

**COORDINATING COMMISSION
FOR POSTSECONDARY EDUCATION**

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PROPOSAL FOR NEW INSTRUCTIONAL PROGRAM
Form 92-40

SECTION I

Institution Submitting Proposal: University of Nebraska-Lincoln

Title of Program: PhD in Complex Biosystems

CIP Codes: 01.9999 (Agriculture, Agriculture operations, and related sciences, other)
14.9999 (Engineering, other)
26.9999 (Biological and biomedical sciences, other)
27.9999 (Mathematics and Statistics, other)
40.0599 (Chemistry, other)
30.9999 (Multi/interdisciplinary studies, other)

Organizational Unit in which program will be located:

Office of Graduate Studies

Name of contact person in the event additional information is needed: Dr. Susan M. Fritz

Telephone: 402-472-5242

Degree, Diploma, or Certificate to be offered (use separate submittal for each level):

PhD in Complex Biosystems

Proposed date to initiate program: When approved by the Coordinating Commission

List the location(s) where this program will be offered: UNL

If the program has a projected ending date, please so indicate:

Date approved by Governing Board: July 22, 2016

(Attach all documents related to this proposal upon which the Governing Board made its decision to approve the proposal.)

Chief Executive Officer's or other Authorized Officer's signature: _____


Susan M. Fritz

TO: The Board of Regents Addendum VII-A-1
Academic Affairs

MEETING DATE: July 22, 2016

SUBJECT: Creation of the Doctor of Philosophy (PhD) in Complex Biosystems administered by the Office of Graduate Studies at the University of Nebraska-Lincoln (UNL)

RECOMMENDED ACTION: Approval is requested to create the PhD in Complex Biosystems administered by the Office of Graduate Studies at UNL

PREVIOUS ACTION: None

EXPLANATION: The PhD Program in Complex Biosystems is directed toward students interested in applying quantitative statistical and computational approaches to data acquisition and analysis in multiple life sciences fields. In addition to scientific communication skills and ethical research conduct, students acquire a foundation in population, cellular and molecular life sciences; statistics; bioinformatics; and computational analysis. Following the first year, each student pursues a training specialization within this multidisciplinary program which will involve over 100 faculty in 21 departments or centers across four colleges.

Advantages to the student include the breadth of choices available for research projects and an interdisciplinary educational approach, which add value by enhancing their perspective and breadth of knowledge in the life sciences. Advantages to participating faculty include the marketing appeal of a cutting edge "big data"-oriented program to students of exceptional quality who may not otherwise apply to UNL, and placing UNL's community of "big data" researchers in the life sciences within the context of the program's research and training activities.

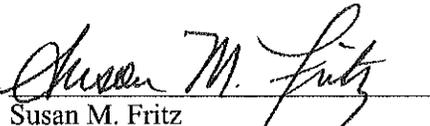
This proposal has been approved by the Executive Graduate Council and the Council of Academic Officers. This proposal also has been reviewed and recommended for approval by the Academic Affairs Committee.

PROGRAM COST: \$296,237 Year 1; \$1,496,500 over five years

SOURCE OF FUNDS: Cash and Revolving Funds: annual budget will be shared by the Office of Research (\$50,000); Senior Vice Chancellor for Academic Affairs (\$100,000); and Institute of Agriculture and Natural Resources (\$150,000)

SPONSORS: Marjorie Kostelnik
Interim Senior Vice Chancellor for Academic Affairs

Ronnie Green, Chancellor
University of Nebraska-Lincoln

RECOMMENDED: 
Susan M. Fritz
Executive Vice President and Provost

DATE: June 30, 2016

Proposal for PhD in Complex Biosystems

Proposal for PhD in Complex Biosystems

I. Descriptive Information

Institution: University of Nebraska – Lincoln (UNL)

Program name: Complex Biosystems Graduate Program

Degree to be awarded: PhD

Other programs offered in this field by this institution: The University of Nebraska – Lincoln offers no other program of study in the field of Complex Biosystems.

CIP codes: 01.9999 (Agriculture, Agriculture operations, and related sciences, other); 14.9999 (Engineering, other); 26.9999 (Biological and biomedical sciences, other); 27.9999 (Mathematics and Statistics, other); 40.0599 (Chemistry, other); 30.9999 (Multi/interdisciplinary studies, other)

Administrative unit for the program: Office of Graduate Studies

Proposed delivery site: University of Nebraska – Lincoln

Date approved by governing board:

Proposed date the program will be initiated: Upon approval

Description and purpose of the proposed program:

Description: The PhD Program in Complex Biosystems is directed toward students interested in applying quantitative statistical and computational approaches to data acquisition and analysis in multiple life sciences fields. In this interdisciplinary program, graduate students participate in a full year of research rotations (three total) on diverse topics, with one semester of laboratory teaching experience. In the first year of study, students consider “big questions” in the life sciences, and learn current technical and analytical approaches to address them. In addition to scientific communication skills and ethical research conduct, students acquire a foundation in population, cellular and molecular life sciences; statistics; bioinformatics; and computational analysis. Following the first year, each student pursues a training specialization within the Complex Biosystems Program.

Advantages to the student include the breadth of choices available for research projects and an interdisciplinary educational approach, which add value by enhancing their perspective and breadth of knowledge in the life sciences. Advantages to participating faculty include the marketing appeal of a cutting edge “big data”-oriented program to students of exceptional quality who may not otherwise apply to UNL, and nucleating UNL’s community of “big data” researchers in the life sciences within the context of the program’s research and training activities.

Purpose: *to build and support a cohort of students trained in acquisition and analysis of large, systems-level datasets in life science research.* Students will become broadly conversant in a variety of research disciplines and specifically trained to apply quantitative or high throughput approaches to data analysis, which is increasingly demanded in contemporary research. The training curriculum and activities are designed to produce highly competent professionals with strong skills in communication, collaboration, and team building, which are needed for success in government, academic, private sector, or other scientific workforces.

