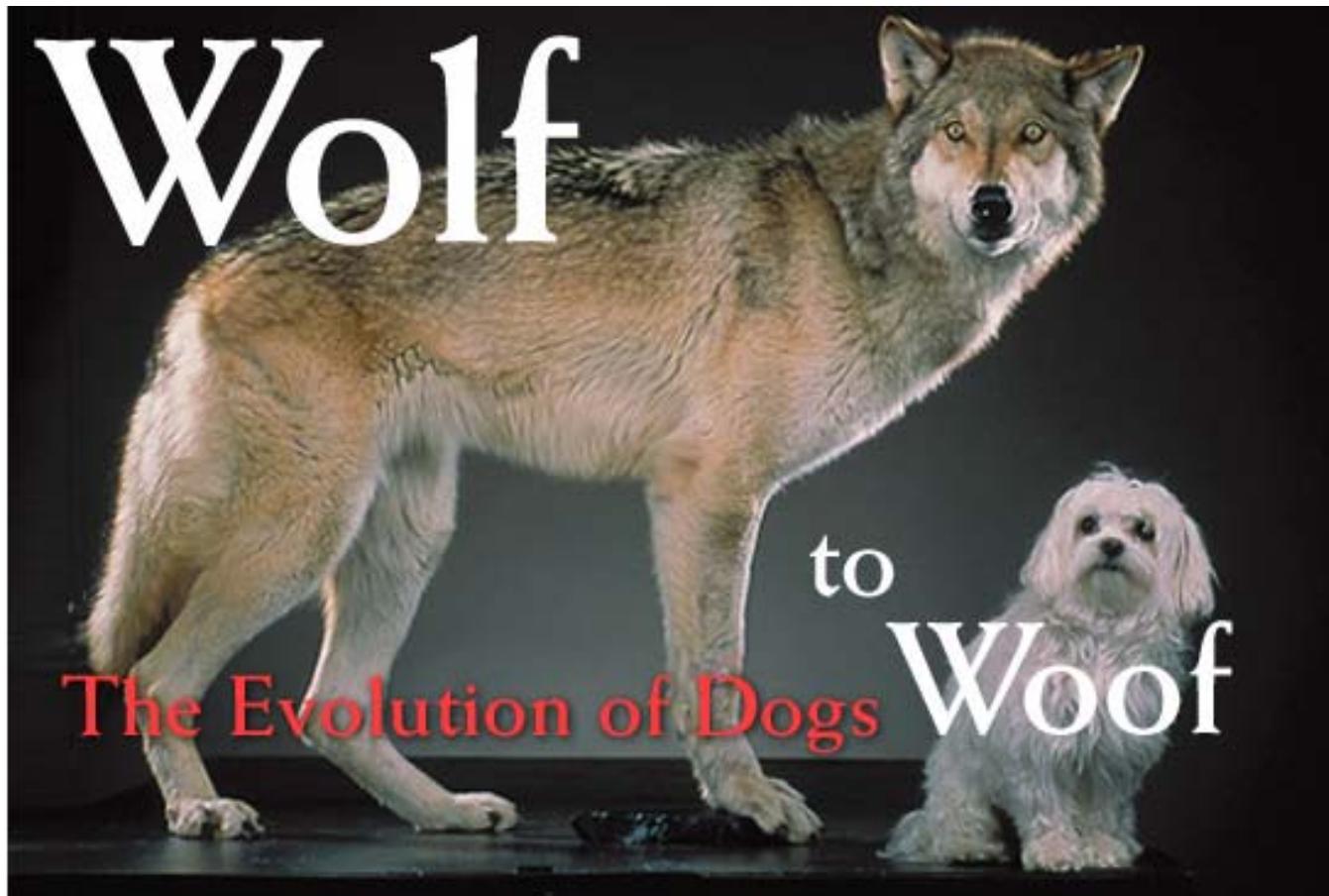
.... the use of living organisms or their products to modify human health and the human environment.....

...any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

# Traditional biotechnology

- Use of animals in agriculture (8,000-10,000 BC)
- Use of micro-organisms for food production: fermented soy bean products (3000BC), fermented bread (2000BC), brewing beer (1750 BC)
- The Chinese used moldy soybean curds as antibiotic to treat boils (500AD).
- Powdered chrysanthemum (active compound pyrethrins) is used in China as an insecticide (100 AD).
- Use of micro-organisms for medicine (e.g. penicillin 1929)
- Selective breeding of desirable characteristics in crops and livestock: a form of genetic manipulation practiced for thousands of years till present day.





Less than 20,000 years separates them: the wolf—the dog's ancestor—and the Maltese.

By selecting specific traits (phenotypes), humans were indirectly selecting the combination of genes (genotypes) that encode these traits in the canid population.

Humans transformed wild canids into the first domesticated animal—the tamable, trainable, incredibly variable dog.

**After wild dogs learned not to bite the hand that fed them, French poodles weren't far behind.**

[http://ngm.nationalgeographic.com/ngm/data/2002/01/01/html/ft\\_20020101.1.html](http://ngm.nationalgeographic.com/ngm/data/2002/01/01/html/ft_20020101.1.html)

# Limitation of selective breeding (traditional biotechnology)

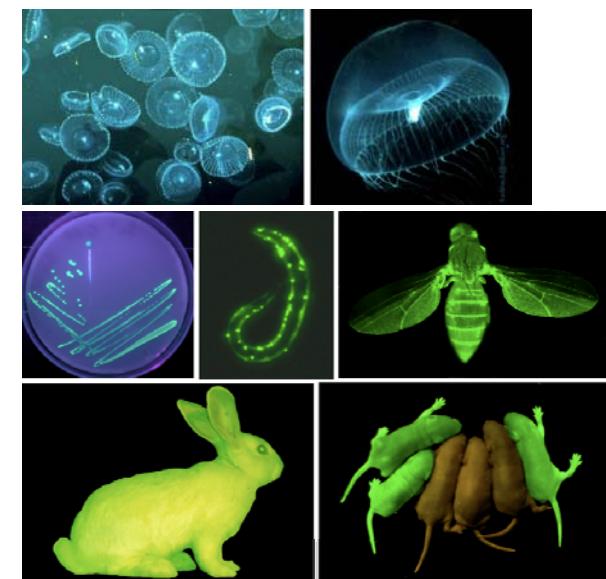
- Limited to the same species (why?) or closely related species (hybrid offspring are usually infertile, why?)
- Limited possibilities (only general existing traits can be selected for enhancement)
- Limited specificity (selection desirable may also lead to selection of undesirable ones)
- Usually requires a longer time (multiple generation of breeding) in order to obtain a desirable trait.

Genetic engineering (modern biotechnology) allows direct, specific selection or manipulation of gene(s) encoding diverse traits or even generating new traits that can be transferred across different species.

However, this would not have been possible without the discovery of genes, DNA and the materials that made the manipulation possible.



[http://ngm.nationalgeographic.com/  
2002/01/dogs/dogs-photography](http://ngm.nationalgeographic.com/2002/01/dogs/dogs-photography)



<http://agapakis.com/hssp/splicing.html>

# Historical Perspective: Classical to Modern Genetics

- ★ 1850 - 1900: From Peas to Heritable factors (Mendel)
- ★ 1900 - 1953 : From Heritable factors to DNA structure (Levine, Avery, Hershey & Chase, Watson & Crick)
- ★ 1953 - 1976: Expanding the Boundaries of DNA Research (Central Dogma of Molecular Biology and Cloning; Boyer & Cohen; Sanger)
- ★ 1977 - 1999: The Explosion of Biotechnology (Diagnostics, Therapeutics, GMOs; Mullis; Anderson)
- ★ 2000 to Present: From Genome to Regenerative & Synthetic Biology (Craig Venter; Francis Collins)



Gregor Mendel.  
Um das Jahr 1862.

<http://www.dnaftb.org/2/gallery.html>

**“My scientific work has brought me a great deal of satisfaction, and I am convinced it will be appreciated before long by the whole world”**

