Darwin@Cornell 2006

A Community Discusses Evolution, Creationism, and Intelligent Design

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Preface

This book is based on two related but independent events.

The first was the decision of Hunter Rawlings, then serving as Interim President of Cornell University, to devote his October 2005 State of the University speech to the issue of intelligent design (ID). Rawlings was one of only a handful of national higher education leaders to speak out on the topic, which was generating heated controversy at local and national levels, and in the courts. During his speech, he called on Cornellians to address head-on the complex cultural issues generated by the religiously based ID controversy. “I believe,” he said, “that the political movement seeking to inject religion into state policy and our schools is serious enough to require our collective time and attention.” Rawlings received a standing ovation—as well as praise in the national media—for his stand. At the time, ID was the focus of Kitzmiller v. Dover, the so-called “Pandatrial” in Harrisburg, Pennsylvania. The verdict was handed down on December 21, 2005 and held against teaching ID in the public school science classroom.

The second event was the celebration of Darwin Day weekend at Cornell and the surrounding Ithaca community on February 9-13, 2006. This first Ithaca Darwin Day celebration was co-sponsored by the Paleontological Research Institution (PRI), the Office of the Provost at Cornell, Cornell United Religious Work, and the Biology Department at Ithaca College. The weekend began February 9 with a panel discussion at PRI’s Museum of the Earth on “Where Do We Go from Here: The Future of Darwinism in American Society,” the edited transcript of which is included in this book. The following day another panel discussion on “Evolutionary Biology: Present and Future” was held at Cornell, the edited transcript of which also appears here. Also, there was a screening at Cornell of the classic 1960 version of the film “Inherit the Wind.” On February 11 activities for families and teachers around the theme of evolution were held at the Museum, as well as a reception and birthday party for Museum members. On February 12, filmmaker and evolutionary biologist Randy Olson hosted a screening on the Cornell campus of his new documentary film “Flock of Dodos,” about the current state of the evolution-creationism debate. The showing was followed by a lively audience discussion that Olson later described as “the best of all five screenings that I did” and “the smartest, most focused group of people.” Finally, on February 13, a panel discussion about evolution was held at Ithaca College. Altogether, more than 700 people participated in the weekend’s activities.

Many people helped support this book and the activities on which it is based. We are grateful to Cornell President Emeritus Hunter Rawlings for taking on such an important and controversial topic from his bully pulpit, and for
permission to reprint his speeches here. We are also grateful to Cornell Provost Carolyn “Biddy” Martin, Janet Shortall at Cornell United Religious Work, and Susan Swensen in the Biology Department at Ithaca College, for agreeing to formally co-sponsor Ithaca’s first Darwin Day weekend. We are especially grateful to Stephan Loewentheil, whose generous financial support made the weekend’s events possible. Special thanks are also due to Cornell Vice President of Communications and Media Relations Thomas W. Bruce for arranging for transcription of the Darwin Day panel discussions and for providing funds for the printing of this volume.

Warren D. Allmon
Linda Grace-Kobas
Ithaca, New York, September, 2006
Foreword
William B. Provine

In the United States in 2006, more than 250 churches (pro and con evolution), atheist organizations, humanist organizations, and universities held Darwin Day Celebrations on or around the date of Charles Darwin’s birthday, February 12\(^1\). Three hundred and twenty churches from 48 states celebrated the compatibility of Darwin and religion. Only a very few universities, however, held Darwin Day events. Salem State College in Salem, Massachusetts, is the champion, with a continuous Darwin Day Festival every year since 1980. The University of Tennessee, under the guidance of Massimo Pigliucci, started its Darwin Day in 1998. Pigliucci recently moved to Stony Brook University where he has started a new Darwin Day. Duquesne University started its Darwin Day celebration in 2003 and plans to keep it going. The University of Wisconsin and a few others have started celebrations recently.

Now Cornell has started its own Darwin Day in 2006 and the results are in this book. The wide range of talented speakers, the depth of comments and replies, and the intense interest shown by audiences show that Cornell is the ideal place for celebrating Darwin Day. We don’t just look forward to the golden year of 2009 (two centuries after Darwin’s birth and the 150th anniversary of *On the Origin of Species*) but to each and every year.

Celebration of Darwin has really changed in the last 30 years. In 1982, I offered to organize a session for the annual meeting of the American Association for the Advancement of Science devoted to Darwin on the occasion of the centenary of his death. My speakers were Stephen Jay Gould, Ernst Mayr, Ledyard Stebbins, and Walter Fitch. AAAS approved the session and scheduled it for a room holding 80. I suggested to the organizers that the audience would fill the room with a large overflow, but they waited until the room was filled before moving it to a large auditorium, which also filled to the brim. This session was the only major celebration of Darwin that year of which I am aware, except for Darwin Day at Salem State College. The thirst for understanding Darwin and evolutionary biology (pro or con) was great, but academia was failing to provide the excitement. That has clearly begun to change.

Cornell’s Darwin Day celebration was important in its first year. In years following, I see it becoming *the* pivotal Darwin Day in the nation. Whether you’re interested, engaged, or enraged by what you read here, participate in the next one!

Notes:
Introduction: Discussing Evolution
Warren D. Allmon

As residents of what is all too often seen as an exclusive ivory tower, academics are frequently criticized for thinking and talking about things that don’t much matter to everyday life and everyday people. For example, it is often said that resources spent in the pursuit of mere ideas - which is what most academics devote their time to - could be better spent on more productive concerns. Yet, as we are reminded every day, ideas are the most potent motivators of human action. They affect war and peace, prosperity and poverty, politics and power. In an important sense, nothing matters more.

Evolution in general, and Darwinian evolution in particular, is one of those ideas that really matter. scientifically it is at the core of most, if not all, biological science at the beginning of what has been called the “century of biology.” Beyond science, Darwinian evolution addresses (importantly but not exhaustively) some of the biggest questions of human existence: what is our place in nature and the universe in general? where did we come from? This joint importance of evolution inside and outside of science is probably responsible for its uniqueness among scientific ideas. Perhaps no other concept in science has produced so much controversy, debate, and emotion beyond scientific circles, and it continues to cause heated arguments today. Yet this turmoil occurs against a backdrop of essentially complete consensus within science about the truth of evolution as an explanation for the history, form, and diversity of life on Earth.

A university is the ideal environment in which to consider such a hugely important idea. Colleges and universities are among the very few places in American society where ideas can be examined from multiple perspectives, where divergent views are regularly given respect, where very different disciplines can find common ground and bring their different points of view to bear on a common issue. Universities are not just places for teaching and the creation of knowledge; they are places where ideas can be picked up, turned over, looked at in detail, apart (at least temporarily) from the increasingly loud, bottom-line, 24-7 pace of modern culture. This is especially true of evolution, which in the general society commonly generates more heat than light from different sides who are often poorly informed of the other point of view. Evolution greatly transcends science in its social importance.

Cornell in particular is an especially appropriate university at which to have a conversation about evolution. Cornell is, first of all, home to some of the best biological and evolutionary science in the world, and it is currently strengthening its already secure position as one of the world’s leading centers of research at the frontiers of life-science, such as genomics and proteomics, which cannot be
understood without reference to evolution. Second, the topics of the relationship between science and religion were an integral part of the very founding of Cornell as an explicitly secular university by Ezra Cornell and Andrew Dixon White in the middle of the nineteenth century. Third, Cornell’s status as New York State’s land grant university stresses its role in educational outreach; Cornell literally reaches out to the general public in every county of the State and beyond.

While these auspicious conditions for discussing evolution have been true at Cornell for almost 150 years, now is a time in which the open and active consideration of this topic are more essential and important than ever. The first decade of the twenty-first century in America has turned out to be a time of resurgent public conversation and conflict over evolution, especially in its Darwinian form that emphasizes materialistic natural selection as its major cause or mechanism. The country is in a politically and socially conservative mood, and the connections between politics and science - and politics and religion - have become issues of regular public discussion. Evolution has never been more central to biology, yet it has not been as successfully attacked outside of science in a quarter century.

Evolution really matters, and for the diverse sides of this frequently very polarized debate, the stakes are high indeed. For scientists - and not just biologists -- it is the very nature of science, science education, and public science literacy that are on trial. Our socioeconomic well-being, furthermore, depends in large part on science and engineering. Even if you accept that one can be a medical doctor or engineer without using or even accepting evolution, almost everyone understands that science education is vital to our economic competitiveness and even survival in a world of increasing technological and environmental change. Evolution is solid science. If it is wrong then surely so is a great deal else we think science tells us about the world. The fate of evolution and modern science are closely intertwined. Outside of science, at stake are profound issues of the nature of the relationship of church and state, science and government, critical thinking, and religious tolerance.

All of this is happening as we approach 2009, the two-hundredth anniversary of the birth of Charles Darwin and the one-hundred-fiftieth anniversary of the publication of his most important book, *On the Origin of Species*. Darwin was born on February 12, 1809 (the very same day as Abraham Lincoln), and the observance of this date has increasingly become known as “Darwin Day” around the world. The activities around Darwin Day are beginning to have the trappings of a minor movement, with websites and books (see Sources of More Information, page 84) and new celebrations popping up in more places every year. In the U.S., college campuses and their surrounding communities are among the most active locations of these fests.

In this context, this little book presents an example of the best of what uni-
iversities can and do bring to the consideration of such a complex and important topic, which is thoughtful and informed dialog among different fields of human thought. It is also an example of how universities can and do collaborate in very meaningful ways with their surrounding communities - including museums, schools, and the general public - to share more than just an occasional expert or spinoff technology. This book is a small example of the results of reaching beyond the ivory tower, beyond biology and politics, to the world of ideas that are the common heritage and birthright of all human beings.
Elizabeth and I are pleased to be back in our previous roles while Cornell searches for its next president. I share Pete Meinig’s enthusiasm for Cornell’s priorities, and I can attest to the momentum with which the university is moving forward to realize them. I am grateful for the role that the Cornell University Council has played under the leadership of Ginger So for the past two years and now plays under your guiding hand. I have every confidence that the search committee will identify a first-rate person to lead Cornell as our next president, and I look forward to rejoining the faculty full time, once he or she has assumed the office.

This morning, though, I want to address a matter of great significance to Cornell and to the country as a whole, a matter with fundamental educational, intellectual, and political implications. This matter has become so urgent that I feel it imperative to make it the central subject of my State of the University Address on Trustee-Council Weekend.

The issue in question is the challenge to science posed by religiously-based opposition to evolution, described, in its current form, as “intelligent design.” This controversy raises profound questions about the nature of public discourse and what we teach in universities, and it has a profound effect on public policy.

Right now, this issue is playing out in school districts, cities, counties and states across the country. In August, the Association of Christian Schools International and the Calvary Chapel Christian Schools in Murrieta, California, brought suit against the University of California system for rejecting three of the Calvary Chapel Schools’ courses, including a creationist-oriented biology course, as inadequate preparation for college. The plaintiffs charge that by rejecting the courses, the University of California infringes on their rights “to freedom of speech, freedom from viewpoint discrimination, freedom of religion and association, freedom from arbitrary discretion, equal protection of the laws, and freedom from hostility toward religion.”

Kansas, which was at the heart of the anti-evolution movement a few years ago, is again considering new science standards that would urge public school teachers to present alternatives to evolution. Here in New York State, a member of the State Assembly introduced a bill last May that would require that “all pupils in grades kindergarten through twelve in all public schools in the state …receive instruction in both theories of intelligent design and evolution.” The bill was referred to the Committee on Education.

As we meet today, a federal court in Pennsylvania is hearing the case of Kitzmiller v. Dover, in which a group of parents is challenging the October
2004 decision of their local school board to teach “intelligent design” along with evolution in biology classes. The parents contend that “intelligent design” is essentially a religious concept and as such violates the separation of church and state.

Disputes involving evolution are brewing in at least 20 states and numerous school districts. And in August, President Bush weighed in by suggesting that schools should teach intelligent design along with evolution.

“I think that part of education is to expose people to different schools of thought,” the president told reporters. “You’re asking me whether or not people ought to be exposed to different ideas. The answer is yes.”

Most of us have some familiarity with “creationism,” which asserts that life as we know it was created more or less in its present form about 10,000 years ago. Intelligent design is a more subtle construct. While not necessarily denying that some forms of life have evolved over time, it contends that some features of the natural world (the flagella of bacteria is one often cited example) are so “irreducibly complex” that they require an intelligent designer.

The Seattle-based Discovery Institute, which has been leading the intelligent design movement, defines it this way: “The scientific theory of intelligent design holds that certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection. Note: Intelligent design theory does NOT claim that science can determine the identity of the intelligent cause. Nor does it claim that the intelligent cause must be a ‘divine being’ or a ‘higher power’ or an ‘all-powerful force.’ All it proposes is that science can identify whether certain features of the natural world are the products of intelligence.”

Evolutionary theory states that genetic mutations and natural selection, over millions of years, gave rise to human beings and all other forms of life. Evolutionary theory says nothing about the existence or the non-existence of “god”. As our own President Emeritus Frank Rhodes, a distinguished scholar of Charles Darwin and the history of evolutionary theory, has written, “…[T]he truth is that evolution is neither anti-theistic nor theistic. So far as religion is concerned, evolution is neutral. It does suggest that species arise by natural selection which proceeds by natural laws, but, like all scientific theories, it provides no ultimate interpretation of the origin of the natural laws themselves; for it no more proves them to be the result of random chance, than it proves them to be the servant and expression of purpose.”

Many Americans, including some supporters of evolution, believe that intelligent design should be taught along with evolution. “Teach the controversy” has become the rallying cry of the Discovery Institute and others in the “I.D.” camp, and it is the view apparently endorsed by President Bush. In fact, according to a recent report by the Pew Research Center in Washington, D.C., which analyzed 20 years of trend data on public attitudes toward evolution, a
large minority of Americans - around 40 percent - says that creationism should be taught instead of evolution in public schools.6

Even here at Cornell, there are sharp divisions on the issue. Each year in his large course on evolution for non-majors, Will Provine, the C.A. Alexander Professor of Biological Sciences in the Department of Ecology and Evolutionary Biology, asks his students a set of questions about evolution. The exact percentages vary a bit from year to year, but typically about half the students come out in favor of some sort of “purpose” informing the process through which life develops and half come out on the side of mechanistic evolution.

Of course, this is not the first time the country has experienced serious disagreement about evolution. In 1860, a year after Darwin published On the Origin of Species by Means of Natural Selection, many Americans eagerly followed accounts of the Wilberforce-Huxley debate before the British Association for the Advancement of Science.

The controversy came up again 80 years ago in Tennessee, pitting William Jennings Bryan against Clarence Darrow to decide the fate of John Scopes, a high school biology teacher accused of violating the state’s law against teaching evolution. In his opening statement, Bryan claimed that “if evolution wins, Christianity goes,” while Darrow argued, “Scopes isn’t on trial; civilization is on trial.” Although the decision in the case achieved less than Darrow had hoped, it provided a significant deterrent to anti-evolution legislation that in 1925 was pending in 15 other states.7

It arose a third time in 1987 when the Supreme Court ruled, in Edwards v. Aguillard, that Louisiana’s “Creationism Act” was invalid. That act forbade the teaching of evolution in public elementary and secondary schools unless accompanied by instruction in “creation science,” and the Supreme Court found that the Louisiana act “lacks a clear secular purpose.”8

Now, with the well-organized, resolute intelligent design movement, the issue is back again. What adds urgency to this iteration of the dispute is the fact that this country is so polarized, both culturally and politically. When we divide ourselves into “Red States” and “Blue States”; into the people who watch Fox News and those who watch PBS; into “people of faith” and “secular humanists,” when ciphers substitute for nuanced ideas, is it any wonder that this debate now concerns matters as fundamental as what we teach in our primary and secondary schools, what academic standards universities require, and what rhetoric candidates adopt in political races? When ideological division replaces informed exchange, dogma is the result and education suffers.

And if we are honest, we have to admit that many of us in universities have contributed to the polarization that afflicts the country as a whole. President Emeritus Frank Rhodes, writing in 1982 at the height of the “creationism” debates, noted that “both fundamentalist advocates and some popular scientists claim an extension of their area of authority which is logically illegitimate. The
fundamentalists offer an old doctrine of scriptural infallibility, improperly disguised as science; the scientists offer an old doctrine of materialism, equally improperly disguised as science. Each, in its increasingly intemperate pronouncements, is guilty of intellectual imperialism.”

Today, as Glenn Altschuler, Cornell’s Litwin Professor of American Studies, has noted, we continue to have scientific imperialists who believe that only science can be looked to for answers to all answerable questions and that those areas where science cannot provide answers are unimportant. And we have religious imperialists who assert that all questions are appropriately directed to faith-based sources for answers.

I want to suggest that universities like Cornell can make a valuable contribution to the nation’s cultural and intellectual discourse. With a breadth of expertise that embraces the humanities and the social sciences as well as science and technology, we need to be engaging issues like evolution and intelligent design both internally, in the classroom, in the residential houses, and in campus-wide debates, and also externally by making our voices heard in the spheres of public policy and politics.

At the time of its founding in 1865 - six years after Darwin published *On the Origin of Species* - Cornell responded to the first assault on science and reason in a direct and forceful way. In creating what has been called the first American university, Ezra Cornell and Andrew Dickson White insisted that it break new intellectual ground. Looking back some years later, White wrote, “We had especially determined that the institution should be under the control of no political party and of no single religious sect, and with Mr. Cornell’s approval, I embodied stringent provisions to this effect in the charter.”

White made the defense of science, including evolution, the center of his scholarly attention during and after his presidency. It figured prominently in the history courses he managed to teach at Cornell while president. It figured in the lectures he was invited to give, as a leading college president, around the country. And it formed the basis of his magnum opus, a two-volume work entitled *A History of the Warfare of Science with Theology in Christendom*.

As Glenn Altschuler wrote in his biography of A.D. White, in *The Warfare of Science*, White sought to provide his readers with a clear distinction between theology and science. The essential difference was methodological.

As a rule, White wrote, the conclusions of a great theologian ripen into dogma. “His disciples labor not to test it, but to establish it; and while, in the Catholic Church, it becomes a dogma to be believed or disbelieved under the penalty of damnation, it becomes in the Protestant Church the basis for one more sect.”

In contrast, as Professor Altschuler noted, “White championed unlimited free inquiry; it was as crucial to the ultimate survival of religion as it was to progress in science.” Religion did more damage to itself than to science,
White observed, when it insisted on adherence to discredited ideas. What we now call “creationism,” in his view, was no more essential to faith than a belief that the earth was at the center of the universe.

Ezra Cornell also found the issue of religion central to his concern for his new university. A few years ago, when we were rebuilding Sage Hall, I had the privilege of reading a letter that he had placed in the building’s original cornerstone on May 15, 1873.

In it, Cornell warned “that the principal danger, and I say almost the only danger I see in the future to be encountered by the friends of education, and by all lovers of true liberty is that which may arise from sectarian strife. From these halls, sectarianism must be forever excluded, all students must be left free to worship God, as their conscience shall dictate, and all persons of any creed or all creeds must find free and easy access, and a hearty and equal welcome, to the educational facilities possessed by the Cornell University….”

In keeping with the convictions of A. D. White and Ezra Cornell, Cornell has remained a non-sectarian university that actively supports students in the practice of their religious faiths. Cornell United Religious Work (CURW), established in 1929, was created in order to give Cornell students an array of religious options. CURW now hosts 26 affiliate groups, including Jews, Roman Catholics, Unitarians, Christian Scientists, the Society of Friends, the Church of Jesus Christ of Latter-Day Saints, the Muslim Educational and Cultural Association, a number of Christian evangelical organizations, an African-American worship service, Muslim, Hindu, Zen and Tibetan Buddhist, Hasidic Orthodox Jewish and Pagan groups. Anabel Taylor Hall provides a physical home to a wide range of student organizations and programs that are religiously-based. Even our dining options have been designed to encourage religious observance.

