# Review of Molecular Life Sciences
# University of Nebraska–Lincoln

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## Executive Summary

The University of Nebraska–Lincoln (UNL) is an AAU land-grant university which depends heavily upon the molecular life sciences to fulfill its goal of becoming a world class university and hence meeting the needs of Nebraskans. To assess the role of the molecular life sciences in the Institute of Agriculture and Natural Resources (IANR) as well as other locations in the university, a team of land-grant university faculty and administrators reviewed the molecular life sciences at UNL with a goal of identifying areas of excellence for future growth and mechanisms by which IANR along with the university could further develop in these areas.

While the review team lacked sufficient expertise to adequately review all aspects of these areas of excellence, the following were recommended:

- bovine genomics/beef systems,
- nutrigenomics,
- food safety (E. coli O157),
- stress biology/climate change/water,
- biomaterials/biosystems engineering,
- the Nebraska Center for Energy Sciences Research,
- microbiology/virology, and
- the Gut Function Initiative.

Administrative issues at the UNL currently cause tensions and do not promote appropriate collaboration between all parts of the university. The team presented several mechanisms used at the University of Arizona (BIO5 model), the University of Missouri (Bond Life Sciences Center), and at Ohio State University (Ohio Centers of Excellence). These models are presented as examples with no firm recommendation about what might work best at Nebraska considering the uniqueness of the university.

Further discussed were the importance of a core life sciences curriculum which would serve all life sciences students at the university and would involve faculty from both the City Campus and IANR. Further, we discussed the importance of core facilities to serve all molecular life scientists at UNL and further recommended a uniform system of faculty evaluation across the entire university, including IANR.

In closing, the team thanks officials at UNL for their hospitality and for making the necessary arrangements for our programmatic review.

## Introduction

Our land-grant universities and their associated agricultural experiment stations and extension services have succeeded because their collective mission links research, teaching, and outreach, as well as providing access to affordable higher education in each state. However, knowledge gathered through scholarship must be integrated and, in today's world, should exploit as far as possible information available through access to genome sequences and other aspects of molecular biology. In this manner it becomes possible to identify genetic markers associated

with production traits, such as growth and development, resistance to pathogens, and the ability to survive harsh environments and even to identify the allelic variants that underpin the traits themselves. Most federal funds to land-grant universities are now used to pay faculty and staff salaries with little left to support operations and even less to support in-depth hypothesis-driven research. In this time of increasing needs for extramural funding for support of research in land-grant universities, collaborations among disciplines in agriculture and life sciences, biomedical sciences, and medicine are essential to ensure use of the most advanced tools to provide new knowledge to enhance agricultural production systems that include food safety, food security, and biosecurity, thereby allowing U.S. agriculture to maintain its leadership role in the world. A safe, abundant, and affordable supply of food is permissive to the health and well being of our global society as well as to maintaining international economic and political stability.

It is critical that the leadership in land-grant universities end their longstanding cultural view that biomedical and other types of basic research are inappropriate to the land-grant mission. This unfortunate attitude is shared by many administrators and influential faculty members in colleges of agriculture. The consequence is a cultural barrier resulting in many agricultural colleges segregating themselves intellectually and programmatically from colleges of human medicine, veterinary medicine, and basic life sciences. The isolation of programs, including ones as fundamental to agriculture as animal sciences and agronomy, has contributed to lack of recruitment of top researchers and teachers who are competitive for funding available for research on agriculturally important species. To succeed, agricultural programs in land-grant universities must provide mechanisms to encourage scientists to engage in the integration of scholarship across disciplines. This maxim also applies to the basic core curricula that serve all students in the life sciences, a discipline that is increasingly more complex, yet at the same time more unified through the underpinning of genomics and molecular biology. The graduate must be prepared for lifelong learning and have the capacity to comprehend, assimilate, and communicate regarding advances in the life sciences and adapt to changing employment opportunities. Likewise, it is incumbent on ranking administrators in these institutions to create an encompassing environment which encourages collaboration across all colleges, institutes, and centers in all directions.