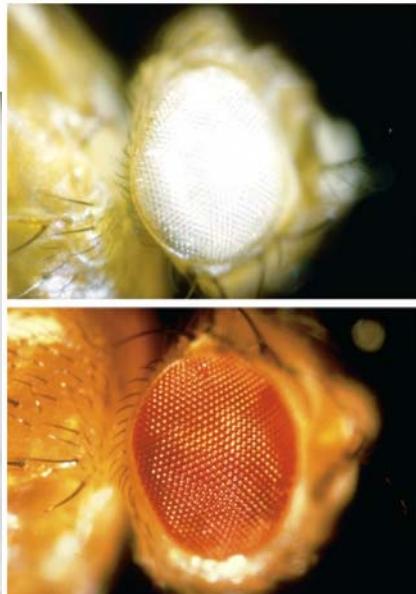
**– Mendel, 1884.**

**1865**

**Gregor Mendel’s proposed  
Paired hereditary factors  
and Basic laws of heredity**



<http://www.dnaftb.org/2/gallery.html>



**1911**  
**Thomas H. Morgan**

**Nobel Prize winner**

**Hereditary factors were found on chromosomes.**

**Formulated Chromosomal Theory of Inheritance and Sex-linked inheritance.**

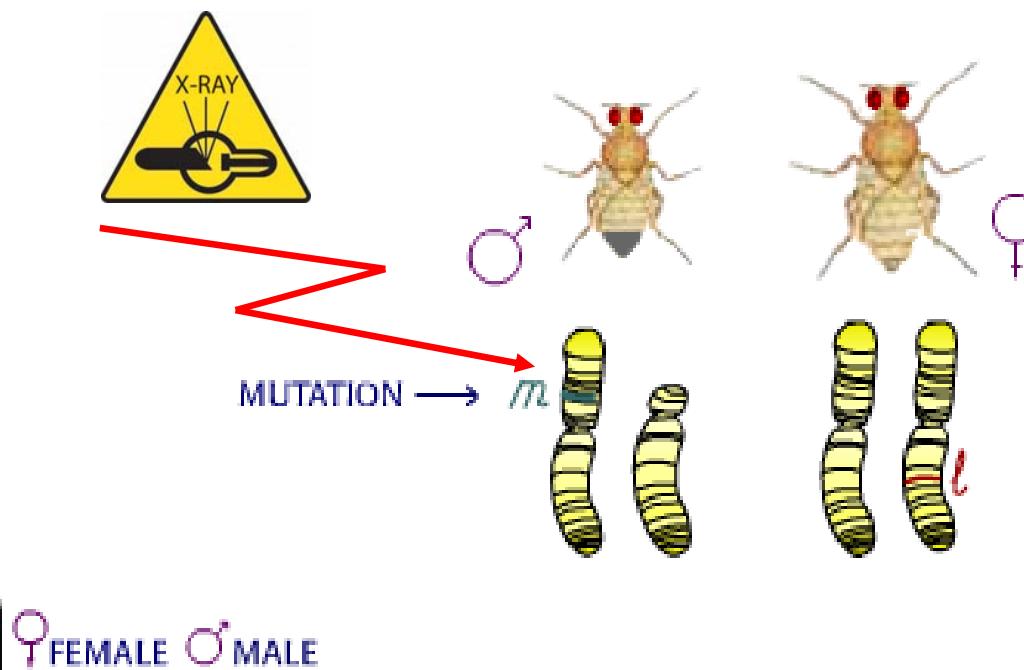
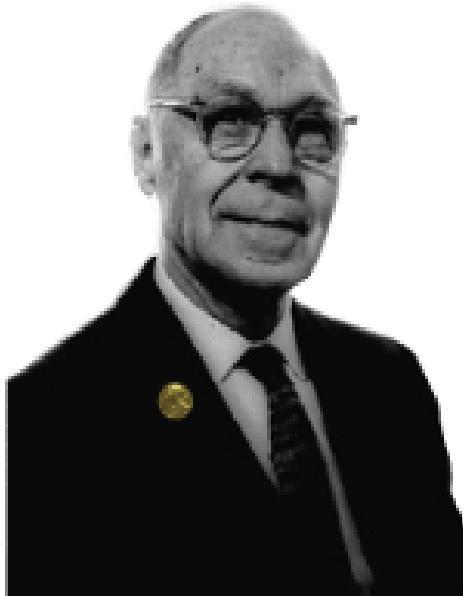
<http://www.dnai.org/timeline/index.html>

“Morgan’s theory of the chromosome transform genetics into an experimental science,...it represents a great leap of imagination comparable with Galileo and Newton.”

—Waddington & Kandel

## Muller and X-ray mutants

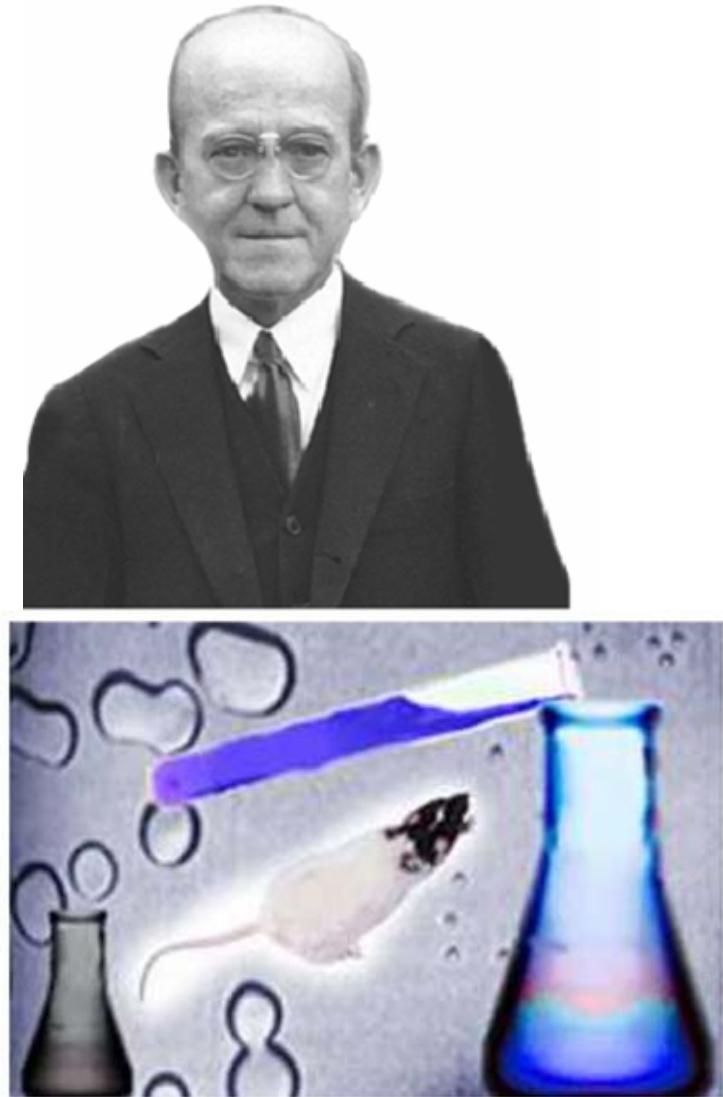
I designed the experiment to detect a mutation (*m*) induced by X-rays in the X chromosome, but mutations can occur anywhere.



<http://www.dnai.org/timeline/index.html>

**1920s**

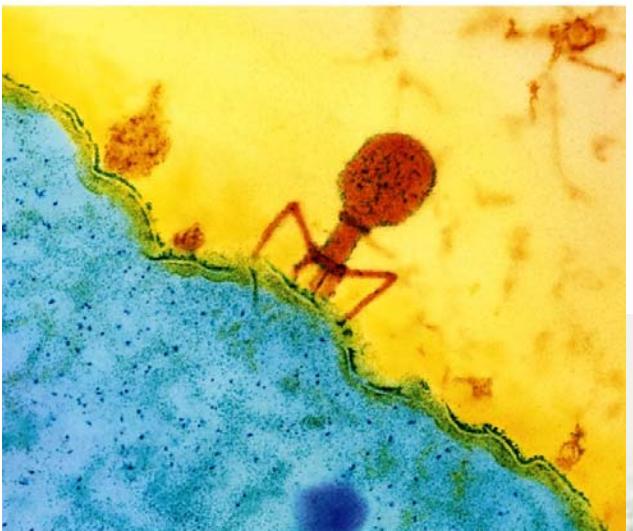
Hermann Muller showed that X-rays could induce mutations on hereditary factors found on chromosomes. Generated more than 100 mutants (flies) within a few weeks.



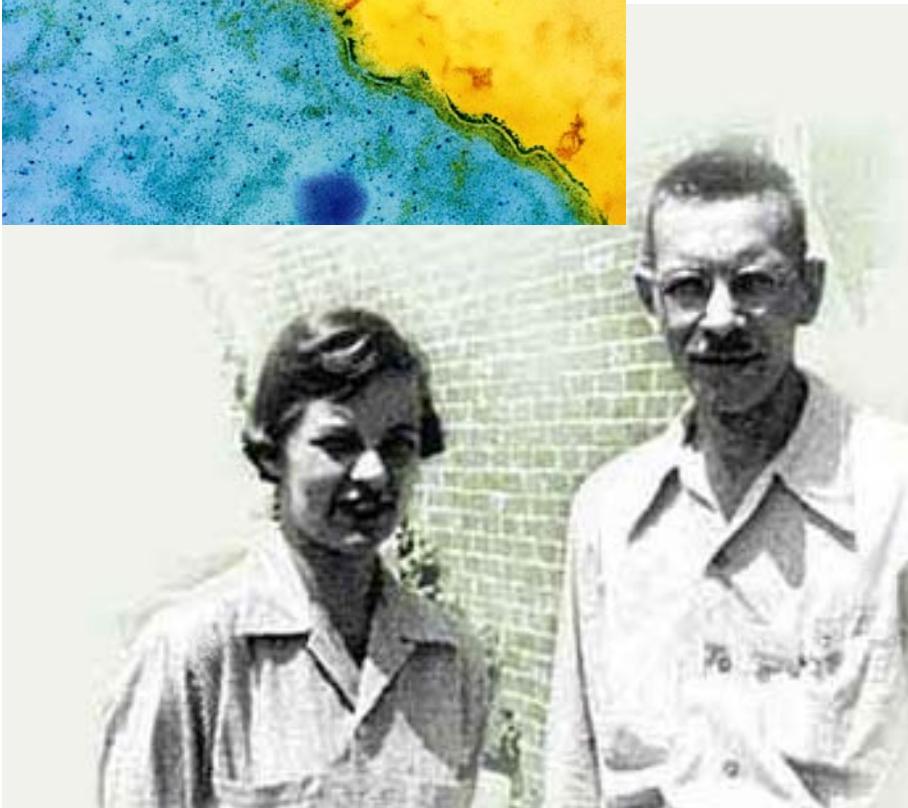
<http://www.dnai.org/timeline/index.html>

# 1943

**Avery and colleagues demonstrate that the hereditary factor is a "transforming factor" that can change phenotype of bacterial cells and it is likely found in the DNA.**



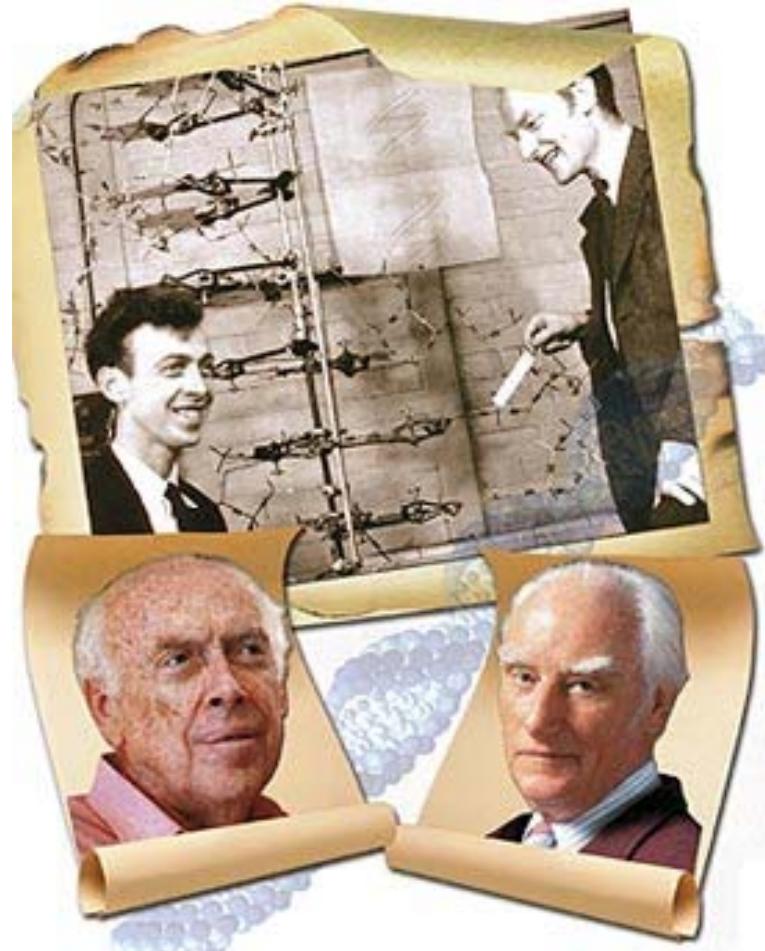
**1952**



**Alfred Hershey  
and Martha Chase  
demonstrated  
elegantly that  
DNA, and not  
protein is the  
genetic material  
using virus  
bacteriophage**

