

A VISION AND PLAN FOR THE PLANT BIOLOGY DEPARTMENT AT THE UNIVERSITY OF VERMONT 2015–2020

April 2015



EXECUTIVE SUMMARY

Basic plant biology is emerging as key to the future prosperity of the human population. In this light, UVM's Plant Biology Department has as its mission *to increase knowledge of plants and provide education in basic plant biology as we engage in fundamental research that explores plants at all levels of organization*. The Department is focused on achieving three fundamental goals in concert with our vision: to discover new insights into the basic biology of plants, to scientifically educate as broad a community of undergraduate and graduate students as possible, and to provide informed and balanced scientific information to the public and policy makers. Looking forward, our teaching and research faculty have recently come to consensus on our concept for the future development of Plant Biology at UVM and concepts for our next two tenure-track hires. First, we seek a faculty member in plant physiology to enhance the plant science community at UVM. Second, we seek a faculty member in the area of plant genomics, which sits at the intersection of an array of major fields in modern-day biology. To support the ongoing development of our Department, we have identified three key agendas for attracting funding support through giving: a full-time curator for the Pringle Herbarium, an endowed chair in forest health and sustainability to promote the research mission of the Proctor Center, and permanent IT staff members to serve researcher needs for expediting data-processing and routine maintenance for large-scale genomic analyses.

OUR VISION—INTRODUCTION

Basic plant biology is emerging as key to the future prosperity of the human population. In the same way that basic medical researchers seek clinical solutions to fundamental challenges in human health care, we plant biologists seek to provide insights that make it possible to feed, clothe, and shelter our ever-larger population in spite of intensifying environmental concerns, especially climate change. To paraphrase the organizers of the AAAS Plant Biology Symposium in February of 2013, *fundamental discoveries and sophisticated research in the plant sciences will provide new technologies, novel strategies, and practical solutions or mitigations to some of the major global challenges that face future generations*. Major problems that plant biologists can address include natural-resource sustainability, food security, global climate change, renewable energy, and human health. Furthermore, the study of model systems in plant biology contributes significantly to our understanding of general biological phenomena.

The Department of Plant Biology has served as an intellectual hub for plant-related science at the University of Vermont for at least seventy years. Our overarching mission is to increase knowledge of plants and provide education in basic plant biology as we engage in fundamental research that explores plants at all levels of organization. Considering the national trends, the Department is focused on achieving three fundamental goals:

- ❖ To discover new insights into the basic biology of plants through our molecular- to ecosystem-level research.
- ❖ To scientifically educate as broad a community of undergraduate and graduate students as possible. These students are the people who will make decisions critical to the future of our species, decisions that must be informed by our insights into plants, the source of all sustenance.
- ❖ To provide informed and balanced scientific information to the public and policy makers, both of whom are increasingly confronted with galvanized and biased views of complex issues involving science and its application.

OUR TEACHING ROLE

Our bread and butter come from teaching, more so under Incentive-Based Budgeting, now being inaugurated at UVM. The transition to Incentive-Based Budgeting has been to our advantage, particularly given our central role in life-science education. We contribute about 15% of the total CALS teaching effort, with over 80% of this effort invested in our teaching of life-science majors. Essential to our success is our extraordinary team of award-winning lecturers (Almstead, Hill, Paris, and Stratton), three of whom are at the senior-lecturer rank. Together with strong educators among our tenure-track faculty, we make substantial contributions to the following courses:

- Basic biology for majors (BCOR 11 and 12) and non-majors (BIO 1 and 2)
- Biochemistry service (PBIO 185 and 187)
- Plant Biology service – entry (PBIO 4 and 6) and 100-level (PBIO 104, 108, 109, 117, 151, 177, and 193-198)
- 200-level courses for plant biology majors and minors
- Laboratory Research experiences for undergraduates with faculty mentors
- Graduate-level courses for our MS and PhD candidates

