

Task Force on Life in the Age of the Genome (TFLAG)  
Final Report  
January 13, 2006

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## **Executive Summary**

In October 2004, President Jeffrey Lehman identified “Life in the Age of the Genome” as one of “three great challenges facing humanity that present exciting opportunities for Cornell.” In February 2005, Provost Martin appointed a Task Force on Life in the Age of the Genome (TFLAG) to identify how the New Life Sciences Initiative (NLSI) can engage social scientists, humanists, and others not working directly in the biological and biomedical sciences. In pursuing this charge, we focused on the Ithaca campus, but were also able to include resources and perspectives from the Weill Medical College.

Our Spring 2005 faculty survey provided inventories of the teaching, research, and service activities that engage Life in the Age of the Genome. The survey also revealed that cutting-edge research relevant to Life in the Age of the Genome has difficulty finding its way into the classroom. Forty-four percent of the 807 faculty who responded to the survey report that their research engages Life in the Age of the Genome, but only 27% report that any of their courses engage this theme in any way.

After much discussion among task force members, as well as with colleagues around campus and around the country, we identified the following six intellectual themes that can and should be pursued by Cornell:

1. Understanding Human Diversity: Nature and Nurture
2. Political Dimensions of the Life Sciences Revolution
3. The New Biology and Cultural Change
4. Public Participation in Science Based Policy
5. Health and Health Care in the Age of the Genome
6. Food Innovations and Challenges: Significance, Production, and Distribution

We also identified a range of mechanisms that will need to be implemented if these themes are to be successfully developed as signature areas of research and teaching in the Cornell community. Our task force strongly maintains that if Cornell is to succeed in this area, existing faculty commitments need to be reduced or additional faculty must be hired, so that more faculty time is available to (1) create communities of scholars whose work goes beyond the NLSI and (2) narrow gaps between research programs and teaching and outreach engagement within this theme. We also propose to establish teaching and research fellows as a mechanism to both train interdisciplinary future leaders and attract successful scholars to our campus. Lectures and seminars will help establish and nurture this community. Additional mechanisms to enhance engagement in Life in the Age of the Genome include forming a case study library, establishing a speaker’s bureau, expanding the VIVO life sciences web portal, supporting confidential data collection and fostering entrepreneurship.

## **Membership**

Andrew Bass	Neurobiology & Behavior
Dick Boyd	Philosophy
Ross Brann	Near Eastern Studies
Joseph Fins	Medical Ethics, WMC (joined September 2005)
John Forester	City and Regional Planning
David Harris (co-chair)	Sociology
Richard Harrison	Ecology & Evolutionary Biology
Stephen Hilgartner	Science & Technology Studies
Bruce Lewenstein	Communication
Janet McCue	Cornell University Library
Pam Tolbert	Organizational Behavior
Marjolein van der Meulen (co-chair)	Mechanical & Aerospace Engineering
Amy Villarejo	Feminist, Gender & Sexuality Studies/Film
William White	Policy Analysis and Management
Kraig Adler	Vice Provost for Life Sciences (Provost's Staff, through June 2005)
Stephen Kresovich	Vice Provost for Life Sciences (Provost's Staff, from September 2005)
Robert Richardson	Vice Provost for Research (Provost's Staff)

## **Background**

In his October 2004 State of the University address, President Lehman identified "Life in the Age of the Genome" as one of "three great challenges facing humanity that present exciting opportunities for Cornell." In February 2005, Provost Martin appointed a Task Force on Life in the Age of the Genome (TFLAG). The task force was charged with identifying how the New Life Sciences Initiative (NLSI) can engage social scientists, humanists, and others not working directly in the biological and biomedical sciences (see full charge in Appendix A). Because of the high level of NLSI-related activities ongoing in the life and physical sciences at Cornell, the task force focused on the way in which research and teaching in social science and the humanities can complement and broaden this existing work to make Cornell a leader in issues that are critical to Life in the Age of the Genome.

Since the task force was initiated by President Lehman, but charged by Provost Martin, the chief academic officer of Cornell University in Ithaca, we further concentrated our efforts on the Ithaca, NY, campus. While these issues are clearly relevant to the Weill Medical College (WMC) located in New York City, in the interest of time, we did not survey the WMC. Nonetheless, because we realized the importance of these issues to the WMC, Dr. Joseph Fins joined the task force in the fall. As the university proceeds in this area, establishing fuller linkages with WMC should be a priority. Therefore, areas of obvious synergy with WMC are highlighted in our report. A similar systematic assessment of the WMC research and teaching activities may be necessary in the future.

The TFLAG had its first meeting on March 2, 2005. At this meeting, Provost Martin reviewed the charge and answered questions about the scope and schedule of task force activities. After subsequent meetings during the spring semester, we submitted a preliminary report to Provost Martin in July 2005. This

preliminary report was the starting point for the task force this fall, with an emphasis on connecting directly with the faculty to identify intellectual areas where Cornell can and should make a substantial contribution. During the fall, task force meetings were held on September 14, October 5, October 26, November 9, November 30, December 7 and December 19.

In preparing this report we relied on many sources, including:

- Strategic Plan of the Ethical, Legal, and Social Issues Focus Group (2001)
- President Lehman's State of the University address (October 2004)
- Provost Martin's Academic Planning report (February 2005)
- One-page reflections on Life in the Age of the Genome written by TFLAG members (March 2005)
- Informal discussions with undergraduates at the Alice Cook House (April 2005)
- Survey of Cornell University faculty (May-June 2005)
- Feedback from the Academic Deans (September 20, 2005)
- Three open meetings with Cornell University faculty and task force members (October 18 and 19, 2005)
- Meeting with the leadership of the Humanities Council (November 4, 2005)

### **Dimensions**

During Spring 2005, the task force used much of its time to identify key dimensions of Life in the Age of the Genome (see Appendix B for a synthesis of our early discussions). Conceptualization was critical and had to be undertaken before compiling an inventory of courses or research projects, and before querying faculty members about their engagement with this theme. This initial identification of dimensions was based on our discussion of the aforementioned documents. The dimensions were always viewed as a work in progress.