**Hershey a Nobel prize winner**

<http://www.dnai.org/timeline/index.html>



**At that time...all I cared about was the DNA structure...It was aided by the fact that effectively there were no girls in Cambridge [to distract me].”**  
– James Watson

**1953**

## **Watson & Crick solved the DNA structure**

**The structure reveals the function.**  
**Opened up a new era of molecular biology in which gene activities could be tracked, charted and ultimately even changed.**

**Nobel Prize Winners**  
<http://www.dnai.org/timeline/index.html>



<http://www.dnai.org/timeline/index.html>



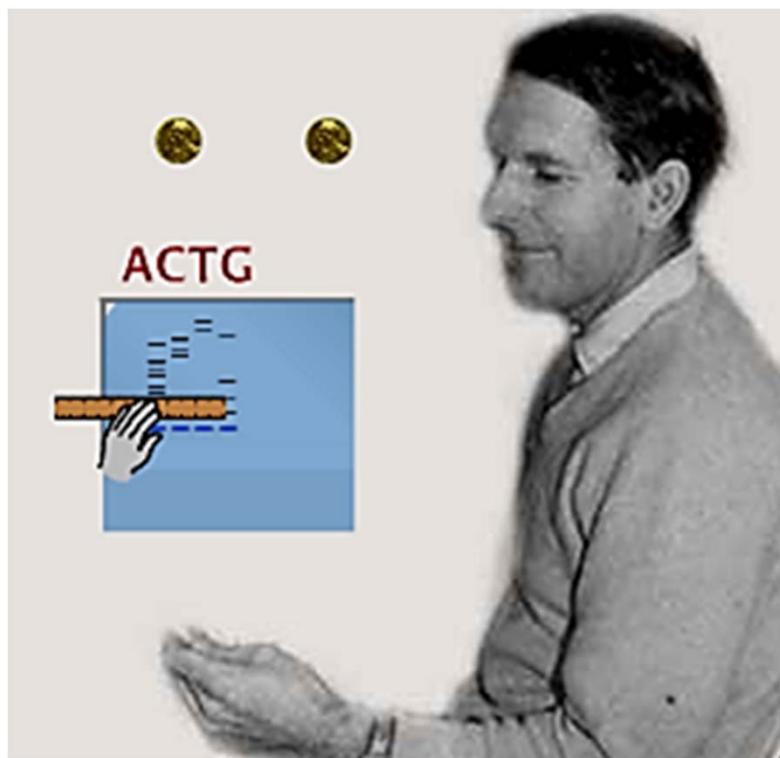
**1973  
Boyer and Cohen  
transferred a gene  
from this toad into  
bacteria.....**

**and it worked!**

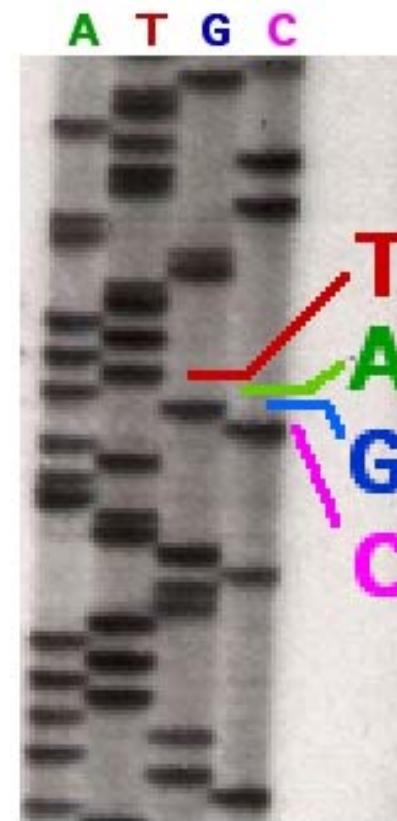
**The Dawn of  
Genetic Engineering**

**1975**

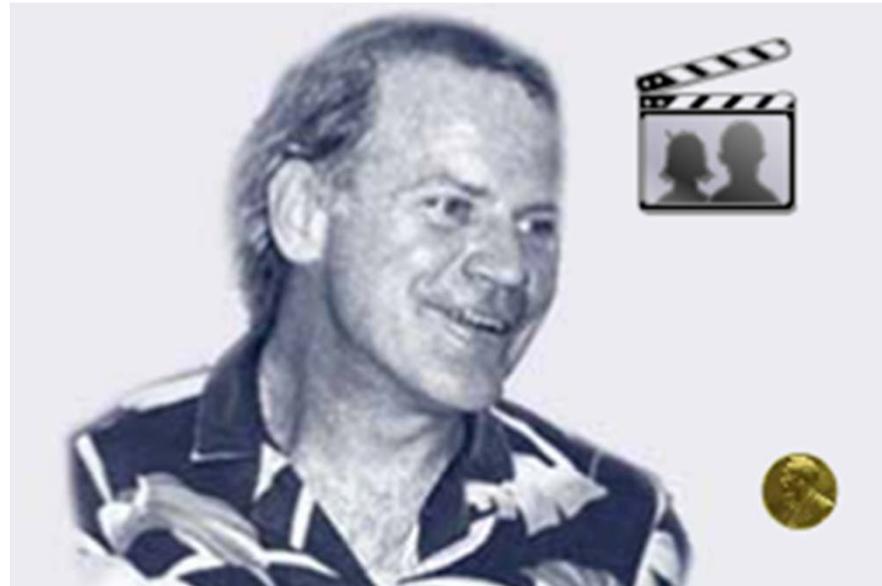
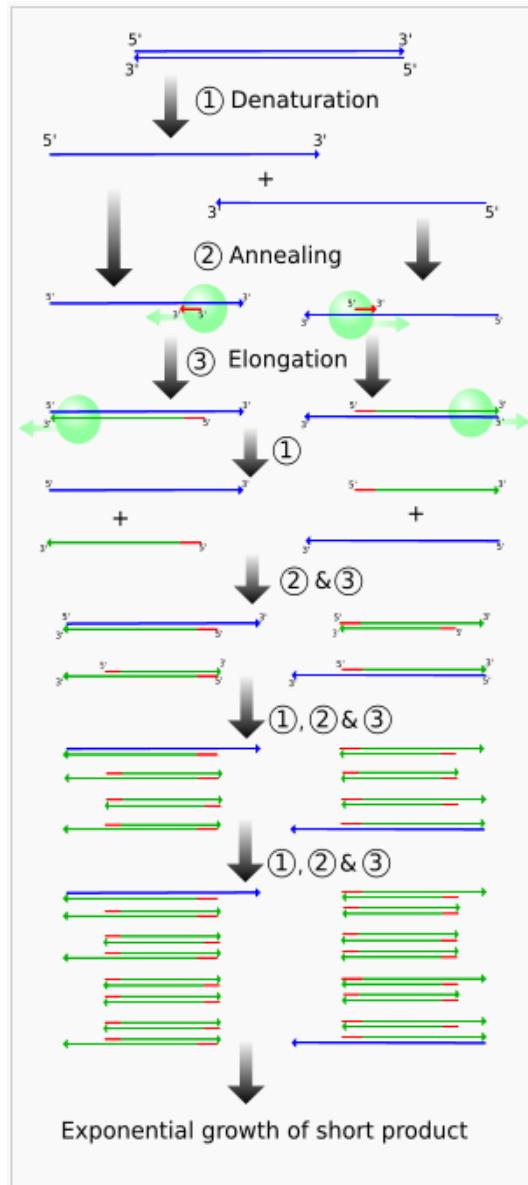
**Frederick Sanger developed Chain Termination DNA Sequencing Technique that enabled us to read the DNA sequences**