To examine these issues, Chancellor Harvey Perlman invited a team of land-grant university faculty and administrators to examine these issues at UNL with a goal of identifying key scientific areas in which Nebraska already had considerable excellence and could be further developed into national preeminence. He further charged the team to recommend mechanisms by which UNL could collaboratively advance these areas across the entire university because no college or unit within any major university has sufficient talent to adequately address disciplinary cross-cutting issues of great magnitude.

The team that visited Lincoln on March 25-27 was composed of Eugene G. Sander, Vice President and Dean, College of Agriculture and Life Sciences, University of Arizona (chair); R. Kirby Barrick, Dean, College of Agricultural and Life Sciences, University of Florida; Fuller W. Bazer, Regents Fellow and Distinguished Professor, Department of Animal Science, Texas A&M University; Deborah Delmer, Professor Emeritus, Department of Plant Biology, University of California, Davis; Michael D. Mullen, Associate Dean for Academic Programs, College of Agriculture, University of Kentucky; R. Michael Roberts, Curators' Professor,

Division of Animal Sciences, University of Missouri; Patrick S. Schnable, Baker Professor of Agronomy, Department of Agronomy, Iowa State University; and Steven A. Slack, Associate Vice President and Associate Dean, Ohio Agricultural Research and Development Center and College of Food, Agricultural and Environmental Sciences, Ohio State University. The conclusions, suggestions, and recommendations included in this report result from a body of data which was presented to the team before visiting Lincoln along with our interviews of administrators and faculty from both the IANR and the College of Arts and Sciences at UNL. The supporting information especially related to the impact of faculty publications and their ability to attract extramural funding was difficult to understand and hence not especially useful to the team. Further, we reviewed the final report dated January 12, 2000 of the Task Force for the Integration and Enhancement of the Life Sciences at UNL. We were pleased to have the opportunity to visit with faculty and administrators at UNL and very much appreciated the rapid response by all to team requests and needs and the spirit in which comments and information were shared with the team.

## Administrative Issues

IANR is a structure unique to the University of Nebraska–Lincoln in that it was created by legislative action in 1973. Its administrative leader has the title of vice-chancellor and vice-president and thus a dual reporting relationship to the chancellor at UNL and to the president of the University of Nebraska system. The person in this leadership position is the "chief academic officer" of IANR and hence within IANR has responsibilities parallel to the senior executive vice-chancellor of the university. Interestingly, the IANR budget, which is about 27% of the total UNL budget, flows through the chancellor of the university and is not directed to IANR as a line item straight from the state legislature. These unique reporting relationships appear to underlie some palpable tensions across the university, especially relative to communication between colleges. Consequently, attempts to develop a vital and contemporary life sciences curriculum, advance research programs, and provide uniform standards of faculty evaluation and advancement have been weakened. These tensions between the City Campus and IANR have caused suspicion, even hostility, between colleagues, undermined the confidence of faculty members in campus leadership, and led to considerable finger pointing with regard to variable standards of excellence across the university.

Understandably, the land-grant university in Nebraska should have as a primary responsibility serving the research, educational, and outreach needs of Nebraskans. However, little was mentioned about being a national leader in any areas of the molecular life sciences or, for that matter, in any of the more applied areas that depend upon the more basic areas of science. Aspirations towards excellence should be an emphasis of future efforts in recruitment of faculty and in any academic reorganization on the Lincoln campus.

It was important that the team had an opportunity to meet the Ag Builders, a dynamic group of Nebraskans who strongly support the IANR and are concerned about the level of recognition of the institute within UNL. Likewise, UNL stands to gain from a unified advocacy. The team strongly recommends that the leadership of both IANR and UNL work with the Ag Builders to focus the energies and allegiance of this group of alumni and friends towards the university as a whole and away from a sole focus on IANR. In 2009, the citizens of Nebraska

need the collective talents of the entire faculty enterprise at UNL if they are to benefit fully from the education, outreach, and research available.

## Areas of Excellence

Based on discussions with faculty and administrators across UNL, the review team have compiled a list of areas of excellence in which the university might consider future investment. For the most part, the review team lacked sufficient information and/or expertise to evaluate the university's potential to reach world class status in these areas. Hence, we recommend that small teams of experts in each of these topics be invited to provide additional input before making any substantial outlay of funds.