Before fielding the faculty survey, TFLAG identified the following key dimensions of Life in the Age of the Genome:

1. Living in the Age of the Genome
  - What constitutes life? (e.g., debate over stem cell research)
  - How will individuals and governments respond to new choices and realities? (e.g., genetically-modified foods, reproductive technologies, longer and healthier lives)
2. Law, Politics, and Governance in the Age of the Genome
  - How will new biological data be stored, shared, and protected? (e.g., insurance, employment)
  - How will governments, non-governmental organizations, social movements, and other political actors attempt to shape the development and use of new biological knowledge and technology?
3. Culture in the Age of the Genome
  - How will film, literature, the media, and other cultural agents interpret and communicate scientific innovations?

4. Biological and Social Explanations in the Age of the Genome
  - How can biological and social information be combined to produce new knowledge about humans? (e.g., race, gender, academic achievement)
  - What are the limits and challenges to such work?
5. History and Philosophy in the Age of the Genome
  - What are the intellectual, technological, and cultural forces that shape the development of the new life sciences?
  - How can an understanding of earlier periods of scientific innovation (e.g., evolution, nuclear power) help us understand the contemporary period?
6. Ethics in the Age of the Genome
  - What are the critical ethical issues in the new life sciences?
7. Other Aspects of Life in the Age of the Genome
  - This dimension includes all aspects of the theme that the task force has yet to uncover.

A majority (52%) of survey respondents (807 total) reported research, teaching, or service engagement with one or more of these dimensions of Life in the Age of the Genome (see Appendix C). Open-ended responses to the faculty survey and subsequent discussion with faculty suggested the following revisions to our list of key dimensions (see Appendix D):

- “Living in the Age of the Genome”
  - Expand to include research that examines how new understandings of life affect our perspectives toward animals
  - Consider how developments in gene therapy and the regeneration and engineering of tissues and organs will change medicine and alter human life?
- “Culture in the Age of the Genome”
  - Include an explicit artistic component
- “History and Philosophy in the Age of the Genome”
  - Adopt a deeper and longer historical perspective
- “Law, Politics, and Governance in the Age of the Genome”
  - Include a more explicit focus on biodefense and biowarfare issues
  - Consider non-federal initiatives for funding research including state initiatives and the private sector
- “Ethics in the Age of the Genome”
  - Include an emphasis on environmental issues
  - Include considerations of justice, equality and fairness
- “Biological and Social Explanations in the Age of the Genome”
  - Expand to consider biological reductionism

Respondents also offered general comments on our key dimensions. They included:

- Greater attention should be paid to effects on underrepresented minorities.
- Greater attention should be focused on international issues.

## **Items to Be Included in Report**

The TFLAG charge required that the task force

- Identify opportunities for more broadly interdisciplinary research and teaching.
- Recommend mechanisms for rapid growth of work on the ethical, legal, and social implications of science and technology and for the support of work on culture.
- Examine the impact of the life sciences initiative on undergraduate and graduate education.
- Determine which programs and projects warrant future investment.

The coordination of research and educational efforts and areas for future investment encompass this charge and are addressed below.

## **Coordination of research and educational efforts**

One of the promises of attending a major research university like Cornell is the opportunity to learn from scholars engaged in cutting-edge research. Although Cornell students have ample opportunity to take classes from leading researchers, the faculty survey suggests that cutting-edge research relevant to Life in the Age of the Genome has difficulty finding its way into the classroom. Forty-four percent of faculty report that their research engages Life in the Age of the Genome, but only 27% report that any of their courses engage this theme in any way (see Appendix C). This gap is of particular interest because courses only had to “touch upon” Life in the Age of the Genome to be considered relevant.

Task force discussions and meetings with students revealed several likely explanations for the gap between research and teaching. Faculty report feeling underprepared to teach broad and interdisciplinary material, and being reluctant to go outside their intellectual “comfort zone” in the classroom. Team teaching would ease these concerns, but problems exist in finding teaching partners and receiving appropriate credit for team taught courses. Students report feeling overwhelmed by the demands of their majors and the pressures of compiling academic records that will allow them to achieve future educational and career goals. In this context, many students have little interest in pursuing intellectual opportunities that are not mandated by their majors or clearly valued by graduate schools and potential employers.

If Life in the Age of the Genome is to significantly influence the Cornell community, we must not only focus on creating additional research opportunities and partnerships, we must also pursue initiatives that target our students. Recommendations for achieving this goal appear throughout the remainder of this report.

## **Where we should begin to make additional investments?**

The task force considered additional investments in Life in the Age of the Genome from two perspectives: (1) intellectual themes that engage broader issues in the life sciences and warrant a strong emphasis on campus, and (2) mechanisms to facilitate creating diverse communities of scholars in these and future interdisciplinary areas. Our recommendations are based on faculty feedback and task force discussions.

### **(1) Intellectual Themes**

During Fall 2005, the task force focused on identifying specific areas of Life in the Age of the Genome that require significant scholarly activity, engage multiple communities and build on Cornell’s existing strengths. The proposed intellectual themes each focus on different questions but also have considerable synergy with one another. We would like to emphasize that these intellectual areas are intentionally broad and encompass a range of activities among the social sciences, humanities and life sciences. Our intent

was not to dictate specific research projects. We also realize that these themes represent issues of importance today, and that progress is rapid in the life sciences and will result in new areas that should be emphasized in the future. Therefore, the mechanisms we propose are appropriate not only to the themes suggested here, but also to areas that will inevitably arise in the future.

