Executive summary

NIDCD and Stem Cells: Current Challenges and Future Promise

James Battey, Director, National Institute of Deafness and Other Communicative Disorders, NIH

- This paper provides an overview of stem cell research and roadblocks to progress in this area of science.
- When stem cells divide, they can either produce more copies of themselves (self-renewal) or they can produce daughter cells able to differentiate into one or more adult cell types.
- Scientists are using human embryonic stem cells (hESC cells) to explore the molecular mechanisms that determine how a pluripotent, self-renewing cell differentiates into a specialized cell type. Understanding these basic mechanisms of stem cells may enable us to someday mobilize and differentiate endogenous populations of pluripotent cells to replace a cell type ravaged by injury or degenerative diseases.
- Scientists require a more complete understanding of the molecular mechanisms that drive pluripotent cells into differentiated cells before they can attempt to use stem cell derivatives for clinical applications. Scientists will need to pilot experimental transplantation therapies in animal model systems to assess the safety and long-term stable functioning of transplanted cells.
- At present, there is no Federal law that limits research involving human embryos and embryonic stem cell research. However, limits have been placed on Federal funding for scientific research. Scientists may pursue research that may not be funded by the Federal government, so long as they procure non-Federal funds for such work.
- To help scientists identify stem cell lines eligible to receive Federal funding, the NIH created the Human Embryonic Stem Cell Registry (the Registry), which lists all human embryonic stem cell lines—at varying stages of development—that meet the President's eligibility criteria.
- Beginning in 1996 and every year thereafter, the Human Embryo Research Ban to the Department of Health and Human Services (DHHS) annual Appropriation Act prohibits the use of funds appropriated to DHHS to support the creation of a human embryo for research purposes or research in which a human embryo is destroyed, discarded, or subjected to risk of injury or death greater than that allowed under Federal requirements for fetuses in utero.
- hESC lines are extremely difficult to grow in culture. Since only a few laboratories in the United States are growing these cells, there is a shortage of people well-versed in the art and science of successful hESC culture.

- NIH offers training grants for institutions to provide hands-on training in the techniques needed to culture hESCs. In addition, the NIH is supporting training in many independent laboratories funded to perform investigator-initiated hESC research.
- NIH is supporting efforts at several different institutions to establish culture conditions using only well-defined components. The University of Wisconsin has reported progress towards eliminating the need for feeder cells either to establish or propagate hESC lines.
- NIH-supported Infrastructure Grant Awards have resulted in the generation of 21 human embryonic stem cell lines that are eligible for Federal funding and are ready to be shipped to investigators.
- NIH initiated a research and development contract to fund a National Stem Cell Bank (NSCB) at WiCell. It is the responsibility of the NSCB to consolidate as many of the 21 available lines as possible in one location, standardize quality control, and reduce the cost of the cells provided to researchers.
- While it is clear that transplantation-based therapies using hESCs are far from imminent, we can never know the full potential of these remarkable cells unless we embark on this important area of biomedical research.
- Research opportunities and advances, as well as links to other information about stem cell research can be found on the NIH Stem Cell Information Web site: stemcells.nih.gov.

Sustained and Balanced Investment in Research & Innovation Critical to U.S. Competitiveness

Prem Paul, Vice Chancellor for Research, University of Nebraska-Lincoln

- The United States' leadership in the global economy has been achieved through technological innovation resulting from significant investments in research and development (R&D). The majority of the R&D investment, especially for fundamental research, has been made through the federal agencies.
- The history of federal support of research and development over the past 30 years shows peaks and valleys in the level of federal R&D funding. These peaks and valleys represent periods of de-prioritization when other needs, such as social services, took larger shares of the federal budget, followed by an awakening to new challenges and a re-commitment to research and development.
- In more recent times, Congress and the President supported doubling of the National Institutes of Health (NIH) budget from 1998 to 2003, with increases of 15% per year. Unfortunately, the NIH budget has not increased since the doubling, but has flattened and actually decreased when adjusted for inflation.
- Although the doubling of NIH funding addressed the needs of medical research from 1998-2003, funding for the physical sciences and engineering suffered. This time, the stimulus for re-awakening the nation was the report "Rising Above the Gathering Storm: Energizing and employing America for a Brighter Economic Future" prepared by the National Academies of Science.
- The report suggested that we are not keeping up with other countries, that we must invest in developing our talent base in science, mathematics and engineering, and

that we must support fundamental research, which is the key to innovation. The report also stated that research and innovation talent, the availability of a qualified workforce, the quality of research universities, and federal support for research and development are all critical in attracting and retaining the multinational corporations that create jobs.