### Bovine Genomics/Beef Systems

The human genome project has provided revolutionary new insights into human health; however, an abundant and safe food supply remains as fundamental to human physical well being and quality of life as the newest discoveries of medicine. Thus, we in agriculture must embrace information derived from genomics, proteomics, bioinformatics, and related disciplines and apply it to agriculturally important species, including cattle, that, like corn, play a dominant role in the economy of Nebraska. Such studies will ultimately allow us to understand the regulation and function of specific genes (functional genomics), how genes interact to provide a complex phenotype, and how phenotype is affected by inheritable changes in chromatin organization and structure that do not involve nucleotide changes (epigenetics).

As in all species, genomic and possibly epigenetic variations underpin host resistance to pathogens, milk production, reproductive efficiency, meat quality, and growth in cattle. The bovine genome sequence provides an invaluable resource for discovery of the genes controlling desirable quantitative traits that benefit beef systems, as well as for ones that might have a negative impact on beef production. In addition, comparisons of the genomes of humans and farm animals will likely contribute to medical advances, especially in studies on disease resistance, obesity, malnutrition, cardiovascular disease, reproductive health, and birth defects central to both human and veterinary medicine.

The 2008 report prepared for a review of life sciences research and teaching in the IANR lists beef systems under its five spires to address key needs of Nebraska "starting at the molecular level and moving through application." Given the developing programs at the University of Nebraska–Lincoln with collaborators at the USDA Meat Animal Research Center (USMARC) in Clay Center, Nebraska and the University of Kansas Medical Center and the potential for collaborations with the University of Nebraska Medical Center in Omaha, Nebraska, there is an opportunity to develop strong programs in bovine genomics/epigenetics/beef systems. The new hires should be able to capitalize on existing expertise in reproductive biology, which is focused on the hypothalamic-pituitary-gonadal axis and how the functions of this system are controlled by energy balance, energy utilization, and the expression of a number of key genes. In addition, faculty with interests in immunology and animal health should also benefit from the addition of faculty with genomics expertise in identifying the genetic and physiological bases for resistance to disease in cattle. Finally, the IANR spire for beef systems should interface well

with existing projects on swine reproduction and production (parity of sows affecting offspring and genetic and functional genomics to improve swine production and quality or pork). In short, provided synergies can be created. The addition of new investigators in the area of bovine genomics/epigenetics/stem cell biology/beef systems should strongly enhance existing programs in the Animal Science Department and make significant contributions to the cattle and swine industries in Nebraska.

As with the other spires, inadequate information was made available to evaluate fully the expectations to be placed on new recruits, the academic level at which the recruits will be hired, or the scope of responsibilities associated with the positions. For a genomics specialist, it is crucial that during the recruitment process strong links be established with USMARC and key producers who can assist in providing research resources, e.g. access to herds, to the new investigator. Extramural funding of such work will be challenging as the USDA will be the only relevant federal agency. Similar approaches must be used in the recruitment of an individual working on epigenetics/stem cell biology where the University of Nebraska Medical Center and existing faculty working on epigenetics (in plants, for example) must be brought into the recruiting/hiring equation. Such an individual will have the opportunity to apply for NIH as well as USDA funds, but this area is becoming highly competitive. Epigenetics is an area of broad interest to both agriculture and medicine, especially in how environmental insults, such as those brought about by endocrine disruptors, can alter phenotype, sometimes in a trans-generational manner. In summary, these will be risky hires, but with a potentially high payoff. This spire, in particular, needs careful prior evaluation from multiple inputs.

**Nutrigenomics**

The Nebraska Gateway for Nutrigenomics (NGN) initiative involves six departments in IANR and 25 faculty from across the UNL campus. There are four positions identified by IANR for this initiative: biotransformation and bioavailability in Biological Systems Engineering, genetic polymorphisms and disease risk in Nutrition and Health Sciences, gene regulation by *miRNA* in humans in Nutrition and Health Sciences, and computational biology. These positions and this program area fit under the IANR food, nutrition and health spire of excellence key initiatives. The NGN has a long-term goal of making UNL an international leader in nutrigenomics with the specific goal of prevention and cure of disease. This initiative is congruent with NIH and USDA priorities as well as meeting the interests of public groups and legislators. Dollars committed include $2.5 million for Leverton Hall renovation, $66,000 for equipment from IANR, and $50,000 per year for two years from the vice-chancellor for research. The genomics area fits nicely with other molecular-focused programs, especially with the Center for Plant Science Innovation and the School of Biological Sciences where cross-fertilization of ideas, concepts, recruitment, etc. should be possible and encouraged. Molecular-based “omics” (genomics, proteomics, metabalomics, etc.) will be critical to Nebraska as well as the nation and there should be excellent federal grant support to buttress more local investments, especially as they address other fundamental issues, including several listed in this report. Establishing a niche for which Nebraska is known is a sound strategy in an era where no one institution can be known for all things.