The intellectual themes identified by the task force that warrant future engagement at Cornell are:

1. Understanding Human Diversity: Nature and Nurture
2. Political Dimensions of the Life Sciences Revolution
3. The New Biology and Cultural Change
4. Public Participation in Science Based Policy
5. Health and Health Care in the Age of the Genome
6. Food Innovations and Challenges: Significance, Production, and Distribution

Each theme is detailed below. The general descriptions include representative critical questions the theme will likely address. Also included with each theme are listings of Cornell's existing strengths. Resources will be needed to support these and similar interdisciplinary activities. A Center for Life in the Age of the Genome, for example, would need designated faculty lines, physical space, administrative support, and funds to develop the theme areas. These resources are common to all proposed intellectual areas, and are therefore not itemized further.

### ***Theme 1: Understanding Human Diversity: Nature and Nurture***

In the social sciences and humanities, studies of human diversity have traditionally focused on environmental factors (e.g., cultural and economic influences on educational attainment). Genetic factors are sometimes acknowledged, but are not generally subjected to serious scrutiny. Recent work has begun to diverge from this environmental focus, as the tools and theories of the life sciences have been applied to dimensions of human diversity (e.g., cognitive ability, obesity, race).

Our hope is that Cornell's activities in Life in the Age of the Genome will encourage scholars from around campus to explore a more complex understanding of the determinants of human diversity, and to use this new appreciation of environmental and genetic influences to revolutionize our existing undergraduate and graduate courses.

We believe that this integration of approaches must occur in an intellectual environment that is critical of the motivations for and implications of cross-disciplinary collaboration. Not only is much to be learned from these collaborations, but our faculty and students must be encouraged to reflect on the broad context in which research and education take place and the different assumptions and tools that scholars bring to their task.

Integral to achieving these goals will be facilitating use of the growing number of social surveys that collect biological data (e.g., National Longitudinal Study of Adolescent Health; Michigan Interdisciplinary Center on Social Inequalities, Mind, and Body), as well as supporting innovative new data collection efforts.

Some of the specific questions that can be asked include:

- How do heredity and environment independently and interactively affect cognitive abilities?

- What is the relationship between allelic variations in geographic populations, and social classifications of race and ethnicity?
- How do biological and social factors contribute to gender differences in schooling and occupation?
- How does exposure to social and environmental factors such as stress contribute to disease and regulate biological markers?
- What are the genetic and social determinants of obesity?
- Why do researchers, policymakers, the media, and the public tend to pit genetic and social explanations against one another, rather than focus on how these factors jointly determine human diversity?
- How does the very attempt to construct questions that link nature and nurture raise concerns about the creation and use of categories (e.g., race, gender)?

*Existing Cornell Strengths:*

The questions raised by this theme engage strengths in several Cornell departments. From a more social perspective, they engage core identity and classification debates in Sociology; Psychology; Feminist, Gender, and Sexuality Studies (FGSS); and Human Development. More technical aspects of these questions engage Neurobiology and Behavior, Animal Sciences, and Molecular Biology and Genetics.

In addition to these departmental strengths, the nature and nurture theme is also able to build on existing centers and programs. The Cornell Institute for Social and Economic Research (CISER) is critical to the sensitive data requirements of the theme. The Bronfenbrenner Life Course Center (BLCC) and the Center for the Study of Inequality (CSI) provide essential forums for dialogue between those whose focus is primarily on nature, and those whose focus is primarily on nurture. Last, the 2004-2007 Institute for Social Science's Evolving Family theme project is engaging these issues regularly through exchanges between Cornell evolutionary and social scientists, and a series of conferences and workshops (e.g., October 2005 Biology Workshop).

Many faculty already work on aspects of this theme including: Elizabeth Adkins-Regan (Psychology and Neurobiology & Behavior: hormonal and neural mechanisms underlying the social behavior and social relationships of birds), Andrew Clark (Molecular Biology & Genetics: the genetic basis of adaptive variation in natural populations), Steve Emlen (Neurobiology & Behavior: behavior and ecology of animal species that live in societies that are structurally similar to those of humans), and Elaine Wethington (Human Development: exposure to stress, access to social support, and health).

Cornell students have opportunities to explore many of these issues through the Biology and Society program. They also have the opportunity to publish on related issues in science, society, and the law through Triple Helix. Among the many relevant courses are:

Human Development 336: *Connecting Social, Cognitive and Emotional Development*  
 ILROB 626: *Organizations and Social Inequality*  
 Sociology 222: *Controversies and Inequality*  
 Mechanical and Aerospace Engineering 464: *Orthopedic Tissue Mechanics*  
 Nutritional Sciences 315: *Obesity and the Regulation of Body Weight*  
 Science & Technology Studies 444: *Historical Issues of Gender and Science*

## **Theme 2: Political Dimensions of the Life Sciences Revolution**

Emerging technologies in the life sciences offer contemporary societies opportunities for creating futures that differ significantly from the past. Many observers expect the new life sciences to contribute to transformations in health care, agriculture, and sustainable development. But these opportunities simultaneously raise major challenges for political institutions, which must find ways to address conflicting interests and values about the shape of the future. These challenges, difficult enough in national politics, are even more formidable at an international or global level, where weaker institutions of governance coexist with larger cultural, economic, religious, and political differences.

Recent conflict over genetically modified organisms in agriculture provides an early indicator of the potential significance of these problems. For the foreseeable future, the use of biotechnology in food production and sustainable development will likely remain entangled in debate about environmental risks, property regimes, international trade, technological choice, consumer sovereignty, and transnational governance. These issues are complicated further by fundamental disparities in economic resources and control over decision making, especially in the context of relations between developed and developing countries.

