

REMARKS BY THE PRESIDENT
ON THE COMPLETION OF THE FIRST SURVEY OF
THE ENTIRE HUMAN GENOME PROJECT

The East Room
June 26, 2000

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I thank Secretary Shalala, who could not be here today; and Secretary Richardson, who is here. Dr. Ruth Kirschstein, Dr. Ari Patrinos, scientists of the Department of Health and Human Services and the Department of Energy, who have played an important role in the Human Genome Project.

I want to say a special word of thanks to my Science Advisor, Dr. Neal Lane. And of course, to Dr. Francis Collins, the Director of the International Human Genome Project; and to the Celera President, Craig Venter. I thank Senator Harkin and Senator Sarbanes for being here, and the other distinguished guests.

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The moment we are here to witness was brought about through brilliant and painstaking work of scientists all over the world, including many men and women here today. It was not even 50 years ago that a young Englishman named Crick and a brash, even

younger American named Watson, first discovered the elegant structure of our genetic code. Dr. Watson, the way you announced your discovery in the journal 'Nature,' was one of the great understatements of all time: "This structure has novel features, which are of considerable biological interest." Thank you, sir.

How far we have come since that day. In the intervening years, we have pooled the combined wisdom of biology, chemistry, physics, engineering, mathematics and computer science; tapped the great strengths and insights of the public and private sectors. More than 1,000 researchers across six nations have revealed nearly all 3 billion letters of our miraculous genetic code. I congratulate all of you on this stunning and humbling achievement.

Today's announcement represents more than just an epic-making triumph of science and reason. After all, when Galileo discovered he could use the tools of mathematics and mechanics to understand the motion of celestial bodies, he felt, in the words of one eminent researcher, "that he had learned the language in which God created the universe."

Today, we are learning the language in which God created life. We are gaining ever more awe for the complexity, the beauty, the wonder of God's most divine and sacred gift. With this profound new knowledge, humankind is on the verge of gaining immense, new power to heal. Genome science will have a real impact on all our lives -- and even more, on the lives of our children. It will revolutionize the diagnosis, prevention and treatment of most, if not all, human diseases.

In coming years, doctors increasingly will be able to cure diseases like Alzheimer's, Parkinson's, diabetes and cancer by attacking their genetic roots. Just to offer one example, patients with some forms of leukemia and breast cancer already are being treated in clinical trials with sophisticated new drugs that precisely target the faulty genes and cancer cells, with little or no risk to healthy cells. In fact, it is now conceivable that our children's children will know the term cancer only as a constellation of stars.

But today's historic achievement is only a starting point. There is much hard work yet to be done. That is why I'm so pleased to announce that from this moment forward, the robust and healthy competition that has led us to this day and that always is essential to the progress of science, will be coupled with enhanced public-private cooperation.

Public and private research teams are committed to publishing their genomic data simultaneously later this year, for the benefit of researchers in every corner of the globe. And after publication, both sets of teams will join together for an historic sequence analysis conference. Together, they will examine what scientific insights have been gleaned from both efforts, and how we can most judiciously proceed toward the next majestic horizons.

What are those next horizons? Well, first, we will complete a virtually error-free final draft of the human genome before the 50th anniversary of the discovery of the double helix, less than three years from now. Second, through sustained and vigorous support for public and private research, we must sort through this trove of genomic data to identify every human gene. We must discover the function of these genes and their protein products, and then we must rapidly convert that knowledge into treatments that can lengthen and enrich lives.

I want to emphasize that biotechnology companies are absolutely essential in this endeavor. For it is they who will bring to the market the life-enhancing applications of the information from the human genome. And for that reason, this administration is committed to helping them to make the kind of long-term investments that will change the face of medicine forever.

The third horizon that lies before us is one that science cannot approach alone. It is the horizon that represents the ethical, moral and spiritual dimension of the power we now possess. We must not shrink from exploring that far frontier of science. But as we consider how to use new discovery, we must also not retreat from our oldest and most cherished human values. We must ensure that new genome science and its benefits will be directed toward making life better for all citizens of the world, never just a privileged few.

As we unlock the secrets of the human genome, we must work simultaneously to ensure that new discoveries never pry open the doors of privacy. And we must guarantee that genetic information cannot be used to stigmatize or discriminate against any individual or group.

Increasing knowledge of the human genome must never change the basic belief on which our ethics, our government, our society are founded. All of us are created equal, entitled to equal treatment under the law. After all, I believe one of the great

truths to emerge from this triumphant expedition inside the human genome is that in genetic terms, all human beings, regardless of race, are more than 99.9 percent the same.

What that means is that modern science has confirmed what we first learned from ancient faiths. The most important fact of life on this Earth is our common humanity. My greatest wish on this day for the ages is that this incandescent truth will always guide our actions as we continue to march forth in this, the greatest age of discovery ever known.

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Now, it is my great pleasure to turn to my friend, Prime Minister Tony Blair, who is joined in the State Dining Room at 10 Downing Street by Dr. Fred Sanger and other world-renowned scientists. With the generous support of the Wellcome Trust, British scientists have played an invaluable role in reaching this milestone.

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On behalf of the American people, I would like to thank the Prime Minister, the scientists, and the British nation for the brilliant work you have brought to this international effort.

And, Mr. Prime Minister, I would like to salute not only your unwavering support for genome research, but also your visionary commitment to sparking ever-greater innovation across the full spectrum of science and technology.

And, on a personal note, I can't help but think that the year of your son's birth will always be remembered for the remarkable achievements we announce today. I think his life expectancy has just gone up by about 25 years.

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PRIME MINISTER BLAIR: Well, thank you very much, President Clinton; Bill. It's a great pleasure to join you, and I think of my little boy, Leo, growing up and learning and knowing things that his grandfather, after whom he was named, could not even have dreamt of. And when you contemplate that, it's almost not like different generations, but different eras of human existence. And there are enormous possibilities for him and his generation, but also some dangers, and our job is to try and develop the possibilities and thwart the dangers.