Relationship to other programs: The integrated programmatic emphasis on systems-level data interpretation and experimental design in a variety of cellular, organismal, and population systems is entirely novel. The first year Biosystems Research I and II courses are newly developed and unique to the program. The program will also capitalize on integration of existing courses from multiple disciplines to meet unique student curricular needs, which is not a feature of many of the programs offered by UNL.

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Administration: The Office of Graduate Studies will administer the program and provide administrative support. The specific degree requirements will be defined and approved by the student's individual supervisory committee. The program director and coordinating committee will oversee progress through the degree program and assess efficacy of outcomes (see Appendix A for administrative structure and operating guidelines of the program).

Proposed program: An overview of the Complex Biosystems program features is provided in Appendix B and summarized below.

- **Core course requirements**
 - Biosystems Research I (3 credit hours)
 - Biosystems Research II (3 credit hours)
 - Statistics 801 or equivalent (4 credit hours)
 - Professional Development (1 credit hour)
 - Biotechnology instrumentation short course (1 credit hour)
- **Mandatory specialization**

To earn the degree, each student will enter a program of studies approved by his/her supervisory committee within one of the Complex Biosystems specializations. Currently, these specializations are (1) Systems analysis; (2) Integrated plant biology; (3) Pathobiology and biomedical science; (4) Microbial interactions; and (5) Computational Organismal Biology, Ecology, and Evolution (COBEE). The specializations are designed to complete a minimum of 35 hours of formal graduate coursework (including the required courses above), consistent with requirements for a PhD degree set by the Office of Graduate Studies.
- **Teaching**

Each student will complete one semester of teaching within the first year, either in LIFE 120 Lab or LIFE 121 Lab as needed. Approximately half of the students will teach in the fall and the remainder will teach in the spring.
- **Research requirements**

Students complete two semesters of research rotation in the first year (three total rotations for 6 credit hours total). One rotation will span the full semester that the student is teaching. The other two rotations will be completed in two 8-week blocks during the semester the student is not teaching. Upon entering their respective specializations, students will complete an additional minimum of 55 hours of dissertation research.
- **Comprehensive examinations**

All students will complete a written and oral examination at least seven months before applying to graduate. The format of the written examination will consist of an original research proposal in a style and on a topic approved by the supervisory committee. The oral examination will consist of a defense of the proposal and concepts important to the student's demonstration of interdisciplinary scientific knowledge.
- **External proposal submission**

Each student in the program will be required to identify an external fellowship opportunity and work with the program director(s) and coordinating committee to develop and submit a proposal. In the case of National Science Foundation fellowships, the proposal will be submitted in the first year. For other agencies, the specific agency requirements will be followed and the proposal will be submitted with support from the student's research advisor as sponsor, and advice or critical review as needed from the supervisory committee.
- **Dissertation, final oral examination, and public seminar**

All students will complete a written dissertation describing their original graduate research. Students will present a public seminar summarizing their research, and will defend the research in a final oral examination before the supervisory committee.

II. Review Criteria

A. Centrality to Role and Mission.

The mission statement of the University of Nebraska – Lincoln states that “The University of Nebraska–Lincoln, chartered by the Legislature in 1869, is that part of the University of Nebraska system which serves as both the land-grant and the comprehensive public University for the State of Nebraska... The University of Nebraska–Lincoln has been recognized by the Legislature as the primary research and doctoral degree granting institution in the state for fields outside the health professions.”

The proposed program in Complex Biosystems is consistent with the University's role and mission by providing PhD training in a rapidly expanding research area that challenges students to integrate skills in quantitative computational methods with in-depth knowledge of basic and applied physical and life science concepts. These students will advance the cutting edge of research in their fields by promoting collaboration and a culture of team science, developing new and innovative solutions to existing global challenges, and contributing to paradigm-shifting discoveries more rapidly achieved by team science.

B. Evidence of Need and Demand

1. Need for the program: over 100 faculty in 20 departments, schools, and centers, housed within 4 colleges at UNL have indicated an interest and a need for students trained in Complex Biosystems research (see Appendix C).

The National Science Foundation¹, the National Institutes of Health², and other agencies have compiled statistics on workforce development that indicate over 60% of graduates in science, technology, engineering, and math (STEM) fields enter non-academic positions following completion of their PhD degree. The outcomes demographic emphasizes a need to train students in a more holistic manner that prepares them for the diverse career options they will face, and training programs supported by these agencies emphasize the need to be attentive to advances in research approaches.

The most rapidly expanding demand within STEM graduate training not currently represented at UNL is in the area of quantitative biosystems-level research. This is broadly defined as use of statistical analysis and computational models, coupled with high throughput experimental design that permits simultaneous collection of highly complex data, to quantify and/or quantitatively interpret responses within whole systems³. Publication rates in this field have increased more than four-fold per year over the past ten years⁴. A survey of the Nebraska Bureau of Labor statistics on job classifications that require doctoral or professional degrees shows recent growth ranging from 6.7% to 16.4% in the computational life sciences research and postsecondary education professions, with continued 10-year projected growth⁵.

Although there is currently an interdisciplinary specialization offered in Bioinformatics at UNL, this specialization is not well utilized by students and faculty, partly because the student still completes a program of study mandated by the discipline-based home graduate program of their mentor. In addition, Bioinformatics as a national and global training emphasis has undergone a significant redefinition within the past five years, as evidenced by notable change in terminology to “Systems Biology”⁶, and by radical increase in the number of researchers at UNL and the scientific community, who now self-identify as systems biologists. Thus, the proposed program is a needed advance to maintain global competitiveness of our university and our students in this contemporary workforce. The expansion of coursework and emphasis on interdisciplinary team-oriented research projects, with training in proposal writing, teaching, and quantitative research methods, will better prepare students trained by UNL in this fundamentally different approach to research to be competitive in meeting changing global needs.