Genetically modified organisms are, of course, only one example. The challenge of governance in this domain is also reflected in conflicts over pharmaceutical development, indigenous rights, epidemiologic surveillance, intellectual property, biological weapons, and the political economy of research systems among others. Thus, in the coming decades, sophisticated scholarship is needed on the global political dimensions of the life sciences revolution, and this work should be grounded in a number of disciplinary perspectives and in area studies. Examples of potential questions include:

- How are biotechnologies being deployed in different societies? What forces are shaping local choices? How do local choices produce global effects?
- How are research systems (both public and private) in different national and transnational contexts setting priorities? How can the problems of the world's poor be better addressed through research?
- How are various democracies coping with the challenge of citizen deliberation and participation in decision making in this domain? How can international institutions address these problems?
- What kinds of regulatory instruments (e.g., formal regulations, market mechanisms, guidelines, soft law, etc.) are used to govern emerging biotechnologies in different places, and how do these vary in their impact on economic and social outcomes?
- How are non-governmental organizations, transnational social movements, multinational corporations, international scientific communities, and other global actors influencing decision making in different contexts?
- How can international institutions, such as the Cartagena Protocol for biosafety or the World Trade Organization, cope with the challenges of assessing risk and setting standards in this contentious context?
- In different contexts, what efforts are being made to rectify institutional deficits (e.g., in anticipatory capacity, decision making ability, political legitimacy, and implementation) and with what success?

*Existing Cornell Strengths:*

Cornell has a comparative advantage in this area relative to our peer institutions, especially in biotechnology and development, owing to the university's strengths in the relevant sciences (e.g., biomedicine, plant and animal sciences, agriculture, and veterinary medicine); prominence in international development; cutting edge research in comparative politics and the study of transnational contention; and strong programs in area studies. Cornell also has significant strength in its Peace Studies Program and in the sciences regarding bioweapons, biosecurity, and technical arms control.

Faculty with interests related to this theme include John Forester (City & Regional Planning), Laura Harrington (Entomology), Stephen Hilgartner (Science & Technology Studies), David Pelletier (Nutrition), Sidney Tarrow (Government) and Kathleen Vogel (Peace Studies).

The global political dimensions of the life sciences connect to the concerns of many groups; the exact groups and centers involved will depend on the specific topic under consideration. For example, a recent conference on "Transgenics and the Poor: Science, Regulation and Development Policy" drew participants from Cornell International Institute for Food, Agriculture, and Development (CIIFAD); Development Sociology; Einaudi Center for International Studies; Ethical, Legal and Social Issues Focus Group of the New Life Sciences Initiative (ELSI); Government; Institute for Genomic Diversity; International Programs CALS; Polson Institute for Global Development; Rural Livelihoods and Biological Resources; Science and Technology Studies; and the Title VI South Asia Program.

Existing course offerings that are relevant to this theme include;

Development Sociology 205: *International Development*

Entomology 210: *Plagues and People*

Natural Resources 331: *Environmental Governance*

Science & Technology Studies 471: *The Dark Side of Biology: Biological Weapons, Bioterrorism, and Biocriminality*

**Theme 3: The New Biology and Cultural Change**

The new life sciences are implicated in a variety of changes in discourses, cultural categories, and identities. As an area of research and development with the explicit goal of intervening in the machinery of life, the new biology often disrupts traditional ways of distinguishing "nature" from "culture," redefining some of the central categories of social orders. At many levels, the new biology is increasingly entangled in struggles over the boundaries of the normal and abnormal, the natural and unnatural, the authentic and artificial, the sacred and profane. Classic debates about free will versus determinism are re-inscribed in language drawn from neurobiology. Ancient warnings about hubris inflect the debate about genetic engineering. Contemporary art, performance, and popular culture draw from the linguistic and visual worlds of biology to evoke new meanings.

One particularly important area for humanistic and social scientific inquiry involving the cultural context of biology concerns changing conceptions of human identity, diversity, and difference. As the life sciences provide new ways of studying the similarities and differences among human beings, they are (once again) finding themselves entangled in identity politics. Research on human genetic diversity has already provoked significant resistance from indigenous peoples, and extensive debate is underway about the politics and ethics of a number of projects in population genetics. Many observers of contemporary biology expect that over the coming decades new knowledge will interact significantly with extant ideas about race, ethnicity, gender, and human nature—perhaps challenging, reinforcing, or otherwise changing existing concepts and stereotypes. At the same time, genomic technologies are creating "new" human

groups, defined not in terms of traditional ethnic or gender categories but on the basis of shared genotypes, such as an allele linked to elevated cancer risk. Some of these groups are beginning to mobilize—a process that may well accelerate as the science develops. Meanwhile, the prospect of using neuropharmacology, nanobiotechnology or gene therapy to modify human beings is inspiring questions about individuality, authenticity and human identity, alarming some and inspiring others to embrace a “post-human” future.

In such a context, ethical and political issues—about human rights, memory and personality, and the possible emergence of new forms of domination—loom large. Understanding the nature and significance of these cultural phenomena will require sustained humanistic and social scientific inquiry in a wide range of social contexts. Specific questions might include:

- How can the changes associated with the new biology be understood in cross-cultural and historical context?
- How are discourses of human enhancement, longevity, and even immortality being mobilized and refigured in contexts ranging from science fiction, to pharmaceutical advertising, to the trans-humanist movement?
- How are the hopes and anxieties of various groups regarding the new biology represented and expressed in art, visual media, and literature?
- How can science itself be understood as a process of translation, one that combines linguistic and visual mediums and uses stories, metaphors, and pictures to create concepts and representations?
- What is the significance of the imagination of the post-human, as it proliferates in a broad range of theoretical discourses including ethics, feminism, cybernetics, and others.
- What roles are new biomedical platforms (e.g., microarrays, functional MRI) playing in altering medical and lay concepts of normality and pathology?
- How are specific groups and emerging social movements using biological knowledge and imagery to refashion identities and self conceptions?