Thank you also, Ambassadors and distinguished guests, for being with us here in London on this momentous day. And as we

have this link, can I not for the first time, thank President Clinton for his role in a different topic, the Northern Ireland peace process. He's been an absolutely unstinting friend to me and to the process of peace in Northern Ireland. And as we continue progress with another important step forward today, I want, if I can, Bill, to underline our gratitude for your enormous contribution to that process. Thank you.

I would also like to pay tribute to President Clinton's support for the Human Genome Project, and for the huge role the United States has played in it. As befits an undertaking that can benefit the whole of humankind, this project has also brought together the best of the global scientific community. Many of the giants of our generation have been involved. Nobel prize-winners, like Fred Sanger and Max Perutz, who are here with me today, thank you for all that you have done.

Scientists from Japan and Germany, France, China, and around the world have been involved, as well as the U.K. and the U.S. And this undertaking, therefore, has brought together the public, private and non-profit sectors in an unprecedented international partnership. In particular, I would like to single out the Wellcome Trust, without whose vision and foresight, Britain's 30-percent contribution to the overall result would not have been possible. And I would like, too, to mention the imaginative work of Celera and Dr. Craig Venter, who in the best spirit of scientific competition, has helped accelerate today's achievement.

For let us be in no doubt about what we are witnessing today -- a revolution in medical science whose implications far surpass even the discovery of antibiotics, the first great technological triumph of the 21st century. And every so often in the history of human endeavor there comes a breakthrough that takes humankind across a frontier and into a new era. And like President Clinton, I believe that today's announcement is such a breakthrough -- a breakthrough that opens the way for massive advances in the treatment of cancer and hereditary diseases, and that is only the beginning.

Ever since Francis Crick and Jim Watson and other great Anglo-American scientific partnership made their historic discovery in the middle of the last century, we've known that DNA was the code to life on Earth. And yet, I guess for Crick and Watson, the process of identifying the billions of units of DNA and piecing them together to form a working blueprint of the human race must have seemed almost a superhuman task, beyond the reach of their generation. And yet, today, it is all but complete.

Nothing better demonstrates the way technology and science are driving us, fast-forwarding us all into the future. But with the power of this discovery comes, of course, the responsibility to use it wisely. As with the greatest scientific achievements, the ethical and the moral questions raised by this astonishing breakthrough are profound. We, all of us, share a duty to ensure that the common property of the human genome is used freely for the common good of the whole human race; to ensure that the powerful information now at our disposal is used to transform medicine, not abused, to make man his own creator or invade individual privacy.

For most of us, today's developments are almost too awesome fully to comprehend. They underline the extraordinary scale of economic, technological, scientific change that sweeps across the modern world. I'm proud that Britain has played, with others, a pioneering role in that. But I believe it says something very important about the process of change. We cannot resist change, but our job, indeed our duty, is to make sense of change, to help people through it, to seize the massive opportunities for better health and a better quality of life; and then, with equal vigor, to minimize the threats such developments pose.

The scientists have presented us with that opportunity that now we, all of us, accept the responsibility to make these advances work for all our people in all our countries for the common good of all humankind.

So, Bill, I believe that this underlines the fact that we do, indeed, as we've often said together, live in a global community, and the importance now of working across national frontiers to safeguard our shared values and put this remarkable scientific achievement at the service of all humankind.

THE PRESIDENT: Tony, if I could, I would like to pick up on your last remark. I think everybody genuinely is concerned about the issues you raised, the privacy issues, and the whole general set of ethical, social and legal issues.

And it strikes me that our scientists -- the British and the American scientists, our French, German, Chinese counterparts who worked on this -- were working toward a single, clearly-defined goal in all those countries and in the other countries of the world that will have to live with both the benefits and the challenges of these discoveries.

There are different legal systems, different social mores, but I think that it would be a very good thing if the U.S., the U.K., and anybody else that wants to work with us, could have the

same sort of joint endeavor we've had with the Human Genome, to deal with the implications of this; to deal with the legal, the social, the ethical implications. We may have differences from country to country, but I think that, if we work together, we'll give a higher sense of urgency to the project, and we'll get a better product.

And so I'm offering you another partnership. It's easy for me to do, because you'll have to do it, and I'll be gone.

PRIME MINISTER BLAIR: Well, Bill, I entirely agree with that. And I think the fascinating possibilities of this scientific breakthrough is that it gives us a chance to do so much for our people, but it will raise really difficult ethical and moral and legal questions.

And the decision for us really as humanity is whether we are going to engage in the right cooperation across national frontiers so that we shape our destiny in a way that genuinely does benefit all our people, that makes the most of the possibilities, and faces up to the challenges and the dangers that it poses. And in a way, I think that the scientists that have been involved in this great undertaking have shown the spirit of cooperation that should now motivate the governments in taking this forward another step. They have given us this opportunity that we, all of us, are going to have a common responsibility in using it in the right way.

So as we now go to join our separate events on either side of the Atlantic, I think and believe that that spirit of cooperation, along with the scientific achievement, is something that we can all celebrate. And I'm, once again, proud to have taken part in this event with you, Bill. And all the very best to you and all your team for the work that you've done.

THE PRESIDENT: Thank you. Thank you very much, Tony.

Now, in a few moments, we'll hear from Celera President, Dr. Craig Venter, who shares in the glory of this day, and deservedly so because of his truly visionary pursuit of innovative strategies to sequence the human genome as rapidly as possible. And I thank you, Craig, for what you have done to make this day possible.

And now I'd like to invite Dr. Francis Collins to the lectern. I also want to congratulate him. From his development of some of the central methods for finding human disease genes, to his successful application of those methods, to the discovery

of the cystic fibrosis gene in 1989, to his current leadership for the International Human Genome Project, he has combined the talents of rigorous science and a profound sensitivity to ethical, legal and social issues. He is a physician scientist of great faith, compassion, energy and integrity. And he has truly helped us, more than anyone else, to understand how the marvels of genome science will actually improve human health.

So Dr. Collins, please come up to the lectern.