<http://www.dnai.org/timeline/index.html>



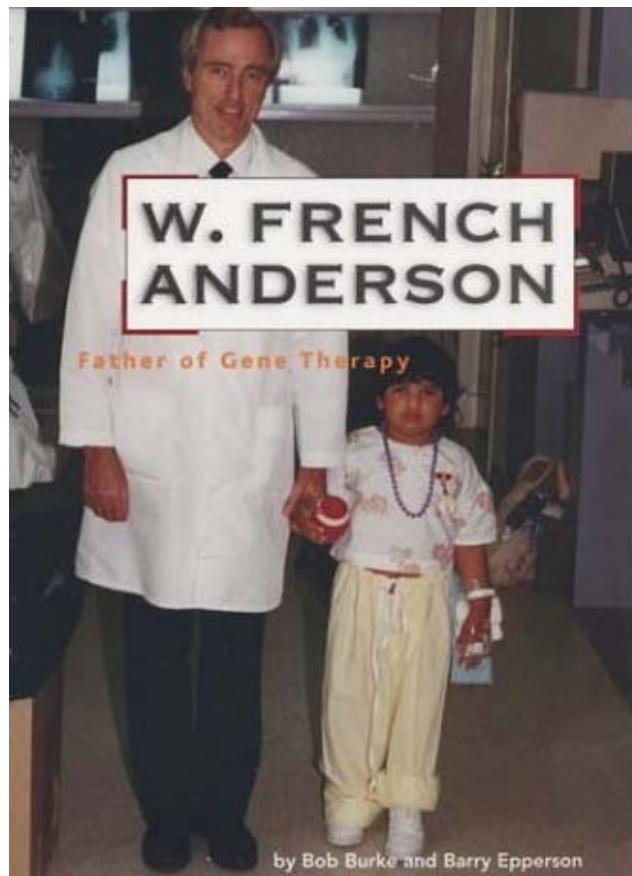
**Nobel Prize Winner**



<http://www.dnai.org/timeline/index.html>

**Nobel Prize Winner**

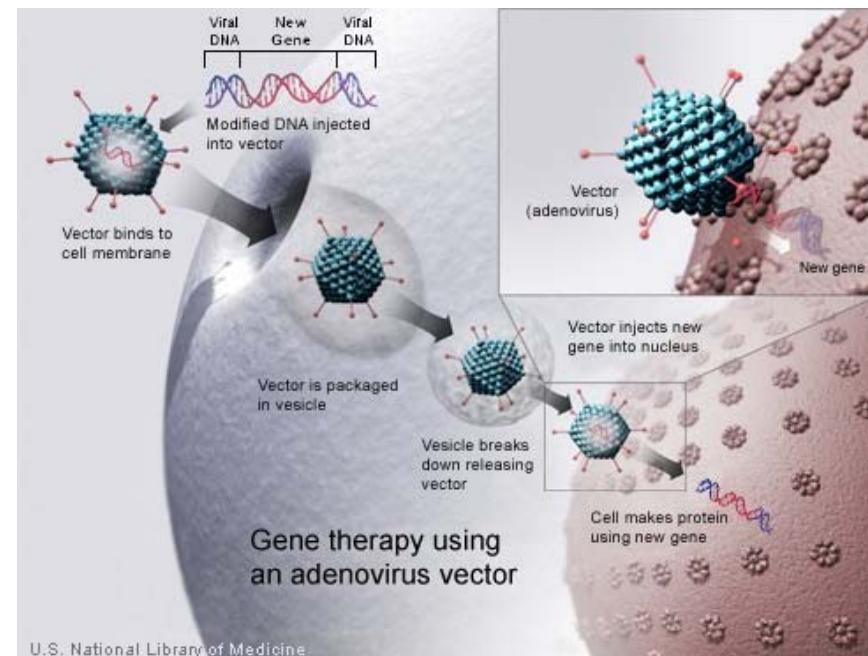
**1983**  
**Kary Mullis invented Polymerase Chain Reaction (PCR):**  
**A Technique for Amplifying DNA**

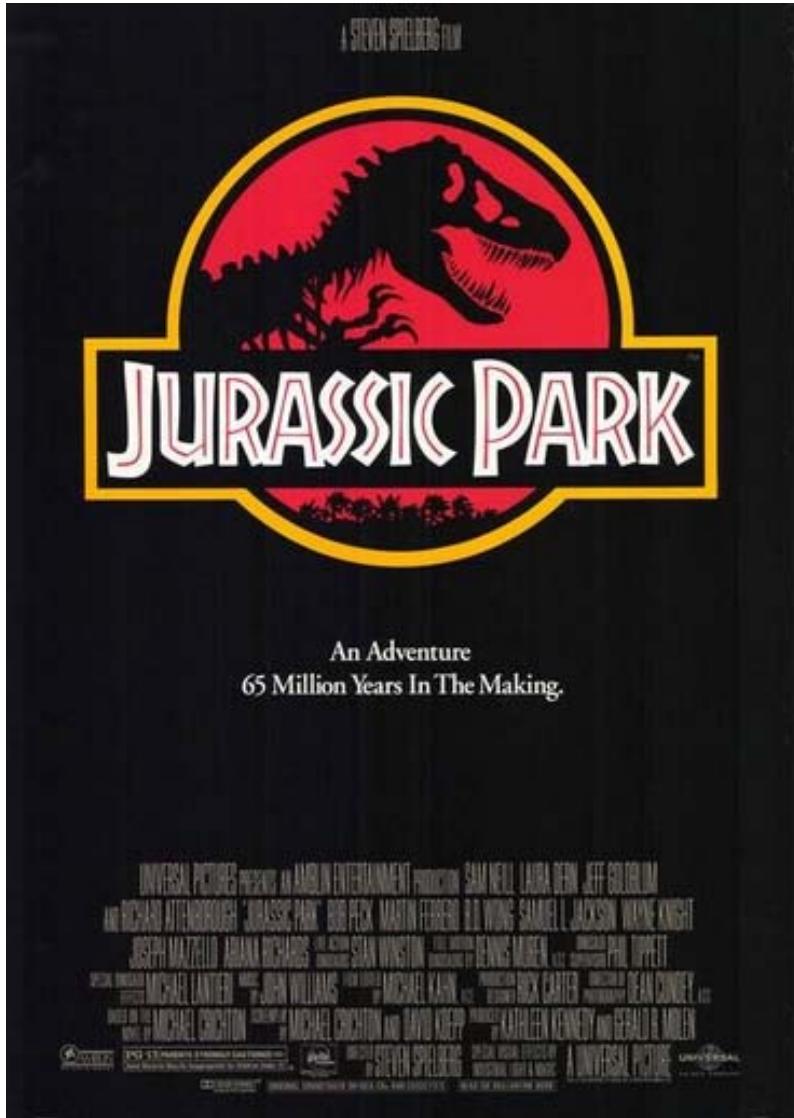


First 'success' in gene therapy of a 4-year-old girl suffering from SCID (a form of an immuno-deficiency disorder also called "bubble boy disease").

1990

## French Anderson's first human *Gene Therapy* on ADA enzyme deficiency





**1993:**

**The story involves scientists visiting an amusement park of genetically engineered dinosaurs on an island over one weekend. Sabotage sets the carnivorous dinosaurs on the loose, and technicians and visitors attempt to escape the island.**

**Bio-engineered ancient species: can it be real?**

## Woolly Mammoth Resurrection, "Jurassic Park" Planned

Stefan Lovgren  
for [National Geographic News](#)  
April 8, 2005

A team of Japanese genetic scientists aims to bring woolly mammoths back to life and create a Jurassic Park-style refuge for resurrected species. The effort has garnered new attention as a frozen mammoth is drawing crowds at the 2005 World Exposition in Aichi, Japan ([see photo](#)).

### Photo in the News: Frozen Mammoth Unveiled



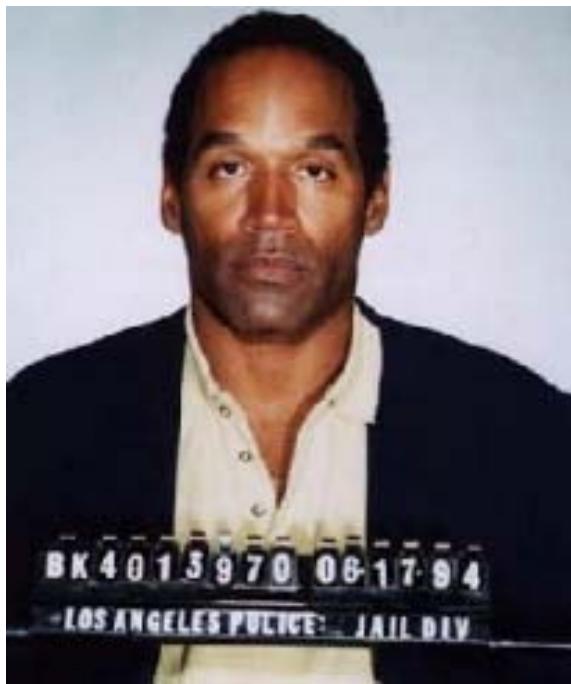
### Mammoth achievement.

Researchers managed to sequence a large chunk of DNA from a Siberian mammoth.

**Should we do it just because we could do it?**

# **Legal battles**

## **The OJ Simpson's case(1995) and Monica Lewinsky's famous dress (1998)**



<http://law2.umkc.edu/faculty/projects/ftrials/Simpson/simpson.htm>



<http://law2.umkc.edu/faculty/projects/ftrials/clinton/lewinskydress.html>

**The media learned about DNA fingerprinting and taught the public**

# The benefits and the fears.....



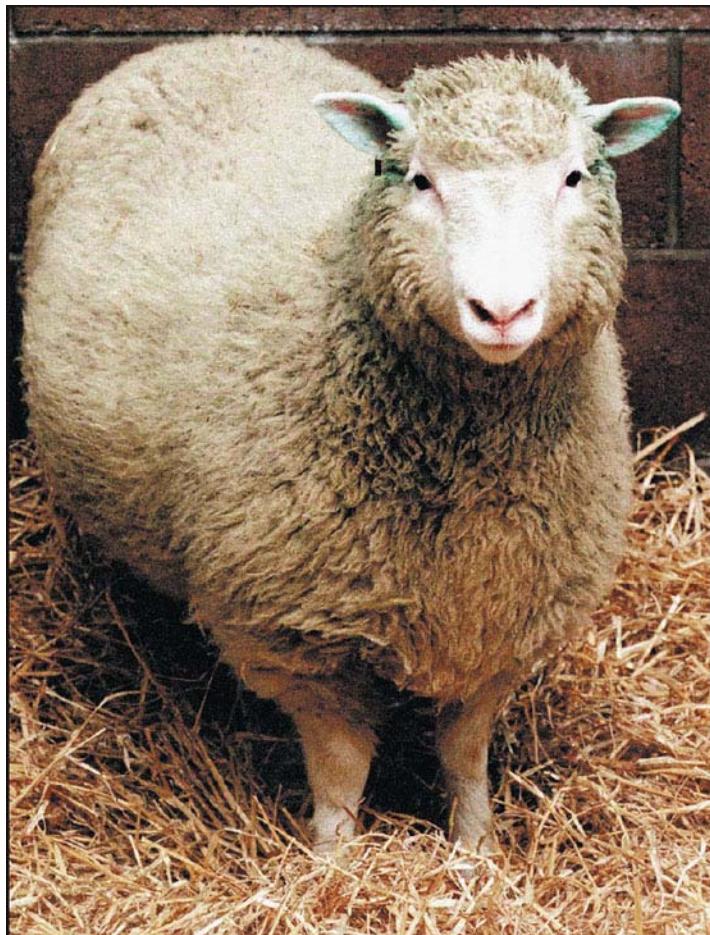
Figure 1-16 Essentials of Genetics, 6/e  
© 2007 Pearson Prentice Hall, Inc.