- This report has had enormous impact in awakening the U.S. to the need for additional investments in R&D. The American Competitive Initiative was launched by President Bush in 2006 with the promise of doubling funding for the NSF, DOE Office of Science, and the National Institute of Standards and Technology. Congress also has embraced the recommendations of the report.
- Still, the proposed NIH budget for FY08 is $28.8 billion. If enacted, this will be 7.4% below the 2004 highest level after adjusting for inflation. The NIH budget for the past five years has been flat and real purchasing power is 13% below that of 2003.
- Currently, distribution of total R&D as well as federal R&D obligations is disproportionate amongst states and between disciplines. Fortunately, Congress initiated the Experimental Program to Stimulate Competitive Research (EPSCoR) in 1978 to build capacity and infrastructure and better position under-funded states to compete for federal R&D.
- Currently, the IDeA program is now the largest such program, with more than $220 million in funding and has two primary programs – Centers of Biomedical Research The federal-wide EPSCoR/IdeA investment has been highly successful in building research infrastructure and has contributed to research capacity in 23 states.
- We as a nation need to continue to provide sustained investment for R&D to ensure long-term prosperity and global competitiveness. These investments need to be balanced across various disciplines and geographic regions to ensure that all of our available talent is engaged in the research and innovation necessary for us to compete successfully in the global economy.

The Importance of External Grant Support for a Public College of Arts and Science

Joseph Steinmetz, Dean, College of Liberal Arts & Sciences, University of Kansas

- External grant support of research provides a great deal of the funds that are necessary for members of the faculty to explore their research and scholarship. External grant support often provides the means for introducing undergraduate students to the world of research and scholarly pursuits.
- The undergraduate mission of Research I colleges of arts and sciences is to expose undergraduates to a wide variety of academic and provide exposure to a variety of research and creative activities that involve members of the faculty as well as postdoctoral scholars and graduate students.
- Faculty and students of colleges of arts and sciences in public institutions provide much of the research, scholarship and creative activity that form the bases of inquiry and the gathering and disseminating of knowledge.
- Given the large commitments to undergraduate and graduate teaching, faculty appointments in colleges of arts and sciences are quite different than in medical schools and research centers or institutes. Inevitably, there are conflicts that arise between teaching and research.

- The landscape of colleges of arts and sciences is in part driven by national priorities for research and teaching. Recently, there has been a trend that favors the formation of larger interdisciplinary and multidisciplinary teams of investigators. There has been a general building of the life sciences, in part because of the doubling of the NIH budget that has occurred over the past decade or so.
- Loss of external research support has some obvious negative consequences, including difficulty maintaining research programs, diversion of funds from under-funded areas of scholarship. Graduate and undergraduate participation in ongoing faculty and graduate student research would suffer, and the gap between funded researchers and unfunded might widen to a gulf. Important areas of study may disappear for lack of support as faculty are hired into areas thought to be of higher priority by external funding agencies.
- To ensure that research and scholarship continue to flourish in colleges of arts and sciences, we must encourage the establishment of interdisciplinary and multidisciplinary centers so as to make use of the full range of talent we have as effectively as possible. Departments and programs must keep up with current trends in their respective fields so they can take advantage of funding opportunities.
- Undergraduate and graduate students need to be prepared for careers with the skills necessary to help assess and identify future trends and directions. Faculty research for work in new areas should be supported, and faculty research bridge funding made available when funding levels are tight. University infrastructure that emphasizes group participation must be developed; this will require a shift in culture for many institutions.
- Federal funding policy makers should recognize that:
  1. Disciplines in the arts and sciences are important and worthy of continued study. The contributions of social and behavioral scientists, computationalists and humanists are great.
  2. More funding should be provided for career changes so that our brightest scholars are able to enter new research areas.
  3. Interdisciplinary and multidisciplinary approaches should be emphasized for training grants and other funding opportunities made available to graduate students and postdoctoral scholars.
- University administrators and those at external funding agencies must work more closely together to make sure that what is going on in the two spheres is maximally aligned and coordinated. There is a lot at stake here as our future rests largely with the students who currently occupy the seats in classrooms within our colleges of arts and sciences.

Update on the General Clinical Research Program and The Heartland Institute for Clinical and Translational Research

Richard Barohn, M.D., Professor and Director, Heartland Institute for Clinical and Translational Research, Kansas University Medical Center

Lauren S. Aaronson, Ph.D., R.N., Deputy Director, Heartland Institute for Clinical and Translational Research

- This presentation provides an update on both the General Clinical Research Center (GCRC) and the Heartland Institute for Clinical and Translational Research (HICTR).
- GENERAL CLINICAL RESEARCH CENTER (GCRC). A GCRC is an NIH-supported multidisciplinary research unit that facilitates investigator-initiated clinical studies and trials conducted by full-time faculty at an academic health center. We began the process of initiating a GCRC for the KUMC campus in 2002
- In January 2005 our GCRC became operational, and we began seeing subjects. In 2006, we applied for an NCRR/NIH grant, which was funded in April 2007 for $7.5 million over three years. As of August 2007, we have approved 82 protocols that use the GCRC resources.
- With the NIH funding, three new programs are also now available to young researchers: the Clinical Research Feasibility Funds (CReFF), Clinical Research Scholars Program (CRSP) and the Summer Clinical Research Program for Medical Students.
- In April 2007, Barbara Atkinson announced the formation of the Heartland Institute for Clinical and Translational Research. The HICTR is the infrastructure and vehicle for our CTSA application.
- In October 2005, the NIH released an RFA for institutional Clinical and Translational Science Awards (CTSA), "to transform the local, regional and national environment for clinical and translational science, thereby increasing the efficiency and speed of clinical and translational research…by creating an academic home…that integrates clinical and translational science across multiple departments, schools, clinical and research institutions".
- The HICTR extends beyond the walls of KUMC and the University of Kansas Hospital, bringing together several academic health centers and their affiliated hospitals and clinics. The HICTR is the academic home for clinical and translational research at KUMC and in the Kansas City region.
- Three resource centers were established to primarily support bench to bedside research, clinical research conducted within the walls of dedicated clinical research units, and community-based and bedside to practice research: the Novel Methods & Translational Technologies Resource Center (NM/TTRC), the Clinical Research Resource Center (CRRC), and the Population Health Research Resource Center (PHRRC).
- The HICTR also includes a dynamic Clinical and Translational Research Education Center (CTREC), which administers a pre-doctoral T32 program, a post doctoral K12 program, and numerous other educational and training programs including mentor training and support and a clinical research coordinator certificate training program.
- The NIH CTSA program is a major change in how the NIH is funding and supporting clinical and translational research. The ultimate goal of the CTSA program