2. Demand for the program: within only six weeks of the program's tentative pilot as an interdisciplinary specialization in Complex Biosystems, we had 22 applications. Of these,

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12 were highly qualified students brought to campus for interviews, and ten were deemed worthy of admission. A survey of these students revealed that they applied to UNL specifically because of this program. Based on this success, we expect to have at least 12 qualified students per year enroll in the program in future years.

The flexibility of the program and its broad interdisciplinary emphasis with a focus on use of high throughput approaches and large dataset analysis is expected to be uniquely attractive to students who do not currently enroll at UNL. Each of the participating departments and schools has a strong discipline-based graduate program from which they draw their current students. A conservative estimate based on the number of faculty mentors participating in the program who indicate a need for students that specialize in large dataset analysis suggests the Complex Biosystems program will have an ongoing enrollment of 12 students per year. Since research emphasis in this field is likely to expand rapidly as the program grows, the number of participating students is expected to increase as additional funds become available.

¹ National Science Foundation, National Center for Science and Engineering Statistics *Unemployment among Doctoral Scientists and Engineers Remained Below the National Average in 2013* Arlington, VA (NSF 14-317) [September 2014]

² Investing in the Future: National Institute of General Medical Sciences Strategic Plan for Biomedical and Behavioral Research. (2011). <http://publications.nigms.nih.gov/trainingstrategicplan/>

³ Vladimir A. Likić, Malcolm J. McConville, Trevor Lithgow, and Antony Bacic, "Systems Biology: The Next Frontier for Bioinformatics," *Advances in Bioinformatics*, vol. 2010, Article ID 268925, 10 pages, 2010.

⁴ Hübner, K., Sahle, S. and Kummer, U. (2011), Applications and trends in systems biology in biochemistry. *FEBS Journal*, 278: 2767–2857.

⁵ http://www.bls.gov/emp/ep_table_102.htm

⁶ Ouzounis CA (2012) Rise and Demise of Bioinformatics? *Promise and Progress*. *PLoS Comput Biol* 8(4): e1002487.

C. Adequacy of Resources.

1. **Faculty and Staff Resources.** No new faculty positions will be required to carry out this degree program, which is designed to support existing faculty within disciplines as well as newly hired faculty whose expertise bridges the more traditional research areas. Some redirection of efforts in the Office of Graduate Studies have been done to implement the degree program, by assigning Hollie Swanson to the position of administrative assistant to the program (0.5 FTE).
2. **Physical Facilities.** Students enrolled in this program will take courses at UNL and serve as teaching assistants within laboratories at UNL. They will participate in original research at UNL or other sites as required by the nature of their original research and with support by funds through the primary research mentor's program. Computational, library, office, and conference space are available at UNL. No new physical facilities are required for the proposed program.
3. **Instructional Equipment and Informational Resources.** No additional equipment or resources are needed for the program.
4. **Budget Projections.** Funding for five years of the program has been secured through shared commitments by the Office of the Chancellor, the Vice Chancellor for Research, and the Vice Chancellor of the Institute of Agriculture and Natural Resources. Details of the operating budget and projected revenue are provided in Tables 1 and 2, respectively. We expect that at steady state, approximately 12 more students per year will be recruited to UNL, bringing revenue in the form of tuition dollars. Also, with the expectation for external proposal submission by all students and a projected funding rate of 1 in 10 for students applying for external fellowships, we expect to increase graduate student support within our program by 10%. Moreover, the emphasis on interdisciplinary training is expected to increase collaborative grant submission by participating faculty, leading to increased potential for research assistantships to bolster the student admission numbers.

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D. Avoidance of Unnecessary Duplication.

The proposed program in Complex Biosystems is the only graduate program offered in the state of Nebraska or among the members of the Midwest Higher Education Compact that is focused on systems-oriented studies within a broad range of biological, biomolecular, and physical systems. The only other program of that name currently offered in the United States is at the University of Michigan. The proposed program is distinct and unique in (1) featuring a flexible curriculum that students and their research mentors tailor to their individual research needs; (2) providing an opportunity to broadly survey the scope of systems ranging from animal, plant, and microbe to cellular, molecular and chemical before choosing a research focus; and (3) infusing a strong emphasis on quantitative statistical and computational approaches to data analysis required for interpretation of large-scale experimental datasets.

E. Consistency with the *Comprehensive Statewide Plan for Postsecondary Education*.

The proposed program in Complex Biosystems will support the following goals for meeting the needs of both students and the state, in an economically efficient and broadly accessible manner, as articulated in the *Comprehensive Statewide Plan*.

1. Meeting the needs of students:

- a. Nebraska's postsecondary institutions will be student-centered and will offer lifelong learning opportunities that are responsive to students' needs.
- b. Postsecondary education institutions will provide appropriate support services to help all students reach their educational goals, regardless of where or how the instruction is delivered.
- c. Nebraska colleges and universities will provide their graduates with the skills and knowledge needed to succeed as capable employees and responsible citizens.

2. Meeting the needs of the state:

- a. Higher education in Nebraska will be responsive to the workforce development and ongoing training needs of employers and industries to sustain a knowledgeable, trained and skilled workforce in both rural and urban areas of the state.
- b. Institutions will contribute to the health and prosperity of the people and to the vitality of the state through research and development efforts, technology transfer and technical assistance, and by attracting external funds to support these activities.
- c. Higher education will serve the state by preparing individuals for productive, fulfilling lives and by developing and nurturing the citizens and future leaders of Nebraska.
- d. Postsecondary education institutions will assess evolving needs and priorities in a timely manner and will be prepared to change and adopt new methods and technologies to address the evolving needs and priorities of the students and people of Nebraska.