Religion has also figured prominently in Cornell’s academic program. As early as 1896, Henry W. Sage agreed to fund a chair of Semitic Languages and Literature, and its first holder, Nathaniel Schmidt, taught courses in Hebrew, Aramaic, and Arabic languages, in the Old Testament Literature, and in oriental history. Today the study of world religions is alive and well at Cornell. There is a Religious Studies Program with an undergraduate major. Its faculty is drawn from several departments including Near Eastern Studies, Asian Studies, History, English, Anthropology, Philosophy, Classics and others. I believe that this is a very good thing.

So if religious beliefs of all sorts are welcomed, encouraged and supported at Cornell and if religious studies has a secure place within the curriculum, should creationism or intelligent design be taught in science courses? A substantial fraction of the American people and of our own students accept creationism or intelligent design, so what is the harm?

The answer is that intelligent design is not valid as science, that is, it has no
ability to develop new knowledge through hypothesis testing, modification of the original theory based on experimental results, and renewed testing through more refined experiments that yield still more refinements and insights.

H. Allen Orr, writing in *The New Yorker* last spring, noted: “Though people often picture science as a collection of clever theories, scientists are generally staunch pragmatists: to scientists, a good theory is one that inspires new experiments and provides unexpected insights into familiar phenomena. By this standard, Darwinism is one of the best theories in the history of science. It has produced countless important experiments … and sudden insight into once puzzling patterns.…”

Orr notes that in the 10 years since one of the “I.D.” movement’s chief theorists, biochemist Michael Behe [pronounced Bee-Hee], offered arguments about the irreducible complexity of cells as evidence for “intelligent design,” “I.D. has inspired no nontrivial experiments and has provided no surprising insights into biology.” And he adds, “As the years pass, intelligent design looks less and less like the science it claimed to be and more and more like an extended exercise in polemics….Biologists aren’t alarmed by intelligent design’s arrival in Dover [PA] and elsewhere because they have all sworn allegiance to atheistic materialism; they’re alarmed because intelligent design is junk science.”

We should not suspend, or rather annul, the rules of science in order to allow any idea into American education. I.D. is a subjective concept. It is, at its core, a religious belief. What about including “I.D.” in public policy discourse? After all, it is an important view of the world shared by many Americans. Many religiously-based views enter the public arena and inform our policy debates, and they should. Religiously-derived arguments, in my view, must bear two burdens: they must be clearly identified as such, that is, as propositions of faith; and, in acknowledging that others do not share these propositions of faith, they must be supported by other arguments.

When religion moves beyond the private realm and into the public square, it must do so with great care; otherwise, it creates serious potential dangers to the civic polity and to religion itself. That is why James Madison, the author of the First Amendment, was at such pains throughout his long public life to separate church and state. In 1785, when his fellow Virginian Patrick Henry proposed that a small tax be imposed to support the churches of the Commonwealth for the avowed secular purpose of improving the general morals of society, Madison responded with his “Memorial and Remonstrance Against Religious Assessments,” the single most influential document in American history on the subject of the separation of church and state.

Madison maintained (in article #1) that “we hold it for a fundamental and undeniable truth, that religion or the duty which we owe to our Creator and the manner of discharging it, can be directed only by reason and conviction, not by force or violence.” He allowed (in article #8) that “Rulers who wished to
subvert the public liberty, may have found an established Clergy convenient auxiliaries.” But he stressed, “A just Government instituted to secure & perpetuate it....will be best supported by protecting every Citizen in the enjoyment of his Religion with the same equal hand which protects his person and his property; by neither invading the equal rights of any Sect, nor suffering any Sect to invade those of another.” And he declared that (in article #5) “… the Bill implies either that the Civil Magistrate is a competent Judge of Religious Truth; or that he may employ Religion as an engine of Civil policy. The first is an arrogant pretension falsified by the contradictory opinions of Rulers in all ages, and throughout the world; the second an unhallowed perversion of the means of salvation.”

In essence, Madison argued that government must be extremely cautious in employing religion as an instrument of civil policy. “I.D.” is a religious belief masquerading as a secular idea. It is neither clearly identified as a proposition of faith nor supported by other rationally-based arguments. As we have seen all too often in human history, and as we see in many countries today, religion can be a source of persecution and repression. As Pascal, the great French philosopher, said, “Men never do evil so completely and cheerfully as when they do it from religious conviction.”

The United States, it is worth noting, where church and state are most rigorously separated, is also the country where churches, synagogues, mosques, and other houses of worship flourish, where a healthy pluralism predominates, and where everyone is free to worship as he or she chooses.

I am convinced that the political movement seeking to inject religion into state policy and our schools is serious enough to require our collective time and attention. Cornell’s history, its intellectual scope, and its current commitments position us well to contribute to the national debate on religion and science.

As you know, Cornell is in the midst of a major investment in the new life sciences, the physical sciences, and computing and information sciences, and also in issues surrounding sustainability. These priorities have come out of a sustained academic planning process with strong involvement of the faculty and academic deans. Along with a focus on student aid and diversity, faculty recruitment and retention, they will figure prominently in the capital campaign, which in its quiet phase is already moving forward with great momentum. Yet I want to suggest that ultimately our efforts to position Cornell as the leading academic citizen of an interconnected world will fall short of their potential if we neglect the background conditions that have put rational thought under attack.

We have at Cornell great intellectual resources to deal with the current attacks on science and reason. We also have a strong tradition of faculty members using their expertise to comment on public policy, as the late Hans Bethe did as an advocate for nuclear non-proliferation, and as Kurt Gottfried is still
doing as the co-founder of the Union of Concerned Scientists.

I believe that now, as we proceed with our investments in scientific inquiry, we should also be addressing the cultural issues that the invasion of science by intelligent design embodies. This is an issue that should engage not simply our science faculty, like Will Provine, but, in particular, our social scientists and humanists.

This is above all a cultural issue, not a scientific one. The controversy is about the tensions between science and belief, reason and faith, public policy and private religiosity.

Modern research universities have become segmented. We have scientists over here, humanists and social scientists over there. Knowledge is divided into ever-smaller categories; our specialization becomes ever more narrow.

I believe it is time to put the disparate parts of the modern research university back together. We have at Cornell philosophers expert at making fine distinctions and careful definitions. We have scholars of literature who have made the close reading of texts their life’s work. We have historians and scholars of American Studies who can identify and explicate the antecedents of the current controversy. We have economists, sociologists, political scientists and others adept at exploring linkages among science, religion and public policy and their relationship to broad societal themes like privilege, poverty, and inequality.

For almost 40 years, the Cornell Society for the Humanities has supported research and encouraged imaginative teaching in the humanities, in part, by focusing each year on a single theme. For the 2005-06 academic year, it is “Culture and Conflict,” a theme that relates quite directly to the issues I have been talking about. And our new Institute for the Social Sciences, partly modeled on the Society for the Humanities and partly on the social science and humanities seminars that Provost Martin helped launch a few years ago, brings together each year about a dozen faculty members from across the university to work collaboratively on a cutting-edge topic that will stimulate new courses and productive discussions on campus, and important scholarship.

Social scientists should be asking questions such as: “How, if at all, might ‘I.D.’ influence the public-policy debate in the United States, given our strict separation of church and state?” “What would constitute evidence of a conscious or intelligent designer of the universe?” Humanists should be asking questions such as: “Are reason and faith polar opposites?” “Are they inevitably antagonistic to one another? How have the aesthetic roots of religious belief and the exploration of the spiritual shaped literature, music, art, and culture?” “How might we frame conversations to talk about when human life begins amidst assertions that a definition of human life may be so inherently subjective as to preclude reaching a consensus?” These are large and important questions. They go to the heart of our American democracy and to the essence of the human experience.
I am pleased that under Provost Martin’s leadership, Cornell’s strong tradition of interdisciplinary collaboration continues to embrace not only the sciences and technological fields, but also the humanities and the social sciences. Humanists and social scientists, whose expertise lies in understanding cultures and ideas, can -- and should -- move us beyond ridiculing or ignoring our opponents or claiming that, at some level, science is good and faith is bad. They can keep us from claiming too much in the sphere of religion or in the sphere of science and give us the language we need to learn from each other.

To that end, I ask our three task forces, on life in the age of the genome, wisdom in the age of digital information, and sustainability, to consider means of confronting the following questions: how to separate information from knowledge and knowledge from ideology; how to understand and address the ethical dilemmas and anxieties that scientific discovery has produced; and how to assess the influence of secular humanism on culture and society.

Consistent with Cornell’s land grant mission, I ask as well that humanists, social scientists, and scientists venture outside the campus to help the American public sort through these complex issues. I ask them to help a wide audience understand what kinds of theories, arguments, and conclusions deserve a place in the academy - and why it isn’t always a good idea to “teach the controversies.” When professors tend only to their own disciplinary gardens, public discourse is undernourished.

Cornell is known the world over as one of the great global research universities. Twenty-eight years ago, with substantial Cornell involvement, the Voyager I spacecraft set out on a journey to Jupiter, Saturn and beyond. Over the years Voyager has confirmed some of our expectations about the solar system and provided data that contravened others. Voyager I is now the most distant human-made object in the universe. It is approaching the very edge of our solar system and is about to venture into the vast unknown of the interstellar medium.

Voyager and its sister craft, Voyager II, traveling along at some distance behind, seem poised to amaze and enlighten us with a new perspective on the universe of which we are a part. They are the results of scientific method and experimentation, but also of imagination and creativity. They inspire in us the emotions we associate with both religion and science: awe, wonder, curiosity, and an intense desire to know more.

The spirit of discovery and innovation, exemplified by the Voyager mission, helped earn Cornell a 12th place ranking in a recent survey of the best universities in the world. Cornell is the place where the science behind the Mars Rovers was, and still is, being done. It is the university that led in the rediscovery of the ivory-billed woodpecker, which had not been reliably reported in the United States for 60 years, and was thought to have become extinct. It is the place where music professors like Steve Stucky win Pulitzer Prizes, and comput-
er scientists like Jon Kleinberg and poets like Alice Fulton win MacArthur Foundation awards.

It is also a place that has nurtured great intellectual leaders who have not only made landmark contributions to their disciplines, but who are willing to speak out, frequently and forcefully, about the obligation of the academy to pursue knowledge and truth unfettered by political or religious dogma. Cornellians who do will be acting in the great tradition of Cornell’s founders, Ezra Cornell and Andrew Dickson White.

Notes:
2. http://assembly.state.ny.us/leg/?bn=A08036&sh=t
Intelligent Design and the Place of Religiously-based Ideas in American Politics
Hunter R. Rawlings III
A lecture given at the Woodrow Wilson Center, Washington, D.C.
April 25, 2006

On March 4, 1865, Abraham Lincoln delivered the most moving and probably the most significant speech in American history, his Second Inaugural Address. Lincoln used his presidential platform to give an anguished rumination on the purposes of the Almighty and the consequences for Americans, in both North and South, of practicing slavery. The Second Inaugural is, as many have pointed out, essentially a sermon. Its biblical, indeed prophetic rhetoric has had a powerful effect upon all subsequent Presidential speechmaking, which struggles, never successfully, to emulate it. In spite of our constitutional separation of church and state, America’s chief executives rarely deliver a major address without a direct appeal to God.

In that same epochal year of 1865, Ezra Cornell and A.D. White founded Cornell University as a new kind of American institution of higher learning. Unlike its predecessors like Harvard, Yale, Princeton and Columbia, Cornell was to be a nonsectarian university, “an asylum for Science,” as President White wrote, “where truth shall be sought for truth’s sake, where it shall not be the main purpose of the Faculty to stretch or cut science exactly to fit ‘Revealed Religion....’”

The charter of Cornell stipulates that “Persons of every religious denomination, or of no religious denomination, shall be equally eligible to all offices and appointments,” and White in his Plan of Organization emphasized that “We have under our charter no right to favor any sect or to promote any creed. No one can be accepted or rejected as trustee, professor or student, because of any opinions and theories which he may or may not hold. On that point our charter is most carefully guarded, and made to conform to the fundamental ideas of our Republic – ideas which too many institutions of learning have forgotten.”

President White consciously modeled Cornell’s chartering documents on the principles of the Constitution. In short order critics attacked Cornell for its liberal spirit and began referring to it as a “godless institution” where theories such as materialism and “evolutionism” received an impartial hearing. And yet “godless Cornell” soon had a large and impressive Christian chapel built in the center of its campus that could accommodate 500 worshippers. President White called for a lectureship in Christian ethics and weekly services offered by “the most eminent divines obtainable, of all faiths, including Catholic and Jewish.” Religion held a prominent place in the curriculum, the calendar, and the architecture of the campus. So it continues today: Cornell is a center of sci-
ence, engineering, agriculture and humanities, and it is also home to thousands of students, faculty and staff members practicing their faith in campus buildings.

Twenty-eight religious groups have registered as members of Cornell United Religious Work, the umbrella organization that coordinates faiths on campus. Religion is a force at Cornell today, just as it was at Cornell’s founding in 1865.

My point is this: even when Americans deny the state establishment of any religion, prohibit religious tests for public office, and never so much as mention God in their Constitution; and even when leaders with such consciously anti-sectarian views as Ezra Cornell and A.D. White found a center for scientific thought and reason, what has been called the first “truly American university,” religion is omnipresent.

Today, in the midst of what history will probably call “the third Great Awakening,” we Americans are seeing a massive movement of religion back into the public square, particularly in the crucial arenas of politics and education. Abortion, stem cell research, and Intelligent Design are just three of the prominent issues revealing the power of religion in local school boards, colleges and universities, municipal governments, state legislatures, and the Congress and the White House. A month ago 55 Democrats in the House of Representatives issued a joint statement clarifying the central role Catholicism plays in their policy making. President Bush makes constant reference to the faith that governs his life and thought, both public and private.

If corpses can do such a thing, my favorite Founder James Madison is turning in his Virginia grave. Madison sincerely believed that, together with his political partner Thomas Jefferson, he had once and for all separated church and state in America in the 1780s and early ’90s. In drafting the revolutionary clause on freedom of conscience in Virginia’s Declaration of Rights, in defeating Patrick Henry’s bill for a religious tax by publishing the Memorial and Remonstrance against Religious Assessments, in pushing Jefferson’s Bill for Establishing Religious Freedom through the Virginia Assembly, in helping to author the Constitution, and in drafting the First Amendment, Madison made separation of Church and State his first principle.

Far from supporting Patrick Henry’s and George Washington’s belief that state support of religion would improve the morals of American society, Madison argued, adamantly and repeatedly, that yoking Church and State together had been disastrous throughout history for both religion and the body politic. To use religion as an instrument of civil policy is, in Madison’s words, “an unhallowed perversion of the means of salvation.”

Furthermore, Madison argued, state support is detrimental to religion and to the body politic: Christianity flourished in a pure state in its early centuries before the Emperor Constantine made it Rome’s official religion. In subsequent
centuries, the state-established Church produced “pride and insolence in the Clergy, ignorance in the laity, bigotry and persecution.” When Virginia passed Jefferson’s Statute for Religious Freedom, Madison triumphantly wrote to Jefferson in Paris, “I flatter myself we have in this country extinguished forever the ambitious hope of making laws for the human mind.”

As President of the United States, and a wartime President at that, Madison strictly observed the separation of Church and State. He opposed public support for chaplains in the Congress and avoided appeals to God. Late in life he regretted that he had called for a day of public thanksgiving during the War of 1812. Madison believed that the State should deregulate religion (his formulation is “religion is wholly exempt from its cognizance”). He predicted, correctly, that such a policy would enable religion to grow and thrive in a free republic, where people of all faiths and of no faith felt equally treated.

Ezra Cornell and Andrew D. White had the same vision, a secular institution where religion flourishes on its own. And yet it has proven impossible to separate church and state completely. Why is that?

“Politics is in large part a function of culture,” and “at the heart of culture is religion,” Richard John Neuhaus wrote three decades ago, as he worried that the public square had become “naked,” that is, shorn of religious belief and values. Neuhaus, as it turned out, had nothing to fear. But Madisonians do.

Evangelical Protestantism has in recent years become ever more potent in American public life, while the voices of secular humanists become ever more strident in their reaction to religious rhetoric. This is a badly polarized state of affairs, as we have recently seen in national debates over the case of Terry Schiavo, abortion, stem cell research, and the opposition of Darwinism and Intelligent Design. What is the right way out of this polarized situation? Let us begin by acknowledging that Madison was wrong: the state MUST take cognizance of religion: it is too important a source of ideas and values to ignore or to privatize completely. Religion shapes most Americans’ values, aspirations, beliefs, in sum, their identities. The history of this country reflects the simultaneous development of grassroots democracy and evangelical Protestantism. The two have gone hand in hand, often reinforcing one another. The problem is that the absolutist tendencies of religion frequently become incompatible with democratic pluralism and the need for give and take in politics.

As Reinhold Niebuhr warned, “The religious imagination is as impatient with the compromises, relativities and imperfections of historic society as with the imperfections of individual life.” How can we insure, then, that religion will inform and improve policy debate, but not polarize? And equally, if not more importantly, how can Americans protect their faiths from becoming political religions, “unhallowed perversions of the means of salvation,” to use Madison’s memorable phrase? These are, in my view, two of the most pressing questions we Americans confront today.
To answer these questions, we should acknowledge that religion has sometimes embarrassed itself by confronting science on its own ground. When the Catholic Church took on Galileo, it passed a short-term sentence on Galileo, a long-term sentence on itself. When Intelligent Designers go to court in the 21st century, they should be prepared for rigorous cross-examination. Judge John Jones found, in the case of *Kitzmiller vs. Dover Area School District*, that I.D. was religion masquerading as science.

In the Schiavo case, right-wing legislators entered a legal battle armed with religious/political conviction, only to retire ignominiously in the face of scientific evidence and public opinion. Science keeps hypothesizing and testing results. Its theories succeed or fail with the discovery of new evidence. Religion emanates from authority and can thus appear arbitrary and ill-informed in the realm of policy making.

For this reason, religion linked directly with state power tends to be repressive and exclusionist. In his day Madison inveighed against the Inquisition because that was an example his audience well understood; today we have Muslim theocracy daily before our eyes. But it is easy to point out the dangers religious power poses to the state. It is a subtler argument to demonstrate the dangers state power poses to religion.

When people of faith use their religion for political purposes, they run the risk of compromising their ideals and politicizing their religious values. Roger Williams was the first American to raise this problem in the mid-17th century in Rhode Island: an ardent Puritan, he warned his fellow citizens against mixing church and state, because the result would make the church too worldly and give it a political agenda. For the church to remain pure and faithful to its mission, it could not, in Williams’ view, consort with politicians.

Americans today find Williams’ rhetoric and his practice extremist in its complete renunciation of any ties between church and state. But many American Christians find the intense political engagement of some Christian churches not only embarrassing, but an affront to their conception of the church as a spiritual home, not a partisan political actor.

As Niebuhr showed, public demonstration of piety can corrupt private faith by transferring religious rhetoric to the political realm, thus lowering and cheapening it. It is bad enough when religious leaders make political pronouncements; it is worse when government leaders use the church for partisan advantage.

Niebuhr wrote that “The religion which is socially most useful is one which can maintain a stubborn indifference to immediate ends and thus give the ethical life of man that touch of the absolute without which all morality is finally reduced to a decorous but essentially unqualified self assertiveness. The paradox of religion is that is serves the world best when it maintains its high disdain for the world’s values.... Its assets easily become moral liabilities when it com-
pounds the pure idealism of Jesus with the calculated practicalities of the age and attempts to give the resultant compromise the prestige of absolute authority.”