is to see that the public's health is improved through more rapidly transferring results from increasing amounts of clinical research to actual health care practice.

The Natural History of a Federally Funded Researcher

Jordan Green, Associate Professor and Corwin Moore Chair in Communication Disorders, University of Nebraska-Lincoln

- The discipline of Communication Science & Disorder (CSD) provides a valuable window into current issues in the life of a behavioral scientist.
- Scientific discovery in the field of CSD is accumulating very slowly. The bases for most speech problems remain unknown and the diagnoses and prognoses of speech disorders are very subjective. Identifying objective criteria for classifying speech disorders has been an ongoing challenge and a major focus in the field.
- Progress in CSD research has been slowed by a leadership crisis, methodological limitations, and federal funding shortages. The field of CSD currently faces a shortage of Ph.D. students with the number of graduates falling short of the number needed to replace retiring faculty.
- The University of Nebraska-Lincoln (UNL) Undergraduate Creative Activities and Research Experience (UCARE) program provides undergraduates with funds to support a two-year research experience. More programs like UCARE are needed to raise students' awareness and interest in research careers.
- A number of initiatives have been implemented by ASHA, NIH, and UNL to encourage the development of new investigators. NIH's programs include the Small Grant Program (R03) and High Program Priority (HPP).
- Another significant challenge to training the next generation of researchers is the shrinking supply of available mentors. Several UNL initiatives are in place (the Grant Mentor and the Preparing Future Faculty Programs) to encourage the formation of mentored relationships between senior faculty, new faculty, and graduate students.
- More programs - like the NIH grant review training workshop sponsored by ASHA's Research and Scientific Affairs Committee - are needed to train the next generation of study section members and journal reviewers.
- Despite its obvious significance to quality of life, speech motor control is a topic that has been understudied. The dearth of scientific work is, in part, because speech is exceedingly difficult to measure. New technologies are needed for accelerating the rate at which researchers can acquire and analyze speech data. Fortunately, the NIH offers the Shared Instrumentation Grant (S10) that provides up to $500,000 annually for equipment related expenses needed by groups of NIH-funded investigators.
- Continuing education is also needed to make researchers aware of emerging technologies. To assist in educating the scientific community, NIH-NIDCD has sponsored several state-of-the-science workshops.
- The reduction in the relative number of grants awarded annually will have deleterious effects on research and education in this country. One necessary strategy to reduce the impact of the current funding crunch will be the formation of multicampus consortiums. Consortiums accelerate pace of discoveries by providing the most efficient means for scientist with diverse perspectives to achieve scientific consensus.

- The long-term goal of our research program is to advance the scientific understanding of speech production and its disorders. One necessary and particularly challenging aspect of our work has been the development of new tools for recording, measuring, and analyzing speech performance. To address this challenge, we have adapted 3D motion capture technology to obtain fine-grained measurements of face movements from infants and young children.
- ALS, which is another focus of our research program on speech production, is a progressive neurodegenerative disease that affects motor nerve cells in the brain and the spinal cord. The goals of our research on ALS are to identify sensitive, quantitative indicators of disease progression. To achieve these goals, we are using the technologies we have developed to study early speech motor development to quantify the natural history of disease progression in individuals with ALS - work which is currently funded by an initiative from the UNL Vice Chancellors of Research office to facilitate inter-campus consortiums.
- In summary, I have given the researcher's perspective on current challenges faced by my discipline and considered several measures to address these challenges which include s training the next generation of scientists, doing bigger, better science through consortiums, focusing funding efforts toward overcoming technological hurdles, and providing continuing education for scientists. A number of outstanding initiatives have already been put into place by the federal government, professional agencies, and universities to address many of these issues. These initiatives, although modest in size, suggest the research community is headed in the right direction.

Industry Funding of University Research: Can It Replace Federal Funding?