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Appendix A: Administrative structure and operating guidelines for the proposed program

Administrative structure

Director

The Complex Biosystems Program Director(s) will oversee and administer all aspects of the program, including budget, progress, training, recruitment, outcomes, curriculum, with input from the Administrative Advisory Committee, Coordinating Committee, and the Admissions and Recruitment committee. The Director(s) will be elected by faculty participating in the program, with recommendations from the previous Director(s) and members of the committees. The founding committee members agreed that co-direction of the program is most effective if shared by two individuals with respective expertise in computational work and laboratory/field research.

Committees

Committees within the Complex Biosystems Program will facilitate communication among deans, directors, heads, and chairs, and provide an organizational structure for the management of program activities.

Administrative Advisory Committee: This committee includes deans, directors and department heads or chairs with faculty members in any of the Complex Biosystems Program specializations. They communicate with the Complex Biosystems Program Director(s), Coordinating Committee, Office of Graduate Studies, and the Senior Vice Chancellor for Academic Affairs, and coordinate shared research and teaching efforts. The role of this committee is to support the participating faculty and provide perspective on the integration of the program. Particularly in the event that a faculty mentor loses funding, the respective unit administrators may be called upon to assist in supporting a student within the program, through teaching assistantship or other means. Their vested participation is important.

Coordinating Committee: This committee works directly with the Complex Biosystems Program Director(s), and is initially responsible for developing the first year curriculum for students, including new courses on Professionalism in the Life Sciences, and Biosystems Research I and II (see below). The committee will also work with faculty to determine and set appropriate admission requirements for the program given its interdisciplinary nature. In addition, this committee will monitor annual progress of students in the program and overall efficacy of the program in meeting needs of students and faculty. This committee will review proposals for new specializations, assess faculty participation in the program, monitor student quality, progress, publications, success and timely completion of comprehensive examinations, PhD completion rates, average time to graduation, and overall student retention. The committee will consist of one faculty member from each specialization elected by the faculty within the specialization. The committee will internally elect a chair. The representatives will serve three-year staggered terms, and the chair will serve a term of 2-5 years.

Admissions and Recruitment Committee: The committee will organize and coordinate recruitment visits for qualified applicants, monitor efficacy of admission requirements for the program, review applications, and select students for admission, with input from the participating faculty. The committee consists of one member from each of the specializations. It is envisioned that each member will serve approximately a three-year term in a staggered manner to promote continuity long term. The responsibility of this committee is to ensure timely consideration of applicants by convening at regular intervals during the critical periods of applicant processing. This committee will also initially provide program orientation for the students in August prior to the start of classes, and assist them in their research rotation and coursework selections.

Participating Faculty: To be eligible for participation in the Complex Biosystems Program, faculty must be members of the UNL graduate faculty, and are expected to maintain a productive research program that is clearly related to the training mission of the Complex

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Biosystems Program, as documented by grant support, peer-reviewed research publications, and evidence of successful graduate student training or potential as a graduate mentor. Early career investigators will be evaluated for their potential on the basis of their training history and research productivity to date. Faculty membership in the program will initially be evaluated annually by the Coordinating Committee in consultation with each specialization's advisory committee. Faculty members of the specialization will elect the advisory committee, whose sole responsibility will be to advise on faculty membership.

Operating guidelines

Admissions

Applications to the Complex Biosystems Program will be transmitted from the Graduate College to the Admissions and Recruitment Committee as they are received. Applicants will be evaluated on the basis of the letter of application, prior academic performance, Graduate Record Examination, Test of English as a Foreign Language, research experience, and letters of recommendation. Worthy applicants must meet or exceed the academic requirements set by the Admissions and Recruitment Committee, and be supported by two-thirds of its membership. Of particular note is the requirement for STAT 801. There is no specific statistics requirement for admission to the program, but quantitative training will be considered during the admission process. Students lacking preparation will be asked to take appropriate preparatory coursework for any graduate classes to which they enroll, including STAT 801. In the event they have achieved a higher level of statistics mastery than that expected in STAT 801, students will be allowed to bypass the requirement.

Application review will be completed in December and the highest rated candidates will be invited to interview on campus in January/February. Notification of applicants to be interviewed will be made to the program faculty, and on-campus interviews will be coordinated with departmental graduate recruitment programs. The number of candidates invited to interview will be based on funding available to participating faculty; interested faculty must notify the Complex Biosystems Director that they are able to support a new graduate student by the end of the fall semester. If the number of meritorious candidates exceeds funding available to the Program, the Admissions and Recruitment Committee will work with departmental graduate committees to find other options to recruit the student to UNL. Departmental graduate committees may also refer worthy candidates to the Admissions and Recruitment Committee for consideration.

Student support

Students will be supported by the program for rotations during semesters 1 and 2, which constitutes 9 months of their 12-month stipend (currently set at \$26,000). The students will then choose research advisors, who will support the students beginning with summer salary in the first year, and extending through the remainder of their program. Faculty advisors will be asked to demonstrate support for the student for two years, which may derive from a combination of research and teaching assistantships, in consultation with the faculty members' unit administrators. Faculty are encouraged to co-advise students and share costs, both to increase collaboration and to allow more faculty to participate in training. The intent of the program is to provide a research intensive experience for each student to the maximum extent possible.

The program is committed to supporting the success of each student admitted. Funding within the program budget is limited and cannot be explicitly put aside for the purpose of bridging support, but given sufficient notice of impending loss of support for a student, the program will have the flexibility to assist with support on a case by case basis. The faculty mentors' home departments will be the first line of negotiation for alternative support of the student. The program director(s) will involve the respective department chairs or directors when a student chooses mentor(s) in their units, so they will be aware of the potential need to contribute support in the event of a decrease in the mentor's funding. Criteria for consideration will be: 1) satisfactory progress of the student toward degree objectives as measured by GPA of

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3.0 or above, manuscripts in progress or preparation, presentations, participation in program activities, satisfactory completion of teaching, passing comprehensive exams; 2) participation of the faculty mentor(s) in program activities and overall demonstration of strong mentoring; 3) an absence of other funding options; 4) faculty scholarship and grant submission.

