Strategic Planning at a Glance

Veterinary and Animal Sciences-2015

- Unifying characteristic: Animal Models of Diseases

- Research groups: Immunology and Infectious Diseases; Reproduction and Development; Endocrinological and Environmental Factors of Disease

- Future themes: Engineering Immune Responses and Origins of Development and Disease

- Areas for future Hires: Microbiome/Microbiota; Gut Development Biologist; Transgenerational Biologist
Introduction to the Uniting Principals of our Department’s Research, Undergraduate & Graduate Education:

Historically, Animal Science has dealt with Nutrition, Genetics and Reproduction, while Veterinary Science dealt with Animal Diseases including those occurring as a result of infection, inflammation, cancer etc. Prior to 1980, those topics were examined and taught following a descriptive approach, which was the norm in agricultural research those days. However, following strategic planning in 1984, our predecessors envisioned a program based on “Animal Biotechnology” and on the understanding of the cellular and molecular aspects of animal health and disease while maintaining the overall research areas related to Veterinary and Animal Sciences (VAS), an approach that has been implemented in the Department during the last 30 years. Further, implementation of this plan has resulted in a growth of extramural mural funding that places the department among the most successful units within CNS. At the same time, we have retained a robust undergraduate teaching program in Veterinary and Animal Sciences that addresses all relevant sub-disciplines of biology and a robust graduate program that is true to those traditions and highly competitive for federal funding. Our graduate program is designed to build upon our undergraduate program with the research programs providing the opportunities for undergraduate research training and for graduate education.

The unifying principle of our department’s current research program is “Animal Models of Disease and Development” (see graph below). Our vision for the future outlined in this strategic plan is captured in two overarching themes that we will pursue to maintain and extend the excellence and recognition that our graduate program has achieved, as confirmed by the most recent analysis of graduate programs on Campus. The two themes are: "Engineering Immune Responses" and “Origins of Development and Disease”. These themes encompass all our research groups and provide many areas of intersection that will allow interaction between groups within the department, with other departments and IALS and with groups outside the university. In addition, they represent areas that our faculty considers will provide the biggest opportunities for both scientific growth and sustained acquisition of Federal and Industry support.

Research & The Faculty:
Our research approaches are united by the use of ‘Animal Models’ applicable to human and animal development and disease. We have three main areas of research focus:

- **Immunological & Infectious Diseases**
  - Immunoresponse, Immunotherapy, Vaccines, Immunomodulators, Microbiome. *These areas overlap into the fields of Health and Food Security.*

- **Reproduction/Development**
  - Gametes, Fertilization, Infertility, Contraception, Epigenetics and Fetal Development, Birth Defects, Stem Cell Therapy, Regenerative Medicine. *These areas have direct impact on Population Control both of humans and Animals.*

- **Endocrinological and Environmental Factors of Disease**
  - Hypothalamic and Pituitary axis, Endocrine Disruption, Breast and Ovarian Cancer, Environmental Toxicants, Birth Defects, Obesity. *These fields extend into the assessment of how factors in the organism and in the environment predispose to disease and the transgenerational impact of these changes.*

### 1- Immunology & Infectious Diseases

**Group composition:**
- Sam Black-Professor
- Cynthia Baldwin-Professor
- Lisa Minter-Assistant Professor
- Barbara Osborne-Professor
- Leonid Pobezinsky-Assistant Professor
- Janice Telfer-Associate Professor

This cluster research group carries on the majority of the research on the immune system and infectious diseases that takes place on Campus. The group uses diverse animal models from the Cape buffalo through all veterinary species as well as humans and rodents. The diseases under consideration affect animals and humans and range from infectious to autoimmune disease and expand into the understanding of the signaling mechanisms that define T and B cell lineages. This expertise has allowed the researchers in the group to establish important collaborations with researchers in Polymer Sciences and other departments on campus seeking to develop methods to prevent or treat diseases, and with colleagues across the globe to generate and catalogue veterinary genes and reagents of veterinary interests. We intent to maintain this strong research focus, and direct it towards the regulation of the immune response at all possible levels.