DR. COLLINS: Mr. President, distinguished Ambassadors, ladies and gentlemen. It is truly a humble -- humbling and profound experience to be asked to speak here this morning. First of all, I would like to thank, most sincerely, President Clinton for his remarkable leadership in getting us to this point.

His strong and consistent voice for the importance of innovative science and its responsible uses to better the human condition has been an inspiration to all of us. He knows that genomics is one of the truly interdisciplinary fields of science requiring vigorous and creative involvement from physics, chemistry, engineering, computer science and biology.

I have also had the privilege to witness time and again the President's personal conviction that we must apply just as much energy and attention to solving the ethical, legal and social issues as we do to the bench research, and you saw that demonstrated again a few moments ago. His effective leadership in this area has moved us substantially closer to the time when no American need fear that information about their genome will be used against them.

Science is a voyage of exploration into the unknown. We are here today to celebrate a milestone along a truly unprecedented voyage, this one into ourselves. Alexander Pope wrote, "Know then thyself. Presume not God to scan. The proper study of mankind is man." What more powerful form of study of mankind could there be than to read our own instruction book?

I've been privileged over the last seven years to lead an international team of more than a thousand of some of the best and brightest scientists of our current generation, some of them here in this room, who have been truly dedicated to this goal. Today, we celebrate the revelation of the first draft of the human book of life.

Now, this milestone could only have come about with the happy combination of vision, determination, creative innovation and teamwork, and we stand on many shoulders here today. Beginning 15 years ago, leaders in the Department of Energy, the National Academy of Sciences and the National Institutes of Health, began to dream this dream.

At first, many thought it unrealistic and unattainable; yet, inspired by visionaries such as James Watson, who is here with us this morning, creative geniuses, such as Waterston, Sulston, Lander, Branscomb, Gibbs and many others here with us this morning, entered the fray. The vigorous involvement of talented colleagues in other countries, now including China, France, Germany, Japan and the United Kingdom, have made this project particularly gratifying to me. I would also like to recognize, publicly, the dedicated leadership of my friend and colleague, Ari Patrinos, of the Department of Energy, in moving this project forward so effectively here in the U.S.

Surely, the human genome is our shared inheritance, and it is fitting and proper that we are all working on it together. Now, thus far, every milestone set by the International Human Genome Project has been met -- on schedule or in some cases, ahead of schedule.

Today, we deliver, ahead of schedule again, the most visible and spectacular milestone of all. Most of the sequencing of the human genome by this international consortium has been done in just the last 15 months. During that time, this consortium has developed the capacity to sequence 1,000 letters of the DNA code per second, seven days a week, 24 hours a day. We have developed a map of overlapping fragments that includes 97 percent of the human genome, and we have sequenced 85 percent of this.

The sequence data is of higher quality than expected with half of it in finished or near-finished form. And all of this information has been placed in public databases every 24 hours, where any scientist with an Internet connection can use it to help unravel the mysteries of human biology. Already, more than a dozen genes, responsible for diseases from deafness to kidney disease to cancer, have been identified using this resource just in the last year.

So there is much to celebrate. But I have to tell you that this morning is also a bitter-sweet experience for me, personally. Less than 24 hours ago, I attended the funeral of my beloved sister-in-law, a wonderful marionette artist who brought magic and joy to thousands of children with her art.

She died much too soon of breast cancer. The hope and promise of understanding all of the genes in the genome and applying this knowledge to the development of powerful new tools came just too late for her.

I think I speak for all of us in this room, and for the millions of others who have come to believe in the remarkable promise of biomedical research, that we must redouble our efforts to speed the application of these profound and fundamental observations about the human genome to the cure of disease. That most desirable of all outcomes will only come about with a continued powerful and dedicated partnership between basic science investigators and academia, and their colleagues in the biotechnology and pharmaceutical industries.

As the President has said, we still have much to do. Many tasks lie ahead if we are to learn how to speak the language of the genome fluently. Today is most certainly not the end of genomics, but perhaps it's the end of the beginning. Together we must develop the advances in medicine that are the real reason for doing this work. And with just as much vigor, we must provide the protections against potential misuses of genetic information. If there is anyone within the sound of my voice who has not seen that as a priority, I hope today's announcement is the necessary wake-up call.

It's a happy day for the world. It is humbling for me and awe-inspiring to realize that we have caught the first glimpse of our own instruction book, previously known only to God. What a profound responsibility it is to do this work. Historians will consider this a turning point. Researchers in a few years will have trouble imagining how we studied human biology without the genome sequence in front of us.

I particularly welcome the opportunity to celebrate this moment jointly with our scientific colleagues at Celera Genomics, and I wish to express my personal gratitude to Dr. Craig Venter for his openness in the cooperative planning process that led to this joint announcement. I congratulate him and his team on the work done at Celera, which uses an elegant and innovative strategy that is highly complementary to the approach taken by the public project. Much will be learned from a comparison of the two.

I'm happy that today, the only race we are talking about is the human race.

It is now my distinct pleasure to introduce to you Dr. J. Craig Venter, the President of Celera Genomics. Inspired by a life-changing experience as a medical corpsman in Vietnam, Craig charged into the field of human biology with remarkable energy and determination. Never satisfied with the status quo, always seeking new technology, inventing new approaches when the old ones wouldn't do, he has made profound contributions to the field of genomics.

His development of the expressed sequence tag, or EST, approach for sampling the expressed part of the genome, reduced to practice the notion of considering the human genome as a bounded, but ascertainable set of information. Just a few years later, he electrified the scientific community by publishing, with his colleague, Hamilton Smith, the complete sequence of a free-living organism, the bacterium *hemophilus influenzae*. And just three months ago, using the innovative whole genome shotgun approach he developed, and working with Gerry Rubin of the University of California at Berkeley, he and his colleagues published a sequence of the fruit fly, *drosophila*, another remarkable milestone in biology.

Articulate, provocative, and never complacent, he has ushered in a new way of thinking about biology. Now under his leadership, Celera Genomics has accomplished a remarkable goal, their own first assembly of the human genome sequence.

It is an honor and a pleasure to invite him to tell you about this landmark achievement.

DR. VENTER: I'm shorter than the previous two speakers.