*Existing Cornell Strengths:*

Cornell is in a unique position to develop this area with broad and deep strength in the humanities (reflected in the full range of humanities departments and in the Society for the Humanities and Program on Ethics and Public Life), strong expertise in relevant social sciences and area studies, and strength in the social aspects of science (e.g., a top-ranked Department of Science & Technology Studies). The theme of cultural change could engage scholars from a wide range of fields, including anthropology; communication; comparative literature; critical theory; cultural studies; feminist, gay, and sexuality studies; government; history; media studies; philosophy; religious studies; science and technology studies; and sociology.

The faculty who will serve as potential resources for this theme include Dominic Boyer (Anthropology), Joan Brumberg (Human Development), Brett de Bary (Asian Studies), Philip McMichael (Development Sociology), Annelise Riles (Law), and Amy Villarejo (Feminist, Gender, and Sexuality Studies).

Existing course offerings that are relevant to this theme include:

Development Sociology 311: *Social Movements*

History 415: *Environmental History: The US & the World*

Philosophy 286: *Science and Human Nature*

Science & Technology Studies 102: *Histories of the Future*

#### ***Theme 4: Public Participation in Science Based Policy***

The tension between scientific expertise and the democratic commitment to public participation in policy making is evident throughout society. Whether the school science curriculum should be designed by scientific experts or local elected officials is a political challenge in many American states. The call for labeling of genetically-modified foods puts the safety claims of researchers against the normative values of individual and consumer choice. Emerging disputes about environmental regulation of nanotechnology highlight the differences between expert and lay constructions of risk. Actors in these arenas range from politicians to scientists, from journalists to bloggers, from activists to “soccer moms” to “NASCAR dads.” Each of them produce knowledge useful and powerful in the social sphere, yet what passes as “fact,” “legitimate evidence,” and “appropriate argument” often varies across scientific journals, cable news channels, talk radio programs, Internet blogs, and church sermons. These tensions formed part of the backdrop to recent controversies over the fate of Terry Schiavo, “intelligent design,” and stem cells and will likely continue to appear as new knowledge – especially about genomics – becomes integrated into the public sphere.

Yet rapid advances in genomics have highlighted the need to understand the tension and develop ways to bring expertise and participation together in ways that enhance, rather than challenge or subvert, democracy. Contemporary society requires new forums and public policies that address privacy, intellectual property, corporate control, environmental, and safety issues. These forums and policies need to reflect reliable knowledge about the natural world (what we usually call “science”), while simultaneously reflecting the diversity of values and interests that shape this knowledge and the public’s contribution to and use of this information.

The standard response to this conflict is to call for “enhanced scientific literacy” through education and outreach initiatives. While valuable, those initiatives address only a limited portion of the problem, because they assume that a “deficit” of technical knowledge is the key issue. Research has demonstrated other levels that need to be studied: the deficits of social knowledge in the technical community that are often apparent in the policy process, the legitimate role of factors beyond technical knowledge in shaping public knowledge of and response to science, the understandings of uncertainty and the meanings of “debate” in the scientific community and nontechnical publics, the nature of engagement and participation in the policy process. Without this deeper exploration, attempts to improve “scientific literacy” will miss the rich complexity of the challenge they face.

Understanding the relationship between scientific knowledge and public participation in modern democracies requires a multifaceted approach. We need to understand public constructions of risk in areas ranging from bioweapons to genetically modified crops, and how policy is developed in response to these constructions. We also need to know more about community action, about the sociology of knowledge – what role do nonscientists play in the creation of scientific knowledge? – and about how the voices of underrepresented groups are included or excluded from technical debates. Looking at the representation of scientific knowledge in public spheres (including mass media, art, and literature) requires expertise in rhetoric, media analysis, visual studies, literary studies, and other humanistic disciplines. All of this, of course, can only be productive with scientists contributing their knowledge of technical possibilities and impossibilities (and debates about which is which), as well as their knowledge of fictional fantasies and realizable futures. Combined, these approaches can yield understanding of the complexities of the use of technical knowledge in democratic societies, which will be valuable for those seeking educational and deliberative tools for the productive use of that knowledge in the future.

Collaborative work among scholars in these areas needs to address a wide range of questions. The democratic opening of power to nonscientists may conflict with deference to expertise when public choices are made in genomics and other science-intensive policy areas. The challenges of public engagement intersect with ideals of democracy, perception, public opinion, and imagery. Intellectual questions that arise include:

- How can new forums for collaborative and productive interaction between experts and the public be created and nurtured?
- How is the balance between democratic ideals and scientific expertise different in cultures with different political traditions and histories— mainstream American, Native American, Latin American, Asian?
- How do representations, imagery, and meanings of genomics change as they are incorporated into different social contexts?
- How do economic and demographic inequalities, varying social access to the policy process, mass media presentations, etc., shape the integration of genomic knowledge and technologies with public life?
- What kinds of scientific knowledge of genomics do various actors need – citizens, consumers, legislators, judges, communicators, scientists in other fields? How might that knowledge be provided most effectively to acknowledge issues raised in the earlier questions?