Religion is most effective publicly, then, not when it joins with the state and speaks prescriptively, but when it acts in what Niebuhr called its prophetic role. Faith can be a great moral force to reform society when government and science fail, as they often do.

Madison’s beloved Constitution did not end slavery, the Abolitionists and then Lincoln did. Civil rights finally came for African Americans partly because secularists called for it, but primarily because Martin Luther King and his Southern Baptist colleagues demanded it on religious and moral grounds. It takes a wake-up call from Catholic Bishops to get Americans to confront the problem of serious poverty in our midst, even if only briefly. In the same way, we can be certain that the issue of abortion will not be solved on the basis of scientific definitions and legal procedures alone. Science and the law have little to tell us about the meaning of life. That is the domain of religious sensibility and moral sensitivity.

Abortion is the most divisive domestic issue afflicting America today. We academics have consistently misunderstood and undervalued religious arguments about abortion, much to our own and the nation’s detriment. Our inability to appreciate the role of religious conviction in discussing abortion is probably the single greatest cause of our diminished role in public policy debate.

Most academics are secular humanists. That is neither surprising nor especially noteworthy, but academic disdain for religion, specifically for Christianity, is noteworthy, and it has unfortunate consequences. Such disdain diminishes the capacity of many academics to understand American culture and politics, and thus lessens their influence in the public square.

It is thought-provoking to note that, although it is liberals who have moved America to an ever more inclusive definition of humanity and human rights over the past century, it is now anti-abortion advocates who are calling for expanding our conception of human life. This is the religious voice speaking, like Abolitionists in the 19th century, while, on the other side, liberal academics seem often to accord more respect to animal rights arguments than to appeals for the “rights of the fetus.”

By the same token, I would sympathize more with arguments from faith about the beginning of life if those who make them showed more interest in moral arguments against ending life. Whatever side one is on in the abortion debate, or in debate over the death penalty, two things appear clear to me: religious views will play a large role in the eventual outcome; and each side needs to show greater respect to the moral basis for the other’s arguments.

When I ask myself how religion should inform politics, I keep returning to
Madison and Lincoln. Madison spent a lifetime trying to ensure that this country would avoid Europe’s long history of religious conflict by separating church and state. Our Constitution and our Bill of Rights do as much as legal documents can do to assure his success. But his could only be a partial victory, because religion cannot long be kept out of the public square in this or any other country.

The largest, deepest issues require religious engagement for political resolution to become possible. This country’s greatest crisis, the final confrontation over slavery, needed, in the end, religious understanding, a national benediction after a national tragedy.

Presiding over civil war and incalculable suffering, Lincoln composed for his second inaugural address a national sermon. Though he found it impossible in spite of great effort to believe in personal salvation. And though he did not join a church, Lincoln read the Bible nearly every day as a source of strength and of powerful poetic language.

Borrowing the language of the Old Testament prophets, and of Christian mercy, he tried to help his fellow countrymen understand the meaning of the Civil War in their history. Unlike most subsequent presidents, Lincoln did not claim that God was on either side in this conflict. He did not even claim that he knew what God’s will was.

To him, the Almighty was inscrutable, a force that seemed to bring much suffering, personal, as repeatedly in his own case, and public, as in the case of the American people. But Lincoln, in hisanguished pondering, did know that we Americans had committed a great sin and that we were paying for it. He also knew that people call upon religion to serve their own purposes: “Both (North and South) read the same Bible, and pray to the same God; and each invokes His aid against the other.” But it was clear to Lincoln that neither was on God’s side: “The Almighty has his own purposes... If we shall suppose that American Slavery is one of those offences which, in the providence of God, must needs come, but which, having continued through His appointed time, He now wills to remove, and that He gives to both North and South, this terrible war, as the woe due to those by whom the offence came, shall we discern therein any departure from those divine attributes which the believers in a Living God always ascribe to Him? Fondly do we hope – fervently do we pray – that this mighty scourge of war may speedily pass away. Yet, if God wills that it continue, until all the wealth piled by the bondman’s two hundred and fifty years of unrequited toil shall be sunk, and until every drop of blood drawn with the lash, shall be paid by another drawn with the sword, as was said three thousand years ago, so still it must be said the judgments of the Lord, are true and righteous altogether.”

That is the prophetic voice of religion speaking from the White House. Madison would probably have found that more than worrisome. Given the
arguments I have made in this talk, I certainly do. For the President of the United States to make God the central figure in his Inaugural Address is to join church and state bluntly and inextricably. It sets a dangerous precedent, as we have seen in the addresses of many a President of the United States.

Let us note two deep mitigating factors, however, that make Lincoln’s choice defensible even to separationists: first, the nation was torn by Civil War, its very existence imperiled; second, Lincoln used religious thought and language with remarkable restraint and care. He was as uncertain in his claims about God’s will as he was in his own religious conviction. He refused to enlist God’s aid in the struggle of the Civil War, he made no claim of personal understanding. He once said to a group of abolitionist ministers imploring him to do God’s will and end slavery that he had no direct divine revelation: “I must study the plain physical facts... and learn what appears wise and right.” Lincoln did, however, know Scripture and its power to assuage suffering and to create moral clarity, and he used it adeptly to grasp the meaning of what Americans experienced, in fact, to define that meaning.

Religion serves society best when it acts with restraint, and when it speaks with a genuine prophetic voice. The state serves religion best by allowing it to function freely on its own, and itself best by listening to the voice of religion and enabling it to contribute to the resolution of critical moral dilemmas.

To disdain religion is to antagonize and radicalize many Americans with deeply held beliefs. To use religion for political purposes, to create political religion, is an affront to religious values and a violation of the great American tradition established by James Madison and deepened by Abraham Lincoln.
Where Do We Go From Here? The Future of Darwinism in American Society
A panel discussion held at the Museum of the Earth, Ithaca, New York
February 9, 2006

Introduction: Warren Allmon, director of the Paleontological Research Institution and adjunct associate professor of earth and atmospheric sciences at Cornell University

Moderator: Carolyn “Biddy” Martin, Provost, Cornell University

Panel Members:
Barbara Crawford, associate professor of education, Cornell University
Sheila Ann Dean, editor, Darwin Correspondence Project, Cambridge University
Thomas Eisner, Jacob Gould Schurman Professor of Chemical Ecology and Entomology, Cornell University
Bruce Lewenstein, associate professor of science communication, Cornell University
William C. Russell, assistant superintendent for curriculum and instruction, Ithaca City School System
Steven H. Shiffrin, professor, Cornell Law School
Janet Shortall, associate director, Cornell United Religious Work

WARREN ALLMON: Thank you all for being here. My name is Warren Allmon, I am the director of the Paleontological Research Institution, which is the parent organization of the building you’re seated in. It’s my great pleasure to welcome you. I am not going to say very much except to explain how we came to be here today.

One hundred and ninety-seven years ago Sunday is of course the birthday of Abraham Lincoln and also on exactly the same day the birthday of Charles Darwin. We all have our lists; it’s a fun parlor game to make your “list of the most important 10 people or 12 people in human history,” or the “most important 12 books in human history,” whether you agree or disagree with them. And whatever your list is, whoever is on your own personal list, there are a few people that we all have to agree as a historical fact are among the most important people in human history in terms of their impact on human thought, and our conception of ourselves. And one of those people by any list is certainly Charles Darwin.

But of course Darwin is unique perhaps on that list in that the vast majority of the general public have no idea actually what he said or wrote. This build-
ing is dedicated to public education in the field that Darwin wrote about, which is the history of the Earth and its life. And so it has seemed to us since we opened the museum almost three years ago that this could be the venue for something that makes an enormous amount of sense - which is to celebrate Charles Darwin in Ithaca. Why Ithaca? Because Cornell University is one of the great research centers in evolutionary biology in the world. And it makes a huge impression on the science of evolution, all around the world in many ways. But it, until recently, really hasn't had a venue to make that available to the general public.

And one of the purposes of this building is to serve as a venue for Cornell expertise to reach a broader audience. And so we thought that this year's Darwin Day was an opportunity to do that. So we are here by the grace of Provost Biddy Martin, who agreed to cosponsor this with us, with the Biology Department at Ithaca College, and through the graces of Janet Shortall of Cornell United Religious Work. All four of us are sponsoring this event. And I also need to thank Stephan Loewentheil, an alumnus of Cornell Law School, who provided the financial support which allowed us to make this happen.

The weekend includes a number of events, as I hope you all know. This is the first. Tomorrow afternoon is really for the science geeks, if you want to know the current state and future of evolutionary biology from some of the people who are actually making that present and future happen, tomorrow at 4 o’clock, we have the panel.

Tomorrow night Inherit the Wind with a question-and-answer session afterwards. If you think Inherit the Wind is the true story of the Scopes trial, you should come to this movie and find out that’s not the case. Saturday we’ll have a talk for educators in the classroom right over here and a whole afternoon of activities for young and old who may not have any idea about Darwin.

And then Sunday is a really special event. Sunday is a kind of an advanced sneak-peak screening of a brand new documentary called Flock of Dodos. The title is a triple or double entendre. The dodos are not just the advocates of intelligent design, they are also the evolutionists who have not done a very good job of communicating to the general public. So that’s a brand-new documentary, making a kind of college tour of the northeast. And so that’s a really special sneak-peak. And then on Monday another biology panel at Ithaca College. So we tried to make something for everybody. And we hope that you will take advantage of some of those other events.

And now I will turn it over to Provost Martin with my gratitude.

PROVOST MARTIN: Good morning. I think first we should all express our gratitude to Warren Allmon who organized and made these events happen. (APPLAUSE.)

PROVOST MARTIN: I am delighted to be here on such a beautiful morning instead of Day Hall. It couldn't be nicer and I appreciate being invited to
As many of you know, Hunter Rawlings in his State of the University Address this past October decided to use that occasion to talk about his objections to intelligent design conceived as a science or scientific theory; and he used that speech quite effectively, I think, to try and distinguish what scientific method or scientific theory might be and what the idea or belief or faith in intelligent design represents. He tried very very hard, carefully to distinguish between the two and to talk at some length about what Cornell, in particular, but also other universities do to promote the study of religion and to welcome religious faiths of all kinds, but at the same time to argue as many others have that intelligent design is itself not science but faith, and to have it masquerade as a science is one set of problems; and he also spoke eloquently about the problem of mixing of science, religion and politics.

There was quite a bit of reaction to Hunter’s speech, as many of you know, both positive response and criticism. I think the overwhelming majority of responses I heard were positive ones, not only about the content of what he said but about the fact that a president of a major research university had decided to use the platform he had at the State of the University speech to talk about matters of critical and social importance, which is increasingly rare for university presidents to do. And I think he deserves enormous credit for having had the courage and foresight to do that.

Now since then, of course, there have been a number of developments, maybe the most interesting one when it comes really specifically to the case of communities considering requiring intelligent design be taught alongside evolution was in the case in Dover, Pennsylvania, where a school board had decided that intelligent design should be taught along with evolution in the classroom, in the high schools there. And two things occurred which I’m sure you are well aware of which are interesting. One is that school board was voted out completely by the community which, I think, in one sense is the best news, and then there was a ruling by a federal judge, a 139-page ruling, a very interesting one, which also said that it was inappropriate to have intelligent design cast or framed as a scientific theory and taught alongside evolution.

Much has happened in the world since then. I was thinking this morning as I thought about coming here and what I might say about trying to put this discussion in other contexts as well. For example, most salient perhaps at the moment, the context of the Danish cartoons or the republication of the Danish cartoons that are causing the forms of protest, but also violence across the Muslim world, which of course raises many of the same issues obviously in different ways, and deserves to be discussed in ways that respect their differences. Nonetheless there is no reason for us here today to confine ourselves to the debate between intelligent design and evolution.

The second context I would like to at least point to is one that sort of
amuses me as a scholar of late 19th and early 20th century German and Austrian culture, and that is that once things get polarized in the way they currently are with the debate about the place of intelligent design in relation to science, what happens is that Darwin suddenly starts to seem like a hero of a kind that's completely unproblematic. In a sense, I think, Darwin is a hero, of course.

I have heard physicists say that Darwin's achievements scientifically might be said even to be greater than Einstein's. That was actually a discussion Hunter Rawlings and I had with three of our best physicists not long ago, where they were debating whose achievement was actually greater, or could be said to be greater. But as a scholar of the late 19th and early 20th century in Europe, I think what gets forgotten in a lot of these debates are the particularly problematic uses of Darwinism and evolution socially and politically, which started just as soon as the opposition to Darwin started.

So the issues are much more complicated, I would say, than a simple for or against evolution, or a simple polarization between Darwinism and radical opposition to Darwinism in the name of faith or faith-based belief and theory. In any case, I hope some of the complexities will reemerge in the discussion today so that we're not caught up in the same terms of a debate that is now already starting to feel a little stale, between the degree to which intelligent design can be said to be a science, and worthy of teaching in our schools alongside evolution, and start to think more broadly about the complexities of the theory of evolution and its relationship between religion and science, religion and public life.

I am going to introduce each of the speakers briefly, and then each of them will take five minutes. And I have told them I am going to hold them to that. Now I don't know what means I will use, but it will be draconian, five minutes. Then we are going to open it up to you to see what you have to say in response to the speakers about the issues in general.

The first speaker today is Barbara Crawford, who is Associate Professor of Education at Cornell University. Her research is actually focused on ways of giving science teachers a good understanding of the nature of scientific inquiry, which is at the heart, I think, of the set of issues that we need to find in a more sophisticated public discussion. So that science teachers can move away from teaching the facts and away from instilling in their students a sense that what they’re learning is mere fact, and more in the direction of teaching what the nature of inquiry in scientific inquiry really is. I think we could all benefit from better education, from K or Pre-K through the rest of our lives in the nature of inquiry, and the fruits of genuine scientific curiosity.

Barbara is active nationally in the science education research community and she serves on the board of directors for the National Association of Research in Science Teaching. And so let's hear now from Barbara Crawford.
BARBARA CRAWFORD: Thank you very much. It is so good to see you all. It’s a pleasure to be here to share my views and my ideas. I’m a teacher educator. I’m an educational researcher and for 16 years a public school biology teacher. I support the urgent call by President Rawlings to engage our intellectual community in responding to this challenge by religiously based opponents to teaching evolution.

Here’s my main stance. I propose that a lack of an understanding of the nature of science, including the role and importance of theory to science, contributes to the recent controversy. My husband is going to be handing out just a very short paper; I’m an academic and I have to have a little paper. So he is just going to pass those along. There is a chart there I want to reference (Figure 1, above).

Science and religion are two different ways of looking at the world. Each uses different kinds of evidence. Science demands empirical evidence. A scientific theory is a robust explanation of a phenomenon; a theory is testable and makes predictions. Intelligent design is outside the realm of science. Students should not be asked to choose between religion and science.

Now back to my main stance. I think this highlights a really important issue that we can grab onto. The importance of teaching students the nature of science relates to developing their ability to think critically about problems. For example, science should not be taught as a dogma. Science is one way of knowing about the world, based on the use of evidence to devise explanations about the nature and role of scientific theories. Now in our vernacular, common vernacular, we use such phrases as “I have a theory” or “it’s just a theory.” Other words such as adapt, fitness, law, and prove, also have everyday meanings that

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Figure 1. Matrices comparing disciplines and understandings of evolutionary concepts from pre and post questionnaires [n=21]. (Crawford et al., pg. 626, 2005)
are different than those used in science, which may contribute to this confusion in the public.

My research focus is on teacher knowledge of inquiry and the nature of science. What do teachers know about the theory of evolution and of the nature of science? There was a study done in 1990 by Bishop and Anderson of undergraduates in a non-majors biology course. And the intent was to develop understandings of evolution. And it was determined by pre- and post-testing that most of these undergraduates did not have a robust understanding of evolutionary theory, even after the instruction.

Our recent study that my colleagues and I published just this past August had to do with 21 prospective teachers in different fields – Earth science and biology and physics. And, we immersed these pre-service teachers in a module that had them grappling with the data and coming up with explanations about natural selection. We gave a pre-test and a post-test. And much to my dismay, these students also had non-robust understandings of natural selection, as well as the nature of science.

For example, one of the questions is, it’s in your handout, cave salamanders are blind. They have eyes that are nonfunctional. How would a biologist explain how blind cave salamanders evolved from sighted ancestors? One of the biology students responded, “What is not used, atrophies; so in the dark, the salamanders kept their eyes closed.”

If you look on the handout, there is a chart showing the biology students and the non-biology students, their understandings before the module, and their understandings after the modules. And this was the distressing point to me, that you can see that the biology students did not have more robust understandings than the non-biology students.

Now I want to quickly say, I’m not blaming teachers. I’m not blaming the students. What do we need to do differently? My stance is we need to think differently about how we prepare science teachers from kindergarten on into our own university-level courses. Science Teaching now is primarily didactic. Students have to memorize huge volumes of terminology. They rarely have the opportunity to grapple with data and to come up with explanations.

Cornellian Anna Botsford Comstock published a book that I really love. It’s called *The Handbook of Nature-Study*, published in 1911. I have a copy of the 24th edition. In it, Professor Comstock says, and I quote, “The object of the nature study teacher should be to cultivate in the children powers of accurate observation and to build up within them understanding.” And she asked teachers to ask questions and have students ask questions. So that in this way a young child might begin to understand the diversity of individuals by their own observations, and by questioning. Professor Comstock’s emphasis on personal understandings is very insightful.

I propose that we might devise and design an interdisciplinary course at
Cornell for all freshmen, centered on understanding the history and the nature of science. Students and professors from many disciplines could come together - biology, chemistry, physics, engineering, art, philosophy, and history. And students could think and reflect on the nature of science and what science is, what science is not, and how science works.

In summary, evolution will remain the central organizing theme of biological science. And it’s going to be an important component of future curricula. But this recent controversy underscores our need to rethink how we prepare teachers to teach science and how we prepare the general public in understanding what science is. Thank you.

PROVOST MARTIN: Thank you, Barbara. Our next speaker is Sheila Ann Dean, who is a visiting scholar in our department at Cornell of Science and Technology Studies. She is working on an extraordinary project. She is editor of the Darwin Correspondence Project, which is jointly managed by the American Council of Learned Societies and Cambridge University Library in England. They’re working to publish the definitive edition of the letters to and from Charles Darwin. It’s a monumental project expected probably to run some 30 volumes, and is already producing new knowledge about the development of Darwin’s thought and about Victorian society. And I am delighted to introduce you, Sheila Ann Dean.

SHEILA DEAN: Thank you, Biddy. In pondering what I could contribute today as a historian, I thought I would try to provide some perspective and recall that the objections in the United States to evolution now are, of course, not entirely new.

Even before Darwin, many scientists and many people in general, were resistant to the notion of species being fixed in time, being stable. When Darwin refined the idea that species were not fixed in time and introduced natural selection, along with a vast array of evidence for it, many more and including many people in science at first, had difficulty with the idea, as some have since. Though by now, of course, the number of scientists and especially biologists not accepting evolution has diminished and practically disappeared.

Now each objection to evolution has a flavor of the time and the culture from which it has come, and these nuances, I think, can be instructional in the problems many American schools are experiencing today in the teaching of evolution. At the same time, I think it’s important to consider what essential similarity - if there is one - contributes to the struggle some have had at different times and in different countries with evolution, and particularly with the evidence that humans have evolved from another animal.