Specializations

Criteria for establishing and removing specializations will be discussed in an ongoing manner during annual formative evaluations of the program. At present, we anticipate that such criteria will include: 1) stable average number of applicants ultimately choosing the specialization each year; 2) stable number of faculty identifying with the specialization each year; 3) meeting the changing needs of new and existing faculty for training emphasis areas or additional systems-level studies.

Biosystems Research I and II: course content and staffing

Two courses are proposed for the core of the program's curriculum. Currently, the course directors are Melanie Simpson and Jennifer Clarke, and both courses will be team taught on a voluntary basis by participating faculty members within the program. Content will be rotated annually among instructors and specializations to maintain its cutting edge and expose students most broadly to multiple research perspectives.

Coordinating first-year student external proposal submission

Each student will work with the graduate studies office (currently Dr. Elizabeth Edwards), the instructor of the Professional Skills course (Dr. James Schnable, Agronomy and Horticulture), and the co-Directors (Drs. Simpson and Clarke), to define their original research proposal concept. With their combined assistance, the students are encouraged to seek input from their prospective rotation mentors and/or appropriate faculty with expertise pertaining to the projects. This worked very well in the first year of the program and all students submitted proposals to the NSF for the deadline of October 27, 2015.

Program evaluation

The program director and coordinating committee will meet annually with the administrative advisory committee to summarize progress of the students and discuss aspects of the program. The program will be evaluated for its success in recruiting, enrolling, and retaining excellent students, stimulating faculty research collaboration, coordinating and communicating information about the program, getting students through program milestones in a timely manner, providing teaching assistance in the LIFE laboratory courses, and any other issues that may arise.

Current committee membership

Co-Director, Melanie Simpson (BIOC)

Co-Director, Jennifer Clarke (STAT, FDST)

Office of Graduate Studies Administrative Assistant

Hollie Swanson (0.5 FTE)

Coordinating committee

Melanie Simpson (BIOC), representing Pathobiology/Biomedical Sciences

Jennifer Clarke (STAT, FDST), representing Systems Analysis

Tom Clemente (Ag/Hort), representing Integrated Plant Biology

Paul Blum (SBS), representing Microbial Interactions

Andy Benson (FDST), representing Microbial Interactions

Kristi Montooth (SBS), representing Computational Organismal Biology, Ecology and Evolution

Admissions and Recruitment (in addition to the Coordinating Committee members)*

Amanda Ramer-Tait (FDST), representing Microbial Interactions

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Dan Schachtman (Ag/Hort), representing Microbial Interactions
Rodrigo Franco (VBMS), representing Pathobiology/Biomedical Sciences
Don Becker (BIOC), representing Pathobiology/Biomedical Sciences
Tala Awada (SNR), representing Integrated Plant Biology
James Schnable (Ag/Hort), representing Integrated Plant Biology
Stephen Scott (CSE), representing Systems Analysis
Tomas Helikar (BIOC), representing Systems Analysis
Steven Thomas (SNR), representing Computational Organismal Biology, Ecology and Evolution

Administrative Advisory Committee

Brian Larkins (VC Life Sciences), Mark Riley (BSE), Paul Black (BIOC), John Osterman (SBS), Don Reynolds (VBMS), Henk Viljoen (CBmE), David Berkowitz (CHEM), Larry Berger (ASCI), Gary Brewer (ENTO), Steve Waller (CASNR), Joe Francisco (A&S), Marjorie Kostelnik (CEHS), Rolando Flores (FDST), Tim Carr (NUTR), Judy Walker (MATH), John Carroll (SNR), Jerry Hudgins (EE), Roch Gaussoin (Ag/Hort), Larry Van Tassel (Ag Econ), Bert Clarke (STAT)

* Note that this was the composition of the committee in this inaugural year. The committee will subsequently be reduced to five elected members for the next cycle of admissions, in accord with the description of its composition in the previous section.

The current committees have agreed to serve until the program is fully approved. The inaugural members will have the option to serve again if approved by the membership within the specializations. However, notification of the opportunity to replace a committee representative will be broadly announced in fall 2016 (pending full approval), nominations for additional members will be sought, and an electronic election held to determine the representative for the next term. Three of the founding members will be retained, and three members will be replaced. This procedure will be repeated in the following year to replace up to three members once more, before establishing the regular term rotations specified in the operating procedures.

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Appendix B: An outline of *first year* program activities.

Semester 1		Semester 2	
Rotation 1		Rotation 2	Rotation 3
LIFE 120 teaching assistant*			
Rotation 1	Rotation 2	Rotation 3	
		LIFE 121 teaching assistant*	
Complex Biosystems Graduate Seminar (1 cr, all 4 years) Program faculty research presentations with student evaluation of research publications and a seminar evaluation; as the program is fully implemented in later years, student research presentations and journal club discussions will be integrated into the seminar rotation.			
Professional Development (1 cr) Data analysis and presentation Literature critique Scientific communication: seminars, posters, journal publications and grant proposals Ethics in research and publication Elective course (3-4 cr)		Statistics 801 (4 cr): Statistical methods in research (or appropriate alternative course if student can document equivalent knowledge of statistics) Center for Biotechnology Instrumentation Core Course (1cr)	
<i>Alternatively</i>			
Professional Development (1 cr) Statistics 801 (4 cr): Statistical methods in research		Elective course (3 cr) Center for Biotechnology Instrumentation Core Course (1cr)	
Biosystems Research I: Big Questions (3 credits) Five** modules featuring a coordinated, systems-level examination of a key research question in each specialization using primary literature: 1. Pathobiology and Biomedical Science 2. Microbial interactions 3. Systems analysis 4. Integrated Plant Biology 5. Comp.Organismal Biol, Ecology, Evolution		Biosystems Research II: Integrating quantitative discovery into basic and applied research (3 credits) Five ** modules featuring in-depth examinations of key challenges in computational and quantitative biology: 1. Genomics 2. Systems and Networks 3. Sequence analysis 4. Phylogenetic inference 5. Quantitative ecology	

* Some of the cohort of first-year students would serve as teaching assistants for LIFE 120 lab and the remainder would be teaching assistants in LIFE 121 lab. For students teaching in LIFE120, fall semester, the first research rotation would be conducted for the full 16 weeks of fall semester, with rotations 2 and 3 in spring semester (each for 8 weeks). For students teaching in LIFE121, spring semester, research rotations 1 and 2 will be conducted in fall semester (each 8 weeks), and rotation 3 will be concurrent with their spring teaching for the full 16 weeks.