OUR RESEARCH ROLE

The Plant Biology Department unites faculty with a broad array of research specialties, from molecular biology to ecosystem functioning. At the molecular level, we have expertise in plant biochemistry, genetics, and development. At the cell and organ levels, we are engaged in understanding the physiology of plant processes with special attention to their chemistry and

biophysics. At the organismal, community, and landscape levels, we study interactions and evolution of plants in response to their abiotic and biotic environments. Department faculty receive extramural support from a variety of competitive programs such as NSF, NIFA and DOE, are regularly invited to speak at International Conferences and Symposia, and publish their research findings in top academic journals. We continually attract students to participate in active research at both the undergraduate and graduate levels, with an eye to developing transferable skills that will be immediately useful in the job market. Our faculty believe that hands-on training is key to the education of our budding young scientists and to the continued productivity of our labs. The Plant Biology PhD program attracts nationally and internationally competitive students, including NSF fellowship recipients and Fulbright scholars. The excellent training received by both our undergraduate and graduate students has resulted in graduates attaining prestigious positions including faculty hires at Cornell University, Yale University, the University of Alabama, the Smithsonian Institution, and the New York Botanical Garden. The Department also hosts internationally recognized scientists for short- and long-term visits.

CURRENT FACULTY RESEARCH PROGRAMS

- Biogeography and phylogeny of vascular plants (Barrington)
- Population and community dynamics during climate change (Beckage)
- Genetics, molecular biology, and biochemistry of plant defenses (Delaney)
- Environmental regulation of root architecture, especially root nodules (Harris)
- Ecological adaptation during rapid environmental change (Keller)
- Biophysics of plant development and microfluidic methods for cell encapsulation (Lintilhac)
- Ecological and evolutionary processes during biological invasions (Molofsky)
- Ecophysiology, quality, and profitability of maple sap production (Perkins; van den Berg)
- Evolutionary genetics and genomics of plant reproductive traits (Preston)
- Control of cell form and function through cell-wall organization (Tierney)

VISION FOR FUTURE TENURE-TRACK HIRES

Looking forward, our teaching and research faculty have recently come to consensus on our concept for the future development of Plant Biology at UVM and, consequently, the directions to take for our next two hires. These two positions will allow the Plant Biology Department to offer advanced courses in plant physiology and in the use of genomics and genomic tools to characterize plant processes. In addition, these new faculty will contribute to teaching of undergraduate life-science majors, an imperative function given the substantial and ongoing increases in the enrollment of biological science majors on this campus. New faculty will also increase our capacity to host undergraduate students in research groups, continuing the Department's tradition of empowering UVM graduates to be on the cutting edge of scientific development as they begin their careers.

We have consistently recruited our top choice of faculty candidates during national searches for over 10 years, yielding a strong and productive faculty. We attribute this success to the Department's collective vision and clear portrayal of desired research specialties and the excellent research programs that are already in residence. The two new faculty positions are similarly well defined, timely, and fit within a clear vision for the future of Plant Biology at UVM. Finally, these two positions complete our concept of a Department hosting a complete array of the research disciplines central to providing *“practical solutions or mitigations to some of the major global challenges that face future generations.”* (AAAS)

POSITION CONCEPT 1: PLANT PHYSIOLOGIST

The Department of Plant Biology recognizes the need for a faculty hire in plant physiology to enhance the plant science community at UVM. Physiology plays a central role in our understanding of the biology of plants, and has become a key component of addressing scientific issues such as plant responses to global environmental change, the challenge of sustainable agriculture, and the promise of advancing novel plant biotechnologies. Twenty-first century plant physiology also benefits from exciting new tools—such as proteomics and metabolomics, stable isotopes, remote sensing, and flux-tower measurements—that are yielding novel insights into our understanding of basic plant physiological processes. Plant physiology connects processes occurring at the cellular or subcellular level with those of the whole organism and its environment, yielding integrated insights across biological scales and disciplines. As such, physiology offers a unifying theme across the Department of Plant Biology that links with our rich history of research addressing areas such as sap flow, mechanical constraints, and light-induced movement, as well as newer interests in developmental biology and the molecular basis of ecological responses. The Department of Plant Biology and other plant-focused departments on campus have been without a faculty member who addresses fundamental physiological processes since 2008, so the new hire would fill a critical gap in the plant sciences at UVM. A new faculty member specializing in plant physiology will be a strong complement to Plant Biology's existing strengths and will catalyze future opportunities for collaboration and student training.