So with that I want to turn to a Darwin anecdote. After all, this is his birthday, almost. Towards the end of Darwin’s life, he was visited at Down House by George Douglas Campbell, the eighth Duke of Argyll. The Duke was a Scottish statesman. He was also a writer on politics and on science and on
religion. And he was a staunch defender of the concept of design in nature. His perception of Darwin’s theory of transmutation was complicated. The Duke, for instance, thought that there was a separate creation for humans. And his ideas, of course, differed on many points with Darwin’s ideas. On the visit to Down House, the Duke remarked on Darwin’s many observations and his books, particularly one called *The Various Contrivances by which Orchids Are Fertilized by Insects.* And he spoke of “the wonderful contrivances for certain purposes in nature”. The Duke said it was “impossible to look at these without seeing that they were the effect and the expression of mind,” meaning a divine mind. And the Duke remembered that then: “He, Darwin, looked at me very hard and said, well that often comes over me with overwhelming force; but at other times” - and he shook his head vaguely - “it seems to go away”.

Now, Darwin here equivocated as he so often did on the subject. He wasn’t interested in discussing design with the Duke and he didn’t want to confront anyone’s religious beliefs. He had always just wanted his theory of transmutation to be accepted because it explained so much in nature. And he was excited about others building on it with further discoveries.

Twelve years before the Duke’s visit, just after *The Origin of Species* was published, Darwin was dismayed by how few people in science understood his book, and he often complained that he must be a very bad explainer. However, his friend, the American botanist Asa Gray, did understand natural selection quite perfectly. Asa Gray, who was actually born in Sauquoit, New York, quite close to here, was a religious man, and a Harvard professor. And when he wrote a review of *The Origin of Species* he included his theistic support of it. Darwin was thrilled that a supporter could demonstrate so clearly that his religion did not interfere with his understanding and acceptance of natural selection. And Darwin was so excited about this that he thought it would be good to publish the article separately as a pamphlet and he contributed financially to having this done and he helped to have it distributed in England.

Now eight years later, in his book, *The Variation of Animals and Plants under Domestication,* Darwin argued against Gray’s suggestion that all variations were divinely ordained. But in 1860, he deeply wanted his theory of transmutation to be understood and accepted, whatever someone’s religious beliefs.

And now almost 150 years later natural selection is no longer a brand new term that many scientists are struggling to understand. And with the research and discoveries that have taken place since, it’s a principle that ideally could be understood by everybody. But instead we have what is so often called this “peculiarly American” problem, and we have even many highly educated people in this country who know very little if anything about evolution, even though it’s the fundamental process that has shaped our organic world as well as ourselves.

Perspective is useful and I want to throw out the idea, following some of
what Barbara Crawford said. I think high school history courses could be taught concurrently with biology courses. History courses could incorporate a section on history of science, including the 19th and 20th century development of Darwin's ideas and the various reactions to them over time. The hope would be to encourage students to think critically about why there have been assorted cultural and religious problems with evolution.

Also, many students who are not interested in science or who are repelled by science or intimidated by science can be drawn into a better understanding of it, through learning its history. And I, of course, would also like to see the biology course in high school taught not just with the unit of evolution, but to have the whole course taught under the unifying principle of evolution. But it might be easier to start with some history of science.

PROVOST MARTIN: Thank you, Sheila. Tom Eisner is the Jacob Gould Schurman Professor of Chemical Ecology at Cornell University. He is one of the world’s leading authorities on animal behavior, ecology and evolution. Tom Eisner is widely regarded as the co-founder of the field of chemical ecology, which deals with chemical interactions between organisms, and he is especially well known for his work on chemical signaling in insects. He has carried out fieldwork on four continents. He is an ardent conservationist and nature photographer who has helped make award-winning documentaries. He is the author or co-author of 400 scientific articles and seven books. He is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society; and he has been honored with the National Medal of Science, which is the nation’s highest civilian award for achievement in a scientific field. He is one of the most wonderful human beings I have had the pleasure to work with and I couldn’t respect him more. Tom Eisner.

THOMAS EISNER: Thank you, Biddy. Ladies and gentlemen: I want to address the question of why there should be such widespread skepticism, why evolutionary thinking should meet with such widespread opposition worldwide. In my judgment, this question has not been properly pondered. Scientists by and large are baffled by the sheer magnitude of this disbelief, which is especially irksome to biologists, who see in evolution the basis of a unifying theory, amply documented, and of vast explanatory and predictive potential. Why, biologists are prone to ask, should evolutionary thinking meet with skepticism when, in fact, it is based on the same criteria of logic and inquiry invoked for establishment of truth in other scientific disciplines. Is the scientific method inadequate, somehow, for ascertainment of biological reality, even when its implementation in the domain of physics, chemistry, and engineering goes unquestioned? There is indeed a paradox here, requiring explanation, but the paradox needs to be formulated in different terms.

In my judgment, evolutionary thinking is held to special account because
people by and large are unknowing or uncomprehending of the scientific method. Physicists, chemists and engineers go unchallenged in their scientific pursuit, not because they adhere to acceptable methodology, but because they have tangible benefits to show for their toils. Collectively, the practitioners in these disciplines can claim credit for the countless “products” that are the hallmark of our inventive society, without need to explain the intellectual process that underlies the inventiveness. There is, in fact, indifference to the scientific methodology that drives technical innovation. Such innovation is judged to be for the common good and hence accepted at face value.

Evolutionists are not so lucky, for a number of reasons. In the first place, they do not through their work engender tangible benefits of the sort that could lead to the unquestioned acceptance of their discipline. The payoff in evolutionary thinking, more often than not, is conceptual rather than material, the consequence of a curiosity that is by no means generally shared. The evolutionist is bent on broadening our understanding of the biological reality on Earth, on delving into the origins of life and its diversification over geologic time, as well as into the process or processes of speciation - heady stuff indeed, viewed by some as not even being answerable by scientific inquiry.

Why invoke an explanatory process, evolutionists are asked, one that is admittedly quite complicated and requiring of considerable intellectual effort if it is to be understood, when there is already a perfectly good alternative explanation in place, one we are taught as children, based on divine creation, easy to comprehend and accept on faith alone? Who needs evolution, the anti-evolutionist asks. Why yield to a set of tenets that call into question our most cherished beliefs without offering compensatory benefits?

Of late, of course, what we’ve come to witness is the exploitation of this intellectual divide by the religious right. That divide, which Darwinism brought to the fore, and which has pitted evolutionist against anti-evolutionist for decades, is now being redefined along political lines, driven by what has become an all-too-evident effort on the part of the extreme right to replace the teacher’s lectern with the pulpit. At stake here is more than intellectual disagreement. The issue is constitutionality itself.

As an evolutionist I have no trouble taking sides in this debate, for simple reasons. To me, it is immensely satisfying to know that we humans are not the product of special creation, that we came into being by the same gradual evolutionary process that gave rise to the other living things on Earth. I derive comfort from the knowledge that I am just another stitch in the fabric of nature, that I was molded by natural selection, not by divine decree or intelligent design. Viewing ourselves for what we are as a species - just one of millions - can have an emancipating effect, in that it can heighten the chance that we will gain a better understanding of ourselves, and of our surrounds, and of our relationship to these surrounds. Our future, ultimately, to the extent that we will
be able to control it, is dependent on that understanding, including the understanding of our origins. Only through comprehension of our evolutionary past can we expect to gain insights into our future. Evolution, given the reality of its occurrence, is thus bound to remain a topic of central focus in the human dialogue. For those of us who believe in evolution, and are privileged who are entrusted with the teaching of biology, the road ahead, if we are to participate in the dialogue, will call for uncompromising political involvement. Thank you.

PROVOST MARTIN: Tom, could I ask you the exact wording? I didn’t understand when you said for you it is a relief, it’s liberating to know you’re just one, what was that? Stitch in the fabric? Thank you. I wanted to be sure I heard that. One stitch in the fabric. I am certainly glad you are one stitch in the fabric, I’ll tell you that.

And here’s another great stitch in the fabric. Bruce Lewenstein is Associate Professor of Science Communication at Cornell. He is an authority on the history of scientific journalism - on how science gets reported to the public and how the public comes to understand controversial scientific issues. He has been focusing on emerging technologies such as nanotechnology and biotechnology, to which Tom just referred. I am going to make sure we come back to that. And how the public understands them. He has done a historical study of science books written since World War II that includes the exploration of cultural tensions between anti-science beliefs and what he calls an enlightenment vision of reason and evidence as the basis for social progress. I am delighted to introduce Bruce Lewenstein.

BRUCE LEWENSTEIN: Thank you, Biddy. Thank you, Warren, and the other sponsors for inviting me. What I want to do is talk a little bit about media coverage of Darwinism, or particularly of the evolution versus intelligent design debate and the relationship between that media coverage and public opinion, and what kinds of implications we can draw from that for the future.

Although evolution as a topic is generally covered by science journalists, people who specialize in science and who have no trouble whatsoever accepting evolution as true, once the issue moves into the courts, once it moves to political settings, the nature of the journalism profession is that it then gets covered by a different set of journalists, by the political journalists or the legal journalists who have much less background in science and for whom the story is that there is conflict.

Remember, go back to your junior high school, middle school English class - story requires conflict. The fact that there is a conflict becomes the core of what’s being covered. It’s no longer an issue of the science journalists who know the science, but rather we have a different set of people who are at work. A typical story might include something like “Intelligent design theory attributes the origin of life to an intelligent being. It counters the theory of evolution which says that people evolve from less complex beings.” The idea here is that we’re
leaving it up to you, the reader, to decide which of those sentences you should believe in. Because the role of the journalist is not to tell you what to think, but simply to give you the information. Of course this plays then directly into the hands of the intelligent design supporters who argue, see, there is a controversy and shouldn't we be what they call “teaching the controversy?”

In some ways this carries over to the opinion pages as well. The people who edit the editorial pages or the op-ed pages of newspapers or schedule the opinion pieces on television see their role not as the gatekeepers of scientific content but, as one of my students Matt Nisbet wrote, “as the enablers of debate within pluralistic communities.” That is to say the role of the editorial person is, in fact, to be providing a platform for important social discussions. They don’t see themselves as necessarily a filter.

What that led to, for example, in York, Pennsylvania, where the largest papers near the Dover case were published, were editorial page editors who published essentially every letter they got that was not libelous or completely incoherent. One of the papers, the York Dispatch, did take a firm editorial stand in support of evolution and against creationist or intelligent design ideas. The other paper however, the York Daily Record, generally sought to minimize the controversy. Similarly in Cobb County, Georgia, outside of Atlanta, where there was a similar controversy going on about labels in textbooks, the newspaper there actually took a very strong editorial position, where the editorial page editor argued quite strongly that the science infrastructure was under attack from religious extremists, and they repeatedly ran columns and op-eds arguing for evolution. And the letters that they ran were quite evidently more in support of evolution. Now we don’t know whether that was because that’s just the balance of letters that they received or whether they shaped their coverage a little bit more. But it is possible for the editors to use their platform, their own platform of editorials, to be much stronger. I think we saw that this morning in the Ithaca Journal where they ran part of their editorial in support of evolution.

So how does all of this then affect what the public actually thinks? The evidence is fairly clear that for the last generation, at least, certainly back into the mid-1970s, no matter how you asked the question, public opinion polls indicate that about half of Americans believe in a biblical creation account. That’s actually a quite steady number. I want to emphasize: there is no growth in that, but that’s a steady number over the last 30 years or so.

Similarly if you ask some specific questions about scientific beliefs we get similar numbers. So, for example, if you ask “True or false, did the earliest humans live at the same time as dinosaurs?” About 50 percent will tell you that that’s true. I refer to that as “the Fred Flintstone effect.”

Another question is: “True or false, human beings as we know them today developed from earlier species of animals.” Again, about half of the general public gets that right. However, about two-thirds of those with a college educa-
tion get it right and about 80 percent of those with graduate or professional degrees get that right. Not science degrees, just general college or graduate degrees. In fact, having a science or math education in college doesn’t make a big difference. If you look at the difference, according to whether they have low, medium or high science, you only get about a four percent difference between low and high. So that’s not the issue. The issue is just general education.

That leads me to my conclusion. The first time I wrote it, I wrote it in such a way that Barbara was going to take my head off, because I was going to say it was the teacher’s fault. But in fact it is a general community need that we have to commit to education, to education at the public school level, to get people through high school, to get people into college, and through college. It’s general education, not specifically science education, but the ability to learn how to think and think critically that ultimately makes a difference. Thank you.

PROVOST MARTIN: Well, speaking of which, that is, the importance of public education and general education, I can’t think of a more important position than the one occupied by Dr. William Russell, who is the assistant superintendent for curriculum and instruction in the Ithaca City School District. He’s responsible, as most of you know, I think, for the academic affairs of the school district, including, among other things, curriculum development and implementation, staff development, instructional materials, libraries, testing, and assessment. Before coming to the school district, Dr. Russell was Associate Dean of the School of Humanities and Sciences at Ithaca College, and also IC’s Director of Teacher Education. And I happen to know that before that he was at Dennison College in social anthropology. He earned his Ph.D. from the University of Cincinnati in educational policy studies, specializing in the history of education, but also on issues of race, gender and class in public schools. I am delighted to introduce William Russell.

WILLIAM RUSSELL: I am here to share with you the good news that the teaching of Darwinian evolution is alive and well in the Ithaca City School District’s science classrooms. And I’m certain that will be a relief to many of you in this audience and many of my fellow panelists.

Whether it’s in our courses in environmental sciences, in Earth science, in ecological or molecular biology, in the living environment, in botany or in AP biology, teaching of evolutionary theory and evidence is at the core of what we do.

Our teachers are very well-versed. Many of you have had experience with teachers in our science department; it’s one of the jewels of the high school. They are well-educated, many from Cornell or from Ithaca College. And they see that teaching about evolution is the key overarching principle of life science, from the fossil record to anatomy and physiology to molecular biology or to
genetics.

But they also are very quick to point out that evolution is completely embedded in the New York State Science Learning Standards and those govern what we teach in our schools in this state and they also determine the various Regents exams that are given throughout the state every year. So this is not a unique Ithaca thing where we do science appropriately and focus on evolution. But indeed it is part of the New York State Learning Standards in Sciences.

To date, in this school district, at any rate, we have not been confronted with a serious attempt to inject intelligent design into our science curriculum. But I started that sentence with “to date.” We shall see whether that struggle comes to the enlightened village or not. We have not yet experienced it in the school district.

In thinking about this panel and this celebration of Darwin Day, I convened a discussion and dialogue with a group of our science teachers, in Earth sciences, in environmental science and in biology to talk about the issue of how do they handle the teaching of evolution and intelligent design in their classroom. And I wanted to share a little bit of what they had to say to one another and to me.

They are unanimous in the notion that intelligent design is not science. They were quick to point to recent court decisions, even a pronouncement from the Pope, to buttress their conclusion that intelligent design is not science.

But they also say that they find it useful to raise the issues in their science classrooms as they begin teaching in any of their disciplines. And they use it in some way, I think, as a foil, as a device to help students understand what many of our panelists have mentioned. That is, what are the basic tenets of scientific explanation, of theory construction, of experimentation, of the role of evidence, of inference, of scientific laws and paradigms, as we do the enterprise we call science?

How do we know, in other words, what is or is not science? And the whole concept of intelligent design countereosed to the science of evolution is a very useful way of exploring that with young students.

They also say they are often confronted with common misperceptions about evolution. And they take it upon themselves to try to help kids understand and develop a more clear understanding about what evolution is and is not, and what the theory says and what it does not, and to help them be able to, in everyday life, with their families, with their friends, to refute misconceptions. For example, they’re commonly confronted with the notion that evolutionary theory provides an explanation for the origin of life. And they need to rebut that notion and make sure that students don’t come away with some misconceptions in that important regard. Many times students will come believing that evolutionary theory shows that evolution is simply a ladder toward ever more advanced life forms. And they are quick to disabuse them of that. Or they
very commonly encounter notions of social Darwinism, and the bastardization of Darwinian evolutionary theory for certain kinds of political purposes, and they introduce discussions about that in their science classes.

On occasion teachers find that they are challenged by students, perhaps who have learned about intelligent design, perhaps who have strong religious faith in their background. For example, one teacher recently said after grading an exam on a unit on evolution, a student had written in the margin, “I understand what you are teaching me” - the student did well on the test - “I understand what you are teaching me, but I don’t believe any of it.” And that’s an interesting challenge for any teacher, and for science teachers in particular.

Others have reported students simply standing up and saying you’re teaching against my religion, this is sacrilege, I won’t hear it. Of course they have to hear it. But it’s a real challenge to teachers who are not prepared to debate issues of religion in their science classes but who are confronted in part because of the intelligent design movement by claims such as that.

They also find that students are sometimes bothered by one of the more facile claims of the intelligent design movement, that is that the theory of evolution has led to gaps in scientific knowledge. Students, especially younger students, ninth grade, tenth grade students, are troubled sometimes by gaps in the scientific record, or by gaps in knowledge, and they believe that must be a telling blow to evolutionary theory. Our science teachers are at pains to disabuse them of that notion, and reassure them that we are consistently working toward filling those gaps with consistent theory and evidence and experiment.

I posed the problem to them: is there a role for intelligent design in a science classroom? As I already mentioned, they do use it to explain science versus non-science. But similar to what Sheila suggested, for example, many of them do introduce these notions as part of a concept of history and a concept of philosophy of science. They want students to understand that science is not simply an aggregation of facts that is ever-growing in some sort of empiricist fashion, but rather there have been significant debates throughout the history of science and that pre-Darwin religion played a very important role, as did arguments from design.

These are not new in the history of science or in the history of the philosophy of science, and our teachers want students to try to understand those things.

Our teachers seem very interested in the debate. They have been following it in the news, they have been reading the articles, and they had much to provide me with background material for thinking about this. And they seemed to want to know more, especially about intelligent design’s claims to being science. In fact they have arranged with a graduate student from Cornell to come and have a seminar with the faculty at the high school over exactly what are the supposed scientific claims of intelligent design, because they want to be more
educated themselves. They want to be able to answer their students’ concerns. And frankly, there is a sense in which I think they are eager to, in their own right, rebut some of those claims because I think they believe them to be relatively specious.

One final piece that I want to engage you with a little bit is: what will we do if New York State were consumed with intelligent design fever and all of a sudden mandated something to do with intelligent design in opposition to evolution, and what would they do, as science teachers.

First of all, they thought it very unlikely. They thought that the important role of science teachers across the state in devising and writing curriculum in the development of our science standards would mitigate against such a movement. They were quick to point out that our curricular offerings in the sciences are very closely aligned to national science standards, which are quite hostile to intelligent design; and they also pointed out that it would be quite counter to our own school district’s curricular policies, which require that our curriculum and our instructional materials be factually accurate, authoritative, and include contemporary research. And in their view and my own, intelligent design fails on all three of those standards. They mentioned that every exam that we give, on Regents exams, and every question has to be vetted by no fewer than seven different committees that are going to determine its appropriateness and that such things would never get by that level of sort of bureaucratic structure. One wag also mentioned that No Child Left Behind requires highly qualified teachers in every subject area, and inquired where we might find highly qualified teachers in intelligent design. They were not among them as they looked at themselves.

But I pressed them, so what if they did, what if we did have to be confronted with some movement at the state or a school board level. One teacher said, well, I guess I’d have to teach to the standards and I’d have to bone up on intelligent design. Her colleague said, I guess I’d have to move to another state. And another one, looking at me with a somewhat ominous note, said, well, if we did refuse to teach it, would they call out the curriculum police? Another one closed the discussion by saying, “Isn’t having tenure tied to concepts of academic freedom?” And I had to conclude that that was in fact the case; and I left that conversation quite reassured that, as I opened, teaching of evolution is very well done and our school district is very firmly entrenched in our curriculum. And I think we are well prepared to meet any challenge from intelligent design, at any rate.