**The potential of cloning to alleviate suffering is so great...that I believe it would be immoral not to clone human embryos for this purpose.” – Ian Wilmut**

**1996**

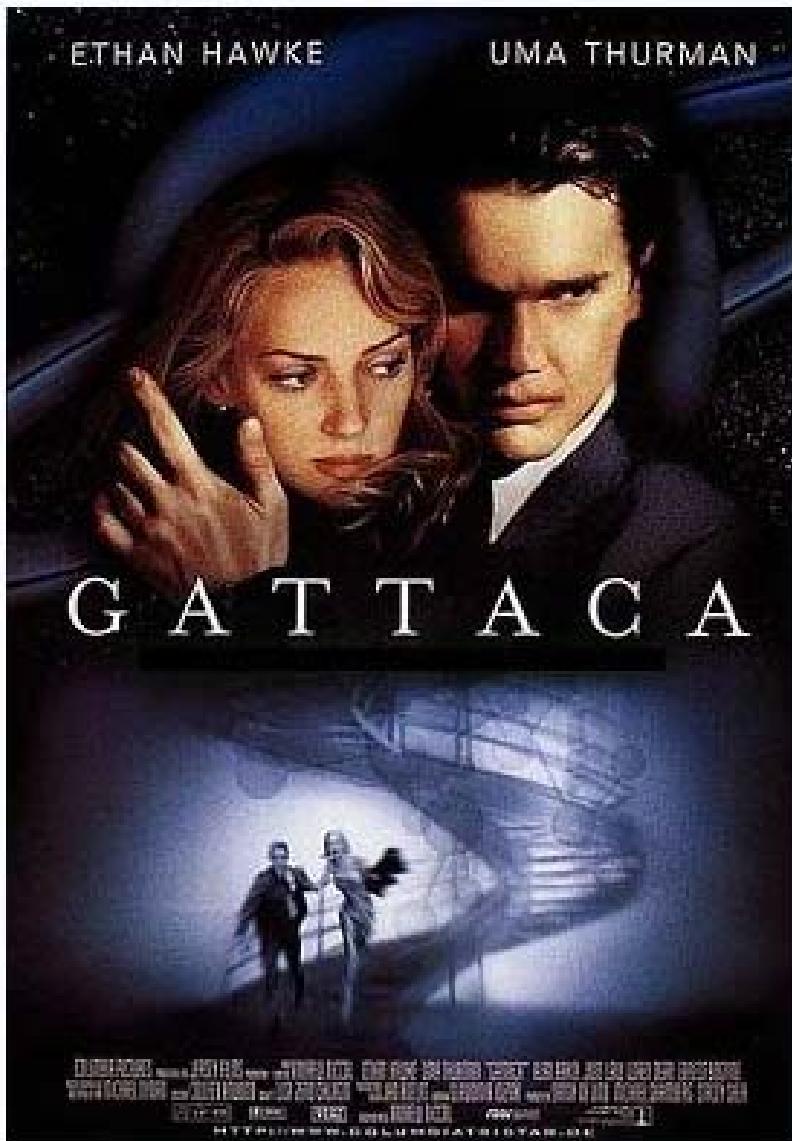
**“Dolly” - the first cloned sheep; using nuclear transfer technique. The cloning of Dolly made it apparent to many that the technique used to produce her could someday be used to clone human beings.**

## **The benefits and the fears.....**



**later, 1997**

**“Polly” - the cloned sheep bearing a human gene Factor IX - producing therapeutic proteins in the sheep's milk. If we can genetically modify and clone a sheep, can we do the same with human?**



# 1997

The film presents a vision of a society driven by “new eugenics”. Children of the middle and upper classes are “designer babies”, genetically engineered in-vitro to be the optimal *recombination* of their parents' genetic material. A genetic registry database uses biometrics to instantly identify and classify those so created as “Valids” while those conceived by traditional means are “In-Valids”. While genetic discrimination is forbidden by law, in practice it is easy to profile one's genotype resulting in the valids qualifying for professional employment while the invalids who are susceptible to disease are relegated to menial jobs.

The movie draws on concerns over technological developments which facilitate reprogenetics, and the possible consequences of such biotechnology for society.

# **Genetically-modified plants for human benefits**



**1999**

**Tobacco plant producing  
human coagulant factors  
VIII and XIII**

[http://www.valentine.gr/plant-blood\\_en.php](http://www.valentine.gr/plant-blood_en.php)

**TABLE 1.1** Some Genetically Altered Traits in Crop Plants

**Herbicide Resistance**

Corn, Soybeans, Rice, Cotton, Sugarbeets, Canola

**Insect Resistance**

Corn, Cotton, Potato

**Virus Resistance**

Potato, Yellow Squash, Papaya

**Altered Oil Content**

Soybeans, Canola

**Delayed Ripening**

Tomato

**WILL**

# **FRANKEN FOOD FEED THE WORLD?**

BY BILL GATES

Genetically modified food has met fierce opposition among well-fed Europeans, but it's the poor and the hungry who need it most



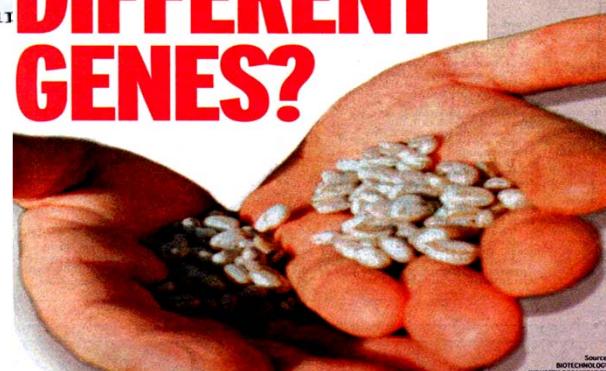
WORLD

THE SUNDAY TIMES : January 16, 200

If you want to spark a heated debate / genetically modified foods. For many people, high-tech crop production raises all kinds of ethical questions. Particularly in countries with green lobbies—the idea seems against nature.

## The good and the bad from modifying genes??

### *Better beans from DIFFERENT GENES?*



#### What is bio-food?

Genetically-modified (GM) crops are grown from seeds implanted with genes of other living organisms. BT corn, for instance, contains a gene derived from a bacterium that produces a toxin which kills the corn borer. However, GM foods' detractors query the safety of altering food genes.

#### What crops gain from genetic technology?

Dozens of agricultural biotechnology products are on the market, and more are on the way. Here are crops that are genetically-altered and the traits their new genes give them:

**CORN** Tolerates weed-killing herbicides. Resists bugs. Grows in low-fertilizing soil. Resists diseases.

**SOYBEANS** Tolerates herbicides. Produces oil with higher oleic acid and lower saturated fats.

**CANOLA** Tolerates herbicides.

**PEPPERS** Improves taste and colour, reduces seeds.

**TOMATOES** Boosts colour, taste, texture. Lengthens shelf life with delayed ripening. Improves firmness for better processing.

**PEANUTS** Lengthens shelf life of nuts, candy, peanut butter.

**COTTON** Requires less herbicide and insecticide. Resists bugs.

**POTATOES** Resists bugs.

**SUNFLOWERS** Produces oil low in fatty acids.



Born in Virginia, the piglets stand at the gateway to a medical revolution that will save countless lives by producing organs for transplant.

## Cloned piglets mark medical breakthrough

Race to produce organs for transplant to humans takes a big step forward, but raises ethical questions and fears about a 'drive towards human cloning'

LONDON — A nine-day-old piglet named Dotcom is in the vanguard of a medical revolution that will save countless lives, raise persistent ethical questions and bring glittering profits to commercial interests.

Dotcom and her four sisters born Monday are the world's first cloned pigs, marking a breakthrough in the race to produce organs for transplant to humans.

"An end to the chronic organ shortage is now in sight," said Mr Ron James, managing director of the Edinburgh-based PPL Therapeutics, which also helped to create Dolly the sheep, the first cloned mammal.

Explaining the choice of the name Dotcom, he joked: "Any association with dot-coms right now seems to have a very positive influence on a company's valuation."

He was referring to the dotcom Internet companies, which are currently the hottest stocks on world markets.

Indeed, the economic potential was grasped immediately as the news caused shares in PPL Therapeutics to shoot up 56 per cent.

Some analysts believe the market for organ transplants could be worth US\$6 billion (\$S10 billion), and the same amount again for

therapies in which insulin-producing cells will be transplanted into diabetics patients — who would no longer need daily injections.

But ethical concerns came instantly to the fore.

Mr Patrick Dixon, author of "The Genetic Revolution", warned of a relentless drive towards human cloning. "There is a global race, if not a stampede, on," he said, adding that that technology developed in Britain — where human cloning is banned — would inevitably be pirated.

He added: "Scientists are ticking off which species they have cloned, pigs being the latest, leading inevitably towards humans. It will be very rewarding for the team which do it."

The PPL scientists are seeking to create a line of pigs whose organs and cells will not be rejected by humans, the stumbling block in earlier attempts. — AFP

LD

# 2000

## Animals for production of organs

THE STRAITS TIMES : Saturday, January 15, 2000

### METHOD YIELDS BETTER LAB MATERIAL



Tetra monkey's business is to pioneer identical monkeys for lab research.

SCIENTISTS say animals cloned by nuclear transfer, like Dolly, are not 100 per cent clones, as they have genetic material both from the adult cell they were taken from, and from the egg hollowed out to make the clone.

Mr Schatten says embryo splitting, which results in genetically-identical animals, is therefore better for laboratory purposes.

One thing these genetically-identical animals can be used to test is the "Nature versus Nurture" theory.

