

Frontiers of Medicine

Student Handout

Background

"Discovery is seeing what everybody else has seen, and thinking what nobody else has thought."

---Albert Szent-Gyorgi
US. Biochemist
(1893-1986)

Genetic mapping... cloning... AIDS treatment... alternative medicine. Medical researchers are pushing the boundaries of a field known for the tireless pursuit of answers to pervasive, but often more common medical questions. Major breakthroughs on the cutting edge of medical research ripple through society as questions are raised about the social, political, religious and economic implications of the finding. In this program, we've gathered a panel of medical researchers to discuss the significance of their remarkable discoveries, both to the medical community and society as a whole. They share their personal thoughts and experiences about the challenges and rewards of a life dedicated to scientific inquiry. Joining us as guests are Dr. Francis Collins, Dr. David Ho, Dr. Barry Marshall, Dr. Ian Wilmut and Dr. Andrew Weil.

PEOPLE, PLACES and EVENTS

You may already be familiar with people who have made significant

PROGRAM GUESTS

Program Guests

Francis S. Collins, M.D., Ph.D.
Human Genome Project



Dr. Collins is Director of the National Center for Human Genome Research, Bethesda, Maryland, better known as the Human Genome Project. An honors graduate from the University of Virginia, he earned his doctorate at Yale, then enrolled in medical school and later joined the faculty of the University of Michigan, swiftly moving through the academic ranks. Collins developed the technique to map and identify genes that cause human disease. One major find was identifying the gene that causes cystic fibrosis. Last year, "after the longest and most frustrating search in the annals of molecular biology" he located the defective gene that causes Huntington's disease. This extraordinary "leader of the genetic revolution"

contributions to medical research. Conduct a brainstorming session with your fellow classmates to generate a list of at least five individuals who have made a noticeable difference in their profession. Next identify a significant contribution or key event in their lives. And then determine the geographic location or place associated with that event.

the genetic revolution was recently appointed as the director of the Human Genome Project, a 15-year multibillion-dollar effort to locate and map every gene in human DNA, one of the most significant undertakings in the history of biological research.

Person	Place	Event
1.		
2.		
3.		
4.		
5.		



David Ho, M.D. AIDS Research

Dr. Ho is Director of

The Aaron Diamond AIDS Research Center and was named Time Magazine's 1996 "Man of the Year". A summa cum laude physics major from Cal Tech, Ho came to the United States at age 12 without knowing a word of English. He earned a scholarship to Harvard Medical School and was among the first physicians to come into contact with the earliest known cases of AIDS. Ho performed or collaborated on much of the basic virology work that showed HIV does not lie dormant, as most scientists thought, but multiplies in vast numbers right from the start. His insights helped shift the focus of AIDS treatment from the late stages of illness to the first weeks

Pre-Program Explorations

Terms to Define

- AIDS
- alternative medicine
- antibiotic
- bacteria
- chromosome
- clone
- diseases of lifestyle
- DNA
- embryologist
- gene
- HIV
- host factors
- immune system
- mutation
- placebo
- RNA
- somatic cell
- stem cell
- ulcer
- vaccine

Topics to Research

- Trace the evolution of the fight against AIDS, from its emergence in the early 1980's to the present. How have incidence rates, treatments, survival and death rates, understanding of the disease, and education efforts changed over this period? What advances are forecast for the future?
- Distinguish between HIV, ARC, and AIDS. How is the virus contracted and what are its effects on the immune system?
- Outline the procedure by which a mammalian clone, such as Dolly, can be produced.
- What is the purpose of the Human Genome Project? What methodologies are being used to meet the goals of the project?
- Explain the roles of genes, chromosomes, and DNA in the replication of cells and organisms.

Issues to Consider

- What should be the goals of medicine and medical research?
- Should medicine and/or science do all of the things of which it is capable?
- What are the potential risks and benefits associated with genetic engineering?
- Although many diseases have well-documented, effective treatments, all

of infection which revolutionized the way the disease was treated. It was his pioneering work with therapeutic "cocktails" of protease inhibitors with other antiviral drugs that brought patients remarkable recoveries and raised hope that the virus might someday be eliminated.

Barry Marshall, M.D. Highest Honor in American Medicine



Dr. Marshall is a researcher at the University of Virginia and the recipient of the Albert Lasker Award, the highest honor in American medicine. As a brash young resident at an obscure hospital in western Australia, he wound up revolutionizing the world of medicine by showing that ulcers were not caused by stress or diet or acid. Marshall focused on proving that the chronic, debilitating disease affecting 10% of U.S. adults and worth \$25 billion to the drug industry is the product of a clever corkscrew-shaped organism which can be eradicated in two weeks of

segments of the world's population do not have equal access to health care. What are the ethical implications of these inequities?