James A. Roberts, Vice Provost for Research, University of Kansas

- The latest funding information for U.S. universities shows that there was a decline in federal funds going to U.S. universities and colleges for research.
- While the percent of R&D funded by industry has been growing, the percent funded by the federal government has been declining, basically since the early 1960s, the post-Sputnik era.
- What fraction of university research funding comes from industry? The percentage has declined from a paltry 1.5% in the early 1990s to where it now hovers at about 1%.
- From the mid-1960s until about 2005 federal funding of university research grew exponentially. The approximate slope of the line indicates an annual growth rate of about 8.1%.
- Suppose that the total research funding level grows at the historic rate, as do state and other sources. Federal funding flattens, and industrial funding is computed to maintain the total. In order to do that, industrial funding of university research would suddenly have to begin growing at 40% annually, compared to an annual growth rate of 4.4% over the past 10 years. And in the end, by 2013, industrial funding would actually exceed federal funding. This simply isn't going to happen.
- What would be the unintended consequences if industry were in fact to make up for the reduced federal funding at universities? What would happen to funding levels

in specific fields of study? What would happen to the mix of basic versus applied research? Would the geographic distribution of research funding change?

- A shift in funding source from federal to industrial might result in a shift to engineering and pharmacy, with a corresponding reduction of funding in the social sciences, natural sciences, and education. In short, the fields with more opportunity for applied research might benefit disproportionately.

Industry tends to fund applied research and development, while the federal government funds basic research. In the scenario presented earlier, where industrial funding replaces flattened federal funding of research, if industry continued to spend only 5% of its budget on basic research there would be a drop of $19.4 billion by 2013 in basic research funding to universities.

- 85% of all U.S. research funding is conducted in the 'coastal' states. Both state and industrial funding have been growing more rapidly on the coasts than in the interior. The problem of unequal distribution of research funding is exacerbated by a shift from federal sources to industrial sources.
- To summarize: none of this is intended to say that industrial funding of research is not important. It absolutely is, and we in academia and the country in general need industrial collaborations. But if one asks the question "Can industry make up for a reduction in federal funding of research?" the answer is "Very unlikely." Not only that, there are some negative consequences if it were to happen.
- Basic research is crucial to the future of our society, and universities are where it is happening. To maintain our leadership as a nation, we must fund curiosity-based research that is not driven by agendas or intentional outcomes.
- In 1945, Vannevar Bush wrote: "Basic research is essentially non-commercial in nature. It will not receive the attention it requires if left to industry. …The simplest and most effective way in which the government can strengthen industrial research is to support basic research and to develop scientific talent."

Initiatives to Increase Faculty Competitiveness for Federal Research Funding

Beth A. Montelone, Associate Dean, College of Arts and Sciences, Kansas State University

- Extramural research funding is the lifeblood of research universities, and few faculty members are unaware that competition for Federal research dollars has become ever more intense in recent years.
- Kansas State University (K-State) has created or participates in a series of initiatives with primary or secondary goals of providing mentoring and/or resources to assist new faculty members in establishing the successful research programs necessary to achieve tenure. Several of these and their outcomes to date are described below.
- Center of Biomedical Research Excellence (COBRE) in Epithelial Health and Disease: The NIH-funded COBRE award to Dr. Daniel Marcus of the Department of Anatomy & Physiology in the College of Veterinary Medicine (CVM) began in 2002. It provides seed funding to the junior faculty and establishes a partnership with a mentor, with the goal of making the junior faculty competitive for independent NIH funding.

To date, six junior faculty members have successfully "graduated" out of the program and are now tenured.

- Kansas Idea Network of Biomedical Research Excellence (K-INBRE): K-State is a partner in this program, which is hosted at the University of Kansas Medical Center. It is funded through the National Institutes of Health Center for Research Resources for the purpose of strengthening biomedical research and training researchers in cell and developmental biology in the state of Kansas. The K-INBRE program has made Faculty Scholar Awards, Starter Grants, and Pilot and Bridging Awards to faculty members from K-State and other KS campuses

- Targeted Excellence: The K-State Targeted Excellence project is funded through the K-State Provost's Office from tuition monies. It was created in 2003 and is intended to enhance inter-disciplinary programs that show the most promise of elevating the university's stature. The program considers cross-departmental projects that involve multi-disciplinary themes or ideas, projects that may vary in length from short-term (one to two years) to long-term (up to five years), and requests from $50,000 to $2,000,000.

- The largest of these awards established new research centers and provide seed funding to stimulate innovative and collaborative research, and provide an important university resource for encouragement, support, and mentoring of junior faculty members. They are the *Ecological Genomics Institute* , the *Center for Genomic Studies on Arthropods Affecting Human, Animal, and Plant Health*, and the *Center for Bio-based Polymers by Design*.

- K-State Mentoring Program: The KSU Mentoring Program for Women and Minority Faculty in the Sciences and Engineering was created in 1993 with a grant from Sloan Foundation. It requires junior faculty members to identify a mentor in their discipline and provides small ($6000) awards that can be used for a variety of purposes. The most common requests include seed money for research supplies and assistants, professional travel, and attendance at short courses.

- K-State ADVANCE Institutional Transformation: K-State received a $3.5M Institutional Transformation Award from NSF in 2003. This five-year project, supported by the ADVANCE program, is intended to promote an equitable environment in which both male and female faculty members in science and engineering can thrive and succeed. Some of the ADVANCE programs are described below.