PROVOST MARTIN: Thank you, Bill. I bet there are people in this room who have other answers to that question. What would we do? It’s a good question. We are almost there.

The next speaker is Steve Shiffrin, who is a Professor of Law at Cornell. He’s been at Cornell since 1987 after teaching for 10 years at UCLA’s law
school. Steve Shiffrin is the coauthor of a book entitled "Constitutional Law," which came out in its 9th edition in 2001. He is also coauthor of a book on the First Amendment, the 2nd edition, which appeared in 2001 as well. Both of these are widely used casebooks in the teaching of law. He is currently working on a book on church-state relations. He is about to present variations of a paper on liberalism and religion at the American Philosophical Society Meeting in Chicago and at a Conference on Philosophy and Social Science in Prague. I know he will have something provocative to say. Steve.

STEVEN SHIFFRIN: I have no expertise in this area. But that has never stopped me. If I had to have a title, it would be "Evolution yes, Darwinism no."

I want you to imagine three different school boards: School board number one says the schools must teach that God exists. School board number two says that intelligent design must be taught, at least as an alternative to evolution. And school board number three says gaps in evolutionary theory must be taught. I want to talk about the legal and cultural aspects of these examples and about Darwinism in general.

First: You would think it’s absolutely obvious that the action of the first school board must be unconstitutional. That is to say, it is no part of what states should be doing to tell us whether God exists or what God has to say about a particular subject. That should be one of the clearest principles of establishment clause law.

However, at 2 o’clock in the morning I began to think, what about the fact that we now have on our courts Scalia, Roberts, Kennedy, Thomas and Alito, that IN GOD WE TRUST is on our coins, and that it’s unquestionable that the Pledge of Allegiance under God will be accepted in the schools as constitutional. What is the basis for distinguishing my first school board’s action? If the school can encourage a child to say “I pledge allegiance . . . under God,” How can it be unconstitutional to teach that God exists. How do you put those two together? I believe that even – Justice Thomas is an exception – the conservatives on the court would say that the action of my first school board is unconstitutional. Although they think ceremonial activities such as I have described are permissible, and although Justice Scalia wrote an opinion for four conservatives saying that it’s okay for the state to prefer religion over non religion, Scalia also said proselytizing is not okay. And Kennedy has written opinions in which he says proselytizing is not okay. To insist that the schools teach that God exists is to insist on proselytizing and that is clearly unconstitutional. I think we can sleep easily over the first example.

The second, intelligent design: Intelligent design has an additional problem. Even if it’s taught as an alternative. If it’s taught as an alternative, it probably, when one probes the facts, as the court did in the Dover case, is designed to proselytize. It is not only put forward for a religious purpose, but the reli-
gious purpose is sectarian. Mainstream Protestants, many Jews, and Catholics, in the main have no trouble with evolution. Many Evangelical Christians have no trouble with evolution. Fundamentalist Christians have trouble with evolution. So intelligent design exists to promote a particular sectarian perspective. And even the conservatives on the court would be opposed to the promotion of sectarian views. Perhaps it helps that five of the Justices are conservative Catholics who are likely not to find that evolution contradicts their own religious views. I believe that intelligent design is not going to pass constitutional muster.

Now the gaps point. Suppose the school board says gaps ought to be taught in the schools. Now it can be unconstitutional for them to do that. If they say the gaps ought to be taught and you have got a record with religion written all over it, then it’s unconstitutional. Then it’s designed to promote a particular religious perspective. But suppose you simply have a goody-two-shoes school board who says, you know, there is a lot of debate about the comprehensiveness of evolutionary theory. And in an effort to avoid the religious right, our science teachers aren’t teaching about some of the gaps that exist, and we think that’s bad teaching. Now I don’t think school boards should be micromanaging. But you can imagine a secular justification for doing this.

When I first started thinking about this, I thought that it was obvious that intelligent design shouldn’t be taught in science classes. I thought that intelligent design was bad science or not science. I of course know nothing, but I just assume that’s true. And therefore, they don’t belong in a science class.

My view now is they do belong in a science class. They belong in a science class because intelligent design should be confronted and refuted. And who would be better equipped than scientists to do this. Millions of people believe things that are bad science. I teach bad legal arguments all the time. I refute them. I make bad legal arguments all the time as well. But why shouldn’t this be in a science class? And in fact there are gaps. And those gaps should be faced up to. There is a hope that evolution will explain the gaps. If evolution can’t explain the gaps, that doesn’t mean that you have to believe in an intelligent designer. It could be some neo-Darwinian theory or other theory about complexity and so forth. But it ought to be explicitly addressed.

Why are people opposed, why is the left particularly opposed to having bad science addressed in the science class? I think there is a cultural fanaticism that rivals the religious right. Some of it is simply anti-religious, some of it is a desire to win a culture war, at least somewhere. And I think it’s a pedagogical mistake.

I also think that in science classes there should be, and I’m pleased to see that there is, discussions of the limits of science. Science cannot prove that God exists, and science cannot prove that God does not exist. Science cannot show us what the meaning of life is. I think Hunter Rawlings does a good job of dis-
cussing that in his recent speech. I was a little surprised about his notion that theologians are rigid. I think many theologians are rigid. I’m not sure that’s true of Hans Küng, Charles Curran, Jonathan Sacks, [who is] the Chief Rabbi of England. And I am not sure if it was true of Reinhold Niebuhr. And now, in the minute I may or may not have remaining...

PROVOST MARTIN: You don’t but hurry.

STEVEN SHIFFRIN: Okay. I just want to say a word about Darwinism. It’s striking to me that religious fundamentalists are the most likely people to believe that truth emerges in the market. They are social Darwinists. They tend to believe that those people are poor should be poor, those people are rich should be rich because there is the survival of the fittest. They believe that the United States is the greatest country on Earth, and they are strong believers in triumphalism. I blame Oliver Wendell Holmes and Charles Darwin for a lot of this.

The idea that the truth emerges in the marketplace of ideas, I believe, is simply silly. And I don’t need Foucault, I can take John Stuart Mill. John Stuart Mill, you know, asked you to imagine (I will change his examples) that you are born in San Francisco, you are born in Rio De Janeiro, you are born in Cairo, you are born in Moscow, you are born in Paris or Prague. Do you suppose that might have an impact on what you believe? And how is it that people who are brought up in these different upbringings, come to believe different things, and all think that truth has emerged in the marketplace of ideas? It is one of the worst ideas that has ever been presented with respect to the First Amendment.

I’m a big believer in freedom of speech, except when I’m not. And it seems to me that the “marketplace of ideas” notion is folly.

PROVOST MARTIN: Okay. I knew he would have some provocative things to say. Now, I want to talk about this one, about whether Darwin’s responsible for the idea of the marketplace of ideas. That’s better. Let’s come back to that.

We have one more speaker and I’m delighted to introduce Reverend Janet Shortall, who’s the Associate Director of Cornell United Religious Work. Cornell United Religious Work includes, as many of you know, 25 affiliated faith communities that offer programs of worship, studies and social life, as well as opportunities for our students to engage in interfaith dialogue for which Cornell is well known, having been from its inception a non-sectarian university.

Reverend Shortall holds a Master’s of Divinity degree from Starr King Seminary. She has worked in the areas of peace and justice education, feminist scholarship and research in theology. I am delighted that she is our final speaker.

JANET SHORTALL: In preparing for this panel, I was reading Scientific American this week, and this month’s issue had an article about Eugenie Scott,
who is the Executive Director of the National Center for Science Education. She is, of course, traveling the country for all these aforementioned trials, having recently been in Dover. She said her greatest accomplishment has been gathering the coalitions of very diverse people in organizations she has knit together in support of science education, especially the clergy. As a molecular biologist and geneticist at the University of Wisconsin-Madison, she was quick to admit that non-scientists, especially clergy, were helpful allies in her work noting, “Because when seriously religious people speak up in favor of evolution, people listen.”

Well that thought scared me because I must admit that much like other liberal clergy persons, I had a rather steep learning curve to find my way into this discussion. I have to say, had I not had the pressures of this panel, and all the reading I have read for it, I’m afraid I would know little about the seriousness of this crisis in science education in the U.S. and I suspect I am not alone, particularly as a liberal religionist.

It doesn’t help that I was raised Catholic. Evolution for Catholics, as Steve mentioned, has never been particularly an issue. The tradition has not historically relied on literalists’ interpretation of the Bible, nor did it rely on a natural theology as evidence to finding God. In considering physical evolution, therefore, it’s not a problem. Catholic teaching promotes the idea that the human soul was what was created in the image of God, not our bodies, so they avoid the whole argument.

The Unitarian Universalists - now one tradition - are both descendents of those theologians who defended modernity in the 1920s, arguing along with our liberal Protestant cousins that religion had to be considered in the light of reason and to look at sacred writings “as if they were human produced, rather than simply transcriptions of a divine dictation.” Liberal Christianity has remained particularly receptive to reflecting on traditional beliefs in light of current scientific insights. In fact, scientific insights help modernity win a lot of battles, by having liberal Christians and others as allies. Sometimes not completely linked together, but for argument’s sake we have been good partners.

For many like myself, entering into this discussion is, therefore, a genuine challenge to even get my head around the resistance to evolution. And like Steve, I think if you polled your liberal religionists in your community and asked how many of us understood evolution or intelligent design, many wouldn’t really be well versed on either. I have found that liberal religionists, because it is not an issue in our communities, many of us don’t spend a great deal of time sitting and thinking about what is it that we are supposed to be supporting in the public sphere of which religion somehow might have some influence in helping people begin to hear the arguments. There is this failed assumption that we worked out this divide nearly a century ago and fail to recognize what is at stake in the current debate.
Many today have referred back to the Scopes’ trial. I explored how the press covered the Scopes’ trial. You would think that for the liberal religionists’ world, victory had been won and that there was a thorough thumping of those “Bible thumping, fundamentalist, hillbilly, ignorant,” - well, you know the rant.

Mind you, in this case there might have been a perceived victory on the national level, but evolution was set back for years in science education across this country as a consequence of the way the debate unfolded across this country. I only learned this in my researching this period of history to know that. My goodness, how many students in our own country, including myself, probably were affected by the fact that the reaction against that decision set back science education for a lot of school districts. For my children’s sake, I am sure glad to be living in Ithaca, New York. If there is anything that should frighten liberal religionists it is probably a lot of the polls you have already heard, that 42 percent, this is a fairly steady statistic, because I checked it many different places because I was so appalled I couldn’t believe it was true. That 42 percent of Americans polled believe that humans and other living things have existed in their present form since the beginning of time. Forty-two percent, some say 40, some say 45. Even at 40 percent - that statistic should have all of us reading about evolution and intelligent design and prepared to speak “intelligently” even as non-scientists. Many of us are not really up to that challenge. And I think we fall prey then to easy arguments that fail to address key issues of this “alleged debate” on evolution. Most of us know that intelligent design is not Biblical literalism. But we need to understand the distinction of how it’s different in order to argue against it more successfully.

In Ithaca I fear that within the liberal religionist community, we are prone to reading about the statistics as simply an indication of the dedicated work of the religious right. Many of us are quick to sound the alarm that our country is moving towards becoming a theocracy. Now that gets everybody up in arms, ready to go to the streets, which is a good thing. I think the radical religious right is a problem and I think we do need to be in the streets. But then we get there. I fear on this issue we often don’t have a lot to say. You know, we get there, and we’re really angry. We think it’s a problem of ignorance, it’s a problem of people being backward. We offend religious conservatives consistently who feel as if we have no ability to distinguish between a fundamentalist and a conservative Christian, many of whom have little issue with evolution and can actually speak a little bit more intelligently because they have had to wrestle with this issue. At least at Cornell, it is the conservative Christian community who have sponsored more discussions on Science and Religion in an attempt to give voice to a greater plurality of perspectives.

For most liberal communities, very little discussion is happening. It’s almost as if evolution is a non-issue. But where we are as a nation begs a deeper engagement about why it is such a big issue for growing numbers of Americans.
This quote stayed with me: “No idea split modernists from fundamentalists more than the Darwinian theory of human evolution” – and this is now back when it really surfaced in this country in the 1920s – “the rift was aggravated by the seeming rise of agnosticism within the cultural, scientific and media elite of America, of Americans.”

I was trying to think, why 1920s? What does that mean within American life? And I was asking Bruce before, why, why did this surface in a certain way? I wanted to read more, not only from the discipline of philosophy but through the field of history of science and religious thought in this country. What we teach in our school is often only basic literacy of religious concepts. I think what we really need to understand is the history of religion in this country. How did culture, and scientific discoveries, and religion shape consciousness in towns across the US? Studying this might give us some insight into what animates this discussion so passionately for so many across the country.

I am left wondering if much energy went into thinking long and hard about how small communities initially responded to a growing national mandate for what education of our children should be. The fallout at the Scopes trial seems to be related to that event serving not so much as an earnest discussion about science but more so, a media circus where this little town of “ignorant, backward people” were put on trial. The backlash was in many instances quite predictable.

The most recent interesting place for me at Cornell, religiously, is the Chesterton Study for Christian Studies at Cornell. I don’t know if any of you are familiar with it. The founder of this center at Cornell, a Cornell alum, is seeking to create a place of engagement for conservative Christians to engage in a discovery of the intellectual riches of the historic Christian faith as that relates to engaging all the academic disciplines represented at Cornell. Countering a certain “anti-intellectualism” and a retreat from the engaging civil society that characterized evangelical scholarship, fueled at least in part by the backlash of the 1930s, this center aims to support students in creating a more integrated sense of their being Christian and scholars of many fields, including science.

This is heartening news when one considers the rising number of children in our country right now, thanks to the benefit of private education (including home schooling), live very isolated lives, often fearing science as a threat to personal faith. It is unfortunate that their fears are not completely without merit as Warren talked about the film earlier where we begin to talk about some of the dogmatism that is not really good science, but sometimes stands in for good science and leaves little room for an active engagement of what is needed to further the aims of useful and needed scientific inquiry.

I must say that in listening to our scientists on the panel today and in reading writers like Ursula Goodenough, a cell biologist, author of *The Sacred Depths of Nature*, that evolutionary biology can engage our senses much like
good poetry. Evolutionary scientists, through their work, often speak eloquently to our shared sense of wonder of existence, our concerns for life on this earth, while remaining open to much of the mystery that still remains.

I do imagine the challenge facing any science teacher currently is considerable when confronted by a child with arms crossed to their chest who is ready to tell you can teach them whatever you want, but they won’t believe in it. But this standoff seems to indicate to me a continued failure of our not having found better ways of speaking to one another. I trust there are many teachers who avoid a posturing that comes off as dogmatic but instead invite their students to probe the mysteries of the natural world genuinely together.

I think liberal religionists have a role to play in reading a lot more about why we don’t seem to be able to speak to people who disagree with us in this debate or why we seem to feel that if you are a conservative Christian, you are therefore someone that we can’t somehow connect with to create a broader consensus of why it’s important to defend science education at this juncture, as America is clearly falling behind internationally in both science and math education.

I apologize for those many scattered thoughts. I began reading for this presentation only to find out how much more I needed to read. I will leave many of you with that thought, too. Most of us deeply committed to science education in this country need to read more and become more and more involved in this debate.

PROVOST MARTIN: Thank you, Janet. Thanks to all the panelists. (APPLAUSE).

PROVOST MARTIN: I choose my words carefully when I say I think I should ordain that we have about ten minutes or so to discuss what we’ve heard, given that we started ten or fifteen minutes late. Obviously if anyone needs to leave, you will do that, despite my having ordained that we can take ten minutes for discussion. So we heard a lot of common themes and I am not sure how much disagreement we heard, but we certainly provoked some, I think.

Let me ask first whether any of the panelists would like to respond to anything they heard from one another?

BRUCE LEWENSTEIN: Actually I just have a question for Tom. When you were talking about whether something was acceptable on faith alone, you implied that it’s easy to have faith. I wonder whether that’s true. Isn’t having faith actually quite difficult?

THOMAS EISNER: Judging from the number of humans who have faith, one might think that humans have a predisposition to accept “soft” arguments. One need only look at the outcome of political campaigns to realize that public opinion is not swayed by logic or scientific proof. Superstition, mysticism, and metaphysical belief generally, including faith in the unproven, are not likely to
be dispelled by the expansion of scientific knowledge. Yet I see some grounds for optimism stemming from the recent legal decision passed down in Pennsylvania. It may well be that the teaching of evolution will be able to survive challenges right up to the Supreme Court. I think there is little chance for the supporters of intelligent design to emerge triumphant - but I am usually wrong about my predictions.

Perhaps we should take an entirely different tack. Evolutionists and anti-evolutionists should bury the hatchet and join forces to face the real issue – environmental destruction and species extinction. In the long term, it may be more important that we unite to save life in its infinite variety, than to expend energy arguing about life’s origin. Surely we can all agree that species face a dismal future if destruction of wilderness continues unabated. All those with a love of nature - which I am sure includes most Creationists - should unite to work for the preservation of wilderness. The integrity of nature is a universal value.

PROVOST MARTIN: Any other panelists want to jump into this discussion? All right. Let me ask the audience. Commentary, questions, provocations?

QUESTION: Has the Ithaca School District done any surveys that would indicate that this great science teaching that’s going on actually produces a different number than the 42 percent or 50 percent [who don’t accept evolution]?

WILLIAM RUSSELL: I am not aware of any.

PROVOST MARTIN: I will repeat the question. Is there any data to support the idea or the notion that the good science teaching in the Ithaca City School District actually produces a better than 42 percent number of people who believe in evolution?

WILLIAM RUSSELL: The answer was I am not aware that anybody has attempted such a survey. I would point you to our many, many graduates that go on to distinguished science careers. I have not done that sort of survey.

QUESTION: Does anybody know about any similar surveys done in Europe? Since we talk about this as a peculiarly American whoha, do we know actually what it is about America?

PROVOST MARTIN: There are surveys that show quite a distinction between the United States and Europe.

BRUCE LEWENSTEIN: Yes, I was just going to say something about that. There are some very similar surveys, using the same sets of questions, across Europe. Clearly on some specific issues, such as evolution, there is more support for evolution in Europe, although if you do a sort of an overall attention to science, knowledge of science, it ends up about the same.

QUESTION: Would someone on the panel or more than one person address what Steve Shiffrin talked about regarding the schools not talking about the evolutionary gaps? Could someone address that?

PROVOST MARTIN: The question is addressed to Professor Shiffrin and other panelists. The speaker would like to know more about teaching the gaps
in evolutionary theory.

STEVEN SHIFFRIN: Well, I would prefer to have somebody who knows the biology to talk about where there are gaps in the evolutionary theory that it is hopefully being fulfilled by the theory of evolution. I know, for example, some of the intelligent design people say wings could not have developed in an incremental way; eyes could not have developed in an incremental way. There is some question about molecules. But there may be – there are many here who know more than I.

PROVOST MARTIN: Those are not necessarily the gaps, right, Tom?

THOMAS EISNER: Of course there are gaps in evolutionary knowledge, just as there are gaps in any scientific field of endeavor. For the scientist, these gaps serve to define new areas of inquiry, rather than provide a basis for questioning the adequacy of the scientific method. Gaps are being filled, for instance, in our understanding of early microbial evolution. Genes might have been transmitted primarily “horizontally” at that time, in other words by “jumping” from lineage to lineage, instead of by descent from parents to offspring, as they are predominantly in the world of today.

The 21st century is rapidly becoming the century of biology, with evolutionary thinking remaining central to the process of biological explanation. In my judgment, acceptance of evolutionary thinking is essential, if we are to exercise any sort of control over our fate. Rejecting evolution is tantamount to denial of the power of reasoning.