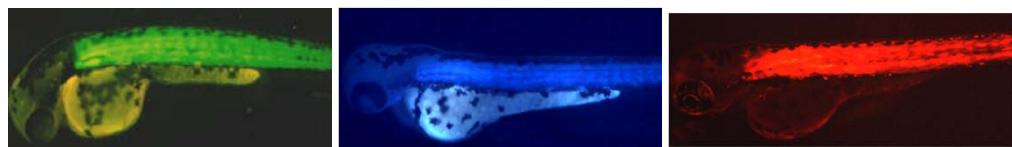
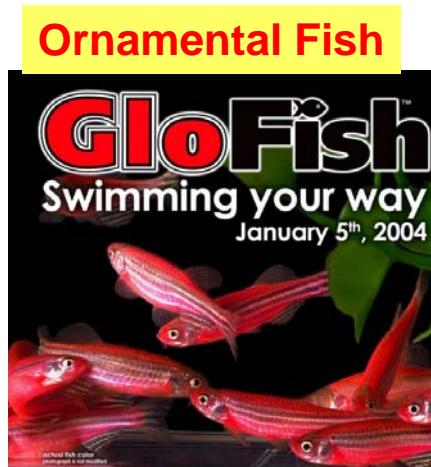
— REUTERS

## First Dolly, and now Tetra the monkey

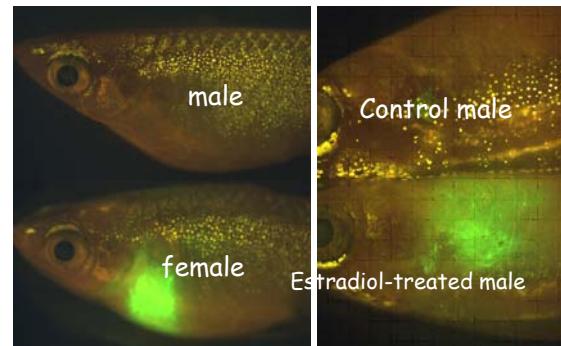


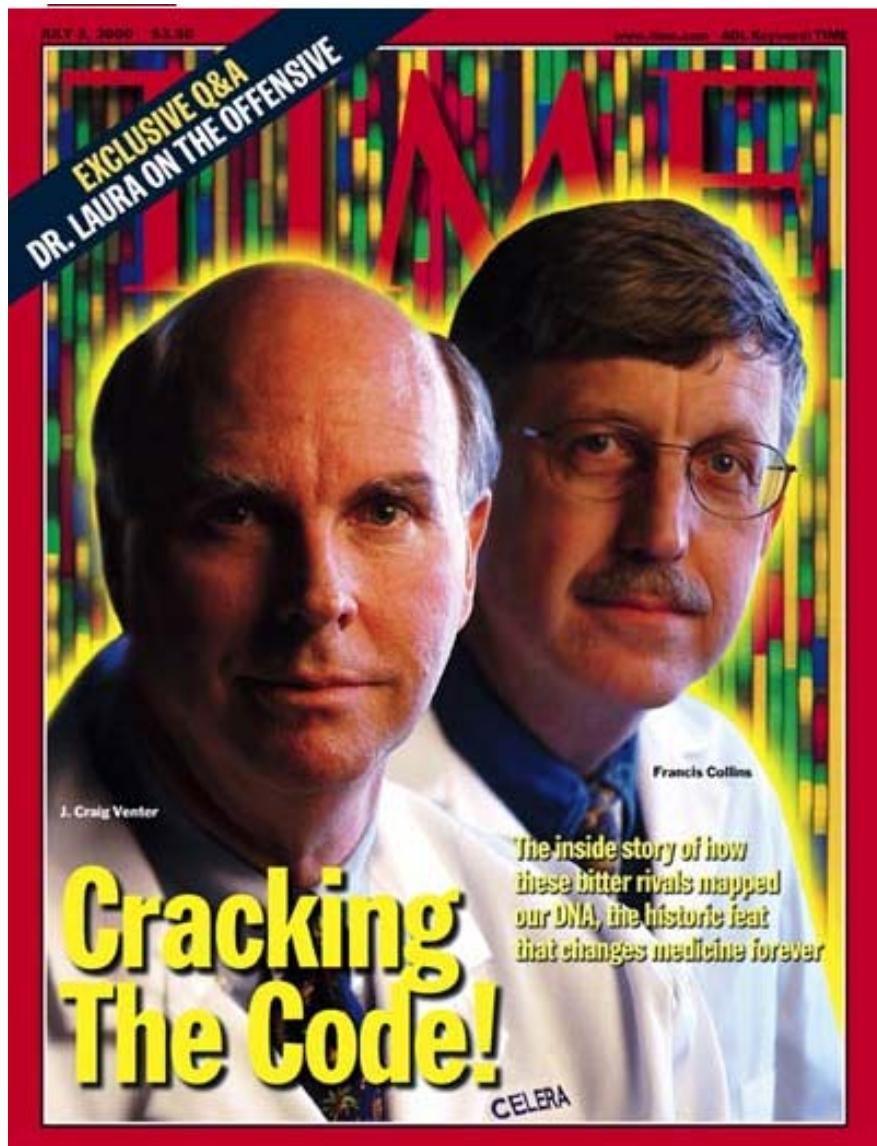
<http://www.newswithviews.com/Patti/edwards102SO.htm>

**The new featherless- chicken would be lower in calories, faster-growing, environmentally friendly, and more likely to survive in warmer conditions**



**Biomonitoring Fish**



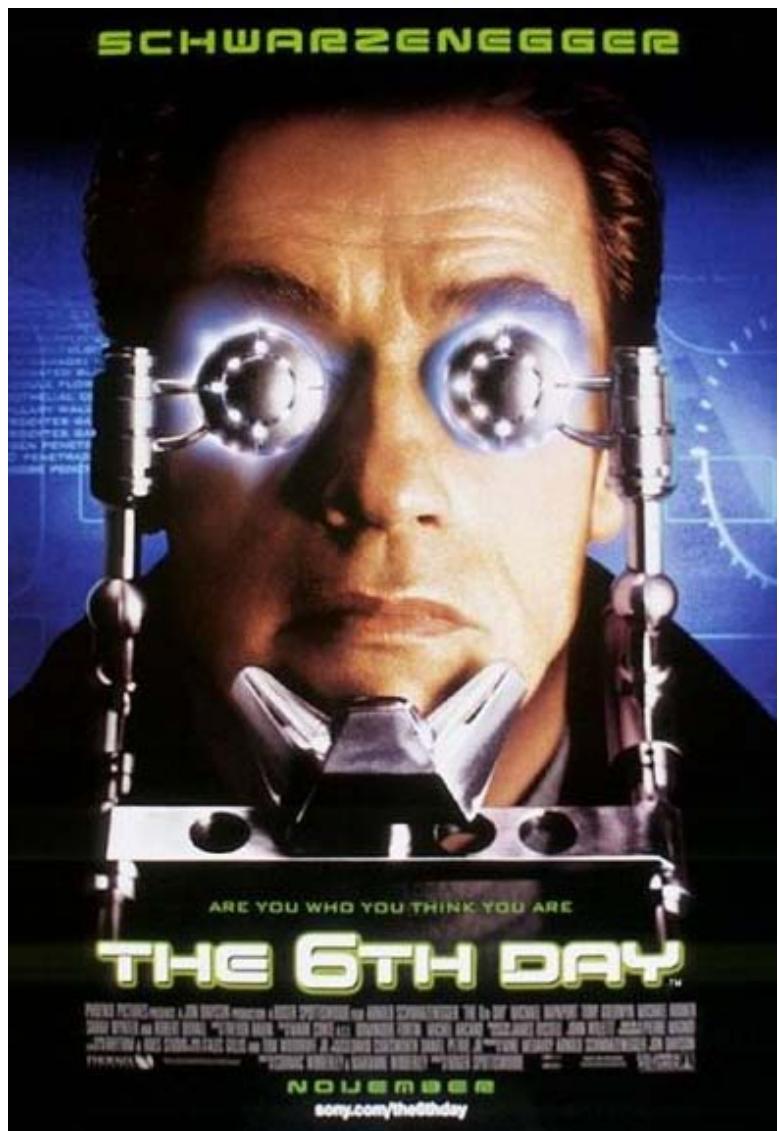


# The Human Genome Project

**1990-2003: to map and sequence the entire human genome**

**First draft: July 2000 !!!**

**“Biodata mining”**



# 2000

In the not-too-distant future, when pets can be cloned after they die and "virtual girlfriends" can be installed and programmed, Adam Gibson (Arnold Schwarzenegger) works as a helicopter tour pilot. On his birthday he comes home to discover an identical version of himself--an illegal human clone--celebrating with his family and friends. The next thing he knows, a squad of killers is after him in order to hide the evidence of their cloning activities, funded by Michael Drucker (Tony Goldwyn), a powerful businessman who hopes to make billions from human cloning in collaboration with his medical expert, Dr. Griffin Weir (Robert Duvall).....

Thursday, 9 August, 2001, 09:34 GMT 10:34 UK

## Cloning doctor sparks furore



<http://news.bbc.co.uk/2/hi/science/nature/1481887.stm>

Dr Antinori (left) and his associate Dr Panos Zavos

**By David Willey in  
Rome**

Doctor Severino Antinori, an Italian gynaecologist who runs a fertility clinic in Rome, has suddenly leaped into the world's headlines by announcing his plans to clone the first human beings.



**JAN 2002**



Saturday 5<sup>th</sup> Jan 2002

THE STRAITS TIMES

WORLD

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# Dolly's creator warns on human cloning

**He says it would be irresponsible to think of producing a person after the sheep gets premature arthritis**

EDINBURGH — The creator of Dolly the sheep warned yesterday against plans to clone humans after he disclosed that the animal had contracted premature arthritis, which raised questions about the safety of mammal cloning.

"I think there was already plenty of evidence that it would be completely irresponsible to think of producing a person," said

Professor Ian Wilmut, who led the team which cloned Dolly in 1996.

Experience with animals has already shown that most clone pregnancies fail, or result in offspring that were stillborn or deformed.

"There was no way of knowing if the five-year-old's condition was a result of the cloning process," he added.

He said: "Dolly has arthritis in her left hind leg at the hip and the knee."

"The fact that Dolly has arthritis at this comparatively young age suggests that there may be problems. We do not know and it's very important that we look," he said.

"We can't tell how it will develop but she is responding well to treatment with anti-inflammatory drugs."

Dolly, the first mammal to be cloned from an adult cell, was being closely monitored by veterinary staff at the centre, Prof Wilmut said.

"In every other way she is perfectly healthy and she has given birth to six healthy lambs," he said.

Sheep have a life expectancy of 13 years.

In May 1999, research suggested Dolly might be susceptible to premature ageing.

A research team, reporting in the journal *Nature*, examined age-linked structures in Dolly's cells called telomeres.

The structures were slightly shorter than would be expected in a sheep of its age which had

been born normally.

Dolly's condition emerged after scientists in the United States said they had produced pig clones that had been genetically modified to help prevent their organs being rejected if they were transplanted into a human.

Meanwhile, Dr Panayiotis Zavos, a US-based andrologist, and Rome-based Italian gynaecologist Severino Antinori have announced plans to clone the first human, a scheme that has triggered criticism and revulsion around the world.

A first step, although for therapeutic research, was made last year by a Massachusetts firm, Advanced Cell Technology (ACT).

ACT said it had created a cloned embryo in the first stage of development — a tiny cluster of cells that were the exact genetic copy of their female donor. Up to half a dozen cells were created before the process halted.

The United States, the European Union (EU), Britain and France all spoke out against ACT's research.