**Food Safety (*E. coli* O157)**

Food safety issues are an ongoing public concern heightened by multiple breaches in our public food supply in recent years. For example, an outbreak of *E. coli* O157 impacted a beef processing plant in Nebraska. The Department of Food Science and Technology in IANR has made food safety a priority, especially for post-harvest foods. They have invested $1.5 million in a unique pathogen-challenging food processing pilot laboratory. Further, IANR has prioritized a position in rumen microbiology in the Animal Science Department to address *E. coli* O157 ecology and management, principally through nutrition management (high fiber diets reportedly suppress *E. coli* in the rumen whereas *E. coli* populations are enhanced in low fiber, starch rich corn-based diets). Food safety issues will continue to be a reality for our food supply and distribution systems that move food long distances, often across international borders, for consumption. The *E. coli* target has already galvanized several faculty members to work together following a $1.25 million investment over five years by the State of Nebraska and this can be further leveraged as food safety will continue to be a national priority for research. Others faculty from across UNL should be key contributors to this broad initiative.

**Stress Biology/Climate Change/Water**

Climate change, water, and stress biology are of critical importance to society and are consequently becoming highly fundable at the federal level (e.g., NSF and USDA). Climate change is likely to have profound and wide-ranging effects on biological and agricultural systems. To understand the magnitude of these effects, consider that by the time a grower passes his operation to a grandchild that farm or ranch may well be in a different climate zone than it is today. The state of Nebraska, with its diversity of agricultural systems ranging from rain-fed to irrigated to dry land systems, is well positioned geographically to contribute to the world-wide challenges of developing productive and sustainable agricultural systems in a world with less available water. Climate change also creates stress on biological systems by changing average (as well as maxima and minima) temperatures and rainfall and weather patterns in general. These changes will have impacts on both managed and natural ecosystems, for example, by allowing existing pests to thrive and permitting new pests to migrate into Nebraska.

These challenges provide numerous opportunities for both basic and applied research. For example, can corn be developed that is more efficient in its water utilization? Can livestock be developed that are productive at high temperatures? Can climate-driven changes in species composition in range ecosystems be managed to promote sustainable livestock production?

The review team was not able to meet with UNL scientists who currently work in these areas, but we note that there is an existing Water Center (Dr. Kyle Hoagland was unable to meet with us) and that UNL is already a leader in the development of low-input turf grasses (viz. new cultivars of buffalo grass). In addition, Center for Plant Science Innovation, in partnership with the Department of Agronomy and Horticulture, would be well positioned to conduct both basic and applied research on plant stress and adaptation to climate change. The existing transformation facility, led by Dr. Tom Clemente, would allow UNL scientists to develop transgenic crops that are better able to resist climate-driven stress. The dedicated Plant Biotechnology Field Facility with its one mile of isolation from neighbors may be unique among

land-grant universities and offers UNL researchers unparalleled opportunities to field test newly developed transgenic crops. Similar opportunities are presumably available in livestock research at UNL.

**Biomaterials/Biosystems Engineering**

The Biological Systems Engineering Department at the University of Nebraska-Lincoln has undergone a dramatic transformation in the past several years. We met several outstanding young faculty members who were pushing back the frontiers in biosystems engineering. Of note, this would be a great opportunity for this particular department, which from a curricular standpoint is already joint with the College of Engineering, to further develop research collaborations. Anecdotally, the team was advised that within the Department of Chemical and Biomolecular Engineering there were six NIH grants, which bodes well for this type of collaboration between Biological Systems Engineering and Chemical and Biomolecular Engineering. Also, Biological Systems Engineering relates very closely to work ongoing in the Center for Biotechnology and other locations on the UNL campus where modern biology is being practiced. Thus, the interaction between IANR in Biological Systems Engineering and the College of Engineering is an important focal point for future development at the University of Nebraska–Lincoln.