PROVOST MARTIN: Does that response satisfy our professor of law?

STEVEN SHIFFRIN: My argument was not a legal argument. It was more of a pedagogical argument. And my source who’s talking about the gaps, I have a lot of confidence in. He is a distinguished law professor (Kent Greenawalt of Columbia) who is opposed to the teaching of intelligent design. But his examination of the evidence and conversations with scientists lead him to conclude that evolution does not yet fully explain all the data. I do not see anything surprising about that. It’s my speculation that there is a tendency among people who want to say intelligent design is wrong, to be very defensive about any claim that there is a gap.

And I am simply cautioning to say really gaps ought to be taught. And as I understood what Bill was saying, Bill was saying in fact the gaps are being explored. Some people have a great deal of confidence that evolution will explain all of the gaps. And other scientists think, you know, evolution may not explain everything. We may need some additional materialist explanations for some parts of organisms. But that’s a question about which I have no particular expertise.

PROVOST MARTIN: Seems like it takes us back to Barbara’s point about education, that science ought not to be taught as if it was dogma but to be taught as a form of inquiry.
BARBARA CRAWFORD: Right. I guess I am feeling kind of uncomfortable focusing on the gaps as if that’s some definitive thing to teach. What we need to think about is developing independent critical thinkers that can take in the evidence, evaluate it, think about the future as citizens making informed decisions, using data and coming up with explanations and meanings of their own. And so rather than focusing on these particular gaps which would necessarily exist because of the nature of the evolutionary theory, instead let’s focus on the positive and develop informed citizens that are independent thinkers and can take data and critically think about it.

PROVOST MARTIN: It’s also the case, I think, there is no theory, scientific or otherwise, that can explain at the moment everything. But that doesn’t necessarily mean theory itself can be opposed on those grounds. So that - all right, go ahead. Let’s argue as we close.

STEVEN SHIFFRIN: I agree with that.

BARBARA CRAWFORD: I’m not getting in an argument with a lawyer.

PROVOST MARTIN: I don’t mind getting in an argument with a lawyer.

STEVEN SHIFFRIN: I agree with that and I agree with the importance of critical thinking. One reason to teach the gaps is to nurture critical thinking. But the gaps should be taught and placed in context because millions of children believe on the basis of these gaps that evolutionary theory is wrong, which is an enormous leap. Finally, children need to know what other people think in society and why they think it.

PROVOST MARTIN: I want to go back and probably we should close, although of course I think these things are so much fun, and more fun than going and handling administrative matters, that I could keep you here all day. But I think it’s very interesting to try to sum up some of this and think about the ways in which both sides of this supposed debate, that is between science on the one hand and religion on the other, have been called into question today by the remarks we’ve heard, or at least that’s what I would like to believe, that this polarization, whether in the form it’s presented in the media or argued between and among members of the community, this polarization is itself inadequate.

I think people imagine, it’s safe to say, that science cannot provide the meaning of life. I think Tom Eisner gave the lie to that to some extent when he talked about what’s - I’ll call it spiritually meaningful - about thinking of oneself as a stitch in the fabric. I also think people tend to think religion is a matter of dogmatic belief. I think Janet Shortall and others gave the lie to that when she defined faith actually by looking at the work of a cell biologist in talking about faith as a matter of wonder, curiosity and imagination. Maybe faith and belief are not themselves the same, and maybe the dichotomy people see when things get so polarized between religion and science is not quite as simple as it can be made to seem.
You looked at me when you said Hunter Rawlings let some anti-religion creep into the State of the University address. I just want you to know I didn’t write that speech. Nonetheless, I think it was a fine speech.

So Tom Eisner says biology can provide a very strong basis for planning the future and, I think, for providing meaning, and indeed faith, in a way, I think, that’s not dogmatic and understands its distinction from scientific method. It can also provide the basis we need for planning the future.

And I hope we will use both of those and all other conceivable tools given the problems we’re facing together. And with that I will close. And let you all come and ask the panelists anything you wish informally. Thank you very much.
Evolutionary Biology: Present and Future
A panel discussion held in Uris Hall Auditorium,
Cornell University, Ithaca, New York
February 10, 2006

Welcome: Warren Allmon, director of the Paleontological Research Institution and adjunct associate professor of earth and atmospheric sciences at Cornell University

Moderator: Stephen Kresovich, Vice Provost for Life Sciences, Cornell University

Panelists:
Richard Harrison, professor of ecology and evolutionary biology, Cornell University
Amy McCune, professor of ecology and evolutionary biology, Cornell University
H. Kern Reeve, professor of neurobiology and behavior, Cornell University
Steven D. Tanksley, Liberty Hyde Bailey Professor of Plant Breeding and Genetics, Cornell University
Mariana Wolfner, professor of molecular biology and genetics, Cornell University

WARREN ALLMON: Thank you all for being here. My name is Warren Allmon and I am the director of the Paleontological Institution (PRI) across the lake and an adjunct professor in Earth and Atmospheric Sciences. This is the second event of the celebration of Darwin’s birthday, which is actually February 12th, Sunday. We started this week of activities yesterday over at the Museum of the Earth at PRI with a panel discussion about the broader social implications of evolution and Darwinism. Today the idea is to talk about the current status of evolutionary biology. Yesterday was about the social “So What?” Today is, “So what is evolution today and where might it be going?”

Before I hand it over to Stephen Kresovich, I want to just mention some of the other events that I hope some of you will want to take advantage of. Tonight, just a couple of hours after we finish here, in Warren Hall auditorium, we will be showing Inherit the Wind, the 1960 film. Even if you’ve seen it before, we will be talking before and after to what degree it is historically accurate - it turns out not much. Tomorrow, starting at 12 o’clock and running to 4 o’clock, over at the museum there will be activities and programs for the general public, so if you have a non-scientist in your family, come over. Starting at 12, we will have a talk entitled “An Educator’s Guide to Evolution and
Creationism” and family activities from 1 o’clock to 4 o’clock. Then on Sunday, a very special event in Kennedy Hall, in Call Auditorium, is a kind of a sneak preview of a brand new documentary film by a biologist and filmmaker named Randy Olson from California called *Flock of Dodos* which is a double or triple entendre about the nature of how we teach evolution to society. The Dodos are not just the advocates of Intelligent Design, they are also the evolutionists who have not done a particularly good job of communicating with the public. So that is Sunday night at 7 o’clock. The filmmaker, Randy, will be here to answer questions. Allan MacNeill and I will be leading a Q&A after that’s over. Then the final event of the week is on Monday afternoon at Ithaca College (IC). Associate Professor Susan Swensen from IC will be leading a panel discussion after that from 3 to 5.

Before we start I want to thank the Provost’s Office for being the main sponsor of this, together with PRI, Cornell United Religious Work, and also the Biology Department at Ithaca College. We hope that this is just the first Ithaca Darwin Day, not the last. I want to turn it over now to Steve Kresovich who is the Vice Provost for Life Sciences who has agreed to moderate today.

STEPHEN KRESOVICH: Welcome. Over the past few years you’ve probably thought a lot about Life Sciences. Building institutional strengths in this area is a university-wide priority because we’ve collectively come to realize the unique strengths that we have at Cornell and the important problems we are going to encounter in the 21st century. There are many topics in the life sciences that we need to address that are of societal importance and they include things like: understanding the care and capacity of an ecosystem or the world and developing effective conservation strategies to protect those ecosystems or species; breeding nutritious, disease resistant, stress tolerant crops for the arid or semi arid tropics; preventing and correcting health-related problems associated with obesity; and finding cures for neurodegenerative diseases like Alzheimer’s.

A keystone discipline within the Life Sciences at Cornell is evolutionary biology. In this area we have great strengths across colleges that are represented here today. Evolutionary biology provides us with theories and approaches to answer such complex and diverse questions as: How many species are there? How do we protect and use these species most effectively and fairly? How do we know species appear and evolve? Do animals cooperate? Why? Why are cultivated tomatoes so big? Can we make them any tastier? Why is there sex? Am I predisposed to particular behaviors or diseases? Ultimately, for me, can I live to be 150 years old and enjoy a good quality of life?

This afternoon you will hear from intellectual leaders on our campus presenting the breadth of evolutionary biology at Cornell. I would like to introduce the speakers but would like to say a few things about the format. Today what we will do is have the speakers go in order for approximately five to ten minutes each. Then at that point we will open it up for questions from the
audience. Now I would like to introduce the speakers starting from your left to the right.

First of all, Dr. Rick Harrison is a professor in the Department of Ecology and Evolutionary Biology. Rick’s current research focuses on examining the genetics of natural populations and applying molecular techniques to questions in evolutionary biology. Much of Rick’s research is directed towards understanding the origin of species and the evolution of barriers to gene exchange and the history and dynamics of natural hybridization. He works across a variety of species ranging from European corn borer and field cricket to the whale.

Next, Dr. Amy McCune is also a professor in Ecology and Evolutionary Biology. She also serves as faculty curator of fishes at Cornell University’s Museum of Vertebrates. Amy’s research interest is in evolution of biological diversity and she works on fish. Research in her laboratory focuses on issues related to speciation through the study of evolution of species’ blocks of fishes, as well as the evolution of phenotype and form in a genetic context and the study of the origin of variation in which natural selection can occur.

Next, Dr. Mariana Wolfner, a professor in the Department of Molecular Biology and Genetics. Mariana is interested in understanding at the molecular and genetic level the importance of reproductive processes that occur around the time the sperm fertilizes the egg. Much of her work uses the model organism *Drosophila*, or the fruit fly. She uses that because of a number of things. First of all, there are excellent genetic and genomic resources available, with which development and reproduction can be studied. Second is the ability of *Drosophila* to serve as a model, because many of the gene products and reproductive and developmental phenomena in *Drosophila* have counterparts or analogues in other animals, including people and insect pests.

Next to Mariana is Dr. Steve Tanksley of the departments of Plant Breeding and Genetics and Plant Biology. Steve’s research focuses on understanding the evolution of crop plants, and, in particular, the size and shape of tomato fruit. What starts as a small berry-like fruit on wild plants eventually evolves into those giant tomatoes that you grow in your garden. He also focuses on comparative genomics and bioinformatic approaches to studying genome evolution in the Nightshade family, which includes tomato, potato, petunia and pepper. And lastly Steve is developing and testing new plant-breeding methodologies to exploit novel genetic variation found in the wild ancestors of crop plants.

Lastly, Kern Reeve is a professor in the Department of Neurobiology and Behavior. Kern’s research goal is to develop and test biologically realistic models of the evolution of cooperation and conflict in animal societies. He is currently investigating two classes of models that bear in the evolution of cooperation. The ultimate aim of these efforts is to develop and refine empirical models in a general theory of colony level consequences of reproduction and reproduction asymmetries within animal societies. The organisms that Kern investigates
include insects from moths to wasps. So with that you can get a flavor of the breadth of expertise that we have on our panel. With that I’ll turn it over to Rick Harrison.

RICHARD HARRISON: In what follows, I want to consider briefly what observations of the natural world motivate evolutionary biologists, discuss what we mean by evolution (as pattern and process), and suggest that understanding evolutionary process is central to modern biology, both basic and applied.

If we look around in the natural world, we see a great variety of different organisms, and we recognize that there are many ways to “make a living.” The natural world reveals an impressive diversity of form and function. In examining the natural world we also recognize that natural diversity is not randomly distributed with respect to environment. Many organisms show an apparent “good fit” to their environments - they appear to be “well adapted” (in morphology, behavior, physiology, biochemistry, etc.).

We also recognize that diversity is not constant in space or in time. We know this from cataloguing the distribution and abundance of organisms of all sorts, from studies of genetic variation within species, from detailed studies of the fossil record, and from observations over many generations in natural populations of animals, plants, fungi, bacteria, etc. For example, by examining the fossil record, we learn that organisms present today were often not around 10 or 100 million years ago and that organisms alive 10 or 100 million years ago are not around today.

In considering the pattern and process of evolution, we can identify three separate but intimately related components. These components were first elegantly integrated by Charles Darwin some 150 years ago.

The first component is change over time - new forms appear, existing forms disappear. These observed patterns of change occur over multiple temporal scales. The fossil record provides a remarkable (yet admittedly incomplete) record of long-term patterns of change. We document large-scale patterns over tens or hundreds of millions of years. Studies of gene frequencies (allele frequencies) within natural populations record changes over tens of years (in shell patterns in snails or wing patterns in butterflies, for example). In bacterial populations we can detect changes over even shorter time scales. Change over time at all temporal scales is observable fact.

The second component of Darwin’s theory - and of the modern theory as well - is descent with modification - that novelty arises through modification of ancestral forms. Evidence for descent with modification emerges from careful comparisons of the form and function of organisms. It is the cumulative weight of evidence of this sort, not any single discovery, that leads us to accept descent with modification as the guiding principle in explaining change over time.

What is the evidence? First, comparative studies consistently reveal a hierarchical organization of life, that organisms can be arranged in a pattern of
groups within groups, exactly what one predicts if living organisms have descended from common ancestors. Second, descent with modification is strongly supported by observations of similarity of structure despite differences in function. The front leg of a horse, the wing of a bat, the flipper of a porpoise, and the arm of a human are constructed from the same set of bones (modified in size and shape). Why would this be unless they are each modifications of the forelimb of an ancestral tetrapod? Vestigial characters (such as the enormously reduced pelvic girdle and miniature legs seen in whales, or eyes in blind cave fish) also are expected if extant species are modified from ancestral forms (and not designed \textit{de novo}). Evidence for descent with modification also comes from direct observations of the fossil record. Although many critics of evolution point to the absence of intermediate forms, in fact the last few decades have witnessed remarkable fossil finds that provide convincing evidence for intermediate forms, for example between theropod dinosaurs and birds, between artiodactyls and whales, and between fish and tetrapods. What were once gaps in the record are gradually being filled in.

The third component of Darwin’s theory is \textit{natural selection}, which provides an explanation for which modifications persist and which do not. Contrary to the assertions of critics of evolution, natural selection is NOT a random process. We do have strong evidence that mutations (genetic changes) are produced randomly with respect to environment. That is, mutations do not occur because they are “needed.” In contrast, selection is a distinctly non-random process - it results from consistent differences in performance among different genetic variants. Natural selection is not a purposive force (it has no goal): it is simply differential survival and reproduction. When “artificial” selection is practiced by plant and animal breeders, there is in fact a clear goal - and differential survival and reproduction are imposed by the breeder. The underlying process is the same - but the breeder is looking to the future, whereas natural selection cannot anticipate what is to come.

Finally, let me emphasize that evolutionary biology is increasingly important for our understanding of fundamental observations in biology - from the scale of whole communities and ecosystems to interactions at the level of cells and molecules. Evolutionary theory is also critical for confronting major problems in both agricultural and medical science. We see this in growing concerns about the evolution of pesticide or herbicide resistance, in the dramatic increase in the prevalence of bacteria that are resistant to antibiotics, and in the patterns of change over time in populations of HIV that occur within the lifetime of a single infected individual.

Criticisms of evolutionary biology tend to target gaps in our knowledge and/or disagreements among evolutionary biologists. As evolutionary biologists, we freely admit that we do not yet have detailed explanations for the origin and maintenance of some components of the diversity of form and function that we
see. The field continues to mature - in large part because of an increasing interface with other biological disciplines. Furthermore, that evolutionary biologists do not always agree on which processes to invoke to explain particular patterns should not come as a surprise. It does not reflect any weakness in our science - instead it is emblematic of our strength, that we continue to examine the available evidence and to consider how best to explain what we observe.

AMY MCCUN E: Each of us was asked to comment on the current state of evolutionary biology and the challenges and opportunities of the near future. Maybe because I was trained as a paleontologist, I find I can’t think about the present and future without also reflecting on the past.

When I first began thinking seriously about evolution, it was in the mid 1970s, at the end of what I consider was the slowest and least innovative period ever in the history of evolutionary biology. Fortunately, it was also the beginning of what I would consider the most exciting period of evolutionary intellectual history since Darwin.

Three very important things have happened in this intervening time.

First, the way we study the fossil record has become far more rigorous and innovative; paleobiology has become a source of ideas for evolutionary theory rather than a sink.

Second, tree-based thinking (phylogenetics) has infused, to varying degrees, virtually all other biological disciplines (physiology, ecology, behavior, genetics, development, molecular biology). There have been dramatic advances in the way we reconstruct evolutionary histories of organisms that stem from the widespread use of a methodology called cladistics, and also from the ability to collect and analyze large amounts of DNA sequence data.

Third, we are making incredible strides in our understanding of how the developmental genetic “programs” that build some organisms have been modified to produce many different kinds of organisms. In part, these advances are due to the increasingly rigorous frameworks provided by paleobiology and tree-based approaches. But to a very large degree, the advances in this important area are coming from discoveries and technical innovations in developmental genetics and functional genomics.

An important discovery in this context is that the same gene can be deployed in a similar way in the same structures of different organisms or even in different structures in the same organism. For example, Distalless, also known as the “sticky-outy” gene, is involved in making a variety of structures that stick-out: like starfish arms, tube feet that stick out from below starfish arms, insect legs, vertebrate legs, and the collapsed sticky-outy structures of eyespots in a butterfly wing.

Another important discovery has to do with the varied effects of genetic changes. Darwin thought that evolutionary change must happen always through the accumulation of many small steps. We now know that some simple
genetic changes (mutations) can produce relatively significant morphological changes. For example, a single gene difference can result in very different color patterns in butterflies. A single gene difference can cause the loss of bony plates along the flank of a stickleback fish. A single gene difference causes the loss of eyes in the cave-dwelling form of the Mexican tetra.

For me, the interface of paleobiology, morphology, phylogeny, developmental genetics, and functional genomics is where the most exciting challenges of future evolutionary biology lie.

The central problem is to understand the relationship between the genotype (genetic makeup) of organisms and their phenotypes (observable attributes of organisms; basically, anything you can see, count or measure). Part of this challenge is to figure out how genotypes have been modified to produce the diversity of organismal structure and function in the living world. This will finally address what the embryologist C.H. Waddington called “the whole real guts of evolution, how do we get horses and tigers and things.”

The key questions are: 1) what is the genetic basis of a given phenotype, and 2) what modifications of genotype produce a particular modification of phenotype?

To give a concrete example: from paleontological and phylogenetic work, we know that 4-footed creatures like salamanders are derived from lobefinned fishes. What modifications of the genetic-developmental processes that fabricate a fin will result in the development of a limb with a hand or foot?

In recent years, much has been learned about several major genes involved in patterning limbs. The same genes are involved in patterning fish fins. We don’t know yet what alteration(s) of the fish fin developmental cascade produces a limb-like morphology. But we do know about one important difference: Hox genes and the gene, Sonic hedgehog, are expressed late in the development of a mouse limb, but they are not expressed late in the development of a fish fin. This change in timing of gene expression has been implicated in the add-on innovation of hands/feet in 4-footed creatures. In contrast, fishes have neither hands/feet nor is there the additional late expression of Hox genes and Sonic hedgehog.

In summary, an important challenge for the future, then, is to uncover not only the similarities in genetic programming of different organisms, like fishes and 4-footed creatures, but to uncover the changes in genetic programming that are responsible for differences in structure and function.

MARIANA WOLFNER: Unlike the two previous speakers (Professors McCune and Harrison), I was not trained as an evolutionary biologist. I was trained as a geneticist and a molecular biologist/biochemist; I’ve applied these approaches to questions about gene function in development and reproduction. But like many molecular/cell biologists, I am trying to become an evolutionary biologist also, as quickly as I can - because I believe (and have seen) that evolu-
tionary biology results and methods are becoming crucial to the understanding of how cells work, how genes work, how molecules work, and how animals and plants develop.