Mr. President, Mr. Prime Minister, members of the Cabinet, honorable members of Congress, ambassadors and distinguished guests. Today, June 26, in the year 2000, marks an historic point in the 100,000-year record of humanity. We're announcing today, for the first time our species can read the chemical letters of its genetic code.

At 12:30 p.m. today, at a joint press conference with the public genome effort, Celera Genomics will describe the first assembly of the human genetic code from the whole genome shotgun method. Starting only nine months ago, on September 8, 1999, 18 miles from the White House, a small team of scientists headed by myself, Hamilton Smith, Mark Adams, Gene Myers, and Granger Sutton, began sequencing the DNA of the human genome using a novel method pioneered by essentially the same team five years earlier at the Institute for Genomic Research.

The method used by Celera has determined the genetic code of five individuals. We have sequenced the genome of three females and two males, who have identified themselves as Hispanic, Asian, Caucasian, or African-American. We did this sampling not in an exclusionary way, but out of respect for the diversity that is America, and to help illustrate that the concept of race has no genetic or scientific basis.

In the five Celera genomes, there is no way to tell one ethnicity from another. Society and medicine treats us all as members of populations, where as individuals we are all unique, and population statistics do not apply.

I would like to acknowledge and congratulate Francis Collins and our colleagues in the public genome effort in the U.S., Europe and Asia, for their tremendous effort in generating a working draft of the human genome. I'd also like to personally thank Francis for his direct actions in working with me to foster cooperation in the genome community, and to shift our collective focus to this historic moment and its future impact on humanity. I would also like to thank the President for his commitment to public-private cooperation, and for making this day even more an historic event.

Obviously, our achievements would not have been possible without the efforts of the thousands of scientists around the world who have gone before us in the quest to better understand life at its most basic level. The beauty of science is that all-important discoveries are made by building on the discoveries of others. I continue to be inspired by the work of the pioneering men and women in the broad array of disciplines that had been brought together to enable this great accomplishment.

I would like to particularly acknowledge Charles DeLisi from the Department of Energy, and Jim Watson from Cold Spring Harbor, both here, for their vision in helping to initiate the Genome Project. The completion of the human genetic blueprint would not have been possible without the continued investment of the U.S. Government and basic research. I applaud the President's efforts and the work of Congress during the last several years in producing the largest funding increases to fuel the engines of basic science.

At the same time, we could not overlook the investment of the private sector in research in America. There would be no announcement today if it were not for the more than \$1 billion that P.E. Biosystems invested in Celera, and into the development of the automated DNA sequencer that both Celera and the public effort used to sequence the genome. In turn, some of the investment was driven by the public investment in science.

Thirty-three years ago, as a young man serving in the medical corps in Vietnam, I learned firsthand how tenuous our hold on life can be. That experience inspired my interest in learning how the trillions of cells in our bodies interact to create and sustain life. When I witnessed firsthand that some men live through devastating trauma to their bodies, while others died after giving up from seemingly small wounds, I realized that the human spirit was at least as important as our physiology.

We're clearly much, much more than the sum total of our genes, just as our society is greater than the sum total of each of us. Our physiology is based on complex and seemingly infinite interactions amongst all our genes and the environment, just as our civilization is based on the interactions amongst all of us.

One of the wonderful discoveries that my colleagues and I have made while decoding the DNA of over two dozen species, from viruses to bacteria to plants to insects, and now human beings, is that we're all connected to the commonality of the genetic code in evolution. When life is reduced to its very essence, we find that we have many genes in common with every species on Earth, and that we're not so different from one another.

You may be surprised to learn that your sequencers are greater than 90 percent identical to proteins in other animals. It's my belief that the basic knowledge that we're providing the world will have a profound impact on the human condition and the treatments for disease, and our view on our place in the biological continuum.

The genome sequence represents a new starting point for science and medicine, with potential impact on every disease. Taking the example, cancer, each day approximately 2,000 die in America from cancer. As a consequence of the genome efforts that you've heard described by Dr. Collins and myself this morning, and the research that will be catalyzed by this information, there's at least the potential to reduce the number of cancer deaths to zero during our lifetimes. The development of new therapeutics will require continued public investment in basic science, and the translations of discoveries into new medicine by the biotechs and pharmaceutical industry.

However, I am concerned, as many of you are, that there are some who will want to use this new knowledge as a basis of discrimination. A CNN-Time poll this morning reported that 46 percent of Americans polled believe that the impact of the Human Genome Project will be negative. We must work together toward higher science literacy and the wise use of our common heritage.

I know from personal discussions with the President over the past several years, and his comments here this morning, that genetic discrimination has been one of his major concerns about the impact of the genomic revolution. While those who will base social decisions on genetic reductionism will be ultimately defeated by science, new laws to protect us from genetic discrimination are critical in order to maximize the medical benefits from genome discoveries.

Some have said to me that sequencing the human genome will diminish humanity by taking the mystery out of life. Poets have argued that genome sequencing is an example of sterilizing reductionism that will rob them of their inspiration. Nothing could be further from the truth. The complexities and wonder of how the inanimate chemicals that are our genetic code give rise to the imponderables of the human spirit should keep poets and philosophers inspired for the millenniums.

Thank you.

THE PRESIDENT: Well, thank you both for those remarkable statements. I suppose, in closing, the most important thing I could do is to associate myself with Dr. Venter's last statement. When we get this all worked out and we're all living to be 150 -- young people will still fall in love, old people will still fight about things that should have been resolved 50 years ago -- we will all, on occasion, do stupid things, and we will all see the unbelievable capacity of humanity to be noble. This is a great day.

Thank you very much.