**Vision and new hires**
Our vision for the future is captured by the theme “Engineering Immune Responses”, with the goals to prevent the establishment of disease, develop treatments for existing diseases and create conditions that improve human and animal health. To realize these goals, we will manipulate the immune response at:

i) the microbiota - immune system interface
ii) the self - immune system interface (including the aging self)
iii) the tumor - immune system interface
iv) the pathogen - immune system interface

The VAS Immunology group currently focuses on the “self-immune system” and “pathogen-immune system” interfaces resulting in many high impact publications and substantial federal and foundation funding. Additional support from the biotech industry and the Gates Foundations is under negotiation. The group spans all levels of the professoriate. Drs. Baldwin, Black and Osborne are full professors with broad expertise in immunology, infectious diseases and regulation of the immune response. Dr. Telfer is an Associate professor with expertise in developmental and molecular immunology. The two most recent hires in the department Dr. Lisa Minter and Leonid Pobezinsky, have greatly strengthened our capacity in the area of autoimmunity and immunoregulation. Therefore, we are seeking a new hire in the area of the microbiome/microbiota, as the microbial composition of the gut, skin, respiratory and urogenital tracts may impact the immune response as well as the susceptibility to other diseases. This is an emerging area of research that is presently underrepresented in the campus. The expectation is that this hire will interact with many faculty in the department and on campus. As noted below, we are also proposing a new hire in the Reproductive/Developmental Biology group in the area of gut development to expand our existing expertise in the developmental biology group. Thus, a person with expertise on the “Microbiome/Microbiota” would support and complement the two research themes that we are outlining in this strategic plan. It is also worth noting that in the next 5 to 10 years there will be retirements within the immunology group. In order to maintain research strength in this area and our Department research focus, we expect to hire to replace all retiring faculty. We would welcome the opportunity to do some “bridge hiring”, to facilitate the transition and incorporation of the new hire to the department.

Relation to the teaching curriculum:
This group teaches important core courses for the department undergraduate curriculum. Importantly, they also teach the majority of undergraduate and graduate courses on Campus related to Immunology and Infectious Diseases. In addition, they run the most popular, in excess of 30 participants, and longer-existing journal club on campus. Thus, maintaining research strength in this area is also critical for the undergraduate and graduate teaching on campus.

- AnSci 365: Fundamental Veterinary and Biomedical Laboratory Techniques
- AnSci 372: Animal Diseases
- AnSci 572: Infection and Immunity
- AnSci 697K: Advanced Immunology
- AnSci 794A: Immunology Journal Club

2- Reproduction and Development

Group composition:
- Dominique Alfandari-Associate Professor
- Rafael Fissore-Professor
- Carlos Gradil-Extension Professor
- Jesse Mager-Associate Professor
- Kimberley Tremblay- Associate Professor
- Pablo Visconti- Professor
This group is responsible for conducting all the research on gametes and embryos that is carried out on campus. In addition, researchers in this group represent the totality of the research in developmental biology that is performed in mammals and significantly contribute to research in vertebrate development. The main animal models are the mouse and the frog, but current research involves studies in humans, bovine, equine and rat species. The areas of research span from investigating how male and female gametes are readied for fertilization, to the discovery of genes important for early embryogenesis and as well as their epigenetic regulation, to elucidating the cellular and molecular aspects of progenitor cells that direct liver and pancreas formation, and to the understanding of the cellular and molecular determinants that control the formation of the tissues of the face, including muscle, bone, cartilage and ganglia. This group has collaborations on campus and with investigators across the US and abroad. The Reproductive and Developmental Biology group has been an area of continuous contribution to the scientific life of the campus for more than 50 years and some of the technologies developed by this group resulted in the first cloned transgenic mammals in the world, the calves Charlie and George. Therefore, given the continuous success in this area of research, we intend to maintain it, and direct it towards the discovery of molecules, mechanisms and cellular events that make possible the generation of healthy offspring.

Vision and new hires

Our vision for the future is to uncover signaling pathways and molecular mechanisms that play important roles in fertilization, embryo development and organ and tissue formation and harness these mechanisms for “Cellular Therapeutics”. Once the molecules and mechanisms involved in these processes are known, the knowledge will be applied to prevent or overcome infertility, to develop contraceptive methods, and for generating conditions for embryo development that lead to healthy offspring. Results of this research could also have implications in preventing birth defects as well as on the treatment of diabetes and liver disease and in the generation of artificial organs. To realize these goals, we will examine the Molecules and Mechanisms of Development at the levels of:

i) Gametes
ii) Embryos
iii) Organs and Tissues

The lines of research in gametes will continue as presently established by Drs. Visconti and Fissore focusing on the mechanisms of sperm capacitation and on Ca2+ homeostasis in the oocyte/egg and embryo. We are proposing to extend our existing research expertise in Embryos and Organs and Tissues, which are the areas of investigation of Drs. Alfandari, Mager and Tremblay. In the area of Embryos, we are seeking to hire a researcher with expertise in “Transgenerational Epigenetics”. Normal embryo development relies on precise gene expression, much of which is regulated by imprinting and by other epigenetics mechanisms. Besides affecting embryo survival, alteration of these mechanisms can lead to permanently altered gene expression profiles that can be passed on through generations. In vitro manipulation of gametes and embryos in fertility clinics as well as exposure to nutritional and environmental factors
may affect these mechanisms in gametes and embryos and persistently alter gene expression in future generations. We therefore propose to expand our research capabilities to examine the impact of these conditions on transgenerational epigenetics. Given the expertise in gametes and embryos within the group, the new hire will find excellent technical and intellectual support. In addition, faculty in the Endocrine and Environmental Factors of Disease group who have ample expertise with compounds that alter gene expression and influence risk of disease, may also be a valuable source of advice and collaboration. Lastly, we are also seeking to expand the research focus of this group by proposing to hire a researcher in the area of “Gut development”. We have expertise in differentiation of the endoderm as well as on the formation of liver and pancreas. Given the implications of the Microbiota/Microbiome for health and disease, and our expertise in Developmental Biology, and Immunology, a researcher with expertise in gut development will strengthen all existing groups in the department and in research area with very large potential for growth.

Relation to the teaching curriculum:
This group teaches important core courses for the department undergraduate curriculum. In addition, they teach many of the courses that cover basic and applied aspects of Reproductive and Developmental Biology on campus. Please note this group also teaches the only graduate course in Developmental Biology offered on campus. Thus, maintaining research strength in this area is also critical for the undergraduate and graduate teaching on campus.

- AnSci 220 Anatomy and Physiology of Domestic Animals
- AnSci 311 Animal Genetics and Breeding
- AnSci 385 Introductory Biotechnology lab
- AnSci 421 Fundamentals of Reproduction
- AnSci 521 Physiology of Reproduction
- Ansci 795J Cells, Genes & Development
- Ansci 795A Cells, Genes & Development-JC

3- Endocrine and Environmental Factors of Disease

Group Composition
- John Clark- Professor
- Sandra Petersen-Professor
- Kathleen Arcaro -Professor
- Joseph Jerry-Professor
- Karen Dunphy-Research Assistant Professor

These faculty have research programs that investigate the effects of common environmental contaminants including estrogenic and other endocrine disruptor compounds on biological systems and reproduction that range from fish to rodent models and humans. Some of the common agents investigated are pyrethroids, dioxins, xenoestrogens, and radiation. This group also carries out significant research on breast cancer, which ranges from studying mouse models of breast cancer and investigating the hormonal regulation of risk and resistance to this disease, to research on the mechanisms of resistance to hormonal therapies as well as identification of biomarkers of breast cancer risk in human samples. They have extensive collaborations with researchers in Food Science, the School of Public Health and in the departments of
Epidemiology and Environmental Engineering as well as extensive network of collaborations outside campus. This group is the most recent addition to the department’s research portfolio strengthening funding opportunities through NIEHS as well as NIH and private foundations. In addition, environmental toxicants impact the tissues being investigated by the other research groups in the Department. Lastly, this group provides Campus-wide expertise in breast cancer and the research under this area fits well with the mission of IALS. It is worth noting that our most recent hire, Dr. Leonid Pobezinsky, an immunologist, also investigates aspects related to cancer but his focus is on the immune system.

Vision and hires
Our vision for the future is captured by the theme “Origins of Endocrinological and Environmental Disease”, and the goals are to uncover the signaling mechanisms affected by endocrine disruptors and other common environmental pollutants so that sensitive tests can be devised for early detection, which will reduce exposure and avert damage to human, animals and the environment. Environmental toxicants pose hazards that are hard to fully quantify and the list of agents that have the potential to affect physiological systems continues to grow. Environmental toxicants and endocrine disruptors have broad effects on tissues and can impair development, reproduction and predispose to cancer as well as to neurological and metabolic diseases, including type 2 diabetes. In addition, detection of previous exposures may require many years to develop and it may require analyses in tissues of a persistent “signature” such as transcriptional and epigenetic signatures. Toward that end, we are requesting the hiring of a PI with expertise in “Transgenerational Epigenetics”, who will be able to decipher these signatures as well as find new ones. This position will also strengthen the on-going work on identification of biomarkers of breast cancer risk in breast epithelial cells, will bring much needed expertise to the campus on epigenetics and will establish close collaborations with the Reproduction and Developmental Biology group. The Endocrine and Environmental Factors of Disease group would also benefit from expertise on the Microbiome/Microbiota, as it has been shown that their alteration dramatically alters the prevalence of type 2 diabetes, which is not unlike the effects of atrazine on predisposing to insulin resistance and type 2 diabetes. It is worth noting that in the near future will be retirements within this group. In order to maintain research strength in this area and our Department research focus, we expect to hire to replace all retiring faculty. We would welcome the opportunity to do some “bridge hiring”, to facilitate the transition and incorporation of the new hire to the department.