Historically, there was a major divide at most U.S. universities (though less so at Cornell) between molecular/cell/biochemical biologists like me and evolutionary biologists like my colleagues McCune and Harrison. Our evolutionary biology colleagues noted the diversity of life. They celebrated this diversity. They studied it and thought about what it meant or reflected. They categorized the organisms comprising this diversity. They thought about how the forces of natural selection would act on variability among individuals of a species, since variation is an essential ingredient for the process of natural selection. In contrast, most molecular/cell biologists and geneticists did exactly the opposite. We wanted to understand what we believed to be the fundamental properties of life. To do this, we took what is called a “reductionist” approach. We ignored the diversity - intentionally - because in our view the fundamental molecules and molecular pathways that all organisms need will be common to all life. We felt that while diversity is very nice, it was just “noise” that we should disregard, at least initially, in our search for those fundamental molecules and pathways. We chose organisms to study based on criteria like simplicity, ease of lab manipulation, experimental convenience - without paying much attention to the evolutionary relationships between these so-called “model” organisms (organisms like baker’s yeast, *Drosophila* fruit flies, or soil-nematode worms, mice or a small weed (*Arabidopsis*).

The reductionist approach has been extremely successful in discovering fundamental molecules, genes, biochemical processes and cell-signaling pathways. As an example, this approach led to the discovery of an important protein that tells cells when to divide. This protein is found in pretty much any kind of eukaryotic (non-bacterial) cell. If you replace the yeast gene for this protein with the human version, a yeast cell with that replacement will grow and divide just as well using the human protein as yeast cells do using the yeast protein. By this kind of reductionist approach, molecular biologists and geneticists identified many genes, proteins and molecular pathways that are essential for all cells. Research on these genes, proteins and pathways continues to this day and continues to reveal new and important information about how cells work, how genes work, and how inheritance works.

But as we continue to study these fundamental molecules, we are becoming increasingly aware that we also need to study them in the contexts of the organisms that we have been studying, and in other organisms. We need to consider the environment in which the organisms find themselves, and the selective pressures that act on our organisms. So over the past ten years, molecular genetics and cell biology have begun to intersect with evolutionary biology. You’ve just heard about one side of this intersection from Professor McCune: that the tech-
niques of molecular and cell biology have permeated all of biology, including evolutionary biology, providing tools with which to answer (or at least a new way to address) some evolutionary questions. I would like to tell you about the flipside of this intersection: that approaches, tools and ways of thinking from evolutionary biology are providing new ways to address and answer questions in basic molecular/cell biology and biomedicine. We reductionists are coming to appreciate, and revel in, exactly the kind of variety you have been hearing about. I would like to illustrate this with three examples that show how the integration of evolutionary biology into the more molecular fields is becoming crucial for the success for those fields.

First, considering the organismal and evolutionary context can help clarify the biological function of a gene or protein. I will use as an example the Distalless gene that Professor McCune introduced (the one that specifies the development of “sticky-outy” structures). When Distalless was discovered, its function was thought to be necessary for the development of legs and antennae in fruit flies. But it was only when scientists at the intersection between evolutionary and developmental biology (a field called “EvoDevo”) started looking systematically at the expression pattern of Distalless, in a range of organisms with known evolutionary relationships, that it became clear that the real function of Distalless was more general: to specify structures that telescope out during development. This information was crucial to how geneticists and molecular biologists think about the function of the Distalless gene and protein - for example in helping to predict the proteins with which Distalless protein might act, the genes that Distalless might regulate, or those that might control the function of Distalless.

Second, evolutionary information can be very helpful to molecular and cell biologists for understanding protein function at the biochemical level. One can compare the sequences of related proteins to see which of their parts are similar or different across organisms. But only comparisons that are made in an evolutionarily-informed manner, between organisms having sufficient (and not too much) evolutionary separation and the correct evolutionary relationship, can be interpreted in a useful way. These comparisons can identify regions of proteins that have been conserved over long or short evolutionary time. Such regions may correspond to the structural framework of the protein - as opposed to parts of the protein that can “flop around” a bit more. Similar comparisons can also identify regions of the protein that must change to provide the flexibility for different functions in different organisms, or to respond to the demands of different environments such as recognizing new pathogens.

The two examples I’ve given illustrate how evolutionary thought and findings have revolutionized the study of genes and proteins. My third example relates to one of the newest areas in biology: genomics. Just over ten years ago, a bold effort was mounted to sequence all the genes in the human genome. It
would give us the identity of each of the over 3 billion base pairs in our chromosomes and the ~24,000 genes that each of us has. This sequencing was completed several years ago. We then knew every base and, at least on a computer screen, the extent of each gene. We had similar information about the genes and genomes of the model organisms I mentioned earlier. But we needed to know what each of our genes specifies. We already knew this information for some genes - those that encode the conserved molecules that the reductionists identified. But the function of probably three-quarters of our genes was still a mystery. How could we solve it? By fusing evolutionary biology with genomics, to create the new field of comparative genomics!

In comparative genomics, one sequences the genomes of organisms whose evolutionary relationship is well known. The phylogenetic trees that you heard about from Professor McCune show how organisms are related evolutionarily and which ones diverged from a common ancestor, and when. Using this information, we can identify in a logical way which organisms’ genomes we need to sequence to get information about the function of their genes. Here is an example. All “jawed vertebrates” (sharks, other fishes, and “4-footed” creatures, including humans), share a number of traits. These include biting jaws, myelinated neurons, and an adaptive immune system (like ours) that uses antibodies. The closest living relatives to these jawed vertebrates are lampreys, which have none of those three traits. The Genome Project, having already sequenced the human genome, is now sequencing the genomes of shark and of lamprey. Scientists will compare the genes in those two genomes and our own, looking for genes that are shared between us and sharks, but that are not in lampreys. Those genes may be the ones that specify the traits we share with sharks but not lampreys, and thus will be good candidates to test for functions in an antibody-based adaptive immune system, myelination of neurons, or the development of biting jaws.

In a related example, as biomedical scientists search for the genes that underlie susceptibility to certain diseases or that correlate with other traits in the human population, they’re sequencing the genomes or parts of genomes of individual people. As they do this, they’re finding huge amounts of variation at the DNA-base sequence level. This might have been a shock to an old-style reductionist, but it is not a surprise to evolutionary biologists, who knew all along that life is rich in variation - and so must genomes be. To dissect through their findings and zero in on the genes that are important in the disease susceptibility or other traits they are studying, genomicists are using analytical tools that were developed by evolutionary biologists to understand and categorize variation.

So I’d like to leave you with the thought that evolutionary biology has now become integrated with molecular/cell biology - and that there is cross-fertilization between these fields in both directions. Each field is becoming greater
because it is using tools and ways of thinking that were developed in the other field. We are ending up with a unified biology that spans, connects, and enriches both areas.

STEVEN TANKSLEY: The evolutionary biologist Theodosius Dobzhansky said that nothing in biology makes sense unless in the light of evolution. I think the other side of that coin is that it is really hard to discuss the future or challenges of evolutionary biology unless you do it in the context of biology in general. So the comments I make are not necessarily restricted to evolutionary biology, but are ones I see as a challenge for biology, an opportunity both scientifically and sociologically. I have two points I want to make. One advantage of being towards the end of the speaker roster is that your colleagues have made a lot of the points you were going to make - so, thank you, I can be much shorter now.

The first is a scientific challenge. I would preface this by saying that, at least for me, the greatest event in biology post-Darwin has been the advent of large scale genome sequencing. It was a technological feat to begin with. It wasn’t one that started with a scientific hypothesis, but rather a premise - the premise that sequencing the DNA or genomes of individual species would lead to many discoveries. I think we have seen that prediction borne out. What it has done is change dramatically how we approach biological questions, and created some very interesting dilemmas and paradoxes. The first dilemma is that the field of biology has gone from a field that used to be limited by information, where people would collect what they could, analyze it the best that they could, to a field that is inundated by information. Biological discovery is now limited by our ability to organize and extract information and knowledge out of genome sequencing. This has brought into the arena of biology a much wider group of scientists - computer scientists, engineers, and physicists. Before the advent of genomics, few individuals from these fields were working on biological problems. The influx of this new intellectual talent has greatly enriched the field of biological research.

The second is that DNA sequencing has overturned some of our ideas of evolution. Equally important, it has posed some very interesting questions and a specific paradox that I want to give by way of example. I think we’re all egocentric in our lives, whether we know it or not. Certainly as humans, we’re very human-centric and that I think most of us, whether we admit it or not, believe that we are the pinnacle of evolution. When we began sequencing the human genome we already had some idea of the genome composition of other organisms such as yeast or the insect *Drosophila*. We undertook sequencing these species first, in part because they had smaller genomes and would thus be less expensive to sequence. Sequencing revealed that the simple, single cell yeast has about 6000 genes. Likewise, *Drosophila* has about 15,000 genes.

So, we look at ourselves and we think, “If a lowly insect has 15,000 genes,
we must surely have a lot more than that because, look at what we are. We are unique in that we are the only species that has developed such complex language, such great civilizations; we launched our stuff into outer space, and we even contemplated such things as the Big Bang and the origin of the universe. Surely our complexity and accomplishments must be reflected in our genes.”

So we set out to sequence the human genome, and we were fairly sure we would find a very large, rich unique set of genes. There were bookmakers taking bets on the number of genes in the human genome, and I didn’t place money on this - I would have lost if I did, I have to point out - but the greatest probabilities were put on the number 100,000, and the numbers ranged anywhere from 50,000 to 150,000. Well, the surprise in the human genome sequence, the number is somewhere around 30,000 genes, not tremendously greater than these other organisms we had looked at. And as we have already heard, we have since sequenced a number of other mammalian genomes - like the mouse, the rat and the chimpanzee - and lo and behold, they have about 30,000 genes. So at first there was a comedown for humans to realize we are working with the same number, but certainly there had to be something unique about it because we’re so unique.

The next surprise was when we actually began to compare these genomes - the mouse, the rat, the chimpanzee, and the human - we basically have not only the same number of genes, but basically the same genes, basically a gene-for-gene relationship. 99% of our genes have an exact match for a gene in the mouse or the rat or the chimp. So the question is, the paradox is, that we know there is diversity, we know we’re unique, we know that we’re different than a mouse or a rat or other mammals that we see around us, or other organisms. So how can we have basically the same set of genes, the same numbers, and have so many different outcomes? For me, this is the biggest question that confronts biology today - to understand the driving force of diversification based on what we now know from genomics. We don’t know the answer yet. We have bits and pieces of information that are now coming forward suggesting that to truly understand this problem, we have to dissect the basis of natural variation, the variation we see amongst us and between us and other species and between all species around the world.

Well, I don’t work on mammals other than having a couple of cats, which I don’t work on. I work on plants and we have, as part of our work, been trying to understand some of the causes of natural variation that have to do with differences between plant species, especially between domesticated and non-domesticated species. We only have a handful of examples and there are a handful from various other organisms, but what we’re finding is that at least half the time, the genes themselves have not changed at all. In other words, they are encoding exactly the same protein. What is really changing are very subtle differences in how the organism deploys a protein. When it turns a protein on,
where it expresses the protein, are at least as important or more important than the actual protein itself. So I think this has been a big surprise for us and I think that in the future we have to wait to understand the true forces that are driving the diversification that we see around us.

Now the second point, and it’s not a paid sponsorship and I probably would not have been invited if I had told that I was going to say this, but I think that the sociological challenge that we have, I think a lot of us have turned our heads away from and failed to confront as scientists or members of society. I think there are two levels of culpability. First, I think it’s misguided for biologists, steeped in evolutionary theory, to put themselves in opposition to spiritualism that we see around us. After all, spiritualism or religion, or whatever you want to call it, has been manifested as far back as humans have been on this planet, and comes in many different forms. There’s not one true spiritualism at any given time, but rather a rich diversity of spiritualism. Nonetheless, spirituality is a constantly occurring theme in human evolution and the features of this are also seen in other species, other mammals, where we can see vestiges or similarities to what we call spiritualism. We, as scientists, cannot and should not put ourselves in opposition to something that is a product of biology. So I think the challenge for us as biologists is not to try to confront or disprove spiritualism, but until we can completely have a comprehensive understanding of biology in all of its manifestations, including spirituality, we will have not done a proper job of understanding biology.

The other culpability comes from misguided spiritualism. This is especially for those that cloak themselves in fundamentalist religion, which forces them to put a blind eye toward the discoveries of science. After all, it was the pursuit of truth that let us reach the plateau of the spiritualism that exists today, and it is only through opening ourselves to all channels of understanding, through science and synthesis, that we will really come to understand our true nature, and spiritualism is included in that. So I think there is a need for all of us to look at this as a holistic problem of biology, and not an oppositional problem.

H. KERN REEVE: My field is animal behavior, which over the last four decades has been truly revolutionized by evolutionary biology. The simple insight was that genes influence behavior, just as they do other biological attributes like eye color, which you are probably mostly aware of. Genes build nervous systems, nervous systems govern behavior, and behavior affects the reproductive output of the performer, the “behaer.” So, it’s inevitable that natural selection will favor genes over time that appear to maximize reproductive success. In other words, organisms should appear to evolve to become cost-benefit analyzers, where the currency of the costs and benefits are the organism’s present-plus-future reproductive output. This prediction suddenly gave quantitative focus to research in all kinds of behavioral decisions faced by animals. Before I list some of the decisions I am talking about, I want to very quickly map out
the logic of the empirical studies in animal behavior.

They come in two major flavors. One is to hypothesize what the fitness-
maximizing behavior a given organism should display in a given context and
then go out and see if it does it. Does it do something different in a different
context that would predict a different fitness-maximizing behavior? You can do
these comparisons either within species or in different species using the com-
parative method. A second kind of empirical test is to go out and see what the
organism is actually doing and measure the fitness that is associated with that
behavior and compare that to the fitness of alternative behaviors that are either
naturally occurring or experimentally created. The prediction of the natural
selection approach is that the behavior that is exhibited in a given context by
the organism in nature should have a higher associated fitness than do the
experimentally created variants. These predictions might be wrong; if they are
not supported, then we have to drop the theoretical framework altogether, so
this is a falsifiable theory.

So using these dual approaches, these two major flavors of empirical study,
behavioral ecologists, people interested in the evolutionary basis of animal
behavior, have studied a large variety of behavioral decisions facing animals.
Many of you might not be aware of any of this. For example, in the rich and
vibrant field of sexual selection, questions are asked like, what characteristics
should an organism favor in a mate? How hard should it compete with other
members of the same sex for access to those mates? What conflicts can arise
even between paired mates, even between male and female? They cooperate to
the extent that they are both trying to reproduce but it has become clear that
there are subtle conflicts of interest between mates. In the field of foraging
behavior in habitat selection, questions include, how should an organism forage
for resources? Or find a place to live? What prey items should it eat? How long
should it stay in a patch? There is a very detailed quantitative theory that makes
very specific predictions about the outcomes of these variables in specific con-
texts. How should an organism choose a patch given that other competing
organisms are faced with exactly the same decision? Game theory is used to
analyze the predictions here, which provide guidance for the field test.

In the realm of animal territoriality and fighting assessment - how hard will
animals fight over a limited resource, as a function of the resource value, the
fighting ability of the organism, kinship, and so on. When will the fight end
and what factors will determine which organism will win the fight? All of these
are extremely active areas of research in behavioral ecology.

In sociobiology, the central question, what I am interested in, is when
should organisms form cooperative groups? How will they divide up the
rewards of cooperation and how selfish should they be? In the extreme, when
should an organism give up its own reproduction altogether and, instead, assist
another organism to reproduce? In evolutionary communication studies ques-
tions include: When will organisms be honest and when will they be deceptive in communication with other organisms? What information do organisms extract from signals generated by other organisms and how are these signal properties shaped by the information that is extracted by the receiver?

Well, recently, research in all these other areas has produced spectacular successes. To get the full range of it, I would encourage you to take a course in animal behavior. Just to take a few examples, we now have a remarkably good theoretical and empirical understanding of why animals, like many social insect workers, forgo reproduction on their own entirely. They don’t reproduce any offspring but instead assist relatives, in particular, the mother queen, with whom they share genes by common descent, to reproduce. The theory says this can make sense because genes are propagating themselves by favoring individuals that tend to share copies of their own genes. This is one of the major breakthroughs in the evolutionary biology of behavior in the last forty years.

Other successes include predictions and explanations of how organisms distribute themselves among different foraging patches when they are foraging for food. There’s been a constant finding that they distribute themselves in proportion to the resources in those patches which are exactly predicted by game theory models of what they should do if they are being optimal cost-benefit analyzers. Their decision is influenced by the decisions other organisms facing exactly the same problem should make. There has been spectacular success in predicting sex ratios in social organisms like social insects, ants, bees, and wasps. There are theoretical conflicts of interest between the queens and the workers about what proportion of the brood should be females vs. males. Incredible and stunning confirmation of the kin selection theories is afforded by such studies. Finally, most recently, we are learning a great deal about why animal courtship signals are honest despite the potential benefits for deception that the male could gain by lying that he is high quality to a courted female, even if he’s not.

A point I want to emphasize is not only are experimental approaches to this line of research increasing in sophistication, but also the underlying theories have become quite mathematical and rich in predictive value, although they are still in development. The areas I have just outlined are undergirded jointly by the twin pedestals of evolutionary game theory and population genetics. These theories make very specific quantitative predictions about what we should see when we go out into nature for a given context. They are sufficiently general that they are easily adapted to predictions and explanations of human behavior. This leads me to what I think is going to be one of the big theories of evolutionary biology in the decades ahead.

Many of you are aware that there are currently skirmishes at the territorial borders between evolutionary biology and parts of psychology, sociology, anthropology, political science, economic, and other human sciences. I think these skirmishes will be slowly replaced over time by bridges. Already we are
beginning to see the incorporation of evolutionary thinking into all branches of
the human sciences. If humans are indeed the products of natural selection, this
cross-fertilization is going to bear big fruit. If it doesn’t, then we have to
rethink our position. This is a falsifiable theory.

A second frontier for the evolutionary study of behavior is the application
of sociobiological theories, not just to interactions between animals of the same
or different species, but also to interactions between plants, between microbes,
or between plants, animals and microbes and any permutation thereof. Even
more interestingly, this theory, the sociobiological theory, makes predictions
about interactions over evolutionary time over cells within an organism, and
also between genes within the genome of a single individual. Even genes within
a genome can be in evolutionary conflict with each other. They don’t have
exactly the same criteria for propagation success. The principles of conflict reso-
lution in animal societies, it has been discovered, can be used to predict the
outcomes of this intragenomic conflict, which could provide an ultimate theory
for the evolution of genetic architecture itself, and the database afforded for
testing this theory will be what’s been discussed so far.

The final research frontier I wanted to mention is the development and
testing of evolutionary theories of how the nervous system itself is put together.
Evolutionary neurobiology is hardly a field yet, but over the next decade, I
expect to see sophisticated and testable models of why animal brains have the
structure that they do, from the molecular level to the level of systems of nerve
cells. As you can see, these are extremely exciting times for the evolutionary
study of behavior that sends tendrils into a wide variety of disciplines within
and also outside of biology. With that, I shall end and hopefully we can open
up the floor for questions.

STEPHEN KRESOVICH: So, first, I’d like to take the opportunity to
thank the speakers for their insights, their clarity and brevity - so if you would
join me.

(APPLAUSE.)

They never fail to surprise me.

With that, I would like to open the discussion from the floor. If you’re
from the floor, I hope you will stand up and identify yourself and make a con-
cise comment or question.

QUESTION: Can you tell us what is the current status of punctuated
equilibrium?