*Existing Cornell Strengths:*

Beyond our obvious strengths in science and technology, Cornell has a tradition of public engagement by senior scientists and engineers. The Departments of Science & Technology Studies and of Communication both include issues of science and the public among their central concerns. The Cornell Cooperative Extension already plays an important role in public outreach and provides the opportunity to both study and implement processes for public communication of science. The Associate Provost for Outreach convenes practitioners and researchers from around campus to address these issues.

Individual faculty in Nutrition, Government, Education, Development Sociology, City & Regional Planning and other departments are interested in how education, outreach, and public policy, at both the individual and the civic levels, interact over issues associated with genomics. Faculty in Physics, Microbiology, Ecology & Evolutionary Biology, Astronomy, Neurobiology & Behavior, Entomology, and elsewhere serve on the boards or as officers of organizations with particular concern for public issues, such as the Ecological Society of America (Alison Power, Ecology & Evolutionary Biology), the Union of Concerned Scientists (Thomas Eisner, Chemical Ecology; Kurt Gottfried, Physics), the American Association for the Advancement of Science (Robert Richardson, Physics), and others.

Many scientific centers on campus have explicit commitments to outreach, e.g., Cornell Center for Materials Research, Nanobiotechnology Center, Astronomy, and Wilson Laboratory. Many centers or programs on campus have at least some interest in this topic: Biology & Society, CALS International Programs, Law & Society, Center for the Environment, Cornell Institute for Biology Teachers, Center for Nanoscale Systems Institute for Physics Teachers, Einaudi Center, Ethics & Public Life, Peace Studies, and the Polson Institute.

Existing course offerings that are relevant to this theme include;

Communication 694: *Public Engagement in Science*

Science & Technology Studies 391/GOVT 309/AMSTUD 389: *Science in the American Polity, 1960-Now*

### **Theme 5: Health and Health Care in the Age of the Genome**

Developments in genomics and biomedical science, concomitant with innovations in engineering, computational biology and nanobiotechnology, have led to a new era of discovery in medicine. New medical advances are dramatically improving the ability to prevent, diagnose and treat disease, leading to increased survival of patients with cancer, heart disease, diabetes and other serious conditions.

As part of our land grant mission, Cornell University has an obligation to ensure that the newest discoveries in biomedical sciences reach the communities in and around New York State and the world. This mission can only be achieved by leveraging the talents of the life sciences, physical sciences, social sciences and humanities. Translating genomic-based biomedical discoveries into meaningful increases in health and well-being is challenging and complex.

Health care delivery systems need to evolve to keep pace with the dramatic and rapid changes occurring in medicine. The development of early diagnostic techniques and new generations of therapeutics is shifting the burden of health care from an acute to a chronic model of disease management. This shift will necessitate changes in the types of services offered and exploring the potential role of patients in the management of their own diseases. In addition, we must critically evaluate how our current governmental policies impact 21<sup>st</sup> century medicine. These challenges are exacerbated by the demographics of the population: By 2010, 20% of the United States population will be 65 years of age or older. Indeed, the “oldest” old ( $\geq 80$  yrs) are the fastest growing segment in many industrialized nations. Numerous medical issues lie ahead. Some of the most pressing, highlighted below, include caring for the elderly, preventing obesity, ensuring fair and equitable health care delivery, protecting privacy, fostering commercialization of new medical innovations and developing regenerative therapies.

- How can societies manage the impact of increased longevity and our aging population on social institutions, including the finance of healthcare, employment policies, pensions and Social Security? Will social policies that assist the elderly necessarily disadvantage other age groups?
- Over half of Americans are overweight and more than a quarter are technically obese, leading to morbidity and associated disability and health care costs. How do genetics, nutrition and social environment contribute to the development of obesity? And how can increased understanding of their role contribute to the development of short and long term policies to address the incidence of obesity and associated disease?
- How can the health care system address the disturbing disparities in health outcomes among ethnic and racial minorities in the US? How can healthcare delivery systems be improved to address these issues and at what cost?
- Will improved genetic testing for disease result in biostratification and discrimination and potentially disrupt insurance markets? How can we balance appropriate standards of genomic privacy against the potential benefits of genetic testing and similar diagnostics?
- What are the appropriate governmental and private roles in fostering innovation, regulating safety and managing intellectual property rights in the biopharmaceutical industry?
- How do we address the ethical and medical issues produced by our ability to engineer and recreate tissues and organs? How are issues of informed consent, voluntariness and scientific literacy best addressed for new and unproven treatments?

### *Existing Cornell Strengths:*

This theme has the potential to engage the entire university. Cornell already demonstrates strong leadership in relevant scientific areas, e.g. genomics and the life sciences, bioengineering, biomedical research, and nutrition and the food sciences, across several colleges. Cornell also is prominent in major social science areas including sociology, economics, the cognitive sciences, policy analysis, and science and technology studies, and has a strong presence in the humanities and law. This theme also provides substantial opportunities to link to the Weill Medical College including all clinical departments, the Department of Public Health, the Division of Medical Ethics, and the Department of Computational Genomics and Bioinformatics. The Cornell Cooperative Extension can be an important contributor to put research into practice, implement innovation in areas such as health education and wellness, and evaluate their performance drawing on an evidence-based approach.

Faculty engaged in health care and health care issues are present across the university. For example, Bruce Ganem (Chemistry and Chemical Biology: biotechnology entrepreneurship), David Levitsky (Division of Nutritional Sciences: obesity), Michael Shuler (Biomedical Engineering: targeted drug delivery), and Will White (Policy Analysis and Management: health care delivery and insurance).

A wide array of existing centers could help support efforts including: Center on Nutritional Genomics, Cornell Institute for Food Science, Bronfenbrenner Life Course Center, Cornell Institute for Translational Research in Aging (a collaboration with WMC), Cornell University Institute for Policy Research, Cornell Gerontology Research Institute, and the Institute for the Social Sciences.