Relation to the teaching curriculum: Besides teaching required courses for our curriculum, the faculty in this group provides teaching in toxicology and on cancer biology-related topics to the department and campus. Faculty in this group also contribute to several journal clubs.

- Envsci 315 Principles of Environmental Toxicology and Chemistry
- AnSci 385 Introductory Biotechnology Lab
- AnSci 494GI Good Intentions
- AnSci 585 Animal and Environmental Health
- AnSci 581 Cancer Biology-Fall 2015 will be the time that this course will be taught.
- Ansci 795A Cells, Genes & Development-JC
Graduate Program - Vision & Strategic Planning

Background

The Graduate Program in Animal Biotechnology & Biomedical Sciences (ABBS) is a departmental-based program of graduate study administered and overseen by the Department of Veterinary & Animal Sciences (VAS). Thesis and non-thesis masters degrees and doctoral degrees are awarded. In 2012 an intensive review of the ABBS graduate program was completed by Analytics Analysis. As a result of this comprehensive review, the ABBS program was recognized as an emerging top-tier graduate program on campus (see graphs comparing some parameters of research output of our department with similar ones at peer institutions). Collectively, the strength and accomplishments of the faculty, their overall consistent funding success, and the right-sizing of the program have contributed to its success in training high caliber PhD recipients who go on to well-placed post-doctoral and industry positions. The figures below from the aforementioned analysis show that in spite the small number of faculty, our program is among the top graduate programs in Animal Science in the country.

As indicated in the Research portion of this document, the Department of Veterinary and Animal Sciences has three distinct but integrated research foci (and subtopics):
1) Immunology & Infectious Disease
   Includes: Immunotherapy, immunomodulation and vaccines, and how they affect
   health and food security
2) Reproduction & Development
   Includes: Infertility, birth control, fetal development, stem cell therapy, and
   regenerative medicine
3) Environmental Toxicology & its Impact on Health & Disease
   Includes: Cancer, development, birth defects, and obesity

These three research areas are strongly linked by their extensive use of specialized and
unique animal models of disease. As such, the ABBS graduate program stands apart
from every other graduate program on campus. For example, across campus,
advancements in nanoplatform discovery have created the need for well-established in
vivo systems in which delivery of nanotherapeutics can be tested. The same could be
said when evaluating immune response and protection after vaccination as well as the
need to develop animal models of disease where to assess the implementation of
preventive or therapeutics approaches. As a result of these needs, strong inter-
departmental collaborations between teams of ABBS graduate students and students
from other departments such as Chemistry, Biology, Polymer Sciences & Engineering,
Chemical Engineering, Food Science, Epidemiology and Environmental Engineering
and the School of Public Health have flourished. It is against this backdrop of
collaborative venture that we provide our vision for the future of the ABBS Graduate
Program.

Vision for the Future of the Doctoral Program
Continued trajectory towards becoming a top-tier graduate program requires both the
desire and means to achieve this end. We outline our vision for the future of our
program by focusing on three key areas:

• Unique qualifications of the students our program attracts and graduate courses we
  offer
• Commitment to funding and maintaining the right-sizing of our program
• Unique strength as a catalyst for campus-wide collaborative research and training a
  qualified work force that is strongly aligned with the mission of the Institute for Applied
  Life Sciences recently established at UMass Amherst and the greater goals of the
  University

Unique qualifications of the students our program attracts and graduate courses
we offer

Our graduate program stands apart from others within the College of Natural Sciences
on several levels, and the skills and research interests of the students we attract reflect
this uniqueness. Students recruited into the ABBS graduate program almost uniformly
have strong backgrounds in tangible aspects of animal science; i.e. graduates of
established programs in animal sciences, including our own, as well as a strong
international cohort which includes many individuals already having completed DVMs. Thus, applicants to our program bring with them a rather specialized set of skills, many of which may limit their attractiveness to more molecular-based programs of study. Nonetheless, our admitted applicants frequently excel in the molecular aspects of faculty research as well as the animal based aspects, whereas we find students recruited from the more molecular-focused programs are less well-prepared for research that is heavily-dependent on animal models.

Our graduate curriculum offers two unique courses: *Cells, Genes, & Development* and *Advanced Immunology*. These courses support not only the graduate students in our department, but are becoming increasingly popular with graduate students in the interdisciplinary graduate programs. This is especially true of the Advanced Immunology course whose attendance has swelled from 8 (ABBS) students two years ago to 22 students this past year, many of them non-ABBS students. We fully envision continuing to provide this interdisciplinary support of graduate education through our ABBS-course offerings, driven by the high level of interest in applied research efforts across campus. We further require graduate level coursework in statistics so as to train students in understanding and adequately powering experimental design using animal models.