- Is there a mind-body connection that affects one's health or one's ability to fend off disease?
- What should be the role of private industry in medical research and the applications thereof?
- How should society determine its priorities for expenditures and commitments? Should genetic engineering be one of those priorities, and if so, what benefits does it bring us?
- The featured guests are described as achievers. Does achievement differ from success, and in what ways? How would you define achievement?

Post-Program Explorations

ACHIEVEMENT EXPLORATIONS

- Achievement Television has defined six components of achievement: vision, preparation, integrity, courage, passion, and perseverance. Choose one of the featured guests and give examples of ways in which he embodies these traits.
- Choose one of the individuals listed in the first science exploration, and analyze his/her contributions, in light of our definition for achievement. Can he/she be described as an achiever?

antibiotic therapy. Animal experiments with the bacteria had failed to generate ulcers so Marshall, desperate to see whether he was right, raised a beaker and gulped down the bacteria. "It tasted like swamp water," he later said. His personal experiment helped confirm that an organism called *Helicobacter pylori* was the culprit. Instead of becoming a hero, he was mocked and his findings ignored by generations of doctors brought up to believe that ulcers were an acid problem. Today, nearly two decades later, his controversial ideas and methods are finding their way into common medical practice and his momentous discovery is being compared with the development of the polio vaccine and the eradication of smallpox.



Andrew Weil, M.D.
Integrative Medicine

Dr. Weil is perhaps America's best-known physician and one of the most sought-after doctors in the world. An advocate of self-help and alternative medicine, he is an honors graduate of Harvard and went on to

described as an achievement.

SCIENCE EXPLORATIONS

- Examine the contribution that each person has made to our current understanding of life and the way in which it functions.
 - Fred Sanger
 - George W. Beadle and Edward L. Tatum
 - Paul Berg
 - Erwin Chargaff
 - Harriet B. Creighton and Barbara McClintock
 - Francis H. C. Crick and James D. Watson
 - Walther Fleming
 - Archibald Garrod
 - Alfred Hershey and Martha Chase
 - Arthur Kornberg
 - Gregor Johann Mendel
 - Friedrich Miescher
 - Hermann J. Muller
 - Kary B. Mullis
 - Marshall Nirenberg and H. Gobind Khorana
 - Hamilton Smith and Kent Wilcox
 - Nettie Stevens and Edmund Wilson
 - Walter Stanborough Sutton
 - Edouard van Beneden
 - August Weismann
 - Maurice Wilkins and Rosalind Franklin
- Read *Race for the Double Helix*, the account of the discovery of DNA's structure. How did the understanding of DNA's structure evolve, after the substance was first discovered? What did you learn about the nature of

Harvard and went on to Harvard Medical School. He later worked at the National Institutes of Mental Health but quit and moved to a Sioux reservation and traveled widely in South America and Africa to investigate and to study indigenous medicine. Now Weil is a best-selling author, lecturer, and a consultant on medicinal plants, natural and preventive medicine, mind-body interactions, addictions, drug abuse, and drug policy. He is the founder of the Center for Integrative Medicine which seeks to integrate the ideas and practices of conventional and alternative medicine. Weil maintains that doctors tend to be pessimistic about natural healing because their training teaches them nothing about it, emphasizing, instead, the treatment of those who have already become seriously ill. Living in a healthy way, for Weil, involves not just nutrition and exercise but also the achievement of mental serenity.

Ian Wilmot, Ph.D.
The Nature of Creation



scientific endeavors? Who do you believe should have been awarded the Nobel Prize for the discovery?

- Pretend that you are a member of the National Bioethics Advisory Committee, which is convening to reevaluate its stand on human cloning. What criteria would you use to decide if efforts to clone humans should be pursued? What conditions would have to be met in order for you to grant approval for scientific cloning efforts?
- Conduct research to determine the cause(s), risk factors, symptoms, incidence, treatment and/or cure, prognosis, and fatality rate for the following genetic diseases: cystic fibrosis, Down's syndrome, hemophilia, muscular dystrophy, sickle cell anemia, Tay-Sachs disease.
- Drs. Marshall and Weil did not agree on whether technology has harmed or aided the cause of medicine. What is your opinion of its role? Support your position with specific examples.
- Conduct research to determine the five leading causes of death in the United States. Which of these can be categorized as "diseases of lifestyle"? What lifestyle changes decrease the likelihood, or delay the onset, of these diseases? Are you willing to make lifestyle changes now, for the sake of disease prevention later in life? Why or why not?

