

Department of Veterinary & Biomedical Sciences Strategic Plan 2020-2025

Spring 2020

The Rod of Asclepius was wielded by the Greek deity associated with healing and medicine. The original Hippocratic Oath began with a vow to Asclepius. Today, it is used by many veterinary and biomedical institutions to represent their commitment to improving health.



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Summary

The Department of Veterinary and Biomedical Sciences (VBS) builds on a long history of excellence in research, teaching, and outreach in biomedical sciences and veterinary medicine. We reached this level of expertise by focusing on supporting the combined efforts of our faculty to provide leadership in their respective areas of knowledge. This strategic plan will set forth four main goals in order to continue to build recognized leaders in our fields and sustain and build excellence in accordance with College and University goals. As a department, we plan to refine our course offerings, integrate our capabilities, seek new positions to complement the existing strengths, explore innovative funding avenues, and update our facilities in order to stay competitive and forward-looking in a challenging environment.

Our four primary goals are to:

- 1. Enhance our ability to prepare undergraduate and graduate students for the scientific challenges of tomorrow.**
- 2. Strengthen and extend our research impact on One Health and encourage research alliances across disciplines to better the lives of our stakeholders locally and globally.**
- 3. Develop new approaches to diagnostics, extension and outreach that will aid in application of new knowledge.**
- 4. Enhance diversity at all levels within the department.**

The department is focused on basic and translational research comprising immunology and infectious disease, molecular toxicology, pharmacology, and carcinogenesis, diagnostics, and extension research and outreach, related to active disease management, to ensure food quality and safety, animal, human, and environmental health. Faculty members conduct a wide variety of research in these areas and are called upon by national and international agencies as content experts in their respected fields. The overarching focus areas of our expertise include: Animal Diagnostics, Immunology and Infectious Disease, Molecular Toxicology and Carcinogenesis, and Veterinary Research and Extension (in the applied areas of livestock health and on-farm food safety). In order to better integrate and expand our focus, VBS along with the Institutes (Huck Institute of the Life Sciences, Penn State Cancer Institute, Social Sciences Research Institute, and Penn State Institute of Energy and Environment) are keen on expanding capabilities in interdisciplinary areas of immunotherapy, metabolomics, biomedical informatics, and medicinal chemistry as expertise in these areas will greatly facilitate our research efforts. In addition, recent faculty departures have increased our need to develop and recruit faculty in the areas of immunology and those with an interest in pathogenomics and metabolomics.

Transition and Outlook:

The department has seen remarkable changes and endured diverse challenges in the last five years. However, quite a few of the objectives from the last strategic plan have been fulfilled.

Most notably, Henning Building is being replaced with a brand-new facility with a department-controlled large seminar hall, consolidation of faculty currently in various buildings, recruitment of faculty with an interest in infectious disease, metabolomics, and biomedical informatics, and appointment of Dr. K. Sandeep Prabhu as the Department Head after many years without a person solidified in the role. These changes made advancements with regard to our previous strategic plan initiatives, and the Department has remained remarkably successful during this challenging period.

The primary goal during the last strategic plan period was to stabilize the department by hiring new faculty and working towards moving the department forward in achieving its mission. To solidify our involvement in the university's Strategic Plan, we worked together to implement our strategic plan to maintain and extend excellence in our signature areas. The success of our department depends upon the quality of its science and will result directly from the people who work here. We aim to continue to recruit the best scientists, support them well, and create an intellectual environment that allows ideas to accelerate rapidly and in unexpected directions to benefit and better human and animal health. Our partnerships and connections to the College and University are vital to this success. As we nurture this scientific team, what matters most is quality training, discipline, productivity, creativity, and the ability to attract, retain, and motivate the best students and faculty. As part of the new strategic plan, we yearn to push the boundaries of scientific investigation and operate at the leading edge. Also, the department engages in and encourages collaborative research alliances through a variety of mechanisms that integrate graduate training and research across disciplines. We will collaborate with other Departments within the College and across Penn State in emerging areas of research importance such as integrated health, food safety and security, highly infectious disease, and environmental stewardship and resilience. We will utilize our advances in these areas to improve human and animal health and well-being, promote sustainability, and to foster entrepreneurship, while connecting with our alumni and improving our networking with student's post-graduation.

Aligning with the College of Agricultural Science and the University's strategic plans, and Inter College Research Institutes, particularly The Huck Institutes of the Life Sciences, Penn State Cancer Institute, Social Sciences Research Institute, and Penn State Institute of Energy and the Environment, the Department of Veterinary and Biomedical Sciences 2020-2025 Strategic Plan will outline our areas of need, focus, and highlight opportunities for growth in educational and research programs that we anticipate will lead to national and international recognition and attract the best students, faculty, and researchers. We will continue to maintain an open environment that fosters basic and applied researchers, new ideas and interdepartmental collaborations so that the human and animal health questions and challenges of the next decade will be addressed by Penn State Scientists.

Our five primary prioritized key investments are:

- 1. Hire faculty to backfill vacant positions with a keen focus on increasing diversity.**
- 2. Crosscutting faculty hire in cancer immunology, bioinformatics, metabolomics, mucosal immunology, inflammation, or nutrition.**

- 3. New undergraduate teaching laboratory.**
- 4. VBS internal leadership development and hires that allow succession planning to offset retirements or other departures.**
- 5. Developing alumni relations.**

Mission, Vision, and Core Values

Department Mission Statement

The mission of the Department of VBS is to create and disseminate new knowledge related to the impact of environmental factors on animal and human health and well-being. We will apply such knowledge to improve health, food safety, and security, and environmental stewardship and resilience.

Department Vision Statement

The department will lead in the development and application of science-based new knowledge pertaining to the effects of the environment on animal and human health through excellence in basic and applied interdisciplinary research, state-of-the-art diagnostics, and extension outreach and research activities. VBS will be universally recognized for excellence in teaching and training the next generation of scientists, and animal and human healthcare professionals. We will continue to proactively respond to emerging challenges locally and globally in areas of integrated health with an emphasis on immunology and infectious disease, molecular toxicology and carcinogenesis, molecular diagnostics, agriculture and food systems, pre-harvest food safety, antimicrobial resistance, and animal welfare. VBS will act with integrity in accordance with the highest academic, professional, and ethical standards to evolve our learning to stimulate sustainability, innovation, and entrepreneurship, while fostering diversity and inclusivity.

Department Values

- Excellence and productivity in the scholarship of education, research, extension outreach and service as our highest priority.
- Creativity and innovation in education, research, extension outreach and service.
- Lifelong learning and access to information and knowledge for all Pennsylvania residents.
- Interdisciplinary collaboration and communication to solve complex problems for the common good.
- Dedication to diversity, multicultural understanding, and cross-cultural competence.
- Involvement, support, and encouragement of our partners and public to actively participate in the planning and implementation of College programs.
- Enhancing intramural and extramural cooperation.
- An atmosphere of mutual respect that promotes open sharing of ideas and viewpoints and debate of issues and concerns.

- The highest standards of integrity, honesty, responsibility, and accountability.
- Openness to change and responsiveness to emerging issues affecting society.
- An environment that nurtures personal and professional growth and development.
- Commitment to Penn State, the College of Agricultural Sciences and their mission.