- The *ADVANCE Distinguished Lecture Series* is intended to help develop the professional network of junior women faculty and diffuse the effects of being isolated as the only woman in a department and geographic isolation in Manhattan. *Parallel Paths* is a peer group mentoring program in College of Veterinary Medicine. The *Career Advancement Program* addresses the transition from associate to full professor as well as providing opportunities for women interested in administration to gain experience in this area.

- The ADVANCE Project is in its fourth year. Early results show impressive increases in numbers of women faculty and increases in the ranks of tenured and full professor women in science and engineering.

- Collaborative for Outreach, Recruitment, and Engagement in STEM (Science, Technology, Engineering, and Mathematics) (CORES): Unlike the other programs described above, the CORES project does not provide direct mentoring or funding for

junior faculty members. Its goals are to synergistically enhance all of its constituent programs, facilitate recruiting and tracking of students, recruit students to K-State undergraduate and graduate programs, and to institutionalize and facilitate "broader impact" activities for K-State faculty preparing grant proposals.

- Kansas State University has recognized the need to cultivate junior faculty members by providing them financial resources and a supportive climate in order to enable them to become established extramurally funded researchers. Our programs, including the COBRE in Epithelial Health and Disease, Targeted Excellence, K-State Mentoring, ADVANCE, and CORES, are funded by a combination of extramural and internal sources. Return on investment data, where available, suggest that these are monies well spent.

The Time is Now: A 10-Year Vision and Strategy to Advance the Life Sciences

Barbara Atkinson, Executive Dean and Vice Chancellor for Clinical Affairs, KU School of Medicine

- The University of Kansas Medical Center has embarked on a 10-year journey to become a world-class life sciences research and teaching institution.
- The University of Kansas Medical Center's (KUMC) 10-year life sciences strategy is based on a regional collaboration among the region's many life sciences assets. This long-term strategy is further bolstered by the area's focus on entrepreneurial and collaborative life sciences research activities.
- As articulated by the Greater Kansas City Community Foundation's *Time to Get it Right* report, a successful life sciences strategy for the greater Kansas City region must include significant investments in its academic institutions. KUMC must be at the forefront to promote a united regional vision that transcends the state line to bring area assets together for a common purpose.
- At the same time, we remain steadfast in our education mission and recognize that quality researchers and clinicians often make the best teachers for our students.
- The 10-year journey requires transformation at many levels. A key component to this transformation will be a renewed focus on advancing the translational research capabilities of KUMC across many disciplines.
- The foundation for excellence in translational research already exists within KUMC. In October 2006, the NIH awarded KUMC, the Kansas City University of Medicine and Biosciences, and the Kansas City Veterans Administration Hospital – collaborators in the new Heartland Institute for Clinical and Translational Research (HICTR) – one of the new Clinical and Translational Science Award planning grants.
- In addition, KUMC just received another NIH grant totaling $7 million to support translational and clinical research in the Kansas City area. Together, these two grants position the HICTR to facilitate the translation of lab discoveries into lifesaving cures and to become a national model for excellence.
- Connected with the HICTR is the drug discovery initiative at both the Kansas City and Lawrence campuses. A key player in this process is the Office of Therapeutics, Discovery and Development (OTDD), which was developed and launched in January

2006 as a bi-campus initiative to streamline and improve the drug discovery and development process.

- The transformation of KUMC will require significant growth – and to that end, significant philanthropic and private investment. Over the next 10 years, KUMC will require an ongoing investment from the community to recruit 152 senior and 92 junior faculty and build and outfit more than 862,500 square feet of new research space.
- The 10-year costs for faculty and facilities are estimated at $798.6 million. While $798.6 million may seem extravagant, all economic indicators point to the potential for this investment to reap economic impact in the billions of dollars for years to come.
- A 10-year, $798.6 million investment supporting established, emerging, and translational research programs and shared resources at KU and KUMC will bring to our region new jobs, new scholars, and new discoveries. It will foster economic development while improving our ability to train health care professionals, and it will give those professionals better options for treating devastating diseases. The transformation is within our reach. Our dream has a plan...help us make it a reality.

Past as Prelude: Lessons for the Future Learned from 50 Years on the Edge

Steven F. Warren, Director, Schiefelbusch Institute for Life Span Studies, Director, Kansas Mental Retardation and Developmental Disabilities Research Center, Professor, Applied Behavioral Science

- How are we to maintain and even expand multi-disciplinary research centers in the current funding climate? What are the secrets to long-term success spanning a wide range of funding climates? The purpose of this paper is to briefly discuss some lessons or principles that I believe can make a real difference.
- Overview of the Life Span Institute (LSI): The mission of the LSI is to create solutions to problems of human and community development, disability, and aging. Currently it is both the oldest and largest research institute at KU with 12 research centers, over 90 PIs and 100 external grants, generating more than 20M in direct costs and 3.7M in indirect costs. The primary stakeholders are: NIH, HHS, USDE, State of Kansas, and various Foundations.
- Since 1960, LSI external funding has increased from $53,000 to over $20,000,000 annually. Over 49 years, $ have gone up 32 years and down 17 years (down 35% of the time). In first 30 years (1960-1990) award $ DECREASED 40% of the time (12 out of 30 years), while since 1990 it has decreased 31% of the time (6 out of 19 years). Also, Multiple year decreases have occurred 4 times.
- At the macro level, there are a lot of positive indicators that suggest the future for university based research centers should be bright in general. Bi-lateral support for science and research is good, and globalization has increased the appreciation for the value of science and research.
- There is an increased need for university research and states are getting into the game in a serious way. In addition, the death of corporate labs has increased the value and need for university research, foundations have more $$$ than ever, and donors will often support "big ideas" (e.g. curing autism, cancer, etc.).