Dr. Wilmut is a trail-blazing embryologist at the Roslin Institute in Edinburgh, Scotland. As a boy, he wanted to be a farmer but, after a summer of laboratory work, he became enchanted by the magical progression of embryos from amorphous balls of cells into living entities of amazing complexity. He went on to earn his doctorate at the University of Cambridge. In the pursuit of the advancement of animal husbandry, he began experimenting with cloning, with a vision of creating genetically engineered farm animals that would manufacture therapeutic proteins in their milk. Instead a lamb named Dolly was cloned in his laboratory, a carbon copy of her mother, grown from a cell taken from an adult ewe's mammary gland. This raised legal, ethical and moral questions from all facets of society causing many to wonder "If sheep could be cloned, could humans be far behind?" The same trick that enabled scientists to clone Dolly could one day be used to clone a human being is a possibility Wilmut finds dismaying. The father of three argues that it is every child's

- Each society has many responsibilities to its members, yet money is a finite resource. Assuming that there is not enough money to explore any and all issues, provide a list of the ten most important areas for medical research, in ranked order. Indicate the reasons that an item is included on the list, as well as the rationale for its ranking.
- Explore the history of women in the field of medicine. What contributions have been made, what obstacles exist (or existed), and how can their role be expanded?

HISTORY/SOCIAL STUDIES/ETHICS EXPLORATIONS

- Trace the development of medicine over the course of history, from a discipline that was steeped in superstition and misunderstanding, to one that relies upon the scientific method to test hypotheses and determine validity of ideas.
- The twentieth century is often referred to as the age of physics, whereas the focus of the twenty-first century is expected to be biology or biotechnology. Discuss the appropriateness of these labels for each epoch. How did the age of physics impact society, and do you think that the age of biology will have similar effects upon humankind?
- As researchers work at the frontiers of medicine, who should ultimately decide which scientific applications should be pursued? And on what criteria should such decisions be based?
- Genetic engineering could give one the ability to alter the genes of one's offspring. For what reasons would such tinkering be ethical?
- Dr. Collins cited a quote from Albert Schweitzer, in which he said that technology must not exceed humanity. Explain this statement, and discuss the implications, for society, if technology were to exceed humanity. Has this already happened?

ENGLISH/LANGUAGE ARTS EXPLORATIONS

- The manner in which an HIV infection progresses has been likened to the episode of the Trojan War that involved the Trojan horse, as recounted in Homer's *Iliad*. Read this segment of Homer's epic and write an essay that evaluates the aptness of this analogy to describe HIV.

- Read Aldous Huxley's *Brave New World*. Evaluate the accuracy of his vision of genetic engineering and its effects.

CURRENT EVENT EXPLORATION (Web lesson)

The Future of Cloning

First there was Dolly. Then there was Polly. Two sheep that have opened our eyes to the possibilities that medical research has uncovered. The ability to clone cells, organisms, and large mammals, already exists. How might these technologies be used in the future, and what are the potential risks and benefits?

In this lesson, you will explore the Web to find out more about the current status of cloning technologies and possible future applications.

Question for Exploration

How might the ability to clone organisms impact future generations?

PROCEDURE

1. Collect background information. In order to formulate an answer to the "Question for Exploration", you'll need to conduct some research to gather pertinent information and data about the topics. Some suggested areas for research are listed below, but you may find that you need to answer additional questions to make an informed response. A list of Web sites is provided, at the end of the procedure section, to help jump-start your search. If you need to gather information from additional resources, be sure to evaluate their validity. Government and university sites generally have more reliable information than personal or commercial sites. Keep a record of the information you've collected, as well as the source of that material. Include both the Web site name and URL address.
 - What is a clone?
 - What is the procedure by which large mammals can be cloned?
 - What are the problems inherent to this procedure? Will scientific advances diminish these problems?
 - Are there any negative effects upon cloned offspring? Do they differ from offspring produced "naturally"?
 - How will changes to the genetic makeup of members of a

- How will changes to the genetic makeup of members of a population impact evolutionary processes and future generations?
- Does the cloning process increase the likelihood or severity of genetic mutations in a population?
- What has been accomplished in the field of cloning to date, and what research avenues are being explored?
- What are the benefits of cloning, on any scale (cells, tissues, organs, organisms), for medicine and the ability to treat and/or prevent disease?
- Currently, could a human be cloned?
- Why would the ability to clone humans be beneficial? When would it be acceptable?
- Is there potential for abuse of these technologies?
- How would such technologies be regulated? Who would benefit from these technologies?

2. Synthesize the information that you've collected to develop a response to the "Question for Exploration". The format for that response, (written, oral, Web-based, etc.) will be decided upon by your teacher.

Suggested Web sites:

[Cloned: News Updates and Information Resources](#)

[Slouching Towards Creation: Peering into the Face of Cloning](#)

[Cloning: A Special Report](#)

[Human Cloning Plans](#)

[The Church of Scotland: Science, Religion, and Technology Project](#)

[Human Cloning Foundation](#)

[Ethical Aspects of Human Cloning](#)