AMY MCCUNE: I think the current status is that punctuated change hap-
pens. Punctuated equilibrium was an idea, suggested by Niles Eldredge and
Steve Gould in 1972, about how morphological change looks in the fossil
record. Punctuated equilibrium holds that changes in the fossil record may be
relatively rapid (geologically speaking) and look relatively abrupt. The flip side
of punctuated change is having periods of stasis (or equilibrium), between
episodes of change. This idea of punctuated equilibrium is quite different than Darwin’s idea that change only occurs very gradually, in small increments, and the idea stimulated a lot of controversy. The controversy about punctuated equilibrium sent a flurry of paleontologists off into the field to do very detailed studies of stratigraphic sequences of organisms to look for gradual vs. punctuated change. That was one of the things I was alluding to when I said the way that paleontology is done now is very different from the way it used to be done.

I would say, to sum up the results of 15 years of very detailed studies, that there is a lot of stasis in the fossil record. There are certainly good cases where change is gradual. But if you were to run a frequency argument, most people would agree that punctuated equilibrium is more common than gradual change, but that both occur.

QUESTION: I am a post-doc here, and my question is for Mariana. So I think that your comments about the great divide between evolutionary biology and molecular biology really hit home for me because I was trained as a molecular biologist and had very little to no exposure to evolutionary biology ... How do you propose we actually start training the scientists of my generation to be able to bridge hypotheses and test hypotheses that are at the intersect of these two fields?

MARIANA WOLFNER: That’s a really good question and something that a lot of us think about quite a bit. I’ll give you several different answers. First, there are new fields that are growing up at the intersection between evolutionary biology and molecular/cell/developmental biology. The one that I am most familiar with is called “EvoDevo.” It’s the intersection between evolution and development. There are now grant programs, post-doc programs, and the like, which encourage people to go into these fields and there are now many very good laboratories established that are taking post-docs and graduate students. So that’s one way to train people who can “bridge.”

The second one is at the undergraduate level; Cornell is a leader in this. All of our biology majors are (and have been for quite some time) required to take evolutionary biology as well as genetics, biochemistry and molecular biology. I think that requiring all biologists to have exposure to all of those areas is a really good way to educate people who can consider, propose and test hypotheses that bridge fields. Unfortunately, not all institutions are as integrative as Cornell, and there are still programs being developed in which molecular biology majors take lots of chemistry and molecular biology and so on but no evolution and, conversely, in which evolution majors don’t take much genetics or molecular biology. I think we need a push for a broad introductory and second-level that will teach both the molecular/genetic and the evolutionary “sides” to all biologists.

Third, “integrative biology” is becoming more common as molecular geneticists/genomicists and evolutionary biologists are appreciating how much
each others’ perspective brings to their field. An increasing number of scientific meetings aim to be integrative, bringing together biologists who study questions within a given area (such as genes and behavior) from different perspectives (such as molecular genetics of model organisms vs. behavioral or field ecology). At some of those meetings, I’ve heard that NSF and some other science agencies are trying very hard to fund and focus resources on integrative teams in which, for example, a laboratory that is more molecular might collaborate with an evolutionary one. This sort of approach will get fields mixing together at many levels.

QUESTION: Those are really great ways to train scientists but I guess maybe more pressingly, to keep science funding, and NSF, it’s wonderful that they give what they have, but...

MARIANA WOLFNER: You are quite right, it is a serious problem that funding for biology is very tight right now and getting tighter. This is bad for all of biology, and can certainly make it even more difficult to carry out work that spans across, or integrates, different fields.

QUESTION: How do we educate the voting public in the fact that there is now this incredible bridge between molecular biology and evolutionary biology, and how it is important for understanding human disease and things that are actually going to affect humans?

MARIANA WOLFNER: I’ll start answering that, but I expect my colleagues will probably want to jump in on this topic as well. I think that the human genome project is doing a good job in that as a new sequence comes out, the public is hearing a lot of comparative-genomics discussions. I think the more this happens, the more the general public will begin to appreciate the importance of the comparative (and hence evolution-based) side. At the same time, I think that how and why evolutionary logic is so important in choosing new organisms to sequence, as in the example I gave earlier (lampreys and sharks), hasn’t yet made it out to the general public; maybe it should.

H. KERN REEVE: I’ll add one thing to that. I feel very strongly that we, as evolutionary biologists - not necessarily the people on this panel - have not been very good, in general, at publicizing our results and stirring up the excitement and the broader implications of these results with the general public. That’s because there is tremendous selection pressure to remain focused on your own research, get awards and tenure and so on, from your immediate peers that tend to be walled off from this general public that I am referring to. So we have to do a better job in investing in fora like this one where we can start to communicate the excitement of these results and how they might not just be exciting in the abstract sense to the general public but how they might yield tangible benefits down the road. I’ll give you one example from my realm. There’s a theory of evolutionary competition between organisms called tug-of-war theory that has implications for how we should optimally grow crops. So sociobiology
doesn’t just refer to our understanding of how social wasps, that I study, cooperate with each other, but will also have potentially tangible benefits on society at a wide scale. We need to do a much better job in communicating the excitement and potential of this research.

MARIANA WOLFRNER: I’d like to add another aspect, though it is a sad one. With pressing health issues like the possibility of an avian flu pandemic, or HIV becoming drug-resistant, or bacteria developing resistance to antibiotics (as Rick mentioned) gripping the interest of the general public, the public is increasingly hearing evolutionary talk. That evolutionary theory is having a visible effect in finding new ways to prevent or combat disease will probably make a difference in what people think of evolution.

RICHARD HARRISON: I’d like to make one final comment and pay back our sponsor as well, which is that places like PRI and the Museum of the Earth potentially have a lot to offer in bringing to the general public the excitement of evolutionary biology and I think that cooperation between PRI and Cornell University is a major advance in that way and I would hope that that same thing would happen lots of places. I do believe that the general public will more likely become more interested if they are self-interested and that’s where the biomedical connections arise. But occasionally, I hope that the public could actually be enticed to wonder about the diversity of nature simply for the wonder itself. Perhaps that gets back to Steve’s comment about spiritualism – that there is indeed something spiritual about nature itself and that although evolution attempts to reduce nature to science, one can do a good job, nonetheless, maintaining the wonder element, and perhaps we’ve failed to do that thus far.

QUESTION: I would characterize all five of you as biologists at some level. One of the things that I have found most fascinating recently and which I am missing here is how evolutionary ideas are spreading out into other fields. Evolution is being talked about in economics, in government, obviously in anthropology, but even things like literature. I am on several lists now, there is one called BioPoetics. Such an idea was inconceivable to me, that when I first started on this list I thought, “What in the world are they talking about?” Would any of you like to comment on how, in some sense, the evolutionary paradigm is spreading outward into all of these fields? It’s happening now and I haven’t heard that discussed.

H. KERN REEVE: I would be happy to expand on that. I completely agree with you. Evolutionary biology is penetrating not only the human sciences, but all human endeavors, including art. There’s an effort to understand the evolutionary basis of music appreciation and the structure of music, of literature. What we’re talking about are expressions of human behavior, and to the extent that human behavior has been molded by natural selection, we ought to be able to make sense of these phenomena. These tend to be sporadic efforts, but there are people who are very determined to apply evolutionary theory to
come up with alternative hypotheses for why we do these things that are not so immediately obvious. I would include that in my bin of growth areas for evolutionary biology in the decades ahead. Maybe two decades instead of one, but it is definitely happening, you put your finger on it. Basically there is no realm of human endeavor that shouldn’t at least potentially be illuminated by evolutionary approaches. Everything that humans do passes through the sieve of natural selection.

QUESTION: I would like to build on that. I am also faculty here at Cornell. The provost set up an interdisciplinary group a year and a half ago, which would be organized into the new Institute for Social Sciences here at Cornell. Teams of interdisciplinary faculty with common interests were admitted by cross-fertilization, so to speak, were encouraged to submit proposals. The first one of those to be supported and funded was called The Evolving Family, which brings together ten faculty. I think we represent eight different departments on campus, to try and look at essentially aspects about human family and how families are changing and what the implications are, essentially looking at human family dynamics and aspects of human families from this lens of many different disciplines.

QUESTION: When Darwin professed his theory, shortly after that, Spencer came up with social Darwinism, which had some very negative political effects. Back in the 60s and 70s, I read a lot of work, such as The Territorial Imperative, that attempted to apply sociobiology, evolutionary biology and make arguments about human societies. A lot of those writings came out to justify forms of male domination (that many of us in the women’s movement were trying to resist) as natural and as evolved. It seems to me that it is fascinating but there is also a strong political social risk that people have to be aware of in the ways that people can use scientific arguments and evolutionary biology to try and justify a particular political view, without acknowledging that that is what they are doing.

H. KERN REEVE: May I respond to that? First of all, the literature that you are referring to, such as The Territorial Imperative and social Darwinism literature, I don’t think any of those principles are rigorously adhered to by evolutionary biologists. There are several levels to the answer. No matter what evolutionary biology turns up as plausible, well-supported explanation for human behavior, it can’t be used to justify any particular political movement or orientation or set of policies. That is simply a logical fallacy, G.E. Moore’s “naturalist fallacy.” But what it can do, is it can tell you what you’re up against if you want to change things to improve the situation.

So, from my perspective, once we figure out what we want to do as a society, to be able to implement those policies to get there the most efficiently, we better know how humans are programmed. By programmed I don’t mean they are tied to their genes; they may have very flexible, cognitive flexibility, that
nevertheless has evolved to promote reproductive success. We better know what our decision rules are like before we try to implement policies that will take us where we want to go. By the way, a lot of that earlier literature put an extreme focus on selfishness and extreme competition but since then, it has become clear that evolutionary theory predicts cooperation and, indeed, love itself as an evolutionarily stable outcome. Genes may be selfish, but sometimes they are selected to build cooperative organisms. So the theory of cooperation is fascinating, that’s what interests me. Organisms throughout the animal kingdom cooperate in predictable contexts. That fills me with hope that we can figure out the decision roles that will promote cooperation in humans even further.

QUESTION: I’d like to hear more comments from the panel about the relationship between evolution and religion, and in particular how we can find common ground between them.

H. KERN REEVE: I believe the point of the question is, “How can we find common ground between groups that are seemingly very disparate and entrenched, such as fundamentalists and religious parts of societies, with very science-based parts of society that seem to have no common ground or give-and-take.” I think your point is that there is a common ground and that we must seek the common grounds if we’re going to move forward in society in a constructive way and preserve the things that are important to all of us. I think from my perspective, I think that is the direction that we all must try and move in. It’s not just an imperative of the fundamentalists; it’s an imperative of all of us, to look for that common ground. Part of it is to be willing to understand or realize that we don’t understand everything. That we don’t have all the answers, none of us, but that we have a common ground in seeking the truth and a common ground in sharing the planet. So, I agree completely.

QUESTION: I have a question for Dr. Kresovich and Dr. Tanksley. The National Center for Science Education (NCSE) maintains a list of scientists who are willing to back a statement on evolution. There is a website about this. It’s called Project Steve. It’s to combat various creationist organizations that have their lists of scientists. So they decided to start a list to end all lists. There’s a catch. To sign onto this list, you have to be named Steve. While the Discovery Institute has their 400 scientists, NCSE has 700 scientists, but they are all named Steve, or Stephen or Stephanie. (Laughter.) So I ask you two and any other scientist Steves in the audience to look into this. Please sign up.

(LAUGHTER, CLAPPING.)

STEPHEN KRESOVICH: Any other Joes or Henrys?

STEVEN TANKSLEY: I think that is a fair question; we can talk about it afterward. I also worry about any club that would have me as a member.

QUESTION: On this response that there is common ground between fundamentalists and scientists - can you give me an example of that?

H. KERN REEVE: Sure. I’d be happy to. There’s more to it than we often
realize. I think we just look at the differences and believe they are irreconcilable and maybe not dissimilar to marriage counseling. For example, all of us have some understanding or love for artwork, poetry, books, dance - things that we really can’t put an explanation for, necessarily, in religious circles or biological circles. We all have that. It’s a common ground. I think it’s an overlap that we can all share and can work from. I think that if we start at the extremes and say, “You have to accept all of my premises in order to join in some common effort,” I think it’s hopeless, but I think there’s a lot of common ground and the reality is that as different as we have in terms of opinions in terms of the human race, we’re a very narrow genetic species and we have much more in common about us than different and I think we just need to not try to exploit the differences so much and look for the commonalities. Or I try to.

AMY MCCUNE: I have a specific example of common ground that was on the news in the last two days. That is that there was a group of fundamentalist ministers who at the instigation of someone who traveled to Antarctica and heard a lot about global warming decided that part of their responsibility as, I can’t remember quite how he put it, perhaps, “children of God,” that there is a responsibility to preserve the Earth, that global warming is serious and a real challenge. So there is a group of 70 fundamentalist ministers who have signed a letter, which I think is being sent to the White House (maybe somebody else knows more detail about this), advocating that we take real and concrete steps to change the situation and reduce global warming. So it seems to me that this is a real concrete example of where scientists and fundamentalist religious folk can find a really important common ground in environmental issues.

QUESTION: I am a graduate student in biophysics. I think what concerns me more than the clash between evolutionists and Christian fundamentalists is, maybe it was the question that was asked a few questions back, the use of evolution, studying human behavior via evolution and the dangers that could arise from that. This past summer, I think, I read a paper on the Ashkenazi Jews and the intelligence among the Ashkenazi Jews relative to their European counterparts. I think that there is a study going on in Sweden to determine why blacks are superior athletes. This seems like this is really dangerous ground. Scientists tend to over-rationalize things. How do you prevent when other people are using scientific justification of one group of people oppressing another?

H. KERN REEVE: My response to that is, first of all, if the worry is that evolutionary biologists are preoccupied by genetic differences between human subpopulations and that raises the possibility that it might be abused, I think most evolutionary biologists who study human behavior focus much more on the commonalities in our decision roles. Sure we do different things in different environments and in different cultures. We’re largely endowed with a similar cognitive machinery that tells us to do different things in different circum-
stances, so there is very little emphasis in the realm that I work in, that is applied to human social behavior, very little emphasis on differences between human subpopulations.

The fundamental point I get back to is that no matter what evidence is found that such differentiation exists and whatever capabilities, it has absolutely no logical implications for what we should be doing. So if people try to use it that way, then they are using an illogical argument so they have no basis for what they are doing. We know from cases in the past that the biologist who says these differences exist, so we should mistreat one group in favor of another - they simply made an illegitimate logical argument that can’t be justified.

RICHARD HARRISON: I would just jump in briefly. I am not a human biologist and this is by no means my area of expertise. I think you identify a very real issue but there are two separable considerations. One is discovering what the data tell us and the other is what Kern suggests, taking those data and making decisions about how one behaves or what one does. There are dangers in discovering the “truth” but there are even greater dangers in suppressing that “truth” in order to prevent certain behaviors that might be subsequent to that discovery. I do think that we need to confront this issue but I don’t think we need to confront it by, not determining whether there are differences between individual humans. We are doing that right now with respect to, for example, disease susceptibility, and that has major implications with respect to health insurance, for example. Each of these discoveries is going to have major societal implications but I don’t think we can sit back and say that we should simply not look for that information. I think that such information is going to become available and we need to figure out how, as a society or a group of societies, we deal with those discoveries.

MARIANA WOLFNER: I am also not in this field. I am a *Drosophila* geneticist but I have two comments on that. The first is, from my reading of the human genetics and behavior field, most of the genetic associations that have been reported are a very very small effect, usually of a percent or two or less. So the actual effects that they might have on a particular individual or group of individuals are really difficult to predict given the differences in other parts of the genetic background.

The second is something that is quite interesting to me that has been coming out recently. Companies have been making available genetic testing so you can test your heritage and trace yourself back and people are getting incredible surprises about what their heritage is or how much they are of what. It means that assumptions about who is what, even the assumption that an individual has of their ancestry, are really questionable at this point.

STEVE TANKSLEY: I would like to make one comment on the same topic. As we learn more and more about genetics and genetic diversity, and get better and better at associating genetic diversity with particular traits, whether it
be athleticism, predisposition to diseases, etc., how is society going to use that information? I think the risk is very real, but I think, as Rick pointed out, the risk of closing our eyes to diversity and looking at it and trying to understand it is greater than the risk of trying to ignore it. I think that if we don’t realize that there is diversity and that we all have different compositions and tendencies and predispositions that are advantageous under certain conditions and not so much under others.

But that what we really have to face is how to educate society how not to treat everything hierarchically. In other words, we can develop a test for any number of predispositions; followed by that is a labeling of good vs. bad. That is the real danger. I think the work we have to do is not so much on trying to limit the use of science and understanding diversity, because I think it’s one of the greatest and most enriching things that is going to happen, but on training ourselves on not treating these things hierarchically. I think part of this is going to be a fallout from the vast number of tests that are going to be available. Your example, I think, was athleticism. So let’s say that we find out some particular alleles are more frequent in people who are faster runners. Well, the reality is that we are going to find tests that are going to predict all kinds of traits. And that particular person who is a faster runner might be someone who’s going to have a higher risk of heart disease, so maybe you don’t want to hire them. We are all going to have a mixed bag of any particular conditions. I think we have to move away from hierarchical treatment of the information and to value the diversity, instead of try to use it in some cynical way.

H. KERN REEVE: And to get very specific, to distill all these points and to put them all together, suppose you found that there are two human subpopulations, x and y, and x underperformed on some measure, behavioral or otherwise, relative to y. What are the social implications of that? One is to say that we, society, should pour more resources into y because that means they will get more bang for their buck, but the exactly opposite response to the same data is to say that we need to modify the environments for x in order to increase the performance in whatever characteristic that is, if that’s something that is desired by members of both subpopulations. So, you can have exactly opposite social responses to exactly the same dataset. The data set does not imply one response at the expense of the other.

STEPHEN KRESOVICH: With that, I’d like to bring this session to closure. I want to thank you all for attending the session and raising interesting points again. I’d like to thank the speakers. I hope you will continue and take advantage of the other events that are coming up through the weekend.
Contributors

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Hunter R. Rawlings III served as Cornell University’s tenth president from 1995 to 2003, and as Interim President from 2005 to 2006. He is currently President Emeritus and Professor of Classics at Cornell.

H. Kern Reeve is a professor in the Department of Neurobiology and Behavior at Cornell University. His principal research goal is to develop and test biologically realistic models of the evolution of cooperation and conflict in animal societies.
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Sources of Further Information

Books


Websites
Darwin Day: www.darwinday.org
Flock of Dodos: www.flockofdodos.com
Ken Miller’s Evolution Page: www.millerandlevine.com/km/evol/
National Center for Science Education: www.ncseweb.org
Paleontological Research Institution: www.priweb.org
University of California Museum of Paleontology: www.ucmp.berkeley.edu/
Notes
Notes
Evolution by natural selection - Darwinism - is one of the most important, influential, and controversial ideas in human history. In 2005 the controversy was particularly intense in the United States as the concept of "intelligent design" was publicly debated in the media and in a federal courtroom in Pennsylvania. Then-President of Cornell University Hunter R. Rawlings III, used the occasion of his October 2005 State of the University speech at Cornell to address the dangers that creationism in general and intelligent design in particular pose to education, science, and democracy, and gained national attention for doing so.

In February 2006, Ithaca, New York celebrated its first official Darwin Day on and around February 12, Charles Darwin's 197th Birthday. Jointly organized by the Paleontological Research Institution, Ithaca College, and Cornell University, the occasion brought together town and gown for five days of events and discussion.

This volume brings together some of the results of these activities, during which a small college town in upstate New York reflected on one of humanity's great ideas.

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