College Values (2014-2019 Strategic Plan)

- Passionately pursuing excellence and innovation across all functions, using a team approach for solving complex problems to serve the common good.
- Fostering diversity, multicultural understanding, cross-cultural competency, and an atmosphere of mutual respect.
- Demonstrating integrity, honesty, openness, shared responsibility, and mutual accountability.
- Engaging students and stakeholders through listening, experiential learning, and problem solving.
- Stewarding resources responsibly and sustainably.
- Nurturing personal and professional growth and development.

University Values <https://universityethics.psu.edu/penn-state-values>

INTEGRITY: We act with integrity and honesty in accordance with the highest academic, professional, and ethical standards.

RESPECT: We respect and honor the dignity of each person, embrace civil discourse, and foster a diverse and inclusive community.

RESPONSIBILITY: We act responsibly, and we are accountable for our decisions, actions, and their consequences.

DISCOVERY: We seek and create new knowledge and understanding, and foster creativity and innovation, for the benefit of our communities, society, and the environment.

EXCELLENCE: We strive for excellence in all our endeavors as individuals, an institution, and a leader in higher education.

COMMUNITY: We work together for the betterment of our University, the communities we serve, and the world.

As a department, we place great value on the quality, productivity, and professionalism of our faculty, undergraduate and graduate students, post-doctoral scholars, and staff. While we take pride in our achievements, we recognize and promote the strengths of our many partners throughout the University. Our colleagues and partners include other units of the College, the Interdisciplinary Institutes, the University, the Commonwealth of Pennsylvania's Department of Agriculture and the Animal Health and Diagnostic Commission, and other animal agriculture stakeholders in Pennsylvania along with regional, national, and international partners. We seek to contribute in the most positive manner possible to the very high level of respect that has been

earned by The Pennsylvania State University.

Strategic Planning Process

Faculty of the Department of VBS were actively involved in the development of the department's 2020-2025 Strategic Plan, as there were multiple occasions provided to them to review the old plan and contribute to the new one. The members of the Department Head's Advisory Group were provided the 2014-19 Strategic Plan and asked to meet within their faculty groups comprised of thematic areas of Molecular Toxicology, Immunology and Infectious Disease, Animal Diagnostics Lab, Extension Outreach and Research, and Teaching, to discuss goals, objectives and measures of success that would benefit them in the next strategic plan. Once all goals and objectives were collected, they were compiled and redistributed to all faculty. A special faculty meeting was then held to solely focus on reviewing the compiled document, discussing the needs and wants of the department, selecting the goals, setting objectives, strategies and measures of success. Dr. Daniel Newhart, Assistant Vice-Provost for Planning, assisted the faculty who participated in this special meeting to construct a draft of these more defined and aligned goals, and the grounds for what will be the 2020-2025 Strategic Plan. Further reviews were conducted again by the Advisory Group, before being finalized by the Department Head. Therefore, the completion of the review of the 2020-2025 Strategic Plan that is articulated in the following pages is a collective effort by all members of VBS faculty with assistance from the administrative staff.

Achievements under Current Plan and Contributions to College Plan

The previous strategic plan listed three goals that the faculty wanted to see through in the 2014 through 2019. Some of the objectives for those goals were met, others deemed to be discontinued and some that need to be carried forward to the next strategic plan. The three main goals from the 2014-2019 were: **1.** Enhance Our Ability to Prepare Undergraduate and Graduate Students for the Scientific Challenges of Tomorrow; **2.** Strengthen and Extend Our Research on the Effects of the Environment on Animal and Human Health, and Encourage Research Alliances across Disciplinary Boundaries; and **3.** Develop New Approaches to Diagnostics and Outreach that Will Aid in Applications of New Knowledge to Our Focus Areas of Integrated Health, Agricultural and Food Systems, and Stimulate Sustainability and Entrepreneurship. The following objectives within goals that were completed:

- Established the One Health minor, originally called Public Health and are enrolling students.
- Successful funding of USDA NIFA Fellowship program “Training in Food, Nutrition, Intestinal Health, and Wellness” to train graduate students in an emphasis area within the department.
- Increased recruitment of undergraduate and graduate students to enhance enrollment.
- Developed opportunities for international study for our students.
- Developed lasting relationships with students after graduation.

Some of the objectives that were somewhat met, but should be continued as part of the next

strategic plan are:

- Increasing the number of Graduate Training Grants and/or participating in their successful renewal.
- Assist students in paying for their education.
- Lead the restructuring of graduate programs in partnership with the University and College.
- Increase research funding.

The department gained three highly talented faculty members under the last Strategic Plan, but lost others to chaired positions at other universities. It will be important for the VBS Department to replace the positions that were lost, but also retain the current faculty we have so that we do not continue to bleed talent. Given that the department has undergone many changes over the last few years, it was collectively decided to keep some objectives that were still relevant, while excluding those that were no longer viable. The objectives that we intend to move forward are highlighted in the following sections, it should be noted that as we continue to work towards previously set and completed goals and in moving forward, we have identified several new goals that will form part of the next strategic plan.

Recent Department Achievements

Based on the expertise, VBS faculty can be grouped into five thematic or emphasis areas that includes: Animal Diagnostics, Veterinary Extension and Research, Immunology and Infectious Disease, Molecular Toxicology and Carcinogenesis, and Undergraduate and Graduate Teaching and Advising Program. Following sections highlight the inter- and intra-programmatic collaborations and achievements over the past five years.

Animal Diagnostics Laboratory

The Penn State Animal Diagnostic Laboratory (ADL) is not only recognized as specialty veterinary diagnostic training facility for international veterinarians, scientists and students, but also is actively engaged in: 1) one-on-one consulting, 2) on-site training, 3) providing advice on establishing infrastructure for veterinary services and diagnostics, 4) collaborating on international surveillance projects, and 5) serving as international subject matter experts on diverse mammalian and avian diseases. As part of the constituent laboratory of the Pennsylvania Diagnostic Laboratory System (PADLS), the Animal Diagnostic Lab (ADL) faculty have a critical mandate to develop and validate diagnostic tests to detect, conduct surveillance, and diagnose diseases of mammalian and avian species in the State of Pennsylvania on a timely basis. The laboratory also conducts research on diseases of economic and zoonotic importance to animal and human health.

Over the last five years, our faculty met this mandate by developing a computer-aided image classification for histologic images using Artificial Intelligence-based learning system. With the classifications, the system can detect with an accuracy of 96-98% of diseased histologic regions in liver, lung and kidneys. Funded by the Defense Threat Reduction Agency (DTRA), ADL was engaged in capacity building of the Animal Health Diagnostic Laboratory at the University of

Veterinary Sciences in Lahore, Pakistan. Faculty at the University of Veterinary Sciences in Lahore were trained to create and establish molecular diagnostic testing services with a focus on molecular epidemiologic assays by current clinical faculty in VBS. The collaborative project resulted in five peer-reviewed publications.