REMARKS BY THE PRESIDENT,
PRIME MINISTER TONY BLAIR OF ENGLAND (VIA SATELLITE),
DR. FRANCIS COLLINS, DIRECTOR OF THE NATIONAL
HUMAN GENOME RESEARCH INSTITUTE, AND
DR. CRAIG VENTER, PRESIDENT AND CHIEF SCIENTIFIC
OFFICER, CELERA GENOMICS CORPORATION,
ON THE COMPLETION OF THE FIRST SURVEY OF
THE ENTIRE HUMAN GENOME PROJECT
The East Room
June 26, 2000

THE PRESIDENT: Good morning. I want to, first of all, acknowledge Prime Minister Blair, who will join us by satellite in just a moment, from London. I want to welcome here the Ambassadors from the United Kingdom, Japan, Germany, France. And I'd also like to acknowledge the contributions not only that their scientists, but also scientists from China, made to the vast international consortium that is the Human Genome Project.

I thank Secretary Shalala, who could not be here today; and Secretary Richardson, who is here. Dr. Ruth Kirschstein, Dr. Ari Patrinos, scientists of the Department of Health and Human Services and the Department of Energy, who have played an important role in the Human Genome Project.

I want to say a special word of thanks to my Science Advisor, Dr. Neal Lane. And of course, to Dr. Francis Collins, the Director of the International Human Genome Project; and to the Celera President, Craig Venter. I thank Senator Harkin and Senator Sarbanes for being here, and the other distinguished guests.

Nearly two centuries ago, in this room, on this floor Thomas Jefferson and a trusted aide spread out a magnificent map -- a map Jefferson had long prayed he would get to see in his lifetime. The aide was Meriwether Lewis and the map was the product of his courageous expedition across the American frontier, all the way to the Pacific. It was a map that defined the contours and forever expanded the frontiers of our continent and our imagination.

Today, the world is joining us here in the East Room to behold a map of even greater significance. We are here to celebrate the completion of the first survey of the entire human genome. Without a doubt, this is the most important, most wondrous map ever produced by humankind.

The moment we are here to witness was brought about through brilliant and painstaking work of scientists all over the world, including many men and women here today. It was not even 50 years ago that a young Englishman named Crick and a brash, even younger American named Watson, first discovered the elegant structure of our genetic code. Dr. Watson, the way you announced your discovery in the journal 'Nature,' was one of the great understatements of all time. "This structure has novel features, which are of considerable biological interest." Thank you, sir.

How far we have come since that day. In the intervening years, we have pooled the combined wisdom of biology, chemistry, physics, engineering, mathematics and computer science; tapped the great strengths and insights of the public and private sectors. More than 1,000 researchers across six nations have revealed nearly all 3 billion letters of our miraculous genetic code. I congratulate all of you on this stunning and humbling achievement.

Today's announcement represents more than just an epic-making triumph of science and reason. After all, when Galileo discovered he could use the tools of mathematics and mechanics to understand the motion of celestial bodies, he felt, in the words of one eminent researcher, "that he had learned the language in which God created the universe."

Today, we are learning the language in which God created life. We are gaining ever more awe for the complexity, the beauty, the wonder of God's most divine and sacred gift. With this profound new knowledge, humankind is on the verge of gaining immense, new power to heal. Genome science will have a real impact on all our lives -- and even more, on the lives of our children. It will revolutionize the diagnosis, prevention and treatment of most, if not all, human diseases.

In coming years, doctors increasingly will be able to cure diseases like Alzheimer's, Parkinson's, diabetes and cancer by attacking their genetic roots. Just to offer one example, patients with some forms of leukemia and breast cancer already are being treated in clinical trials with sophisticated new drugs that precisely target the faulty genes and cancer cells, with little or no risk to healthy cells. In fact, it is now conceivable that our children's children will know the term cancer only as a constellation of stars.

But today's historic achievement is only a starting point. There is much hard work yet to be done. That is why I'm so

pleased to announce that from this moment forward, the robust and healthy competition that has led us to this day and that always is essential to the progress of science, will be coupled with enhanced public-private cooperation.

Public and private research teams are committed to publishing their genomic data simultaneously later this year, for the benefit of researchers in every corner of the globe. And after publication, both sets of teams will join together for an historic sequence analysis conference. Together, they will examine what scientific insights have been gleaned from both efforts, and how we can most judiciously proceed toward the next majestic horizons.

What are those next horizons? Well, first, we will complete a virtually error-free final draft of the human genome before the 50th anniversary of the discovery of the double helix, less than three years from now. Second, through sustained and vigorous support for public and private research, we must sort through this trove of genomic data to identify every human gene. We must discover the function of these genes and their protein products, and then we must rapidly convert that knowledge into treatments that can lengthen and enrich lives.

I want to emphasize that biotechnology companies are absolutely essential in this endeavor. For it is they who will bring to the market the life-enhancing applications of the information from the human genome. And for that reason, this administration is committed to helping them to make the kind of long-term investments that will change the face of medicine forever.

The third horizon that lies before us is one that science cannot approach alone. It is the horizon that represents the ethical, moral and spiritual dimension of the power we now possess. We must not shrink from exploring that far frontier of science. But as we consider how to use new discovery, we must also not retreat from our oldest and most cherished human values. We must ensure that new genome science and its benefits will be directed toward making life better for all citizens of the world, never just a privileged few.

As we unlock the secrets of the human genome, we must work simultaneously to ensure that new discoveries never pry open the doors of privacy. And we must guarantee that genetic information cannot be used to stigmatize or discriminate against any individual or group.

Increasing knowledge of the human genome must never change the basic belief on which our ethics, our government, our society are founded. All of us are created equal, entitled to equal treatment under the law. After all, I believe one of the great truths to emerge from this triumphant expedition inside the human genome is that in genetic terms, all human beings, regardless of race, are more than 99.9 percent the same.

What that means is that ^{fact,} modern science has confirmed what we first learned from ancient ~~fates~~. The most important fact of life on this Earth is our common humanity. My greatest wish on this day for the ages is that this incandescent truth will always guide our actions as we continue to march forth in this, the greatest age of discovery ever known.

Now, it is my great pleasure to turn to my friend, Prime Minister Tony Blair, who is joined in the State Dining Room at 10 Downing Street by Dr. Fred Sanger and other world-renowned scientists. With the generous support of the Wellcome Trust, British scientists have played an invaluable role in reaching this milestone.

On behalf of the American people, I would like to thank the Prime Minister, the scientists, and the British nation for the brilliant work you have brought to this international effort.