**Number of modules may change to accommodate specializations.

Teaching credit is apportioned to the departmental homes of faculty who instruct. Each module in Biosystems Research I would be instructed by two faculty who participate in that specialization, with a lead instructor of record (e.g.; a member of the Complex Biosystems Program Committee) coordinating the course.

***Biosystems Research II is currently envisioned with multiple possible topics. Those listed are not exhaustive and will be presented in the context of current literature.

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Appendix C: Participating units, colleges, and faculty mentors by specialization

Pathobiology	Microbial interactions	Systems analysis	IPB	COBEE
Melanie Simpson (BIOC)	Paul Blum (SBS)	Jennifer Clarke (Stat, FDST)	Tom Clemente (Ag & Hort, PSI)	Kristi Montooth (SBS)
Rodrigo Franco (VBMS)	Andy Benson (FDST)	Hasan Otu (EE)	Ed Cahoon (BIOC, PSI)	Steven Thomas (SNR)
Greg Somerville (VBMS)	Amanda Ramer-Tait (FDST)	Khalid Sayood (EE)	Karrie Weber (SBS)	Karrie Weber (SBS)
Jay Reddy (VBMS)	Bob Hutkins (FDST)	Tomas Helikar (BIOC)	Karin van Dijk (BIOC)	Amy Burgin (SNR)
Fernando Osorio (VBMS)	Janos Zemleni (NUTR)	Juan Cui (CSE)	Rebecca Roston (BIOC)	Terrence Loecke (SNR)
Mark Wilson (BIOC)	Samodha Fernando (AnSci)	Max Pierobon (CSE)	Sabrina Russo (SBS)	Mark Pegg (SNR)
Jaekwon Lee (BIOC)	Jennifer Clarke (Stat, FDST)	Chi Zhang (SBS, PSI)	Suat Irmak (BSE)	Drew Tyre (SNR)
Concetta DiRusso (BIOC)	Stephen Kachman (Stat)	Etsuko Moriyama (SBS, PSI)	Diana Pilson (SBS)	TJ Fontaine (SNR, F&W Coop)
Paul Black (BIOC)	Etsuko Moriyama (SBS, PSI)	James Schnable (Ag & Hort, PSI)	Tala Awada (SNR)	Craig Allen (SNR, F&W Coop)
Joe Barycki (BIOC)	Khalid Sayood (EE)	Istvan Ladunga (Stat)	Guillermo Baigorria (SNR, Ag & Hort)	Kevin Pope (SNR, F&W Coop)
Nicole Buan (BIOC)	Hasan Otu (EE)	Keenan Amundsen (Ag & Hort)	Harkamal Walia (Ag & Hort, PSI)	Larkin Powell (SNR)
Oleh Khalimonchuk (BIOC)	Matt Spangler (AS)	JJ Reithoven (SBS)	Tim Arkebauer (Ag & Hort)	Dave Wedin (SNR)
Ed Harris (BIOC)	Jessica Petersen (AS)	David Dunigan (Plant Path, NCV)	George Graef (Ag & Hort)	Tala Awada (SNR)
Don Becker (BIOC)	Dan Ciobanu (AS)	Yumou Qiu (Stat)	Ismail Dweikat (Ag & Hort)	Chad Brassil (SBS)
Jiri Adamec (BIOC)	Daniel Schachtman (Ag & Hort, PSI)	Bo Deng (Math)	Bin Yu (SBS)	John DeLong (SBS)
Pat Dussault (Chem)	Jim Alfano (SBS/PSI)*	Adam Larios (Math)	Heriberto Cerutti (SBS)	Sabrina Russo (SBS)
Dave Berkowitz (Chem)	Sydney Everhart (PP)	Daniel Schachtman (Ag & Hort, PSI)	Jim Alfano (SBS/PSI)*	Brigitte Tenhumberg (SBS)
Cliff Stains (Chem)	Bo Deng (Math)	Paul Blum (SBS, PSI)	Steve Baenziger (Ag & Hort)	Robert Gibson (SBS)
Jim Takacs (Chem)	Qingsheng Li (NCV, SBS)	Trenton Franz (SNR)	Zoya Avramova (SBS)	Colin Meiklejohn (SBS)
Jiantao Guo (Chem)	Karrie Weber (SBS)	David Wedin (SNR)	James Schnable (Ag & Hort, PSI)	Glenn Ledder (Mathematics)
Eric Dodds (Chem)	Ken Nickerson (SBS)	Craig Allen (SNR)	Yufeng Ge (BSE)	Eileen Hebets (SBS)
Robert Powers (Chem)	Audrey Atkin (SBS)	Yufeng Ge (BSE)	Tiffany Heng-Moss (Ento)	Diana Pilson (SBS)
David Hage (Chem)	Joshua Herr (SBS, Plant Path)	Hongfeng Yu (CSE)	Daniel Schachtman (Ag & Hort, PSI)	Daizaburo Shizuka (SBS)