- Caution signs in the macro environment include enormous pressure on the federal budget, rising cost of research infrastructure , and the fact that many universities and most medical research centers are HIGHLY leveraged.
- The Real Dangers: Treating research centers as cash cows, failure to bridge individual investigators during rough spots, cutting back support to centers during short term declines, simplistic forecasting methods, expecting unreasonable growth and "return-on-investment", and decoupling the research mission from the academic and service missions of the university
- Lessons from the Past for the Future: things go up more than they go down, keep a diversified portfolio, build from your strengths and stick to your mission, evolve or die, encourage competition at all levels, listen to the PIs, focus on the "impact" of the work, encourage, support, and reward collaboration at all levels, and persist, persist, persist.
- In summary, universities face very challenging conditions in terms of building the future of their research enterprises. This has mostly been the case in the past as well and so there is nothing really special about the current period. Securing our futures requires that we learn from the successes and failures of the past. Failure to attend to the lessons of the past could be the biggest source of risk in the present environment.

The Emerging Field of Ecological Genomics

Loretta Johnson, Associate Professor, Division of Biology, Kansas State University

- In 1995, the sequence of nucleotide bases (the genetic alphabet) comprising the DNA code for a free-living organism was determined for the first time. Since then hundreds of species have been sequenced, including the human genome in 2004.
- Genomics provides unprecedented opportunities to assess the health and integrity of ecological systems. An ecological system is the assemblage of living organisms interacting with each other and their physical environment. Just as genomics can characterize human responses to disease onset, so might it characterize the functions of ecological systems. Analogous to human medicine, it may be possible to use genomic methods to monitor ecological system responses to the challenges of global changes in environmental health.
- We all depend on ecological systems to sustain us – ecological applications of genomic technologies are therefore likely to be as important as medical uses. Just as we can use genomics in the pursuit of human health, we envision using these same methods to assess adaptive capacity, predict, and maintain the health of our environment.
- Ecological Genomics seeks to understand the genetic mechanisms underlying responses of organisms to their natural and changing environments. These responses include modifications of biochemical, physiological, morphological, or behavioral traits of adaptive significance. Ecological Genomics refers to the use of any genome-enabled approach to identify and characterize genes with ecological and evolutionary relevance.
- An Institute must have a firm foundation in an exciting science question. The overarching science question guiding the institute is: How are organisms adjusting to human-induced biotic and abiotic environmental changes at the genetic level?

- Our institute seeks to examine environmental effects on organisms at the level of genes and gene expression, and identify major genes and pathways directly involved in the organismal response to a changing environment.
- The KSU Ecological Genomics Institute is bringing the genomic revolution to the environment around us to better understand the health of the environment on which we all depend.
- The mission of the Ecological Genomics Institute is to advance the discipline of ecological genomics and to make EGI the center for ecological genomics locally, nationally, and internationally by providing a fertile intellectual environment as well as resources to enable integrated research approaches. The research is now supported through the KSU Provost's program in Targeted Excellence and that has enabled the Institute to expand and develop into the national and international leader in the new field of Ecological Genomics.
- Members of the KSU Ecological Genomics Institute have published 41 manuscripts, one book and two book chapters related to Ecological Genomics since the Institute's inception. Our seed grant program provides approximately 250K per year in funding for pilot studies to make researchers more competitive. Members currently hold 18 extramural grants ($5,468,790) relevant to Ecological Genomics, of which 10 ($2,344,160) were funded since the beginning of the TE project. Six intramural grants have been funded ($4,008,944). $1.15 million investment from TE in first 2 years has resulted in $2.3 million in extramural funds.
- The KSU Ecological Genomics Institute has implemented a number of programs that stimulate and provide support for research in this new field. Our annual ecological genomics symposium, now in its 5th year, attracts ~150 attendees from 45 different universities nationally and internationally. Technical workshops, visiting scholar programs, international student exchanges and other programs have successfully increased the visibility of ecological genomics at Kansas State University.
- Why is this institute so successful? First and foremost, the institute starts with cutting edge and big science questions as its foundation. Furthermore, we take advantage of unique skills and opportunities such as the research platform at Konza Prairie. We provide state of the art infrastructure to do cutting edge research and provide funding opportunities such as seed grants that promote competitiveness.
- Perhaps most importantly, inception of the ecological genomics institute began at the grass roots level, at the level of researchers who have a willingness to "think outside the box" and to "work outside their usual comfort zone". We posit that the next great discoveries in science will be at the intersection of diverse disciplines. Ecological genomics is a new model for such interdisciplinary research.