And, Mr. Prime Minister, I would like to salute not only your unwavering support for genome research, but also your visionary commitment to sparking ever-greater innovation across the full spectrum of science and technology.

And, on a personal note, I can't help but think that the year of your son's birth will always be remembered for the remarkable achievements we announce today. I think his life expectancy has just gone up by about 25 years.

PRIME MINISTER BLAIR: Well, thank you very much, President Clinton; Bill. It's a great pleasure to join you, and I think of my little boy, Leo, growing up and learning and knowing things that his grandfather, after whom he was named, could not even have dreamt of. And when you contemplate that, it's almost not like different generations, but different eras of human existence. And there are enormous possibilities for him and his generation, but also some dangers, and our job is to try and develop the possibilities and thwart the dangers.

Thank you also, Ambassadors and distinguished guests, for being with us here in London on this momentous day. And as we

have this link, can I not for the first time, thank President Clinton for his role in a different topic, the Northern Ireland peace process. He's been an absolutely unstinting friend to me and to the process of peace in Northern Ireland. And as we continue progress with another important step forward today, I want, if I can, Bill, to underline our gratitude for your enormous contribution to that process. Thank you.

I would also like to pay tribute to President Clinton's support for the Human Genome Project, and for the huge role the United States has played in it. As befits an undertaking that can benefit the whole of humankind, this project has also brought together the best of the global scientific community. Many of the giants of our generation have been involved. Nobel prize-winners, like Fred Sanger and Max Perutz, who are here with me today, thank you for all that you have done.

Scientists from Japan and Germany, France, China, and around the world have been involved, as well as the U.K. and the U.S. And this undertaking, therefore, has brought together the public, private and non-profit sectors in an unprecedented international partnership. In particular, I would like to single out the Wellcome Trust, without whose vision and foresight, Britain's 30-percent contribution to the overall result would not have been possible. And I would like, too, to mention the imaginative work of Celera and Dr. Craig Venter, who in the best spirit of scientific competition, has helped accelerate today's achievement.

For let us be in no doubt about what we are witnessing today -- a revolution in medical science whose implications far surpass even the discovery of antibiotics, the first great technological triumph of the 21st century. And every so often in the history of human endeavor there comes a breakthrough that takes humankind across a frontier and into a new era. And like President Clinton, I believe that today's announcement is such a breakthrough -- a breakthrough that opens the way for massive advances in the treatment of cancer and hereditary diseases, and that is only the beginning.

Ever since Francis Crick and Jim Watson and other great Anglo-American scientific partnership made their historic discovery in the middle of the last century, we've known that DNA was the code to life on Earth. And yet, I guess for Crick and Watson, the process of identifying the billions of units of DNA and piecing them together to form a working blueprint of the human race must have seemed almost a superhuman task, beyond the reach of their generation. And yet, today, it is all but complete.

Nothing better demonstrates the way technology and science are driving us, fast-forwarding us all into the future. But with the power of this discovery comes, of course, the responsibility to use it wisely. As with the greatest scientific achievements, the ethical and the moral questions raised by this astonishing breakthrough are profound. We, all of us, share a duty to ensure that the common property of the human genome is used freely for the common good of the whole human race; to ensure that the powerful information now at our disposal is used to transform medicine, not abused, to make man his own creator or invade individual privacy.

For most of us, today's developments are almost too awesome fully to comprehend. They underline the extraordinary scale of economic, technological, scientific change that sweeps across the modern world. I'm proud that Britain has played, with others, a pioneering role in that. But I believe it says something very important about the process of change. We cannot resist change, but our job, indeed our duty, is to make sense of change, to help people through it, to seize the massive opportunities for better health and a better quality of life; and then, with equal vigor, to minimize the threats such developments pose.

The scientists have presented us with that opportunity that now we, all of us, accept the responsibility to make these advances work for all our people in all our countries for the common good of all humankind.

So, Bill, I believe that this underlines the fact that we do, indeed, as we've often said together, live in a global community, and the importance now of working across national frontiers to safeguard our shared values and put this remarkable scientific achievement at the service of all humankind.

THE PRESIDENT: Tony, if I could, I would like to pick up on your last remark. I think everybody genuinely is concerned about the issues you raised, the privacy issues, and the whole general set of ethical, social and legal issues.

And it strikes me that our scientists -- the British and the American scientists, our French, German, Chinese counterparts who worked on this -- were working toward a single, clearly-defined goal in all those countries and in the other countries of the world that will have to live with both the benefits and the challenges of these discoveries.

There are different legal systems, different social mores, but I think that it would be a very good thing if the U.S., the U.K., and anybody else that wants to work with us, could have the

same sort of joint endeavor we've had with the Human Genome, to deal with the implications of this; to deal with the legal, the social, the ethical implications. We may have differences from country to country, but I think that, if we work together, we'll give a higher sense of urgency to the project, and we'll get a better product.

And so I'm offering you another partnership. It's easy for me to do, because you'll have to do it, and I'll be gone.

PRIME MINISTER BLAIR: Well, Bill, I entirely agree with that. And I think the fascinating possibilities of this scientific breakthrough is that it gives us a chance to do so much for our people, but it will raise really difficult ethical and moral and legal questions.

And the decision for us really as humanity is whether we are going to engage in the right cooperation across national frontiers so that we shape our destiny in a way that genuinely does benefit all our people, that makes the most of the possibilities, and faces up to the challenges and the dangers that it poses. And in a way, I think that the scientists that have been involved in this great undertaking have shown the spirit of cooperation that should now motivate the governments in taking this forward another step. They have given us this opportunity that we, all of us, are going to have a common responsibility in using it in the right way.

So as we now go to join our separate events on either side of the Atlantic, I think and believe that that spirit of cooperation, along with the scientific achievement, is something that we can all celebrate. And I'm, once again, proud to have taken part in this event with you, Bill. And all the very best to you and all your team for the work that you've done.

THE PRESIDENT: Thank you. Thank you very much, Tony.