Proposal for PhD in Complex Biosystems

Audrey Atkin (SBS)		Francisco Arriola (BSE)	Paul Blum (SBS, PSI)	Johannes Knops (SBS)
Ken Nickerson (SBS)		Stephen Kachman (Stat)	Alan Christensen (SBS)	Sheri Fritz (EAS)
Jim Alfano (SBS, PSI)		Samodha Fernando (AnSci)	Rich Wilson (Plant Path)	
Larry Harshman (SBS)		Matt Spangler (AnSci)	Amit Mitra (Plant Path)	
Steve Harris (SBS, PSI)		Jessica Peterson (AnSci)	Wayne Riekhof (SBS)	
Bob Hutkins (FDST)		Sydney Everhart (Plant Path)	Keenan Amundsen (Ag & Hort)	
Amanda Ramer-Tait (FDST)		Guillermo Baigorria (SNR, Ag & Hort)	Jeff Mower (Ag & Hort)	
Andrea Cupp (AnSci)		Dennis Molfese (Psych, CB3)	Brian Waters (Ag & Hort)	
Jennifer Wood (AnSci)		Jeffrey Mower (Ag & Hort)	Rhae Drijber (Ag & Hort)	
Samodha Fernando (AnSci)		Joshua Herr (SBS, Plant Path)	Joe Louis (Ento)	
Angie Pannier (BSE)			Mark Lagrimini (Ag & Hort)	
Sri Kidambi (CBE)			David Holding (Ag & Hort)	
Bill Velander (CBE)			Brian Wardlow (SBS)	
Shadi Othman (BSE)			Lilyan Fulginiti (AgEcon)	
Deb Brown (SBS/NCV)			Sally MacKenzie (Ag & Hort)	
Qingsheng Li (SBS, NCV)			Lirong Zeng (SBS, PSI)	
Luwen Zhang (SBS, NCV)				
Charles Wood (SBS, NCV)				
Shi-Hua Xiang (VBMS, NCV)				
Wayne Riekhof (SBS)				

Proposal for PhD in Complex Biosystems

Participating Departments/Units

Pathobiology	Microbial	Systems analysis	IPB	COBEE
SBS	SBS	SBS	SBS	SBS
CBE				
Chemistry				
	FDST	FDST		
PSI		PSI	PSI	PSI
		EE		
Animal Science		Animal Science		Animal Science
VBMS	VBMS	VBMS		
Biochemistry		Biochemistry	Biochemistry	Biochemistry
	CSE	CSE		
	Statistics	Statistics		
		Ag and Hort	Ag and Hort	Ag and Hort
		SNR	SNR	SNR
		Plant Path	Plant Path	Plant Path
			Ag Econ	
NCV		NCV		
BSE		BSE	BSE	BSE
			Entomology	Entomology
		Mathematics		Mathematics
		CB3		
	Nutrition			

BSE = Biological Systems Engineering
 CB3 = Center for Brain, Biology and Behavior
 CBE = Chemical and Biomolecular Engineering
 CSE = Computer Science and Engineering
 EE = Electrical Engineering
 FDST = Food Science and Technology
 NCV = Nebraska Center for Virology
 PSI = Center for Plant Science Innovation
 SBS = School of Biological Sciences
 SNR = School of Natural Resources
 VBMS = Veterinary and Biomedical Sciences

December 22, 2015

Dr. Brian Larkins
Associate Vice Chancellor for Life Sciences
University of Nebraska
2200 Vine Street
Lincoln, NE 68583

Dear Dr. Larkins,

On behalf of the Bio Nebraska Life Sciences Association, I'm pleased to submit this letter of support for the University of Nebraska's Complex Biosystems Graduate Program.

Nebraska's life science companies, especially those in the agriculture, ethanol, medical device, food safety and pharmaceutical sectors, are struggling to fill unmet workforce needs and are searching for potential employees that have technical and analytical expertise. In addition, there is a strong demand for employees that have math and computational skills and the ability to work in a collaborative environment.

Bio Nebraska sees the interdisciplinary Complex Biosystems PhD program as a way to address the workforce needs of the life science companies in Nebraska by providing educated and trained professionals ready to contribute and help grow the life sciences industry in Nebraska.

We strongly encourage your consideration of this graduate program because it will provide students with a unique multi-discipline approach to understanding the life sciences while providing both the public and private sectors in Nebraska with a much needed influx of educated and experienced professionals. If we can be a resource as you review the Complex Biosystems initiative, please let me know.

Sincerely,



Philip Kozera
Executive Director



November 2015

Jennifer L. Clarke, PhD
Director, Quantitative Life Sciences Initiative (QLSI)
Associate Professor Department of Food Science and Technology Department of Statistics University of
Nebraska-Lincoln

Subject: PhD Program in Complex Biosystems

Dear Jennifer,

I was excited to learn about the proposal you are putting together to develop a new PhD program in Complex Biosystems. It's clear that we need to train students to work across disciplines to enable the use of data sciences to improve plants. It also is well appreciated that individuals who communicate well with diverse audiences are in high demand for science administration and other roles. Your program promises to train students with both aspects in mind and is of great interest to us at Pioneer.

We are committed to sending seminar speakers to talk about DuPont Pioneer and industry careers generally for your seminar series. In addition, trainees from your program would be considered for internships and, upon graduation, full-time employment within DuPont Pioneer. In addition, we will be honored to serve on the External Advisory Committee of your program, and to provide ad-hoc advise if requested.

Your program promises to produce graduates that would be eminently employable in the field of agricultural research. We are excited about the opportunity to work with you to ready trainees for jobs in industry and look forward to working with you and your trainees.

Sincerely,

A handwritten signature in black ink that reads "Tabare Abadie". The signature is written in a cursive style and is enclosed within a hand-drawn oval.