Our clinical faculty have also made significant contributions in avian related diseases in the last five years. First, Dr. Kuchipudi worked with a private poultry company that supplied eggs for production of Avian Influenza (AI) vaccines to assess genetic lines capable of producing high virus titer load for use production of AI vaccines. This study immensely helped the poultry companies to reassess their genetic lines and improve the value of the embryonated eggs for AI vaccine production. Second, Dr. Pendleton developed *the Poultry Handling and Transportation Quality Assurance Program (PHTQAP)*, a national animal welfare certification and training module collaborating with the US Poultry and Egg Association. This program is now the national standard and mandated by many poultry operations for their employees to partake in and obtain the PHTQAP certification. Third, the faculty and research groups at ADL promptly responded to address the Avian Corzya outbreak of 2019 that affected tens of thousands of birds in Pennsylvania alone. Dr. Kuchipudi's group performed whole genome sequence analysis of 30 isolates of *Avibacterium paragallinarium* and used the information to develop a species-specific qPCR assay to detect this pathogen directly from suspect samples with a turnaround time of 48 hours. This assay was crucial for rapid diagnosis of this disease. Fourth, ADL played a significant role in assisting PADLS in their source tracking efforts to address an outbreak of *Streptococcus equi* subsp. *Zooepidemicus* in swine operations in PA. Drs Kuchipudi and Jayarao sequenced the isolates responsible for the outbreak in PA and are currently in the process of developing a strain specific qPCR for rapid diagnosis of this pathogen.

Finally, the faculty have developed and implemented a minor in One Health for undergraduate students in VBS and other programs at the university level. This minor is expected to grow as the One Health concept provides a holistic approach towards recognizing the interconnectedness between the health of animals, people and the environment. We are excited to support this minor through the next strategic plan and beyond. The faculty are actively training and mentoring undergraduate and graduate students, visiting veterinarians and scholars, and postdoctoral fellows from over a dozen countries in a variety of specialized areas related to veterinary diagnostics and epidemiology. We will continue to build and maintain our collaborative nature in the next strategic plan.

Veterinary Extension and Applied Research

The veterinarian faculty in Extension have many ways in which they serve the dairy and livestock industries, along with the allied support industries, in the Commonwealth, nationally, and around the world. The faculty has significant knowledge and practical experience in a wide range of topics that are of direct importance to the health and well-being of dairy and beef cattle, small ruminants, and camelids, as well as expertise in prudent antimicrobial use, biosecurity, food safety and food quality. There are exciting opportunities to significantly increase the creation of relevant online resources and learning experiences for farm employees and managers, as well allied industries, in both English and Spanish. At the same time, the faculty recognizes

there is an opportunity to produce and conduct more bilingual hands-on trainings and workshops throughout the state for farm employees, managers and owners, to teach skills and techniques that cannot be readily learned in an online, remote learning environment.

One of the major challenges facing this group of faculty is the lack of time that is needed to take advantage of the opportunities and to provide additional services. The team members carry a very significant resident education and World Campus teaching load, although only two of the four faculty have a teaching appointment, and their official allocation to teaching totals only 0.35 FTE. Three of the four faculty also carry a heavy advising load. We propose that adding another veterinarian to the faculty, assigned with a teaching/research or teaching/extension/research split, that would alleviate the current teaching burden and increase all faculty in this group the opportunity to take advantage of the initiatives identified above. The addition of a veterinary technician faculty position to support the team would also free up current faculty members time so that they could be more efficient and productive with their research, teaching, extension and field investigation activities.

Our faculty have been dedicated to providing service, testing and teaching locally and throughout the State of Pennsylvania. Dr. Hovingh conducted an extensive survey on the prevalence and distribution of foodborne pathogens in raw milk in Pennsylvania. The findings of this study revealed that the prevalence of foodborne pathogens in bulk tank milk in Pennsylvania is significantly lower than previously reported in the United States. Additionally, Dr. Barragan has been recognized by faculty, students, and industry workers for his work and teachings on to farm personnel in both English and Spanish. Our veterinary faculty are dedicated teachers, researchers and mission-driven community stakeholders, and these innovative changes will continue to add to the success and growth of the programs, students and communities they serve.

Immunology and Infectious Disease

Many of the objectives of the previous strategic plan related to the IID program were met, but there continues to be a need for efforts and allocations of resources to the area for success in the future. The faculty were successful in assisting with the implementation of a new graduate program at Penn State, the Molecular Cellular Integrative BioSciences (MCIBS) with IID as a major emphasis area. The faculty completed a successful rebranding of the Pathobiology Graduate Program web page that contributed to the increase in the recruitment of graduate students with an interest in IID. However, it is clear that more effort is needed to expand our visibility in order to increase graduate applicants in the MCIBS and Pathobiology graduate programs. Additionally, we will continue to work towards enhancing and increasing the recruitment efforts and retention of students in the undergraduate majors. Due to the tireless effort of Drs Acar and Hankey and a robust research portfolio, the IID undergraduate recruitment effort has been excellent, but that presents a major challenge for the existing faculty to meet the needs of larger cohorts of students.

Most of the faculty have been successful in obtaining continuous extramural funding for their programs, and we will build upon this in the years to come. Funding was obtained for projects related to inflammation, nutritional immunology, red cell development, microbiology, food safety, bacterial pathogenesis, and virology. This variety and continued successful funding of grants is a testament to the strong research portfolio of our faculty. The funding also led to an

outstanding number of publications, patents, and extramural grants, and as a result, this brought visibility to our new facilities such as ABSL-3 and the Gnotobiotic Core here at Penn State. Drs Hankey and Kennett led the NIH-funded training (T32) grant on “Animal Models of Inflammation” during the last strategic planning period (unsuccessful in its renewal for the new strategic plan), and Dr. Cantorna has taken the lead as a Co-PI on another NIH predoctoral training (T32) grant on “Research Training in Physiological Adaptations to Stress”. Such training platforms are needed to increase the graduate student recruitment along with highly trained faculty with a vision of further growing the programs. Hiring additional faculty is part of the new strategic plan as we continue to promote our visibility and recruitment of undergraduate and graduate students, and post-doctoral trainees.

Molecular Toxicology and Carcinogenesis

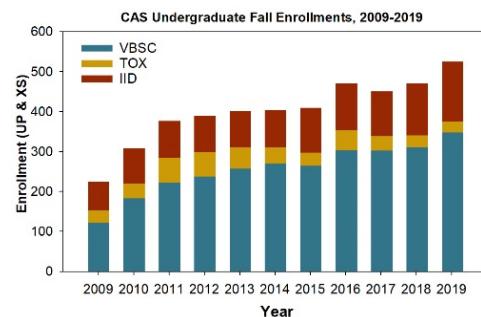
During the last strategic plan period, the Toxicology group saw some changes, some improvements, and some ways to improve. Enrollment in the Toxicology undergraduate major was modest, but the group developed a strategy to increase enrollment in the Toxicology major by revising the curriculum and renaming the program as Pharmacology and Toxicology (PCTX). Such a change has been approved by the Faculty Senate, which will allow us to grow this major and appeal to a wider range of students. We feel as though continued exposure of our major and through continued recruitment efforts, this major will grow and succeed under the new strategic plan. The Molecular Toxicology (MT) graduate program was merged with MCIBS under the old strategic plan. With this change, there are now three emphasis areas that are major efforts of the faculty that include: Molecular Toxicology, Cancer Biology, and Immunology and Infectious Diseases. The Cancer Biology emphasis was added in 2019, led by the efforts of Dr. Glick.

The toxicology faculty proposed to the Huck the development of the Metabolomics facility and were responsible for the recruitment of Dr. Patterson to lead this effort. This goal has been achieved and is now one of the best metabolomics centers in the country. In addition, an additional hire has been made in the metabolomics area, Dr. Kellogg, to further expand our efforts in this important technology that will integrate in all areas within VBS and the College of Agricultural Sciences. This new resource has enabled numerous collaborations from within and outside the university to extract chemical fingerprints at high resolution to be applied using chemometrics to solve both descriptive and predictive problems in experimental biological systems within all areas of natural sciences. Thus, the Metabolomics Core serves as a model for successful intra- and inter-collegiate and university collaborative projects.