Existing course offerings that are relevant to this theme include;

Design & Environmental Analysis 661: *Environments and Health*

Nutritional Sciences 115: *Nutrition, Health and Society*

Policy Analysis & Management 559: *Epidemiology, Clinical Medicine, and Management Interface Issues*

Science & Technology Studies 431: *From Surgery to Simulation*

### **Theme 6: The Significance, Production, and Distribution of Food: Innovations and Challenges in the Modern Era**

Nearly one third of young children in developing countries are malnourished—16% severely. Between 1992 and 2003, over 35% of food emergencies were primarily due to human, not natural, causes. Hunger—macronutrient (protein and energy) undernutrition—clearly remains a significant global problem. Micronutrient deficiencies (e.g., insufficient intake and absorption of iodine, iron, vitamin A, and zinc) affect more than half the world's population and account for most new cases of brain damage, blindness, and related maladies, especially among children. Cornell University is uniquely-positioned to address the food production and distribution challenges that contribute to the persistence of global hunger and micronutrient malnutrition.

Cornell faculty are leading efforts to use new scientific tools and knowledge to increase the yield and nutritional value of crops such as tomatoes, rice, and corn. These innovations in production have the potential to provide people around the world with nutritious and ample supplies of food.

The promise of these innovations intersects with cultural and political challenges that limit food distribution. Societies have reacted with indifference or appreciation to genetically engineered pharmaceuticals, beginning with insulin; yet for food and agriculture, globally contentious politics and

unprecedented policy dilemmas have arisen. Transgenic organisms raise questions of property, ethics and safety unimaginable a generation ago: what can be owned and with what responsibility? Much turns on science: how one conceptualizes evidence, knowledge, uncertainty and risk.

The balance in this global debate has perceptibly shifted; a new consensus concludes that the world's poor may benefit from genetic engineering: the question is 'under what conditions'? There is also a socially charged question that accompanies cost-benefit ratios: whose benefits and whose costs?

In addition to the politics of new foods, Cornell scholars also examine how war and other prolonged conflicts reshape agricultural production, household structures, and nutrition in fundamental ways.

The questions that this theme can address include:

- What scientific innovations are most likely to lead to further advances in food production?
- Who defines food safety? How do social values define safety? What tests are conducted to ensure the safety of new foods? How can testing be improved?
- Why do governments and consumers reject foods produced with new technologies? How do internal political and social conditions affect the acceptance of modified foods?
- How can governments and consumers best be educated about the technical and cultural risks and benefits of new foods? What lessons does the history of organic food hold for genetically-modified food?
- How can our understanding of cultural and political factors be used to enhance the value of food?

*Existing Cornell Strengths:*

Cornell University has a tremendous opportunity to continue serving as the land grant university to the world by strengthening and coordinating such departments as Applied Economics and Management (AEM), City and Regional Planning, Development Sociology, Food Science, Government, Nutritional Sciences, and Plant Breeding. The activities of these departments are enhanced by the Center for Nutritional Genomics, CIIFAD, the Polson Institute, and the Food and Water Safety Program.

Cornell's comparative advantage in this area is illustrated by the range of faculty expertise, which includes Chris Barrett (AEM: agricultural economics, poverty, international development), Ron Herring (Government: development, biotechnology), Steve Kresovich (Plant Breeding and Plant Biology: crop genomic organization, variation, and evolution), Susan McCouch (Plant Breeding and Plant Biology: rice production), and Rebecca Stoltzfus (Nutritional Sciences: poverty and nutrition).

Existing courses include:

- AEM 200: *Contemporary Controversies in the Global Economy*
- Anthropology 250: *Anthropology of Food and Cuisine*
- Food Science 150: *Food Choices and Issues*
- Hotel 432: *Contemporary Healthful Foods*
- Nutritional Science 614: *Topics in Maternal and Child Nutrition*

## **(2) Interdisciplinary Engagement Mechanisms**

The task force is enthusiastic about recommending a series of mechanisms that will foster intellectual engagement in the Life in the Age of the Genome. Although our recommendations address multiple goals, we believe two goals should be given the highest priority: (1) creating diverse communities of scholars whose work goes beyond the NLSI, and engages the broader issues of Life in the Age of the Genome, and (2) narrowing gaps between research engagement with Life in the Age of the Genome, and teaching and outreach engagement with this theme. Our recommendations are presented in order of priority based on task force discussions, discussions with groups of faculty and the faculty survey (Appendix D).

In discussions with all constituencies, we have repeatedly heard a need to increase the faculty time that can be devoted to Life in the Age of the Genome activities. Faculty already face too many research, teaching, and service demands. Creating a community of scholars who can engage in Life in the Age of the Genome activities will require reducing demands on existing faculty (e.g., reduced teaching or committee loads), or hiring additional faculty. Devoting more faculty time to this theme is a necessary condition for success, but is not sufficient. Success will also require implementation of the following mechanisms:

- **Life in the Age of the Genome Cluster Hires**
  - Goal is to increase the number of faculty who are committed to teaching, research and outreach engaging Life in the Age of the Genome
  - Utilize existing NLSI hiring mechanisms and explore new mechanisms to recruit faculty with common interests
  
- **Life in the Age of the Genome Teaching Fellows**
  - Goal is to reduce faculty barriers to addressing Life in the Age of the Genome in their courses
    - Addresses the need to compensate departments for additional demands on their curriculum and faculty for additional demands on their time
  - Award contingent on department commitment to offer course at least three times over subsequent 5 years
    - Team taught courses could be taught by a single faculty member after the first year
  - Provide funds for replacement lecturers and course development
  - Offer some courses in conjunction with the Knight Institute for Writing in the Disciplines
  - Fund at least 10 awards per year
  - Gather fellows in spring for a one day retreat to discuss courses
    - Community building
  
- **Life in the Age of the Genome Research Fellows**
  - Goals
    - Create a vibrant intellectual and physical space on campus for Life in the Age of the Genome
    - Enhance opportunities to hire intellectual leaders who engage Life in the Age of the Genome
    - Establish Cornell as a national leader in Life in the Age of the Genome
  - This mechanism is inspired by responses to the faculty survey, as well as a pair of Robert Wood Johnson Foundation programs that have been extremely successful at encouraging social scientists and physicians to engage around health policy.