**The Nebraska Center for Energy Sciences Research**

This appears to be a very large initiative led by Ken Cassman and involving a wide range of scientists with expertise that ranges broadly over areas that include irrigation science, power usage, all the way to crop improvement. As such, it has the potential to enhance interactive science on the UNL campuses. It also aims to address some of the most important issues facing agriculture in Nebraska today---the challenges of increased demands for water and energy coupled with the increasing prices of energy and uncertainties caused by climate change. The importance of these issues suggests that every effort should be made to ensure success of this initiative.

Thus, it was unfortunate that the team did not have a chance to interact directly with Cassman or other key members of this large effort. Our assessment therefore is only based upon our understanding of how important the topic is to agriculture in Nebraska, our own knowledge of the topic, and what we could learn from the website for the initiative. Based upon this limited assessment, the key strengths appear to be that the center is indeed focusing on the issues of how energy and water intersect and is apparently getting good support from the state through contributions from various sources, including the power sector.

One possibly worrisome aspect is that we could find no evidence that the center has any direct support from the Department of Energy (DOE) nor does it appear to be involved as a partner in any of the other large initiatives across a wide range of U.S. campuses that are supported by DOE. Since the major source of support for biofuels research is coming from DOE and one can project even more to come based upon the current administration's strong support for energy research, this is indeed worrisome. Also, one other possible worry is that many in the field are not promoting corn as a major biofuels crop. Certainly, the major current approach of

conversion of corn starch to ethanol yields only marginal gains in terms of energy when all factors are considered. Even if the efficiency of conversion of the cellulosic residues to sugar or other fuel feedstocks could enhance the energy conversion factors for corn (not an area researched by this center), a significant portion of the residues for corn needs to be returned to the field to maintain soil quality. Adding to this is strong competition between use of corn for fuel and for food. Because the leader of the effort seems to be a strong promoter of corn as a biofuel crop and the pressure that the center may get from Nebraska in general to promote use of corn, one has to question how this may lead the center to pursue objectives that are not in line with most of the other thinking on biofuels. It would seem that other approaches should be considered and provided emphasis as this important initiative moves forward.

**Microbiology/Virology**

Although difficult to assess the true effectiveness of these programs, the institute and the College of Arts and Sciences have both indicated that microbiology and virology represents an area of collaboration and synergy across IANR and the School of Biological Sciences (SBS). During conversations with both SBS and IANR faculty, there was concurrence on the need to develop an interdisciplinary microbiology degree program at the undergraduate level.

We did find the website for the Microbiology Initiative (http://www.microbiology.unl.edu/), labeled as a "Program of Excellence" that listed faculty from several departments who are identified as part of the program. There are currently 45 faculty members from SBS, Chemistry in Arts and Sciences, Chemical and Biomedical Engineering, and six departments in IANR. This is an impressive cadre of scientists studying everything from microbial genetics, industrial and environmental microbiology, plant pathology, food microbiology, veterinary and biomedical microbiology, physiology, genomics and proteomics, and mycology. Members of this group are also part of other centers: the Nebraska Center for Virology, the Center for Plant Science Innovation, and the Redox Biology Center. Of the 45 scientists in the Microbiology Initiative, 12 are also part of the Nebraska Center for Virology, providing strong cross-disciplinary expertise there as well. Campus support for microbiology appears to be quite good with a number of core facilities available across departmental lines.

There are 27 IANR faculty involved in the Microbiology Initiative, indicating a strong commitment to this area by the institute. Information from the IANR administration indicated that the Gut Function Initiative (see below) is also of importance, and this will potentially add a ruminant microbiologist in the future.

The team had the opportunity to meet with Dr. Charles Wood to discuss the Nebraska Center for Virology, but the format did not leave much time for in-depth discussions. It is clear, however, that this center has attracted many scientists across the University of Nebraska campuses, including several from IANR. Since its inception from a COBRE grant, it has attracted several new faculty to the University of Nebraska system. One weakness of the Nebraska Center for Virology is stable funding for support. There was an indication that there are no central funds available for technical or support staff, which may hamper the program as it moves forward beyond the limits of the original funding. There will be a clear need to evaluate the success of the program to determine how it will continue to operate in the future.