In the last five years, the USDA training grant (PI-Perdew) was a success in terms of publications and trainees, but unfortunately the grant mechanism was not renewable. However, this program served as a template for the development of an NIH training (T32) grant entitled “Integrative Analysis of Metabolic Phenotypes (IAMP) Predoctoral Training Program”, which was funded and will start in 2020. The PI of this grant is Dr. Patterson and co-PI is Dr. Perdew. Dr. Patterson was also successfully awarded a High-End Instrumentation Grant award (S10) from the NIH to purchase the Thermo Fisher Orbitrap Fusion Lumos mass spectrometer for the Metabolomics Core Facility that he directs

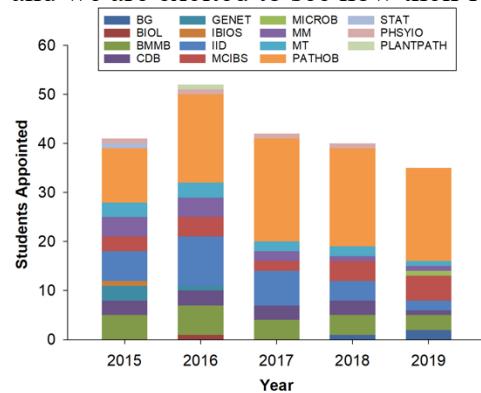
Undergraduate and Graduate Enrollment, Students, and Teaching

All our undergraduate majors will continue with the recruitment efforts at the department, college, and university level to increase enrollment. This is an ongoing objective which will carry over to the next strategic plan. It is anticipated that enrollment will increase based on the work done in the previous plan. In our three undergraduate majors, VBSC, IID, and TOX (now PCTX), we are excited to see that from 2015 to present, our undergraduate student enrollment numbers have increased from 380 to over 500 at UP and other branch campuses (XS). This was made possible given the continued support by the college, recruitment efforts by the faculty and staff, and the robust current course offerings with hands-on



research experience. Additionally, the proposed Public Health Minor was finally approved under the name of “One Health” and is currently enrolling students in the minor. For these majors, the newly recruited faculty members (three tenure-track, one teaching, five clinical, one instructor) were able to teach and develop courses in these areas. We are excited to see what expertise these new faculty and perspective faculty can bring to our students and our courses.

The Pathobiology Graduate Program (Patho), which represents VBS’s flagship graduate program, remains strong, currently has 19 students enrolled, with more on the way as recruitment for Fall 2020 finalizes. Our Patho graduate students come from a diverse and global background, and we are excited to see how their research contributes to the biomedical field and where their



studies take them. Additionally, our faculty are actively involved in advising students in several inter-college graduate programs such as Molecular, Cellular, and Integrative Biosciences (MCIBS), Biochemistry and Molecular Biology, and Physiology. Upon graduation, our graduate students advised by our faculty (and appointed through VBS) have taken up industry positions in Celgene, Genentech, Pfizer, Merck, Chevron, and Rubius. Our students have also opted for post-doctoral training in academic institutions such as St. Jude Children’s Research Hospital, The University

of Pennsylvania, The University of San Francisco, Harvard Medical School, Cleveland Clinic, Vanderbilt University, and National Institutes of Health, and Cedars-Sinai Medical Center, to name a few. We are very proud of our alumni and their accomplishments. Our efforts include continued support and sustained connections with them in the years to come.

Faculty and Staff

Since 2015, we have welcomed 13 new faculty members into tenure-track, non-tenure track, and clinical positions at assistant and associate professor levels. Of these 13 new faculty, six were women, four were hired from international institutions, and one is an underrepresented minority (URM) as defined by the College of Agricultural Sciences Diversity Definitions¹. This is by far

¹ (Diversity Definitions, 2020)

the most diverse cohort of hires that the department has generated, and we are enthusiastic to continue the trend. However, we recognize that we are lagging in diversity with regard to tenure-track faculty and are prepared to address this issue in the form a major goal for the 2020-2025 plan.

From 2015-2018, the faculty of our department generated over \$46,000,000 worth of grants and have used that money to make novel discoveries in the areas of human and animals disease, cancer, and health; hire excellent post-docs, graduate students; attend conferences and have their research highlighted in invited talks and seminars. Additionally, the funding led to over 400 articles accepted and published in referred journals by VBS faculty. Most of these research articles were co-authored by post docs and graduate students along with their PIs. This speaks highly to the collaborative and collective group of scientists who work in the department as a whole. Our faculty also received numerous awards and recognitions from both Penn State and International Societies in the last five years. We have ambitious faculty that we are eager to continue to retain in the coming years.

With regard to the departmental staff, VBS has experienced almost full turnover in the last five years, suggesting that one of the priorities for 2020-2025 will be to retain and train our staff and continue to build a strong department in every respect. This includes streamlining procedures, recognizing dedication and hard work, and prioritize participation in committee work at the department, college, and university levels when appropriate. Being able to retain staff is critical to maintaining institutional knowledge and should continue to be something that the department continues to contribute as a whole. Such a highly competent support system is needed for future success of the department to ensure long-term stability.

Collaborations

The department has a strong history of fostering extensive national and international collaborations. VBS faculty collaborate with colleagues in other colleges at Penn State's UP campus and other branch campuses, and two other laboratories of the Pennsylvania Department of Agriculture's Diagnostic Laboratory System (PADLS). Our faculty, particularly those engaged in Extension outreach and ADL, have deep interactions with the farming community within the Commonwealth. Faculty have established research collaborations with many institutions including University of Pennsylvania, University of Maryland, Harvard Medical School, University of San Francisco, and the National Institutes of Health to name a few. Although part of the Penn State system, VBS faculty have long-standing collaborations with the faculty at the College of Medicine and Penn State Cancer Institute, Hershey. At the international level, faculty maintain collaborations with National Agricultural University, La Molina in Lima, Peru, Slovak Republic, Romania, Czech Republic, Spain, China, and India, with active teaching and research projects. In addition, our faculty have interactions with pharmaceutical and biotechnology companies, medical devices' companies, and ag industries, where they conduct collaborative research. Some of these entities also support research personnel in the form of veterinary clinical residents, post-doctoral fellows, graduate students, or research technicians, and provide some support for undergraduate research.

While majority of our faculty are funded through federal grants, our faculty also work with Defense Threat Reduction Agency (DTRA) Partner Countries to improve and modernize their veterinary education, so that they are in-line with international standards and conform with the OIE (World Organization for Animal Health) Day One Curriculum. They seek out extramural funding to set-up twinning programs between DTRA partner country veterinary schools and Western veterinary schools. They also perform gap analysis on the veterinary educational system and make recommendations for improvement and modernization. Our faculty engage veterinary school faculty in DTRA partner countries in order to serve as DTRA trainers to train host country veterinarians and seek institutionalization of the new training materials into the veterinary school curricula of the host country. This program works to improve public health in Russia, Kazakhstan, Azerbaijan, Georgia, Armenia, Pakistan, Tanzania, and Kenya.

Our faculty also work as collaborators on research projects in many countries, mainly interacting with Ministry of Agriculture or Ministry of Health employees. They are always looking for opportunities to engage students in professional schools with their research. In some cases, our faculty interact with research institutes within the host nation, and often there are graduate students studying within those institutes. Our roles are to assist in experimental design, provide mentorship and help with the writing of proposals; deliver technical assistance in performing research, mentor host country primary investigators and graduate students in the execution and interpretation of the research; and lend assistance with publications in peer-reviewed journals. We look forward to continued engagement in collaborations nationally and internationally in all areas within VBS in the next strategic plan period.