- Scholars in Health Policy Research Program
  - [www.healthpolicyscholars.org](http://www.healthpolicyscholars.org)
  - established in 1992
  - current sites: Michigan, Harvard, Berkeley
- Clinical Scholars Program
  - [rwjcsp.stanford.edu](http://rwjcsp.stanford.edu)
  - established in 1972
  - current sites: Michigan, Yale, Penn, UCLA
- Track 1: Recent PhDs (i.e., “Life in the Age of the Genome Postdoctoral Fellows”)
  - PhD awarded within the past 5 years
  - 2 or 3 year fellowship
  - Outreach component developed with faculty advisor (e.g., undergraduate teaching, campus lectures, community engagement)
  - Generous compensation to attract the best young scholars from fields where postdoctoral fellowships are uncommon (e.g., philosophy, history)
- Track 2: Advanced scholars (i.e., “Life in the Age of the Genome Visiting Fellows”)
  - Scholars
    - PhD awarded 5 or more years ago
    - Expect many will combine fellowship with sabbatical leave
  - Journalists and policymakers
    - Smaller number of positions reserved for these groups
    - Journalists and policymakers contribute to outreach goals by
      - helping faculty engage with broader audiences
      - engaging broader audiences directly
    - 1 year fellowship
- Common features
  - Weekly seminar
  - Shared space
    - critical for community building
    - possible locations
      - Life Sciences Technology Building
      - Institute for the Social Sciences
      - Society for the Humanities
      - Cornell University Library
- Cornell faculty
  - Ineligible for either fellowship
  - Serve critical role as affiliates
    - mentor postdoctoral fellows
    - participate in intellectual events
    - compensation alternatives
      - intellectual opportunities
      - annual stipend
      - research funds

- undergraduate or graduate research assistants
    - course release
  - community building component
- Eligible for small grants to support pilot studies, white papers, conferences, and other related research activities
- Cornell students
  - Most events would be open to Cornell undergraduate and graduate students
  - Funds would be provided to support student research and research assistantships affiliated with research fellows or Cornell faculty affiliates
- **Lecture series**
  - Goal is to promote campus discussion of research and ideas that engage Life in the Age of the Genome
  - Coordinate with the Institute for the Social Sciences, the New Life Sciences Initiative, and the Society for the Humanities
  - Explore A.D. White Professor-at-Large opportunities
  - Integrate with the Life in the Age of the Genome Teaching and Research Fellowship programs
- **Life in the Age of the Genome Summer Seminars**
  - Goal is to broaden Cornell faculty expertise in Life in the Age of the Genome through a series of modules (e.g., biology for social scientists, social determinants for life scientists, ethics in the age of the genome)
  - Research and teaching fellows will be involved as participants and instructors
  - Inspired by summer ethics seminars that were previously held at Cornell
  - Similar to University of Michigan Summer Courses in quantitative social science
  - Community building component
- **Develop and maintain a library of case studies**
  - Goal is to increase curricular engagement with Life in the Age of the Genome
  - Students are substantially more likely to engage interdisciplinary or unconventional material that is part of required courses, rather than taking additional courses that do not fulfill major and concentration requirements
  - Some faculty report that aspects of this theme are not incorporated into their courses, because they are not sure how to proceed
  - Case studies address both student and faculty barriers to incorporating Life in the Age of the Genome into the curriculum
  - Business schools offer excellent models for how to effectively use case studies
  - Cases should be prepared by an expert in case studies, or by research fellows, Cornell faculty, or Cornell students in collaboration with an expert in writing cases
  - Guest lectures by experts could be used to enhance cases
- **Establish a speakers bureau**

- A speaker would lecture in Cornell courses, participate in Extension activities, engage the media, or deliver lectures for the general public
- Speakers would include Cornell faculty and research fellows
- The Cornell News Service and the Vice President for Media Relations should be involved in activities outside Cornell
  
- **Expand VIVO ([vivo.library.cornell.edu](http://vivo.library.cornell.edu))**
  - Goals are to encourage collaboration among Cornell scholars, and allow individuals outside Cornell to easily identify Life in the Age of the Genome resources
  - VIVO should be greatly expanded to include faculty outside the technical life sciences
  - A database of scholars and activities is necessary to build and maintain communities
  
- **Support confidential data collection and use**
  - Support for CISER's restricted data center should be expanded
  - Seed money and bridge funding will be required to launch and maintain integrative, longitudinal data collection projects that engage researchers from multiple perspectives (e.g., social scientists and life scientists)
  
- **Encourage entrepreneurship**
  - Several faculty raised concerns about the lack of entrepreneurship in areas related to this theme
  - Sufficient support should be provided for the Innovation Development and Economic Application (IDEA) Center in the new Life Sciences Technology Building
  - Aggressive commercialization should be pursued by the Cornell Research Foundation and the IDEA Center

## **Conclusion**

We have identified six intellectual themes that Cornell can and should explore in the area of Life in the Age of the Genome, as well as several promising mechanisms. We wholeheartedly believe that a key to our task force's success is our intellectual diversity. As this initiative continues to develop, future efforts must be led by an intellectually diverse community of scholars.