The Status of Research at Kansas University Medical Center

Paul Terranova, Director, Center for Reproductive Sciences, Kansas University Medical Center

- This paper summarizes KUMC's research progress in FY2006, in response to a request by Dr. Benno Schmidt and the Blue Ribbon Task Force. This Task Force was charged by the Greater Kansas City Community Foundation in early 2005 with evaluating the state of higher education in Kansas City.
- The task force completed its work on July 1, 2005. Their conclusions were subsequently published in the Time to Get it Right (www.gkccf.org), a report that identified two important elements to strengthen higher education in the Kansas City region: 1) a strong urban university and 2) enhanced research capacity.
KUMC reallocated internal funds to address specific issues within the report. The Blue Ribbon Task Force recommended that KUMC:
    - Develop a 10-year strategy to build research capacity
    - Add 100 high-quality researchers
    - Double enrollment in the Ph.D. program
    - Increase the number of postdoctoral fellows
    - Increase external research and development funding from $76M to $300M annually
    - Invest $645M in KUMC over 10 years
- KUMC developed a document entitled The Time is Now: a 10-year Vision & Strategy to Advance the Life Sciences, which was released in January 2007. This 48-page document summarizes KUMC's plan to build research (www.kumc.edu/evc/TheTimeIsNow.pdf).
- KUMC's 10-year vision plan estimates that 244 researchers are required in the established and emerging research programs in order to accomplish its goals. Specific recruits for research included 22 new basic science faculty and 6 clinical faculty from 2005 to 2006.
- Slow progress has been made in 2006 in terms of doubling the Ph.D. enrollment over 10 years as suggested by the Task Force, with a 3% increase in the number of predoctoral students over 2005. The total number of students enrolled for the fall of 2007 is 112 which represent an increase of 9.8% over 2006.
- A 24.6 % increase in the number of postdoctoral students was recorded in the KU School of Medicine from 2005 to 2006. This increase was largely due to increasing the number of faculty, increasing the amount of NIH funding, renewal of institutional NIH postdoctoral training grants, and garnering individual postdoctoral awards from NIH and other private foundations.
- Significant progress has been made regarding increasing external research and development funding from $76M to $300M over the next 10 years. The total dollars awarded in 2006 were $82.1M compared to $68.8M in 2005 (a 19.3% increase).
- Regarding investment of $645M in life sciences research over 10 years suggested by the Task Force, the KUMC 10-year strategy estimates that $798.6M is required. $380M is estimated for recruitment of 152 senior faculty, $73.6M for 92 junior faculty, $345M for additional facilities to house the expanding research faculty and programs.

- These estimates are detailed in 'The Time Is Now—A 10-Year Vision & Strategy to Advance Life Sciences' (www.kumc.edu/evc/TheTimeIsNow.pdf). KUMC and its partner institutions will seek opportunities with the State of Kansas including the Kansas Bioscience Authority, the Kansas City Area Life Sciences Institute, business leaders in the Kansas City region, Philanthropy, national resources including the NIH and other private foundations, Internal University Resources, and partnerships with area institutions that share our vision.

Keeping Our Bearings in Very Rough Seas

Brian Foster, Provost, University of Missouri/Columbia

- We have been presented with a daunting set of changes in the world of higher education-based research, and we can't just ignore them. In 1980, with passage of the Bayh-Dole Act, universities began to be able to profit from inventions of their faculty and staff coming out of federally funded research. Universities are now central to the national, state, and local economic development discussion as never before.
- Fundamental ethical issues about openness, publishing research results, and the like, challenge fundamental ethical premises of higher education. To be clear: these are not necessarily good or bad developments; they clearly are challenging and require fundamental rethinking of the basic premises of university research.
- Higher education has become politicized differently than at any time before. Any political figure can get broad interest in higher education issues, since they directly affect the lives of millions of constituents. In this sense, higher education is in a position much like health care was thirty years ago.
- All of the above has been exacerbated by the challenging state appropriations since the economic downturn in the early 21st century. Across the country, state appropriations were reduced or grew very slowly for the past five years or so, and for state universities, the proportion of total revenue that came from the state dropped dramatically.
- Another area that poses major concerns is the area of compliance, much of which is directly related to research—e.g., IRB, hazardous materials, radiation safety, and animal care. In a time of fiscal challenges, compliance costs have risen dramatically, and the consequences of noncompliance are enormous.
- A dramatic outcome of these changes is that there are growing disparities between the elite privates and the best publics in faculty compensation, in the socioeconomic status of students, in expenditures per student, and so on.
- There are fundamental, probably irreversible changes in the environment for higher education in the U.S. We have to adapt to these new circumstances. In fact, these dynamics rest on some very positive changes—at least from my point of view. The question is, how do we deal with these new dynamics?
- Develop other sources of funds. Some are obvious (e.g., philanthropic fundraising, tech transfer revenues), some challenge the culture of higher education (e.g., commercializing intellectual property). Corporate collaborations, community partnerships, regional cooperation - all could be key factors in achieving what no single

entity could do alone. It is critical that public universities position themselves effectively in their states.