Strategic Challenges and Opportunities

Animal Diagnostics Laboratory

The next generation of rapid diagnostic screening tests (lateral flow immunoassays and nucleic acid-based assays) will replace many of the traditional testing now performed in animal diagnostic laboratories. It is anticipated that more diagnostic tests and applications will be performed at the veterinary clinic or at the farm at a higher frequency. This will drive the Veterinary Diagnostic Laboratories, including ADL to reshape themselves to capture niche markets or offer specialized testing by having an edge on one or several of diagnostic requirements (high throughput, rapid turnaround time, mail-based services, and diagnostic service packages).

In order to be viable, relevant, and competitive in the current diagnostic market, the existing operational space that ADL is not adequate to meet the future challenges. ADL needs state-of-the-art operational space to perform contemporary diagnostics. We foresee that Penn State ADL's ability to continue to offer reliable, quality and state of the art diagnostic services to our clientele will be compromised largely due to constraints presented by existing declining infrastructure. Our current facility is over 50 years old and is not amenable for further renovation or expansion. What we look forward to seeing in a new space are the following:

- An educational center for hands-on training for students, producers, industry, and veterinarians.
- A flexible floor plan that can be converted to a swing laboratory space to accommodate additional testing in the event of a high consequence disease outbreak.
- A research unit/facility that is solely focused on developing the next generation of diagnostic tests.
- An affiliate ADL laboratory or a unit dedicated for preparing reagents, autogenous vaccines and lateral flow devices for the animal health industry.

Over the next five to ten years, ADL will need to replace or hire faculty and staff with contemporary skills and expertise in order to meet the needs of the food animal industry. Future faculty replacements at ADL should include hiring board certified veterinarians for providing diagnostic services (50-70%) and diagnostic test development (30-50%) for both infectious and non-infectious diseases, or with an appointment (30-50%) to develop fee-based specialized training programs (international externships in diagnostic medicine, genomics medicine, veterinary forensics, telemedicine diagnostic services), and also assist in teaching courses in the VBSC rubric.

Veterinary Extension and Applied Research

The Extension veterinarians see an opportunity to increase interest in biosecurity and disease prevention throughout Pennsylvania, and possibly nationally in the next 5-10 years, by expanding their operation and services. The drive here is that an increase in public interest will lead to an increase in funding opportunities and sources. Notably, the recent addition of a Spanish-speaking veterinarian has led to a significant increase in the population of farm personnel that as a group, we are able to serve. In eliminating the language barrier, we have been able to educate more farm personnel overall, and this continues to receive only positive feedback. This change allowed us to begin teaching students basic farm/dairy related Spanish as a summer course, which also gives them hands-on and bi-lingual experience. There is still work to be done in this, as farming is conducted in a variety of languages, and we will look for ways to incorporate that philosophy into the veterinarians that we will seek to assist us, because we have only received positive feedback regarding our addition of Spanish-speaking veterinarians. We are anxious to see how this continues to grow and be prosperous for Extension. Moving forward, there is a need to continue to progressively attract diverse faculty in the Extension group, while maintaining a high visibility to those we currently service.

Immunology and Infectious Disease

With the aging population and unhealthy lifestyle in US, the disease and economic burden has shifted towards cancer, autoimmune diseases, addictions, and immune diseases due to metabolic syndromes. All these diseases have major immune components in their pathophysiology, either as their root cause or as the effect of these on immune response. Latest developments indicate that immune-based therapy or approaches hold promise in treating or managing these diseases. However, there is a big void at Penn State to address these impending epidemics (or pandemics), which will have direct impact on Pennsylvania demographics. Therefore, there is a need to expand our faculty-based research to include the area that covers the intersection of immunology

and autoimmune diseases, parasitology, cancer, and addictions (in the form of new recruitment of tenure-track faculty at all levels). This will position the VBS Department and the College to tap into likelihood of a major funding boost by federal and state agencies in these areas. As detailed in the University's Strategic Plan that has been reiterated by the University Health Sciences Council (UHSC), Penn State has already committed significant investment in cancer and opioid addiction and parasitology, through the support of programs at the Penn State Cancer Institute, the Social Sciences Research Institute, and the Huck Institute of the Life Sciences, respectively. Our faculty have a long-standing interaction with these institutes and are strategically placed to contribute to Penn State's mission as a global leader in immunology and infectious disease via such strategic hires. In order to fulfill these goals, we propose to recruit additional faculty in the areas of microbial pathogenesis, parasite immunology, oncoimmunology, immunogenomics, and other cross-disciplinary areas. As with the previous plan, we will continue to build on our strengths in the field of immunology as related to infectious diseases and inflammation. This will be a challenging phase due to the recent departure of several faculty critical to the area. However, the outlook is optimistic with the hire of two new faculty members. We are also poised to hire new faculty in the areas of mucosal immunology and general immunology, which will significantly add to the existing strengths and extend the range of expertise for the area.

There are opportunities that exist for a close collaboration with ADL and Immunology faculty to address significant nutritional and infectious disease related problems in animal industry. With the emergence and rapid spread of new viruses that threaten livestock industry and human health (nationally and globally), there is a need to understand the viral pathogenesis with a particular focus on how they interact with the host immune system that enables them to increase host range and pathogenesis. An example of a possible tenure-track faculty hired by the department would have a focus on the viral pathogenesis with an interest in human and animal viruses using “one health approaches”, such as African Swine Fever, with the ultimate goal of developing a novel vaccine platform that could be broadly applicable to most emerging infections, including the SARS-CoV2 pandemic and other emerging viruses that cause multiorgan failure. This individual will study how gene-encoded ‘pattern’ recognition motifs within the antibody repertoire naturally support recognition of normally ‘difficult to see’ or rapidly mutating vaccine targets on viruses. These targets can then be tested using novel humanized mouse vaccine models. With this model, one can systematically evaluate the immunoglobulin-gene encoded contribution to the formation of an antibody paratope, all as a function of immune challenge. This will provide novel “universal vaccine” candidate platforms to rapidly test in a variety of diseases that are seen within the Commonwealth and this position will bolster basic research in host-viral interactions. These integrated and multidisciplinary solutions for food and biosecurity falls within the scope of the department and college strategic plans and positions the VBS department in the forefront of emerging infectious disease research.

Several faculty within the department are playing a vital role in University's effort to combat the global health and economic challenges of COVID-19. With funded projects related to diagnostics, therapeutics, animal models, and molecular studies, our faculty are poised to make substantial contributions to the field. These ongoing studies also highlight the highly collaborative and interdisciplinary nature of research programs of our faculty. Leveraging these grants, IID faculty have initiated joint projects with faculty within (from ADL and Molecular

Toxicology) and outside of VBS (Engineering, BMB, Kinesiology) to examine novel interventions related to nCOV2 pathogenesis. The unique expertise and facilities managed by the IID faculty provides a great opportunity to obtain funding from federal sources and industry partners to position VBS and the College to be recognized as leaders in infectious disease research. This opportunity has also exposed the limitation of IID faculty in terms of expertise in host responses to emerging viral diseases.