The team encourages the continued facilitation of communication among this group of scientists to advance microbiology and virology as a strength in the molecular life sciences. The creation of a new undergraduate program in microbiology, across disciplinary lines, should provide more opportunities for collaboration in research and education. There is already a good graduate program, and the development of the B.S. makes good educational sense. It is our understanding that outlines of this microbiology degree program exist. The vice-chancellor for IANR and the senior vice chancellor for academic affairs should make this a priority and facilitate the creation of this multi-disciplinary research and education group. A strong undergraduate degree in microbiology would complement the existing biochemistry program as well.

**The Gut Function Initiative**

One of the most promising new spires the team recognized was the relatively new Gut Function Initiative, which offers real promise for fruitful collaborations among scientists in the agricultural and health communities. The team had the opportunity to meet directly with two of the young scientists (Andy Benson and Daniel Peterson) who will play key roles in this effort along with about 10 other faculty from several departments and colleges. This initiative will rely upon several very sophisticated new technologies, including exploiting the new field of metagenomics that involves very high throughput sequencing of the combined DNA derived from the huge, largely uncharacterized array of microbes found in the guts of humans and animals. This approach will be combined with sophisticated bioinformatics to analyze the resulting DNA sequences and identify key microbial populations. Benson impressed us as a very dynamic young man who will lead this part of the effort. Also impressive was Peterson, who will lead a complementary effort employing germ-free mice to systematically add back individual species of gut microbes to determine how they may play roles in many key diseases/traits such as obesity, diabetes, bowel disorder syndromes, allergies, etc. This is the type of groundbreaking research that addresses the possible origins of human (and animal) disorders of great prominence these days and is highly favored at NIH. For this reason, the project with the type of talent we met should have no trouble gaining substantial funding for this effort. The effort could also have strong overlap with other campus efforts in food safety (e.g., studies on virulent *E. coli* strains and other studies on food allergens) and on the microbiology and nutrigenomics initiatives, the latter of which has the potential to modify foods that express key allergens.

**<u>Implementation</u>**

Ohio State University, the University of Arizona, and the University of Missouri have approaches to enhance university collaboration in the molecular life sciences. These examples are provided for consideration.

**BIO5 Model/University of Arizona**

At the University of Arizona, an institute called BIO5 was established. BIO5 has a director, several staff members to handle its business, a board of directors composed of five deans

(agriculture and life sciences, science, medicine, pharmacy, and engineering), a steering committee of senior faculty, and an outside advisory board composed of industry leaders in the life sciences. Of great importance, BIO5 is funded by approximately $5 million of money which "does not have tenure," i.e., it is used on an annual basis to fund important life sciences initiatives such as faculty salaries for two to three years, start-up money, facilities, and other projects that do not require continuing money. Hence, the partnership between colleges, departments, and BIO5 is critical to the success of this institute.

For example, consider an initiative within the University of Arizona's College of Agriculture and Life Sciences (CALS). The faculty steering committee recommended to the director of BIO5 that we needed to hire a new individual in plant molecular biology. The director of BIO5, in consultation with the dean of CALS, would work out an arrangement in which BIO5 would provide salary for two years, start-up money, renovation of space, and other non-continuing budget issues. At the end of the two-year period, the dean of CALS and the Department of Plant Sciences would be responsible for the entire faculty salary including any other personnel issues that would be of a continuing nature, i.e., technicians, graduate students, etc. This would free up the BIO5 funds for use in other parts of the university. Hence, the money in BIO5 rotates, with some money always being available for new initiatives on an annual basis. Like Missouri, BIO5 has a new building to promote these collaborative arrangements.

**Bond Life Sciences Center/University of Missouri**

Buildings do not ensure scientific creativity, but, if planned properly, they can encourage, even promote, inventiveness and productivity by bringing together groups of like-minded investigators and allowing vertical interactions that drive cross-disciplinary endeavors. Advantages of a well-designed life sciences building include:

- provide home space for groups of scientists from different departments pursuing common, long-term goals;
- allow such groups/centers to operate away from departmental restrictions;
- relieve space constraints;
- attractive space for recruiting new investigators to the institution; and
- optimal for promoting cross-disciplinary collaboration.