Tabare Abadie, PhD
Lead of Research Effectiveness, DuPont-Pioneer
7300 NW 62nd Ave, Po Box 1004
Johnston IA 50131-1004
Tel 515 535 6818 (Tabare.Abadie@Pioneer.com)

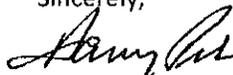
March 14, 2016

To Whom It May Concern:

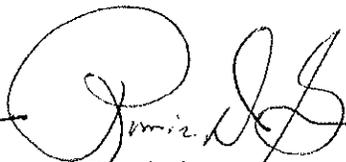
We are strongly committed to the development of interdisciplinary graduate training at the University of Nebraska-Lincoln (UNL) and view the Complex Biosystems program as an effective paradigm for accomplishing this by capitalizing on UNL's burgeoning expertise at the forefront of Big Data approaches to research in the life sciences. The widespread initial positive response to this program among life sciences faculty, as well as current and potential graduate students, has already built a strong platform for the future success of this program.

Collectively we committed \$300,000 for the 2015-2016 academic year to support Complex Biosystems. It is our intention to maintain this level of support through 2020-2021 (5 years), at which time we will reassess the effectiveness of the program and its value to graduate student recruitment and training at UNL.

Sincerely,



Harvey Perlmán
Chancellor



Ronnie Green
Senior Vice Chancellor for
Academic Affairs
Vice President, Agriculture and
Natural Resources
Harlan Vice Chancellor, Institute of
Agriculture and Natural Resources



Prem Paul
Vice Chancellor for
Research and Economic
Development

**TABLE 1: PROJECTED EXPENSES - NEW INSTRUCTIONAL PROGRAM
PhD in Complex Biosystems at UNL**

	(FY16-17) Year 1		(FY17-18) Year 2		(FY18-19) Year 3		(FY19-20) Year 4		(FY20-21) Year 5	
	FTE	Cost								
Personnel										
Faculty ¹										
Professional										
Graduate assistants (GA) ²		\$256,237		\$257,081		\$257,992		\$258,971		\$260,037
Support staff ³	0.5	\$20,000	0.5	\$20,600	0.5	\$21,218	0.5	\$21,855	0.5	\$22,510
Subtotal	0.5	\$276,237	0.5	\$277,681	0.5	\$279,210	0.5	\$280,826	0.5	\$282,547
Operating										
General Operating										
Equipment										
New or renovated space										
Library/Information Resources										
Other ⁴		\$20,000		\$20,000		\$20,000		\$20,000		\$20,000
Subtotal		\$20,000		\$20,000		\$20,000		\$20,000		\$20,000
Total Expenses		\$296,236.75		\$297,681.00		\$299,210.00		\$300,825.54		\$302,547.18

¹ The multi-disciplinary program requires no additional faculty or technical staff.

² Calculated as 9 graduate assistants with a \$19,500 9-month stipend. Tuition remission is applied at a rate of 40%; health insurance is estimated as a fixed value per year, adjusted for nine-months (yearly: 16/17: \$1561, 17/18: \$1686, 18/19: \$1821, 19/20: \$1966, 20/21: \$2124). Total cost per student is estimated at ~\$28,471 (FY16-17). When students receive grant-funded GAs (anticipated beginning with year 1 summer salary), tuition remission (~40% of base salary) and UNL's contribution to student health insurance is charged to the grant. Raises in GA salaries are not shown, and would only be available as funding allows.

³ Support staff proposed at 0.5 FTE for program administration including recruiting, housed in the Office of Graduate Studies. Salaries are incremented by 3% yearly.

⁴ Recruiting and annual faculty/student retreat.

**TABLE 2: REVENUE SOURCES FOR PROJECTED EXPENSES - NEW INSTRUCTIONAL PROGRAM
PhD in Complex Biosystems at UNL**

	(FY16-17) Year 1	(FY17-18) Year 2	(FY18-19) Year 3	(FY19-20) Year 4	(FY20-21) Year 5	Total
Existing Funds ¹	\$300,000	\$300,000	\$300,000	\$300,000	\$300,000	\$1,500,000
Required New Public Funds						\$0
1. State Funds						\$0
2. Local Tax Funds (community colleges)						\$0
Gross Tuition and Course Fees ²	\$0	\$186,896	\$385,006	\$594,834	\$816,905	\$1,983,641
Other Funding						\$0
1						\$0
2						\$0
3						\$0
Total Revenue	\$300,000	\$486,896	\$685,006	\$894,834	\$1,116,905	\$3,483,641

¹Annual budget is shared by the Offices of Research and Economic Development, the Senior Vice Chancellor of Academic Affairs, and the Institute of Agriculture and Natural Resources as follows: Office of Research: \$50,000; SVCAA: \$100,000; IANR: \$150,000.

²Gross Tuition and Course Fees (see below). First year tuition revenue (students in rotation) receive tuition remission; therefore, tuition income for these students is not recorded.

	# of Students	Number of Credit Hours	Tuition Rate Per Credit Hour (3% inc. assumed)	Gross Tuition Revenue
FY 16-17	0	18	\$840	\$0
FY 17-18	12	18	\$865	\$186,896
FY 18-19	24	18	\$891	\$385,006
FY 19-20	36	18	\$918	\$594,834
FY 20-21	48	18	\$945	\$816,905

July 25, 2016

Dr. Michael Baumgartner
Executive Director
Coordinating Commission for
Postsecondary Education
140 N. 8th Street, Suite 300
Lincoln, NE 68509

RECEIVED
JUL 25 2016
Coordinating Commission
for Postsecondary Ed.

Dear Michael:

Enclosed is a copy of the proposal to create a PhD in Complex Biosystems administered by the Office of Graduate Studies at UNL. The proposal was approved by the Board of Regents at the July 22, 2016 meeting. Also enclosed is the Proposal for New Instructional Program Form 92-40.

Please do not hesitate to contact me if you have any questions.

Sincerely,



Susan M. Fritz
Executive Vice President and Provost

Enclosure

c: Chancellor Ronnie Green
Interim Senior Vice Chancellor Marjorie Kostelnik
Acting Dean Laurie Bellows, Office of Graduate Studies
Vice Provost David Jackson