Finally, the significant expansion of IID undergraduate program poses a challenge for the existing faculty to fulfill the needs of future students. Particularly, training in the areas of immunology and infectious diseases such as vaccinology, mucosal immunology, clinical immunology, and applied immunology, including immunotoxicology and immunooncology, will benefit our students to face the real-world challenges and provide a successful career pathway. Therefore, there is a significant need to develop (and recruit faculty to teach) these courses, including a lab-based course to prepare students for higher education or potential employment.

Molecular Toxicology and Carcinogenesis

Toxicology is an interdisciplinary science that draws upon expertise across a wide range of fields from physiology, biochemistry, metabolism, immunology, epidemiology, and social sciences. The application of information derived from toxicology influences humans and other species because it can: 1) be used to determine the relatively safety profile of numerous chemical agents used in today's society; 2) delineate mechanisms of how chemicals cause toxicities and cancer; 3) provide the foundation to determine the hazards and risk of exposures to environmental chemicals; 4) identify biomarkers to determine relative exposure of environmental chemicals, 5) help develop approaches to mitigate environmental hazards, 6) used to develop therapeutic approaches to treat/prevent toxicities caused by exposure to environmental chemicals, and many others. The field of toxicology is therefore paramount to the continued survival of many species and relies on interdisciplinary approaches to achieve this goal.

To address the health impact of environmental exposures for the 21st century, the Toxicology group is committed to maintaining its world-class status in the area of receptor-mediated toxicology and expand its efforts in the field of carcinogenesis and metabolism. We want to incorporate new areas of expertise being developed by the Toxicology group, such as studying the role of the microbiome and gastrointestinal health in modulating the toxic and carcinogenic effect of environmental chemicals and how dietary components regulate these metabolic pathways. There is also increasing evidence that the immune system may have an important regulatory role in both toxicology and cancers. Thus, the addition of faculty members with expertise in the field of gastrointestinal health and mucosal immunology would help the toxicology group achieve these new goals. New faculty members with this expertise would greatly complement the current expertise of the Toxicology group including incorporation of microbiological, metabolomic, and genomic methodologies into most faculty member's research and teaching program. The recent addition of Drs Hall (genomics) and Kellogg (metabolomics, natural products) will contribute to the goal of maintaining and building on the expertise of the Toxicology group. Successful incorporation of these cutting-edge techniques and successful recruitment of interdisciplinary new faculty members will require support for the College of Agricultural Sciences, Huck Institutes, and Institutes for the Energy and Environment. Through

these efforts, the Toxicology group will continue to evolve and remain a world-class, unique research group that is highly competitive and successful in acquiring extramural funding and fulfilling its teaching mission.

Teaching

Veterinary and Biomedical Sciences (VBSC) is a successful major and the enrollment and graduation numbers are on the rise, which has placed a lot of strain on the faculty to appropriately advise and teach both the required and supported courses. Many of the faculty that teach VBSC courses do not have teaching appointments or teach significantly more than their current appointment dictates. Most of the VBSC courses that are required of the major are completely filled and there are little to no opportunities to expand with our current teaching faculty to meet the demand of increased enrollment. The current need for increased support for teaching and advising in the VBSC Major will significantly increase with multiple potential retirements that could occur during the next 5 years, including faculty that contribute to VBSC 421 (lab and lecture), VBSC 403, VBSC 050, multiple 400-level supporting courses, and advising of greater than half our current VBSC students. Currently, there is a desperate need for laboratory space to teach VBSC 421 (Comparative Anatomy Laboratory) in a most effective manner considering the growth of the major. Having a dedicated laboratory for teaching would not only allow us to handle the increasing enrollment, but the room could be set up in a way to improve the safety, flow of people, and comfort of the classroom. This laboratory could also be used for other VBSC courses that have a laboratory component, as well as extracurricular activities (e.g. workshops, hands-on lectures).

Immunology and Infectious Disease (IID) major has been a thriving major in the last five years. The undecided student pool has been a great source for students to enroll in the IID major. A significant expansion of IID undergraduate program poses a challenge for the existing faculty to fulfill the needs of future students. Particularly, training in the areas of immunology and infectious diseases such as vaccinology, mucosal immunology, clinical immunology, and applied immunology that will benefit our students to face the real-world challenges and grab future opportunities. Previous and recent departures of faculty created a big void, particularly in teaching of some of the required courses. Even with the new two hires, the need for new faculty in the areas of mucosal immunology, and general immunology will significantly add to the existing strengths and extend the range of expertise within and outside the department. A hands-on laboratory course in the area of immunology with focus on diagnostics will prepare IID students to be “job-ready” in diagnostics labs, pharmaceutical, and biotech industries.

Toxicology major has seen a decline in the last five years, most likely due to “Name recognition” and attracting first- and second-year students into the major. The department is in the process of collecting data on graduating senior students and alumni, which has been a challenge and requires investing time which we are short on. We are also looking at ways to get the first- and second-year students to interact more as a cohort. This may assist with the retention in this major as well. We are also looking to increase the scholarship opportunities for Toxicology majors both departmentally and university wide, as a way to entice and attract students to stay in the major. Lastly, increasing opportunities at job fairs within the College or the University to have more opportunities for Toxicology students to interact or see what their major can lead to in terms of

academic or industry would be of great help in retention rates.

Finally, the current Toxicology program has undergone a recent name change in addition to an overhaul of the curriculum, and it is now called Pharmacology and Toxicology (PCTX). We see this as a more inclusive opportunity to increase the enrollment in the major. Advertising the major through Department and College web sites, social media, and handouts will be continued to attract undecided students.

Opportunities for Majors

Veterinary and Biomedical Sciences

With the current trend of an increased interest in this major, we propose that hiring faculty to fill the teaching need be a priority to proactively address the demands associated with increasing student enrollment and to not lose the opportunity to pass along institutional knowledge. In hiring new faculty, we should really strive to find a veterinarian to contribute to teaching and advising in the VBSC curriculum. This individual would also contribute to advising VBSC students and teaching in VBSC 050 as well as various VBSC 400-level courses. We should also provide a mechanism for Veterinary Extension and ADL faculty to have some teaching appointment for VBSC courses that they instruct in. However, this might overburden the current faculty, so additions to their resources would need to be made first. This major needs a teaching laboratory dedicated to VBSC courses, particularly VBSC 421 (Veterinary Anatomy). Finally, we need to provide an additional applied course for VBSC students on various aspects of the diagnostic process in varying animal health settings, to round out our major and not rely so much on Biology.

During 2019-2020, Dr. Justin Brown received funds from the College of Agricultural Sciences to host two workshops (Fall and Spring) at Metzger Animal Hospital in State College, PA. The workshop, entitled *Applied Use of Laboratory Diagnostics in a Small Animal Clinic Setting*, exposed 40 VBSC students to various in-clinic diagnostics (e.g. hematology and biochemistry). The post-workshop assessment indicated that the students found the experience very valuable and would like to see it expanded into a course in the VBSC major. Currently, it is not possible to provide this course due to existing teaching load. However, if currently listed goals were accomplished under this Strategic Plan, we would be able to pursue this course to retain students and apply what they are learning in the classroom in an actual veterinarian setting. Finally, we have but would like to expand upon our abilities to include international research opportunities, veterinary student externships in nutrition or reproduction, and additional continuing education events.