There are several models that could be used for developing the building concept to ensure the "buy in" of the various colleges and departments, usually by providing limited-time salary support to investigators and space predicated on continued productivity and ability to collaborate. At the University of Missouri the Bond Life Sciences Center was intentionally built on central campus. In addition to containing wet labs and designed space for computational biologists, it houses undergraduate teaching laboratories and the Office of Undergraduate Research. Groups were established in the building based on competitive "white papers" from multi-departmental groups and led by one or more senior investigators. No departments are housed within the building and investigators are not guaranteed permanent station; in fact, faculty rotations are desired. The director of the building reports to the Office of Research, and the building depends for a high percentage of its budget on a fraction of the F&A "earned" by its faculty and salary

savings on grants (with appropriate incentives for faculty to win grant support). The model might be similar to Nebraska's concept for Beadle II.

**Ohio Centers of Excellence Model**

Nebraska has examples of incentives for research, especially through white paper exercises that faculty described during our visit as well as examples described by Vice Chancellor for Research and Economic Development Prem Paul. Ohio State University has found incentives to work both at the college and the university level.

At the college level, two programs have been utilized, a SEEDS program and a Centers for Innovation program to impact culture as well as to leverage resources. SEEDS is a competitive program where individual faculty ($50,000 grant limit) or small faculty clusters ($100,000 limit) can generate initial data to make them more competitive for federal grant support or to put them in alignment with state industry or commodity needs on a match basis. SEEDS outcomes include a $5 extramural investment for every $1 of state monies invested and glossy one-pagers written in lay language to explain research objectives and accomplishments. The latter can be used in multiple ways but are excellent vehicles for communicating with budget decision-makers on how research dollars are being utilized. The Centers of Innovation are focused on cluster themes where discoveries with intellectual property implications have been made and groups of faculty can/will come together to develop the theme (e.g., "Center for Advanced Functional Foods Research and Entrepreneurship" or CAFFRE). In response to requests for proposals, faculty groups develop white papers and make short presentations to a panel, funding is $150,000-$300,000 over two years with renewals based on progress. Leadership is expected from our equivalent of IANR but participation and co-leadership from other colleges is encouraged (CAFFRE involves faculty and leadership from three colleges). More recently, the university has been identifying central themes through white paper exercises to identify college priorities as well as faculty clusters of excellence; the Centers for Innovation have been a critical element in the alignment of college programs and resources with university priorities and research strengths.

**Core Life Sciences Curriculum**

The long-awaited report of the National Academy of Sciences should serve as a starting point for curricular review and revision throughout the land-grant university system. The administration of the College of Agricultural Science and Natural Resources (CASNR) at UNL has prepared a preliminary document that will serve to guide the process. To that end, a critical examination of the core life sciences curriculum in CASNR is timely.

From the documents provided for the review, it was noted that there is a vast array of undergraduate majors and specializations in CASNR, several with very low student enrollments. One step in revising the life sciences core could be to consolidate majors and specializations and then create a meaningful and appropriate life sciences core. After careful examination of the majors and the intended outcomes (what happens to students after graduation), there could be proposed two "core" life sciences tracks: one for majors where students will enter

graduate/professional school or obtain employment in high-science fields and one for majors where students will enter the workforce or continue to graduate school in other fields.

Apparently, the current system of advising is utilized to place students into the "right" life sciences courses. While faculty advising is a valuable tool, the opportunity exists for students to be misdirected into life sciences courses that do not prepare them for advanced courses in science and their major nor for advanced study. Advising should help students select the appropriate life sciences core track of courses rather than allow a student to choose from a variety of non-equivalent, perhaps less rigorous, course options.

