4 February 2011

Prof. Linda Katehi
Chancellor

Prof. Ralph Hexter
Provost & Executive Vice-Chancellor

Re: College of Biological Sciences Vision Statement

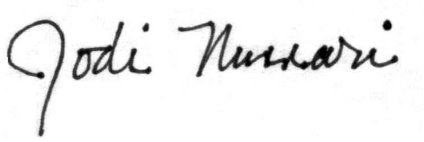
Dear Colleagues,

You confront difficult choices in making future resource allocations. Meanwhile the search continues for a new leader to serve as Dean–College of Biological Sciences (CBS).

The appended document aims to help guide these interlinked decisions. It provides an overview of the central role for CBS at UC-Davis, and presents three representative examples of areas where existing strengths correspond with national challenges and opportunities.

We hope you find this useful.

Sincerely,



Jodi Nunnari
Chair–Department of Molecular & Cellular Biology

Valley Stewart
Chair–CBS Executive Committee

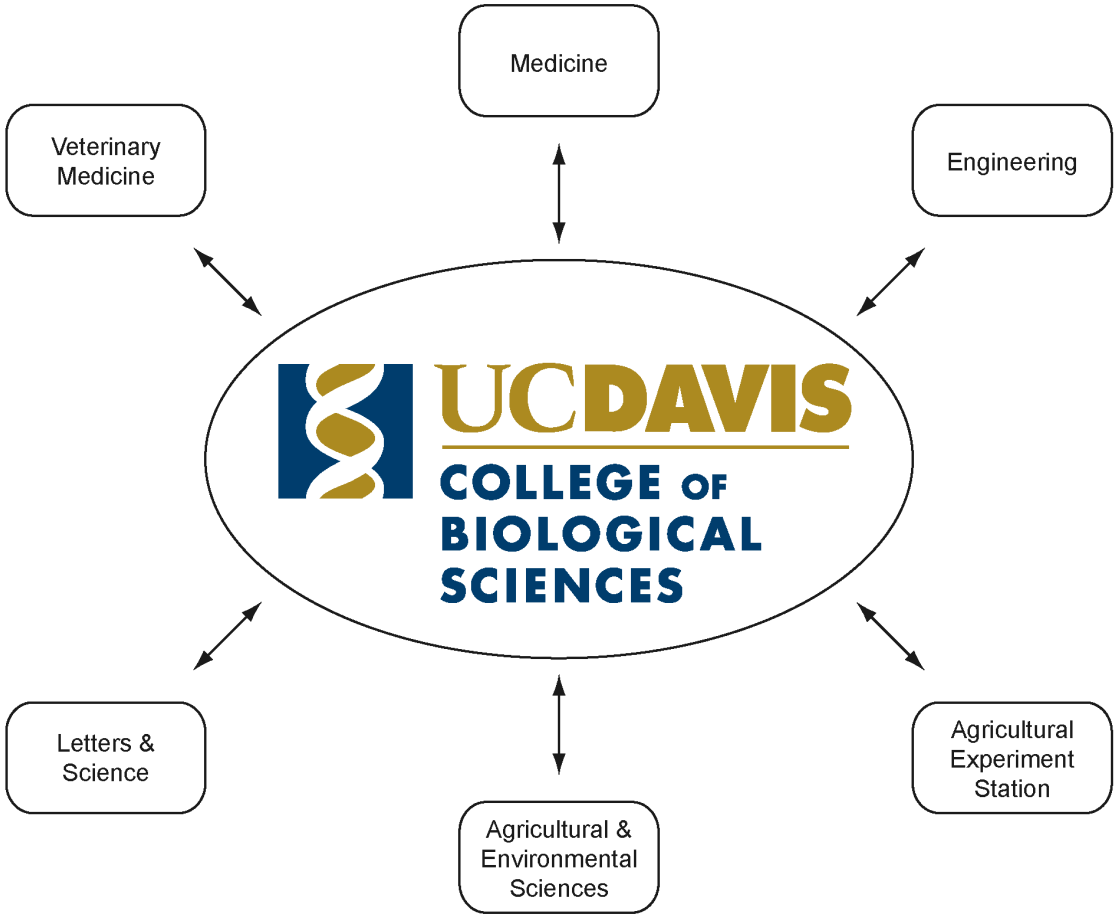
c: Stanley Nosek, Vice Chancellor–Research
Harris Lewin, Vice Chancellor-Designate–Research
Ken Burtis, Dean–CBS
CBS Department Chairs
CBS Executive Committee

Enabling and Coordinating Interdisciplinary Biology Research: 2011 and Beyond

Report of the College of Biological Sciences Vision Committee

A Special Committee, established jointly by the
CBS Department Chairs and CBS Executive Committee

4 February 2011



Every aspect of human life and of the ecology of the planet will be affected by rapid advances in biological science throughout the 21st century. The University of California–Davis (UCD), among the top institutions for biological sciences in the world today, is poised to lead the nation in discovery and application. Therefore, it is incumbent upon us to seize this moment in history to define a strategic vision for future development of biological sciences at UCD.