- Effective enrollment management. If universities can shape their program inventory and their student body favorably, they may generate large amounts of new net revenue. This requires very business-like systems for understanding marginal costs, for shaping the student body to grow areas with sufficiently low marginal costs that significant profit centers can be created.
- Serious planning is a complex and demanding process. Good plans are layered in such a way that the mission statement and broad goals are very robust, essentially unchanged for decades, while tactical plans by which the broad goals are achieved are constantly adapting to the environment.
- Getting past our history. We usually think of the structure of higher education—especially curriculum and instruction—in ways that are very constraining, probably not cost-effective, and not the best ways to support student learning.
- Get serious about impact as the measure of success. Much of the stature of higher education institutions is based on characteristics such as restrictiveness of admissions, not the impact of the institutions on students. However, these are crude indicators of impact. In the research area, we tend to rely almost entirely on "poundage" (i.e., the volume of publications), sometimes on citations, and on research dollars generated to evaluate impact.
- We in higher education are in a new world. The environment has changed; the nature of higher education institutions has changed; public expectations have changed. It's challenging, but many of the changes are really triumphs. But business as usual will not work. We are at serious risk of losing all that we value if we don't adapt.

Rough Seas or Normal Swells?

Richard Lariviere, Provost and Executive Vice Chancellor, University of Kansas

- In the course of our discussions at this conference we have discussed many of the current challenges confronting research universities. Some of these matters are national/political issues and others are trends within the academy. I would like to try to place a couple of these issues in some kind of historical perspective.
- Perhaps the most compelling presentation of the conference has been that of Jim Battey on the current promise and challenges to stem cell research. The political storm around stem cell research is familiar to this group. It is important to note that the intervention of political causes in the realm of science is not a new problem. Like stem cell research, anti-communism was once the tool of the demagogue who knew little or nothing of the fundamental issues, but who rode the hobby-horse to electoral gains.
- Jim Battey's presentation is a source of encouragement. The scientists of the NIH clearly are not cowed by the current political interference with scientific inquiry. Such colleagues will rightly take a place of distinction in posterity's view of yet another peculiar moment in the history of science.

- Many of the presentations made by our colleagues here have had as their common theme money. Without adequate funding, the best minds and the most creative ideas will come to very little in the realm of research.
- When I listen to conversations in the academy on the question of society's support for higher education, I hear an understandable frustration verging on anger. This is understandable because most of our colleagues understand that the work that goes on in the academy has the potential to improve, shape, invigorate, and even save society. However, our audiences seldom share the same degree of understanding that we have. We sometimes fail to give them explanations that they can grasp. This is essential if they are to put our needs ahead of other voices in society.
- As Joe Steinmetz pointed out, public institutions are struggling to maintain their competitiveness. Whipsawed by diminishing legislative support and public resistance to tuition increases, staying competitive with the best of our private rivals is difficult.
- Brian Foster spoke of the entitlement status of higher education. He observed that a college degree has supplanted the high school degree as the base level of education that an American student should aspire to in order to achieve a good life. His point is that this shift has colored the conversations about access to higher education and has increased pressure to make accommodations for students who are under-prepared.
- I do not find this cause for alarm. What we do at major research institutions is dramatically different in purpose and effect than what takes place at community colleges and such places as the University of Phoenix. The challenge is in articulating how attending a research university differs from attending a community college.
- The challenge of describing the differences between community colleges and universities is more difficult than it may seem. The majority of American voters do not understand the difference. It is our obligation to be able to reasonably and clearly articulate the difference.
- If we look to history for a similar moment of dramatic shift of university attendance we can find it in the period just after World War II. The passage of the G.I. Bill changed America profoundly. At the time, there was vigorous opposition to this legislation by the higher education establishment. However, this "catastrophic imposition" on higher education resulted in the education of 14 Nobel Prize winners, three Supreme Court judges, three Presidents, 12 Senators, 24 Pulitzer Prize winners – not to mention millions of professionals in various fields.
- Dramatically heightened expectations for higher education is a good thing. But it *has* changed the playing field. We need to justify the huge investment that is being made in what we do. We need to explain what we do more often and more carefully than at any time in the past.
- The politicization of higher education to this degree is largely due to the fact that the stakes associated with what we do have never been greater. Higher education has to bear a greater share of basic research than has been the case at any time since World War II. The costs of higher education are growing at a rate that far outstrips increases in all other sectors except health care.
- Public higher education institutions such as ours are going to have to take more direct responsibility for our fiscal future. A billion dollar endowment for a research institution of 30,000 students is not adequate. Private endowments will be the leading

discriminator in determining which of our institutions will flourish and which will languish.

- There are large and serious challenges confronting higher education. Those challenges are not of any greater magnitude than those faced by previous generations of scholars and scientists in the academy. We have never had more money or greater numbers involved in our work than we have at the moment. It isn't enough money and there aren't enough scientists, teachers, and scholars in the pipeline to sustain what we will need in the future. But those challenges are likely to always be with us. That we have them is a reason for optimism rather than dismay.