Discussions within CASNR and with Arts and Sciences administrators hinted fairly strongly that there is mistrust and a lack of respect between the two faculty groups. The perception in Arts and Sciences is that CASNR students do not perform as well as other UNL students. Data were presented to back up the claim, but the data are seriously flawed. Additionally, a claim was made that CASNR faculty do not teach the life sciences as well as Arts and Sciences faculty, a claim that was not substantiated in any way. The team was not provided with teaching evaluations or other data to support this assertion. In the absence of a singular provost for all academic programming, it is imperative that the vice chancellor for IANR and the senior vice chancellor for academic affairs work together to address these important issues. Further, CASNR faculty indicated that spaces in life sciences courses are limited; selected CASNR faculty could be called upon to teach core life sciences courses (not for only CASNR students) to help alleviate the demand issues. Indeed, one young faculty member from CASNR indicated that he would like to teach freshman biology but has not been permitted to do so.

An additional opportunity for cooperation between CASNR and Arts and Sciences exists in terms of a microbiology major for students in both colleges. Such a major could also be central to the core life sciences curriculum in both colleges.

To move forward expeditiously, a carefully selected faculty task force with representation from the College of Arts and Sciences and CASNR should be established to determine the needs of students in all majors and then create no more than two core life sciences tracks that address the needs of the students' educational and career aspirations. We should also note that some members of the team noted that in many universities it has been possible to design a single core curriculum that met the needs of all students in science and science-related disciplines, and we would not want to rule out exploring this option as well. The two vice chancellors must assume leadership for ensuring that the faculty task force moves beyond the historical limitations of joint work and cooperation.

**Faculty Evaluation and Advancement**

An issue continually brought up by the faculty and some of the administrators, particularly in the City Campus of UNL, was the lack of any uniform university-wide faculty evaluation and advancements procedures. For example, some departments within IANR and most departments within the College of Arts and Sciences use outside letters of evaluation as an important part of the promotion and tenure process; others do not, and they are not required across the entire university. Consequently, we recommend that the senior vice chancellor for academic affairs

and the vice chancellor for IANR agree to develop uniform university-wide faculty evaluations that involve outside peer review of faculty performance. The team was unanimous in its belief that no university in this day and age can achieve excellence without the promotion of very high performance standards for its faculty and that one important measure of achievement must include rigorous peer review that includes letters of evaluation from respected members of the broader scientific community. The procedures would obviously involve department heads, senior faculty, and shared faculty governance to make this a workable university-wide procedure.

**Core Facilities**

Core facilities benefit from having an intellectual component (faculty leadership along with a skilled, service-oriented manager) and state-of-the-art equipment to allow faculty to go beyond their own limitations in terms of techniques and available equipment to conduct research. To that end, it is highly laudable that, according to Vice Chancellor Paul, some $12 million annually is available for support of research core facilities. The administrators of IANR indicated that core facilities at UNL are excellent. However, there are some key issues that should be addressed that include:

- the need to avoid wasting resources by using funds to duplicate equipment available in some underutilized cores;
- lack of coordination in purchase of expensive equipment;
- failure to make equipment in some cores accessible to all faculty, especially those faculty not in the "original club" that recommended purchase of key equipment;
- the need for consideration of distance between primary users and location of cores to minimize inconvenience;
- a mechanism to integrate new equipment into an existing core to ensure that hard money funding is available to support service activities; and
- a web site under the vice chancellor for research and economic development that lists every core facility, specialized equipment, and describes services, costs, and availability of each for use by all faculty of UNL.

**There is an urgent need to address the following core issues by implementing a process to provide for**:

***Bioinformatics/computational biology*** that engages faculty in various disciplines, including computer sciences, electrical engineering, mathematics, and statistics to evaluate large amounts of data from genome analyses to advance all aspects of life sciences efforts to understand the genetic basis for differences among individuals in their growth and development, reproductive potential, response to environmental factors, and resistance to disease and parasites.

***Laboratory Animal Research Resources core*** (LARR) for research with rodents is critical to many faculty and programs at UNL; however, its major deficiencies include:

- inadequate clean "quality" space especially for transgenic animals;
- lack of an attending veterinarian and veterinary technicians;
- excessive costs per cage;

- lack of a “Genetically Engineered Mouse” service to produce mice with genes knocked out or knocked in; and
- lack of a LARR director.

It cannot be over-emphasized that without a commitment to improving small animal facilities at the University of Nebraska–Lincoln, the ability of the university and its life sciences colleges to hire and retain faculty will be severely compromised.