Now, in a few moments, we'll hear from Celera President, Dr. Craig Venter, who shares in the glory of this day, and deservedly so because of his truly visionary pursuit of innovative strategies to sequence the human genome as rapidly as possible. And I thank you, Craig, for what you have done to make this day possible.

And now I'd like to invite Dr. Francis Collins to the lectern. I also want to congratulate him. From his development of some of the central methods for finding human disease genes, to his successful application of those methods, to the discovery

of the cystic fibrosis gene in 1989, to his current leadership for the International Human Genome Project, he has combined the talents of rigorous science and a profound sensitivity to ethical, legal and social issues. He is a physician scientist of great faith, compassion, energy and integrity. And he has truly helped us, more than anyone else, to understand how the marvels of genome science will actually improve human health.

So Dr. Collins, please come up to the lectern.

DR. COLLINS: Mr. President, distinguished Ambassadors, ladies and gentlemen. It is truly a humble -- humbling and profound experience to be asked to speak here this morning. First of all, I would like to thank, most sincerely, President Clinton for his remarkable leadership in getting us to this point.

His strong and consistent voice for the importance of innovative science and its responsible uses to better the human condition has been an inspiration to all of us. He knows that genomics is one of the truly interdisciplinary fields of science requiring vigorous and creative involvement from physics, chemistry, engineering, computer science and biology.

I have also had the privilege to witness time and again the President's personal conviction that we must apply just as much energy and attention to solving the ethical, legal and social issues as we do to the bench research, and you saw that demonstrated again a few moments ago. His effective leadership in this area has moved us substantially closer to the time when no American need fear that information about their genome will be used against them.

Science is a voyage of exploration into the unknown. We are here today to celebrate a milestone along a truly unprecedented voyage, this one into ourselves. Alexander Pope wrote, "Know then thyself. Presume not God to scan. The proper study of mankind is man." What more powerful form of study of mankind could there be than to read our own instruction book?

I've been privileged over the last seven years to lead an international team of more than a thousand of some of the best and brightest scientists of our current generation, some of them here in this room, who have been truly dedicated to this goal. Today, we celebrate the revelation of the first draft of the human book of life.

Now, this milestone could only have come about with the happy combination of vision, determination, creative innovation and teamwork, and we stand on many shoulders here today. Beginning 15 years ago, leaders in the Department of Energy, the National Academy of Sciences and the National Institutes of Health, began to dream this dream.

At first, many thought it unrealistic and unattainable; yet, inspired by visionaries such as James Watson, who is here with us this morning, creative geniuses, such as Waterston, Sulston, Lander, Branscomb, Gibbs and many others here with us this morning, entered the fray. The vigorous involvement of talented colleagues in other countries, now including China, France, Germany, Japan and the United Kingdom, have made this project particularly gratifying to me. I would also like to recognize, publicly, the dedicated leadership of my friend and colleague, Ari Patrinos, of the Department of Energy, in moving this project forward so effectively here in the U.S.

Surely, the human genome is our shared inheritance, and it is fitting and proper that we are all working on it together. Now, thus far, every milestone set by the International Human Genome Project has been met -- on schedule or in some cases, ahead of schedule.

Today, we deliver, ahead of schedule again, the most visible and spectacular milestone of all. Most of the sequencing of the human genome by this international consortium has been done in just the last 15 months. During that time, this consortium has developed the capacity to sequence 1,000 letters of the DNA code per second, seven days a week, 24 hours a day. We have developed a map of overlapping fragments that includes 97 percent of the human genome, and we have sequenced 85 percent of this.

The sequence data is of higher quality than expected with half of it in finished or near-finished form. And all of this information has been placed in public databases every 24 hours, where any scientist with an Internet connection can use it to help unravel the mysteries of human biology. Already, more than a dozen genes, responsible for diseases from deafness to kidney disease to cancer, have been identified using this resource just in the last year.

So there is much to celebrate. But I have to tell you that this morning is also a bitter-sweet experience for me, personally. Less than 24 hours ago, I attended the funeral of my beloved sister-in-law, a wonderful marionette artist who brought magic and joy to thousands of children with her art.

She died much too soon of breast cancer. The hope and promise of understanding all of the genes in the genome and applying this knowledge to the development of powerful new tools came just too late for her.

I think I speak for all of us in this room, and for the millions of others who have come to believe in the remarkable promise of biomedical research, that we must redouble our efforts to speed the application of these profound and fundamental observations about the human genome to the cure of disease. That most desirable of all outcomes will only come about with a continued powerful and dedicated partnership between basic science investigators and academia, and their colleagues in the biotechnology and pharmaceutical industries.

As the President has said, we still have much to do. Many tasks lie ahead if we are to learn how to speak the language of the genome fluently. Today is most certainly not the end of genomics, but perhaps it's the end of the beginning. Together we must develop the advances in medicine that are the real reason for doing this work. And with just as much vigor, we must provide the protections against potential misuses of genetic information. If there is anyone within the sound of my voice who has not seen that as a priority, I hope today's announcement is the necessary wake-up call.

It's a happy day for the world. It is humbling for me and awe-inspiring to realize that we have caught the first glimpse of our own instruction book, previously known only to God. What a profound responsibility it is to do this work. Historians will consider this a turning point. Researchers in a few years will have trouble imagining how we studied human biology without the genome sequence in front of us.

I particularly welcome the opportunity to celebrate this moment jointly with our scientific colleagues at Celera Genomics, and I wish to express my personal gratitude to Dr. Craig Venter for his openness in the cooperative planning process that led to this joint announcement. I congratulate him and his team on the work done at Celera, which uses an elegant and innovative strategy that is highly complementary to the approach taken by the public project. Much will be learned from a comparison of the two.

I'm happy that today, the only race we are talking about is the human race.

It is now my distinct pleasure to introduce to you Dr. J. Craig Venter, the President of Celera Genomics. Inspired by a life-changing experience as a medical corpsman in Vietnam, Craig charged into the field of human biology with remarkable energy and determination. Never satisfied with the status quo, always seeking new technology, inventing new approaches when the old ones wouldn't do, he has made profound contributions to the field of genomics.