We envision a broad-based search for a plant physiologist who uses innovative approaches to address fundamental physiological processes. Essential qualities of a successful candidate include the ability to interact with and complement existing faculty and the potential to stimulate new ideas and collaborations. Among the possible realizations of our vision are 1) a *plant biophysicist* with particular emphasis on biomechanics and its role in controlling developmental or environmentally-induced responses during growth, or 2) a *plant ecophysiologist* with particular emphasis on adaptive physiological responses to environmental cues at the organ or whole-plant level.

POSITION CONCEPT 2: PLANT GENOMICS

The Plant Biology Department has identified the need for a faculty hire in the area of plant genomics. Genomics sits at the intersection of major fields in biology—including ecology, evolution, molecular and cell biology, development, phylogenetics, and systematics—all of which are active areas of research in the Department. New advances in genomic techniques have opened the door to addressing many new and exciting questions in biology, including the role that genomic processes play in trait evolution and the effect of genome perturbations on gene expression. These novel insights are leading to paradigm shifts in how cellular, developmental, and evolutionary processes are manifested through organizational changes at the molecular level. A new faculty member in the area of Plant Genomics will bring state-of-the-art research expertise in multiple areas of plant biology including, but not limited to, phylogenomics, coevolution of microbes and their hosts, and comparative genomics.

Currently, the majority of Plant Biology faculty is engaged in research involving the mining and generation of large genomic datasets. The growing availability and affordability of next-generation sequencing will likely provoke a burgeoning demand in the Department for expertise in this research area. We are excited about bringing a plant genomic research program into the Plant Biology community and the ensuing collaborations that will result from this new hire. In addition, the new faculty member will provide understanding of cutting-edge technology and data processing capabilities that both our undergraduate and graduate students require, and will build new

collaborations within and between departments.

CAPITAL FUND DRIVE PRIORITIES

Here we provide the current version of our priorities for attracting additional resources to the department through development initiatives. These priorities, fully integrated with our vision for the Department, are a refinement of the Plant Biology Department's key areas for capital fund investment provided to the College in November 2014.

CURATOR FOR THE PRINGLE HERBARIUM. The Pringle Herbarium, a major player in UVM's Natural History Museum, serves as a key resource for modern plant research into the diversity of plant life, with special reference to the origin and management of plant diversity in an evolutionary and conservation context. As the largest resource of its kind in northern New England and the third largest in New England as a whole, the collection has a central place in its research community. Our highest priority for the institution is investment in a full-time curator to envision its future and realize the potential for this great collection to serve the University and the State of Vermont.

PROCTOR CHAIR IN FOREST HEALTH AND SUSTAINABILITY. The Plant Biology Department's Proctor Maple Research Center serves the needs of maple producers within the state and throughout the northeast and north-central United States through research on tree physiology including the mechanism of sap flow, sap biochemistry and microbiology, the effects of climate change on forest health, and the impact of exotic pests and pathogens on Northern hardwood forests and the US Maple Industry. We envision an expanded mission for the Proctor Center, casting it as a mid-latitude center for climate-change research and teaching in tune with the University's interdisciplinary interest in the environment. An endowed chair in forest health and sustainability within the Department of Plant Biology with a charge to promote the research mission of the Proctor Center will provide the foundation for the realization of this expanded mission.

BIG DATA ANALYSIS INFRASTRUCTURE

The proposition to open a plant genomics position (*POSITION CONCEPT 2*) is part of a larger, STEM-wide movement in the direction of attracting young faculty with modern genomic approaches to solve key problems in the sciences. Success in this realm will require state-of-the-art computational facilities and technical support staff able to help navigate complex analytical challenges to yield efficient, trustworthy pipelines. Currently, faculty in Plant Biology, Plant and Soil Science, and Animal and Veterinary Science are limited in their research productivity for lack of infrastructure support in the areas of bioinformatics and analysis of large datasets. Our Department would like to work with the College in meeting our current and future bioinformatics demands by (1) hiring a permanent VACC IT staff member to take care of routine maintenance that can otherwise derail large-scale analyses, (2) hiring additional VACC personnel to serve researcher needs for expediting data-processing, and (3) providing training opportunities for the ever-growing community of CALS users. By combining new faculty and IT hires, we endeavor to develop a competitive edge in harnessing and applying next-generation data akin to our strongest peer institutions.