A major asset of the College of Biological Sciences (CBS) is the breadth of phylogenetic diversity under study, including a variety of microbes, plants and animals. Simultaneously, CBS faculty also probe the full range of biological organization, from molecules through gene and developmental networks to ecosystems. These horizontal and vertical approaches are integrated to provide mechanistic insights into numerous topics in contemporary biology. This powerful combination of breadth and depth across the range of biological sciences is the defining strength of our research and teaching.

UCD likewise is characterized by disciplinary breadth and depth. This includes an ever-increasing interest in biology that is virtually campus-wide. Engineers seek ways to repair tissues, management specialists foster biotechnology entrepreneurs, and lawyers debate the ethics surrounding reproductive and genetic technologies. UCD initiatives in the environmental, food and health sciences all have essential biology components. Developing and furthering these interdisciplinary research efforts necessarily begins with existing strengths in the foundational disciplines. Accordingly, CBS is the natural locus for integrating the life sciences at UCD.

CBS evolved from departments formed originally in the College of Agricultural & Environmental Sciences and the College of Letters & Science. Our culture therefore reflects a history of integrating curiosity-driven and mission-oriented research, in collaboration with colleagues campus-wide. With its disciplinary strengths, CBS is positioned optimally to enable and enhance disparate areas of biology research across UCD. This essential function of CBS as a hub for biology research is conceptually illustrated on the cover page for this report.

The vision of CBS is to:

- Accelerate existing areas of research excellence through strategic investments;
- Prioritize new endeavors to address 21st century challenges and opportunities;
- Lead in creating new campus-wide life sciences research networks.

This brief paper does not seek to enumerate the large number of existing and developing areas of excellence within CBS. That information is detailed in recently-completed academic planning documents. Instead, we present overviews for **three representative venues** to illustrate some of the ways to accomplish our tripartite vision, in accord with the recent National Academy of Sciences Report, *A New Biology for the 21st Century*. This report, highlighting the changing face of biology, emphasizes that the great potential for the new biology will best be realized by integrating research programs across all levels of biological diversity (e.g., cells with ecosystems, molecules with networks, plants with bacteria) and with other fields (e.g., engineering, physics, chemistry). UCD and specifically CBS is in the best position to realize this potential and lead the new biology revolution because of our strong historical and future commitment to integrating the life sciences.

HEALTH SCIENCES. One of the primary strengths of the CBS faculty is our ability to achieve a deep mechanistic understanding of biological processes through the use of modern tools of genetics, biochemistry, cellular biology, and physiology. This is evident in the success of our team of internationally recognized scientists in the area of chromosome biology, which include two members of the National Academy of Sciences as well as the only UCD appointee to the Howard Hughes Medical Institute. This chromosome biology group has successfully

translated high impact discoveries in basic biology of model organisms to breakthrough discoveries in human cancer biology. We are poised to leverage this approach and expertise to expand our reach into the study of human genetics and genomics. This initiative is critical for UCD to remain competitive in a rapidly evolving area of science with far-reaching societal, medical and financial implications. Building excellence around human genetics and genomics will also serve to bridge and strengthen multiple units on campus, including the Schools of Medicine and of Veterinary Medicine; the Cancer, Genome and Neuroscience Centers; and the Medical Investigation of Neurodevelopmental Disorders (MIND) Institute. To realize these goals, we need to recruit outstanding faculty in the areas of computational biology, human epigenomics, disease mechanisms, and human development

To fully translate findings from human genomic research, we also need to build on the breadth of our basic molecular, cellular and physiological research. CBS faculty have pioneered the development and implementation of techniques to address biological problems at scales ranging from single molecules, through organelles and cells, to tissues and whole organisms. To build on these strengths, we need to continue to develop a program that integrates these approaches and addresses complex biological problems in a broad, system-based manner, which will allow CBS successfully to tackle modern biological questions and remain competitive nationally and internationally.

These key areas directly respond to societal needs and will position CBS at the forefront of 21st century research in biology. They also will catalyze formation of new academic units and training programs that will be critical to establishing UCD as a premier research university. Accordingly, we envision that many of the new faculty hired in these areas will hold joint appointments between departments in CBS and in other units such as the School of Medicine. Such intercollege connections will seed basic, translational and clinical projects and be able to mature into larger programs, synergize collaborative research projects and increase extramural funding. These also will extend our undergraduate and graduate teaching missions by incorporating the expertise of the different faculty toward a common goal or major.