Immunology and Infectious Disease

The challenges that presented themselves over the last five years that would benefit the IID group in the next five years include modifying the current curriculum to fit the future needs of the program. As the enrollment within the IID major increases, we anticipate the need to make arrangements for faculty be able to teach large classes without overburdening themselves. Since experiential learning also includes independent research credits (VBSC 496 and 494H) that does

not get counted for student contact hours, the faculty have proposed to convert the independent studies course 496 into a full-fledged practicum course that would offer greater benefit to the students in terms of laboratory research in addition to instructional support in areas such as bioethics and data analysis. As previously stated, the recruitment of additional and diverse faculty will enhance the quality of the program with course offerings in areas of interest and need, such as Vaccinology and Mucosal Immunology.

We have also identified the need to seek more scholarships and internship opportunities, to make sure that our students are financially motivated to stay in the program, and that they stay actively engaged in the program through all four years. In order to revitalize the curriculum, we would like to also develop a lab-based course, convert VBSC 211 into a General Education Course, and develop a clinical immunology course in association with ADL. Such changes and collaborations will help us showcase the diverse strengths within our department and ultimately make our IID undergraduate major a well-rounded program. We anticipate that such a strong curriculum will enable our graduates to enter the workforce even during challenging times.

Toxicology

In response to enrollment that have remained low, but steady, we have changed this major in the hopes that we can increase enrollment and excitement for this major to undergraduate students. Addition for Pharmacology has allowed us to create and rebrand the Tox major as Pharmacology and Toxicology (PCTX) major. This should change the way enrollment was headed when the major was just Toxicology, and therefore we should see improvements to our overall enrollment. While we increase enrollment, we will also need to work with the College to provide opportunities for PCTX students to interact with federal and state toxicology labs and pharma companies to enhance their exposure and create career options following graduation. An example of this would be to make sure companies that work with these students are invited to University or College-sponsored career fair events year-round. We will also need to provide undergraduate research opportunities to promote hands-on and practical learning considering that companies value lab experience. We should also look to increased networking and possible connections with VBS alumni in major health and pharmaceutical companies to establish internships and externships for students.

Unit Goals and Strategies for 2020-2025

The Department of Veterinary and Biomedical Sciences, in working in conjunction with the College of Agricultural Sciences and the University, have created a set of unit goals with related objectives and strategies to further enhance the department, attract the best undergraduate and graduate students, retain productive post-doctoral scholars and faculty, and continue our mission to be the best in areas of human and animal health, and where the two intersect. Our goals were created by the faculty, to be beneficial to faculty, staff, students, alumni, and our stakeholders as well as be in line with the College and University's Strategic Plans.

The Department of VBS currently has 35 faculty (down from 45 when the last strategic plan was created): 18 tenure-track faculty, 17 non tenure-track faculty, 28 research staff members and nine administrative staff members.

Goal #1 – Enhance our ability to prepare undergraduate and graduate students for the challenges of tomorrow

Objective	Key Performance Indicators	Measures of Success
Improve number of teaching faculty to cover all required courses in our majors (UG)	<ul style="list-style-type: none">• Number of Immunology faculty to create and teach Vaccinology, Clinical Immunology, Mucosal Immunology, and Applied Immunology courses• Number of TOX faculty to create and teach Toxicology and Pharmacology courses• Number of veterinarians as faculty	<ul style="list-style-type: none">• 100% IID courses with qualified Immunology teachers• 100% PCTX courses with qualified Pharmacology and Toxicology teachers• Increase the number of veterinarians teaching in our courses
Improve the quality of the undergraduate education experience (UG)	<ul style="list-style-type: none">• Number of new courses developed• Number of curricular revisions• Number of new laboratory courses• Number of organized interactions between students and faculty	<ul style="list-style-type: none">• 1-2 new courses/major• 1 curricular revision per 3 years/major• Add 1 laboratory course for PCTX and IID• 1-2 social events per year/major
Increase recruitment and retention of undergraduate students into our programs (UG)	<ul style="list-style-type: none">• Student enrollment• Graduation rate• Faculty participation in recruitment• Current student involvement in recruitment• Number of social media posts• GPA upon graduation• Job placement upon graduation	<ul style="list-style-type: none">• Enrollment and retention numbers by 10% per year• Maintain current graduation rate• Increased faculty participation• Increased student participation• Regular social media posts• Maintain graduating GPA at current• Maintain graduate placement at current
Improve the quality of the graduate education experience (Grad)	<ul style="list-style-type: none">• Number of Training grants within department• Number of interdisciplinary training grants faculty participate• Transition some courses to World Campus	<ul style="list-style-type: none">• One T32 training grant within department• Increase number of training grant opportunities for our students that originate in other departments

Increase recruitment efforts for graduate students into our programs. (Grad)	<ul style="list-style-type: none"> • Student enrollment • Faculty participation in recruitment • Current student involvement in recruitment • Number of social media posts • Job placement upon graduation 	<ul style="list-style-type: none"> • Increased enrollment and retention numbers by 10%/year • Increased faculty participation • Increased student participation • Regular social media posts • Maintain graduate placement at current
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Goal #2 – Strengthen and extend our research impact on One Health and encourage research alliances across disciplines to better the lives of our stakeholders locally and globally.

Objective	Key Performance Indicators	Measures of Success
Expand cross disciplinary research efforts in microbiome, metabolome, toxicology/cancer, gut health, viral pathogenesis, and immunology	<ul style="list-style-type: none"> • Hire two faculty members; one in gastrointestinal health and another in mucosal immunology • Work with microbiome center to expand microbiome research across campus • Work with metabolomics facility to expand capabilities to assess the metabolome of the microbiota <i>in vivo</i> and <i>in vitro</i> • Establish a program to study the effect of toxicants directly on the microbiota • Collaborate with groups to expand efforts on integration of multi-omics data 	<ul style="list-style-type: none"> • Successful faculty collaboration as seen in the form of grants, publications, external speaking engagements
Maintain and expand in the research area of toxicology/cancer and nuclear receptors	<ul style="list-style-type: none"> • Training grants to support faculty in this area • Hire one additional faculty member in toxicology/pharmacology and nuclear receptors • Host national and international meetings to increase visibility 	<ul style="list-style-type: none"> • Increased number of applications and funded grants • Successful hire • Conduct Summer Symposia and workshops
Increase visibility and improve the new PCTX major and One Health minor. Increase recruitment efforts for all.	<ul style="list-style-type: none"> • Publicize One Health minor • Start LinkedIn group • Increase social media presence (e.g., Twitter, Instagram) • Increase presence at recruitment events for especially PCTX major, One Health minor • Enhancing “majors” web site to be more visible • Involving alumni to spread the word on all three majors • Revamp the PCTX curriculum: add VBSC 3XX; replace BIOL 472 with BIOL 141 • VBSC 230 to be converted to a GEN ED course • VBSC 230 and VBSC 485 on-line courses/World Campus • Organize a welcome event every Fall for PCTX students 	<ul style="list-style-type: none"> • Increase enrollment and quality of new major • Enroll students in minor • Increase presence at recruitment fairs/conferences • Graduated student testimonials

	<ul style="list-style-type: none"> Participate in an event for all graduating VBSC/TOX/IID seniors and their families 	
New Building for ADL	<ul style="list-style-type: none"> Work with the leadership (locally and Harrisburg) 	<ul style="list-style-type: none"> New building
Training Grants	<ul style="list-style-type: none"> A T32 to replace “animal models of inflammation” Collaborate in other university training grant opportunities and successfully develop new training grant proposals 	<ul style="list-style-type: none"> Accounting of students and student success Number and quality of training programs
Discovery of integrated health solutions. Establishing One Health Research Portfolio.	<ul style="list-style-type: none"> Collaboration with ADL and extension groups in the area of nutritional and emerging and novel infectious diseases Collaboration with bioengineers for testing new and novel diagnostic (AI-based) platforms 	<ul style="list-style-type: none"> Successful collaborations in grants, publications and patents.