We envision creating a new graduate course, “Basic Research to Contribute to Solutions”, modeled on the success of the recently instituted undergraduate departmental integrated general education courses. We envision this course addressing topics such as: i) Solutions to the great neglected infectious diseases; ii) Vector-based solutions for HIV using CD4 decoys, as vaccine vehicles for antigen delivery, or to provide ongoing production of antibodies or hormones; iii) Animal health as it relates to human health, including zoonotic diseases and mitigating risks of pandemics; iv) The environment, endocrine disruptors and strategies for a cleaner environment; v) Contraceptives methods for all mammals; vi) Evaluating cancer risks. We would approach each topic using examples of both basic and applied research. We would engage students in these or other areas of global importance using team-based learning exercises with a strong emphasis on writing, hypothesis-driven applied research and experimental design, using a Gates Foundation model of grant proposal preparation.

**Commitment to funding and maintaining the right-sizing of our program**

Faculty within our department represent some of the best-funded on campus. Nonetheless, the cost of training graduate students is increasing at the same time awards are often being funded at reduced levels. As a result of maintaining the highest commitment to fully-funding ABBS graduate students, maintaining the right-size of our program is critical. Given the high and ever-increasing curriculum fee, it is impractical to raise the graduate student stipend to attract higher quality candidates; faculty would not be able to support graduate student training as their overall costs begin to approach that of a post-doctoral fellow. Because of the unique training of our applicants, they are exceptionally well-suited to support the undergraduate teaching mission of our department by serving as TAs for many of our animal care-focused classes. Thus, we
propose to continue to bring in two highly-qualified applicants each year for the foreseeable future, providing them with TA-supported lab rotations for their first year, and providing permanent labs for them thereafter, based on the funding status of individual faculty within the department. For the most part, our faculty labs are relatively small, with faculty mentoring 3-4 students on average (Masters and PhD). This low student-to-faculty ratio allows us to move students through their graduate training in a timely manner, with 74.7% of students completing their PhD in less than or equal to six years, with a median time to degree of 4.9 years. Bringing in two new students each year, coupled with timely graduation of students already in the program will allow us to right-size our program at about two dozen students, distributed fairly equally between Masters and PhD students. Commitment to and active pursuit of this “right-size for us” mentality allows us to continue to do what we do well, without trying to be “all things to all individuals”. It further provides flexibility for faculty to maintain research momentum by taking masters level students, if the PIs are between funding by major grants. This flexibility has been further enhanced by a recent endowment, the Frances and Chou-Chu Hong, D.V.M., Ph.D Graduate Fellowship in Veterinary and Animal Sciences, which will provide approximately $10,000 per year, this year and thereafter, to be used towards the stipend of a graduate student in the ABBS graduate program.

Unique strength as a catalyst for campus-wide collaborative research and training a qualified work force

Our collective training of students in the use of cutting edge molecular and cellular biotechnology, supported by extensive training using animal models prepares our ABBS graduates exceptionally well to pursue positions either in academia or industry. It also positions them well to support cross-campus collaborations that support the mission of the Institute of Applied Life Sciences (IALS) and the greater mission of the university in i) promoting translational research opportunities for graduate students and ii) strengthening and expanding ties between academia and industry. There are now a large and growing number of collaborations between VAS faculty and faculty in many department across campus. Many of these collaborations are built on the strong training in the use of primary cells and, further, in animal models of disease, provided by ABBS students. The ABBS graduate program provides a unique and sought-after training infrastructure that prepares students for future career trajectories in either academic or industry post-doctoral positions, or directly as staff scientists for biotechnology or pharmaceutical companies. These training opportunities include extensive experience in experimental design of hypothesis-driven research, training in the use of advanced biotechnology protocols and instruments, opportunities to promote research discovery to the greater scientific community through attendance at national and international conferences. The research areas supported within the labs of VAS faculty address real-world challenges such as those presented by analyzing the effects of environmental toxicants on health and disease, disease mechanisms of global health challenges for developing countries, understanding livestock health in support of greater global health, understanding basic immunology to gain insight into aberrations leading to immune dysregulation in autoimmunity and cancer, dissecting basic mechanisms of breast cancer, and understanding fundamental processes of human reproduction. Collectively,
these areas of high impact research provide training platforms for students to go on and truly impact the world in which they will be living and working.