BIODIVERSITY. The breadth of research in CBS has taken on still greater importance as comparative approaches at the molecular, cellular, and organismal levels are more commonplace. Although many features of different organisms are unique, the rules and principles by which organisms adapt and respond to changes appear to be very general. It is specifically the study of diverse organisms and levels of organization that reveal these foundational rules and principles of biological innovation.

Recently, these distinct aspects of biodiversity have been transformed and integrated via new approaches such as genomics, computational biology, bioinformatics, and network analysis (e.g., transcriptional, developmental, ecological). These tools make it much easier to study “non-model” organisms, and also allow discoveries in model organisms to be extended across the tree of life. Comparative and phylogenetic approaches allow for the complete annotation of features and functions to make full use of genomic information about key organisms (e.g., humans, crop plants, pathogens). Understanding how novel functions and properties evolve in diverse organisms now allows us to comprehensively characterize the features of key organisms. Using this interdisciplinary set of approaches and tools to address outstanding questions has unprecedented implications for medicine, agriculture and other aspects of applied biological research.

Biodiversity research exploits and enhances links between CBS and the College of Agricultural & Environmental Sciences (CA&ES). For example, CBS researchers have discovered a novel way to make instantly true breeding plants. This method could greatly accelerate development of new agricultural varieties adapted for a changing climate, and can also be used to study biodiversity in wild species. A productive collaboration between CBS and CA&ES researchers

is focusing on how to apply the power of this new breeding method to the huge collection of tomato varieties at UCD.

There are several key areas that CBS and UCD need to augment in order to lead this revolution. We need to maintain and enhance our coverage of phylogenetic and functional diversity, for example evolutionary analysis of plant development, and metagenomics of microbial ecosystems. Presently we are weaker than we should be in some areas of microbial diversity, including mycology, phycology, and virology. Finally, we should increase work in model organisms that is integrative and forward looking, such as network analysis of genomic and phenotypic data. In all of this, bioinformatics is a unifying science and tool. The focus will be on comparative genomics, and on faculty members who act as collaborative hubs.

PHYSICAL BIOSCIENCES. By means of extensive structural hierarchies, with each level itself containing a complex architecture, natural substances can display a wide range of physical, chemical and biological functions which all contribute to the complexity of life. Understanding how such systems function, change over time, respond to outside forces and heal is a challenge that can cut across all areas of science and engineering. The first stage in identifying and addressing/mitigating all of these factors is to be able to observe the structure of biological systems over the important length scales, often a multi-scale problem ranging from the structure of individual proteins up to their arrangement and function in cells. In this regard, UCD is in a strong scientific position having already established state of the art facilities on campus for optical, electron and scanning probe microscopy, nuclear magnetic resonance, and mass spectrometry, along with extensive connections to national synchrotron facilities and the Stanford Linac Coherent Light Source for X-ray diffraction studies. The success of this approach is exemplified by the achievements of faculty involved in the Interdisciplinary Center for Electron Microscopy (ICEM), which is a joint venture between CBS and the College of Engineering.

In this regard, another recent National Academy of Sciences Report, *Research at the Intersection of the Physical and Life Sciences*, highlights the huge opportunities at this interface. This report documents the common themes that exist with biology and the physical sciences, the synergy in developing new technologies and tools for research, and finally the benefits of cross-training in these disciplines. The report concludes that cooperation among the biological, physical and engineering sciences can solve grand challenges including synthesizing lifelike systems, understanding the brain, predicting organisms' characteristics from their DNA sequences, and understanding interactions of the Earth, its climate and the biosphere. Some of these challenges represent recurring themes already highlighted in this document. This fact underscores the unique position of CBS to serve as the main hub on campus for integrating biological sciences, both basic and applied.

In addition to providing a unique and stimulating research environment, a campus-wide effort to create interdisciplinary programs at the interface between the biological sciences, the physical sciences and engineering would offer the possibility of developing a new core curriculum. Centered on biophysical characterization methods, this curriculum can be offered campus-wide for collaboration and development of graduate student research projects. This program would strengthen liaisons between units and provide cutting-edge technology to an already strong science campus. To achieve these goals, we will focus and coordinate expertise from what are now small, disparate research efforts spread over CBS, the Division of Mathematical & Physical Sciences, and the College of Engineering, to forge state-of-the-art campus-wide interdisciplinary centers such as the ICEM. The guiding principle behind such centers will be to provide a forum for biologists, chemists, physicists and engineers to both perform research within their own communities and to search for and exploit synergistic interactions for structural biology.

CBS Vision Committee
Fall 2010

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CBS Executive Committee