Britain responded by racing anti-cloning measures through Parliament in just a few days last year after a surprise High Court ruling that cloning humans was not technically illegal.

— AFP



**Dolly the sheep** making an appearance at the Roslin Institute in Edinburgh yesterday. Now almost six years old, the sheep is being treated with anti-inflammatory drugs for premature arthritis.

AP



Cells near the end of their lifespan are used to clone (from left) Lily, Daffodil, Crocus, Forsythia and Rose. But their cells show no signs of ageing.

# Eureka! No premature ageing in cells from cloned cows

**The six healthy cows have chromosomes that are 'the picture of youth', unlike the aged ones found in Dolly the cloned sheep, say scientists**

LOS ANGELES — Researchers, who produced six healthy cows through cloning, found that cells taken from the cows showed rejuvenation that was the reverse of the premature ageing reported in the case of Dolly the cloned sheep, according to a report yesterday.

Dolly, cloned in 1997 by

British scientist Ian Wilmut, was old before her time as her cells appeared to inherit the age of her genetic mother.

However, "chromosomes from the cow sisters are the picture of youth", according to Advanced Cell Technologies (ACT) researcher Robert Lanza, in the report pub-

lished in Science magazine. "Surprisingly... the cloning process seemed to restore the 'nine lives' of these cells in the six cows," Mr Lanza, a co-author of the research, said. The cows are now seven months old.

"Cells from the cow clones appear to have recaptured, and even prolonged, their youth," he explained.

"Instead of being zero to four division cycles away from the end of their lives, cells taken from the cows were more than 90 cycles away from the end."

The ACT researchers, based in Massachusetts in

the United States, used cells that were near the end of their lifespan, instead of cloning from cells that had been starved and sent into a resting state — like those used for cloning Dolly.

While they do not yet understand why there should be such a marked contrast in the youthfulness of the cloned animals, the condition of the donor cell appeared to be significant, the researchers say.

And the different origins of the cells could be a factor, the report noted.

Mammary cells were used for Dolly and

fibroblast (connective tissue) cells for the cows.

Researchers hope that cloning could supply a crop of youthful cells for uses including the design and transplant of replacement tissue for the human body, and increasing breeding years of farm animals.

Another indication of ageing in cells is in the wear and tear on telomeres — the regions at the tip of chromosomes which stop the genetic thread from fraying as the cell divides, according to the researchers.

In the cells taken from the cloned cows, the telomeres

were actually longer — that is, seemingly younger — than those from normal cows of the same age and, in most cases, even longer than those of newborn cows.

Mr Lanza and his co-authors do not yet know if the findings translate into a longer lifespan for the animals themselves.

"Despite these unsolved mysteries, the finding erases a lingering doubt about the utility of cloned cells, by demonstrating that the process doesn't automatically rob cells of a normal lifespan," Mr Lanza said.

— AFP

# Religious sect cloning people in secret lab

A MEDICAL firm linked to a religious sect is working in a secret laboratory in the United States on cloning a human being.

"We are in the process of doing it in the US," Ms Brigitte Boisselier, 44, a Frenchwoman who is the scientific director of the firm Clonaid, told a congressional hearing on Wednesday.

Clonaid, a Nevada-based firm founded by the sect Raelians, has announced plans to clone a 10-month-old dead baby.

Ms Boisselier said a team of four scientists had been working on the pro-

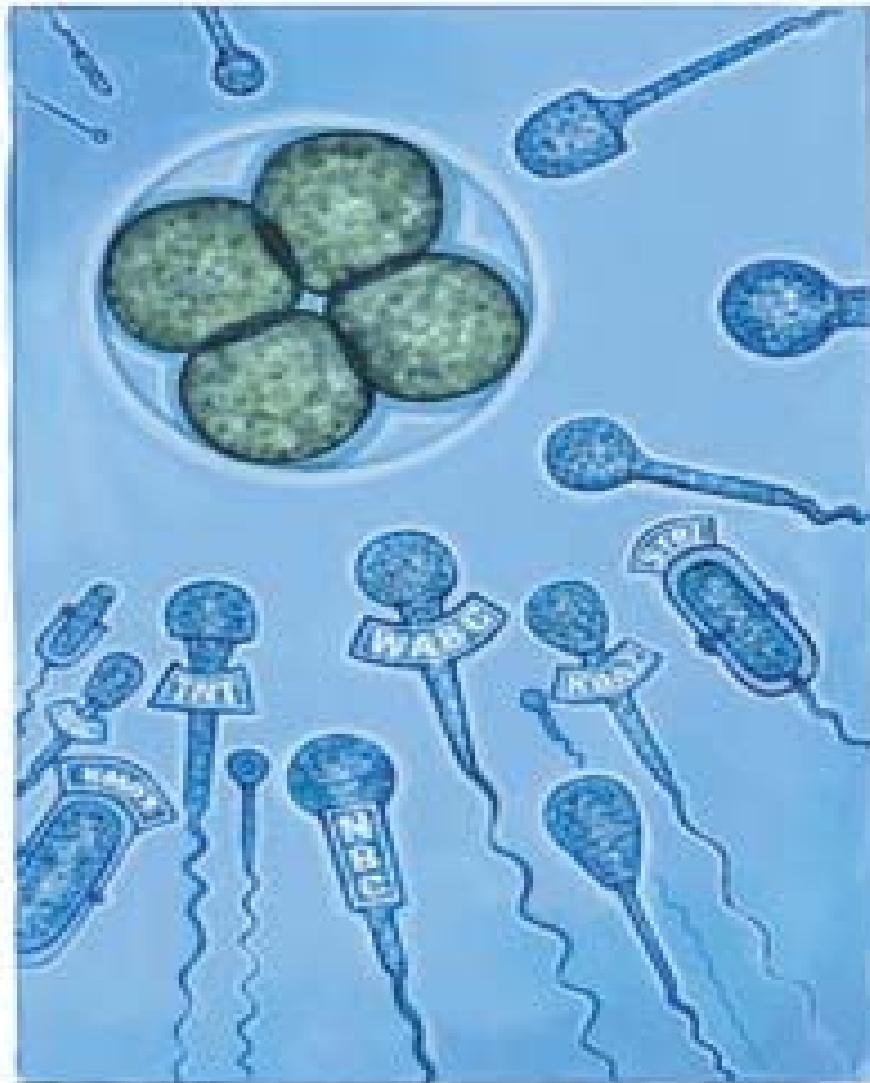
ject since December at an undisclosed location.

The sect, which claims to have 55,000 members around the world, was founded by former French journalist Claude Vorilhon.

He believes that life on Earth was created by extraterrestrials who arrived in a flying saucer 25,000 years ago and that cloning will allow humans to crack the secret of eternal life.

However, the US Food and Drug Administration said it would not authorise cloning, because of "unresolved safety questions".

— AFP



<http://news.bbc.co.uk/1/hi/health/2608655.stm>

## Raelian leader says cloning first step to immortality

Saturday, December 28, 2002

<http://edition.cnn.com/2002/HEALTH/12/27/human.cloning/>

**MIAMI, Florida (CNN) --** The leader of a religious sect that claimed to have created the first human clone Friday called the development "just the first step" toward human immortality through cloning.

Former French journalist Claude Vorilhon, who now calls himself Rael, claims to be a direct descendant of extraterrestrials who created human life on Earth through genetic engineering. A company founded by his followers announced Friday that the first human clone has been born -- a 7-pound baby girl dubbed "Eve."

The announcement was met with skepticism and concern, since other cloned mammals have had serious birth defects or developed health problems later. But in an interview with CNN, Rael dismissed concerns about health problems in cloned animals, saying "I have no doubt the child will be perfectly healthy."



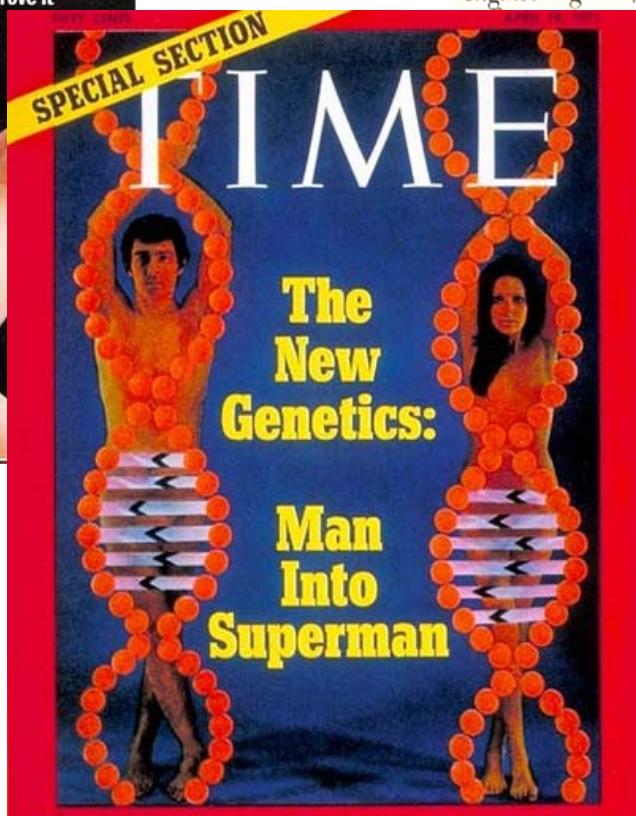
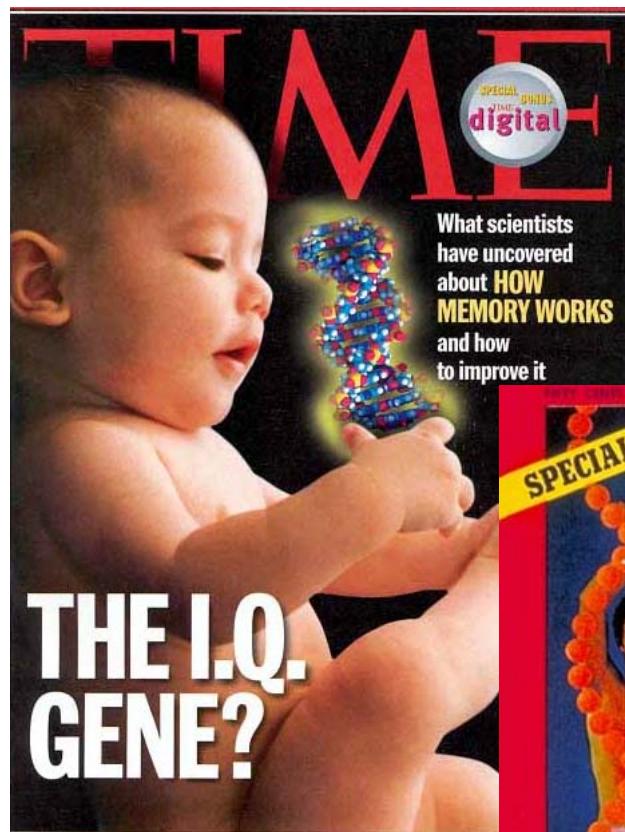
Brigitte Boisselier, scientific director of Clonaid, said the first cloned human baby was born Thursday.