His development of the expressed sequence tag, or EST, approach for sampling the expressed part of the genome, reduced to practice the notion of considering the human genome as a bounded, but ascertainable set of information. Just a few years later, he electrified the scientific community by publishing, with his colleague, Hamilton Smith, the complete sequence of a free-living organism, the bacterium *hemophilus influenzae*. And just three months ago, using the innovative whole genome shotgun approach he developed, and working with Gerry Rubin of the University of California at Berkeley, he and his colleagues published a sequence of the fruit fly, *drosophila*, another remarkable milestone in biology.

Articulate, provocative, and never complacent, he has ushered in a new way of thinking about biology. Now under his leadership, Celera Genomics has accomplished a remarkable goal, their own first assembly of the human genome sequence.

It is an honor and a pleasure to invite him to tell you about this landmark achievement.

DR. VENTER: I'm shorter than the previous two speakers.

Mr. President, Mr. Prime Minister, members of the Cabinet, honorable members of Congress, ambassadors and distinguished guests. Today, June 26, in the year 2000, marks an historic point in the 100,000-year record of humanity. We're announcing today, for the first time our species can read the chemical letters of its genetic code.

At 12:30 p.m. today, at a joint press conference with the public genome effort, Celera Genomics will describe the first assembly of the human genetic code from the whole genome shotgun method. Starting only nine months ago, on September 8, 1999, 18 miles from the White House, a small team of scientists headed by myself, Hamilton Smith, Mark Adams, Gene Myers, and Granger Sutton, began sequencing the DNA of the human genome using a novel method pioneered by essentially the same team five years earlier at the Institute for Genomic Research.

The method used by Celera has determined the genetic code of five individuals. We have sequenced the genome of three females and two males, who have identified themselves as Hispanic, Asian, Caucasian, or African-American. We did this sampling not in an exclusionary way, but out of respect for the diversity that is America, and to help illustrate that the concept of race has no genetic or scientific basis.

In the five Celera genomes, there is no way to tell one ethnicity from another. Society and medicine treats us all as members of populations, where as individuals we are all unique, and population statistics do not apply.

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Obviously, our achievements would not have been possible without the efforts of the thousands of scientists around the world who have gone before us in the quest to better understand life at its most basic level. The beauty of science is that all-important discoveries are made by building on the discoveries of others. I continue to be inspired by the work of the pioneering men and women in the broad array of disciplines that had been brought together to enable this great accomplishment.

I would like to particularly acknowledge Charles DeLisi from the Department of Energy, and Jim Watson from Cold Spring Harbor, both here, for their vision in helping to initiate the Genome Project. The completion of the human genetic blueprint would not have been possible without the continued investment of the U.S. Government and basic research. I applaud the President's efforts and the work of Congress during the last several years in producing the largest funding increases to fuel the engines of basic science.

At the same time, we could not overlook the investment of the private sector in research in America. There would be no announcement today if it were not for the more than \$1 billion that P.E. Biosystems invested in Celera, and into the development of the automated DNA sequencer that both Celera and the public effort used to sequence the genome. In turn, some of the investment was driven by the public investment in science.

Thirty-three years ago, as a young man serving in the medical corps in Vietnam, I learned firsthand how tenuous our hold on life can be. That experience inspired my interest in learning how the trillions of cells in our bodies interact to create and sustain life. When I witnessed firsthand that some men live through devastating trauma to their bodies, while others died after giving up from seemingly small wounds, I realized that the human spirit was at least as important as our physiology.

We're clearly much, much more than the sum total of our genes, just as our society is greater than the sum total of each of us. Our physiology is based on complex and seemingly infinite interactions amongst all our genes and the environment, just as our civilization is based on the interactions amongst all of us.

One of the wonderful discoveries that my colleagues and I have made while decoding the DNA of over two dozen species, from viruses to bacteria to plants to insects, and now human beings, is that we're all connected to the commonality of the genetic code in evolution. When life is reduced to its very essence, we find that we have many genes in common with every species on Earth, and that we're not so different from one another.

You may be surprised to learn that your sequencers are greater than 90 percent identical to proteins in other animals. It's my belief that the basic knowledge that we're providing the world will have a profound impact on the human condition and the treatments for disease, and our view on our place in the biological continuum.

The genome sequence represents a new starting point for science and medicine, with potential impact on every disease. Taking the example, cancer, each day approximately 2,000 die in America from cancer. As a consequence of the genome efforts that you've heard described by Dr. Collins and myself this morning, and the research that will be catalyzed by this information, there's at least the potential to reduce the number of cancer deaths to zero during our lifetimes. The development of new therapeutics will require continued public investment in basic science, and the translations of discoveries into new medicine by the biotechs and pharmaceutical industry.

However, I am concerned, as many of you are, that there are some who will want to use this new knowledge as a basis of discrimination. A CNN-Time poll this morning reported that 46 percent of Americans polled believe that the impact of the Human Genome Project will be negative. We must work together toward higher science literacy and the wise use of our common heritage.

I know from personal discussions with the President over the past several years, and his comments here this morning, that genetic discrimination has been one of his major concerns about the impact of the genomic revolution. While those who will base social decisions on genetic reductionism will be ultimately defeated by science, new laws to protect us from genetic discrimination are critical in order to maximize the medical benefits from genome discoveries.

Some have said to me that sequencing the human genome will diminish humanity by taking the mystery out of life. Poets have argued that genome sequencing is an example of sterilizing reductionism that will rob them of their inspiration. Nothing could be further from the truth. The complexities and wonder of how the inanimate chemicals that are our genetic code give rise to the imponderables of the human spirit should keep poets and philosophers inspired for the millenniums.

Thank you.

THE PRESIDENT: Well, thank you both for those remarkable statements. I suppose, in closing, the most important thing I could do is to associate myself with Dr. Venter's last statement. When we get this all worked out and we're all living to be 150 -- young people will still fall in love, old people will still fight about things that should have been resolved 50 years ago -- we will all, on occasion, do stupid things, and we will all see the unbelievable capacity of humanity to be noble. This is a great day.

Thank you very much.