The cult had launched a company offering \$200,000 cloning service to couples seeking to recreate dead children.



Dolly had to be euthanized at aged 6 because of a progressive lung disease

(Feb 2003)



## Improving Our Genome?

# Should you design your baby?

### Germline engineering

cess of natural procreation. Experts disagree on when this will be possible. Perhaps in 10 years. Perhaps not for many decades. But they do agree it is coming.

"We live in a huge supermarket," says Mr. Leslie Adler, an essayist and cultural critic at the University of Buffalo. "And one of the things that's going to be offered for sale in the future is making yourself a better human being. Living longer, growing taller, jumping higher."

Some applications, such as eradicating fatal defects including cystic fibrosis, could be unquestionably a boon to humankind.

But would a germline intervention that prevented obesity be the greatest public health advance of the 21st century or the pathological ice of a vain society obsessed with thinness?

People endowed with the



Meddling with a baby's genes may prevent birth defects but it may also cause anguish.

But in a world where parents select their children's genes, they would bear responsibility for every choice.

What if your parents decided against a particular genetic improvement and you feel you should have had it? Conversely, what if your parents chose a trait for you that you wish you did not have?

Would you be resentful? Could you sue? This sort of thing could create incomparable anguish, especially since recent research suggests that some of the same genes that confer desirable characteristics also contribute to undesirable ones.

For example, the same genes that contribute to manic depressive illness also seem to confer artistic creativity. Disable the mental illness genes, the argument goes, and you could deprive the world of future Vincent Van Goghs, Ernest Heming-

the population? But what if everyone lived to be 100? Or 120? The world would become an increasingly crowded place.

Another complication: Germline engineering will not be free; not everyone will be able to afford it.

Will this create a new genetic gap between rich and poor? Will it lead to a world in which babies of the rich will be guaranteed genes for intelligence, longevity and other desirable traits while the babies of the poor will have to take their chances?

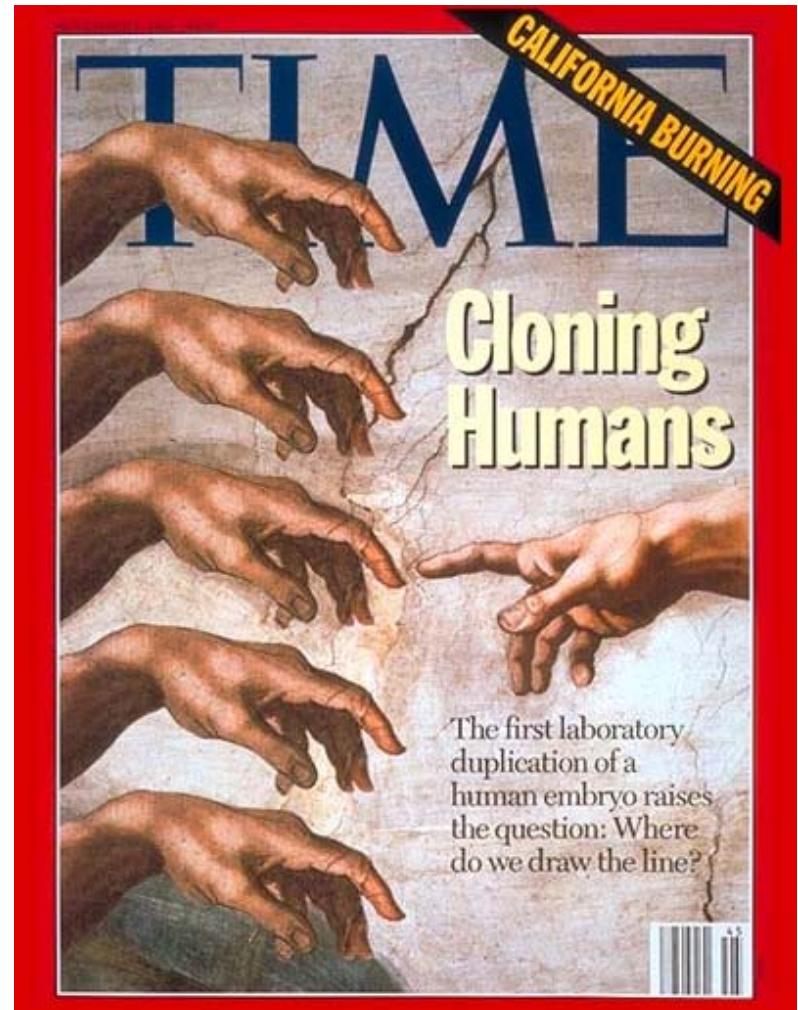
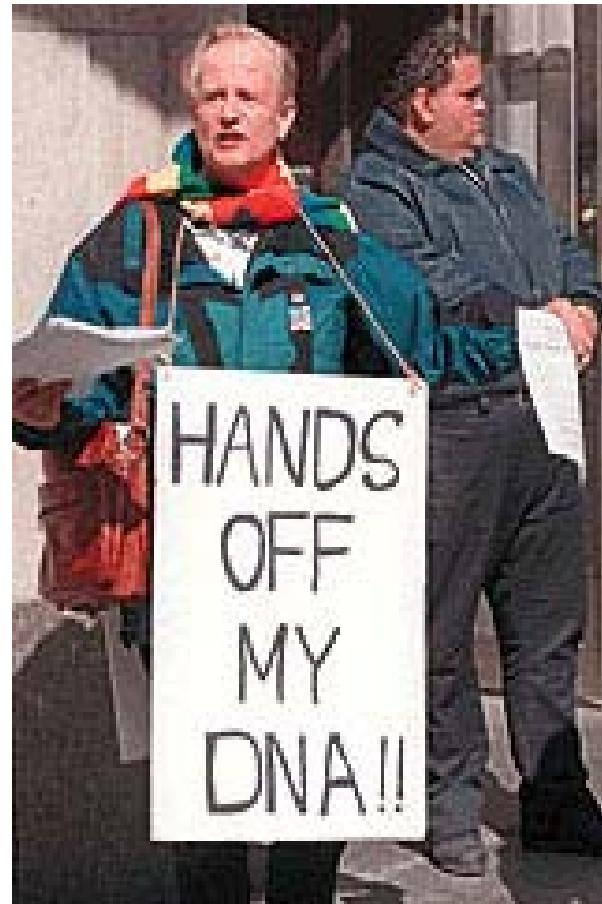
And what of the nature of parenthood itself?

Today, babies born to you are truly yours. Half of their inherited traits come from the father and half from the mother. Genetically designed babies would have genes that would come from neither side of the family. They would be the product not of blessed union but of a

**"I want to take us far from shore onto unknown waters, to a new phase of evolution, to the day when one DNA-based species can sit down at a computer to design another. I plan to show that we understand the software of life by creating new artificial life"**

— Craig Venter

The human genome project and the advances in biotechnology & genetic engineering have thrown up ethical issues that scientists, policy-makers and the public alike have struggled to come to terms with.



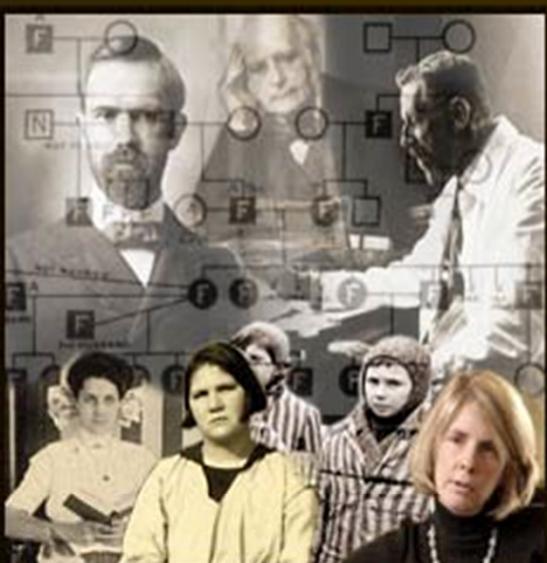


## 2010

Superstar genetic engineers Clive Nicoli (Adrien Brody) and Elsa Kast (Sarah Polley) achieve fame by successfully splicing together the DNA of different animals, to create incredible new hybrid animals. Now they want to use human DNA in a hybrid that could revolutionize science and medicine. But when the pharmaceutical company that funds their research forbids it, Clive and Elsa secretly conduct their own experiments in the pursuit of even greater scientific discovery. They secretly blend human DNA with their creations, ignoring their society's ethical and legal boundaries

# Ethical, Legal and Social Implications

## CHRONICLE



The Human Genome Project has provided the tools to determine the genes that influence human health and behavior. In the face of this knowledge, will society gravitate toward a prescribed definition of the genetic "right stuff?" Will we look with compassion or disdain on people with genes that predispose them to physical or mental illness?

Eugenics was the name of society's first attempt to grapple with these questions. The movement began benignly in England with positive efforts by families to improve their own heredity. Eugenics took a negative turn in America, where 30 states passed sterilization laws in a misguided attempt to limit the spread of mental illnesses and other "dysgenic" traits. Then, the Nazis began their march toward a "final solution" for racial purity with a massive program to sterilize mental patients.

Coming to grips with the past failings of eugenics may allow us to move with greater confidence into the new gene age.

Choose a module to begin:

THREAT of the UNFIT

TRIAL of CARRIE BUCK

IN the THIRD REICH

LIVING WITH EUGENICS



# What is YOUR role?



The ‘scientificisation’ of the humanities,  
and the humanization of the sciences  
—we should have this two-way flow.

-Catherine Lim  
(author & political commentator)

- Good *appreciation* of basic concepts of genetics & biotechnology.
- Relate their *impact* on society and environment.
- Empowering you with knowledge for decision-making in near future.