Goal #3 – Develop new approaches to diagnostics, Extension and outreach that will aid in application of new knowledge

Objective	Key Performance Indicators	Measures of Success
Expand reach and impact of Department Activities (alumni and government) extension and outreach (veterinary CE) efforts	<ul style="list-style-type: none"> Revamp and offer the next iteration of the Dairy Production Medicine Certificate programs for veterinarians. Develop and market a “Dairy Production Medicine”-like program in Spanish, especially targeting veterinarians and animal health professionals in Central and South America. Increase extension programming efforts in Spanish for audiences in Pennsylvania and nationally. Assess short and long-term impacts on knowledge, attitudes and behavior of participants. 	<ul style="list-style-type: none"> Attendance at DPM, attendee satisfaction/feedback Attendance at DPM-E, attendee satisfaction/feedback Number of extension workshops and presentations offered in Spanish by the Veterinary Extension Team
Provide facilities and new courses to promote excellence in teaching	<ul style="list-style-type: none"> Including an anatomy lab to accommodate the increasing demand in enrollment and to promote excellence in teaching Immunology Lab course Pharm Tox Lab course 	<ul style="list-style-type: none"> Enroll students in new courses Exit interviews to gain student feedback Monitoring job placement and placement in graduate and professional schools (PA, nursing, pharm, vet, or med)
Establish a new teaching/student laboratory and develop a new lab course for Tox.	<ul style="list-style-type: none"> Partner with the College to identify space, funds and equipment for the lab Develop the new course, Molecular Epidemiology 445 Convert 496s to a practicum course 	<ul style="list-style-type: none"> New course is approved Hold course in the new lab
Provide facilities and new courses to promote excellence in teaching	<ul style="list-style-type: none"> Including an anatomy lab to accommodate the increasing demand in enrollment and to promote excellence in teaching Immunology Lab course 	<ul style="list-style-type: none"> Enroll students in new courses Exit interviews to gain student feedback

	<ul style="list-style-type: none"> • Pharm Tox Lab course 	<ul style="list-style-type: none"> • Monitoring job placement and placement in graduate and professional schools (PA, nursing, pharm, vet, or med)
Discovery of integrated health solutions. Establishing One Heath Research Portfolio.	<ul style="list-style-type: none"> • Collaboration with ADL and extension groups in the area of nutritional and emerging and novel infectious diseases • Collaboration with bioengineers for testing new diagnostic (AI-based) platforms 	<ul style="list-style-type: none"> • Successful collaborations in grants, publications and patents.

Goal #4 – Enhance diversity at all levels within the department

Objective	Key Performance Indicators	Measures of Success
Increase diversity amongst faculty	<ul style="list-style-type: none"> • Advertise more broadly to attract diversity applicants that include women and URM • Advertise on social media, pay to advertise in nationally and internationally recognized journals • Incorporate impactful statements on diversity and inclusion in faculty advertisements • Evaluate annually and provide a report on the progress made with regards to diversity • All future faculty searches to keep diversity as a key criterion • Search committee members to undergo an immersion in diversity enhancement 	<ul style="list-style-type: none"> • Increased recruitment of diverse faculty • Be able to statistically show our numbers are becoming more diverse • Commit to advertising in international, well known, job sites.
Increase recruitment and retention of URM undergraduate students	<ul style="list-style-type: none"> • Advertise our programs in school districts that have greater enrollment of URM high school students • Include current URM students during recruitment tours and events • Work with the Diversity Office to increase interactions amongst peer URM students 	<ul style="list-style-type: none"> • Increased recruitment and retention of diverse students • Be able to statistically show our numbers are becoming more diverse
Increase recruitment of URM graduate students	<ul style="list-style-type: none"> • Advertise graduate programs in universities with high number of undergraduate URM students • Qualified URM applicants to be invited for in-person interviews on campus • Submission of NIH-Bridges and/or INTREPID -type grants to increase URM recruitment. VBS faculty members have a previous history with these funding mechanisms. 	<ul style="list-style-type: none"> • Increased recruitment of diverse students • Be able to statistically show our numbers are becoming more diverse

Diversity and Inclusion

The VBS Department enjoys a diverse climate amongst its faculty, staff, and students. Our goal is to continue to stand out as a department within the College that encourages the inclusion of all and seeks out individuals for consideration irrespective of their nationality, color, sexual orientation, and religious and political beliefs. Currently, our faculty dynamics are the following:

- 12 of the 35 faculty members are women: 3 are tenure track, 9 are non-tenure track
- Of the 18-tenure track faculty, there are no URM faculty members
- 9 of the 35 faculty members would be defined as non-white
- 1 URM non-tenure track faculty member

We continue to support our faculty, staff, and students to attend events and trainings geared towards diversity and inclusion that are conducted by the Human Resources Department and other University groups. We adhere to a standard of making sure that new and incoming members are greeted by a welcoming and genuinely helpful atmosphere. Throughout 2020-2025, we will seek opportunities to improve our commitment to diversity through new programs, improving existing programs, recruiting the best students and hiring the best candidates.

Best Practices for Hiring, Recruiting, and Retention

We work closely with the HR consultants within the College to ensure high visibility is provided to all our advertisements for positions (at all levels) in appropriate jobs/career sites of organizations that emphasize diversity. We will also ensure that potential candidates that meet the criteria for diversity are considered and that our interview practices are consistent for each individual.

For graduate students, the process is similar, and we are fortunate that we have always had applicants who are women, and members of minority and under-represented groups. Our department is keen to build upon this and in 2019, we were excited to extend offers to three individuals from URM groups to join the Pathobiology graduate program.

Practices that Promote Integrity and Ethical Behavior

VBS department continues to promote integrity and ethical behavior through regular re-training. The Scholastic and Research Integrity (SARI) ethics course is encouraged for faculty and required for graduate students. We have hosted lunch talks and will more actively pursue more interaction with representatives from the Office for Research Protections (ORP) to instruct our faculty and students on conflict of interest. Faculty who teach VB SC 280, Current Issues in Veterinary Medicine, cover social, ethical, and economic aspects of veterinary medicine. Also, department leadership models integrity and ethical behavior through the thoughtful way they approach issues. By encouraging an open communication with regard to these, among faculty, staff, and students, we come even closer to achieving this goal.

Undergraduate and Graduate Learning Outcomes and Assessment

We agree that quality education is more important than the numbers but are always pleased to report that the numbers are satisfactory for all of our majors. Recruitment efforts for our majors and our graduate program are adequate and are somewhat dependent on the College's venues, which we participate in all. The department's efforts in recruitment are also satisfactory, as we continue to work with prospective students and our staff attends recruitment opportunities to discuss the programs that we offer to undergraduates. Our graduate recruitment has been robust in the last five years as we have seen an increase in applicants and the pool continues to diversify. On average we recruit four graduate students per year, which satisfies the current need of our faculty. There is still a need to track all our undergraduates in order to keep them engaged as alumni and to take a vested interest in where they end up in their profession or graduate school careers. We believe that the previously suggested social media presence will increase our opportunities in this matter. We will also be conducting exit interviews with our undergraduates to gauge their satisfaction level with their education and experience and take into consideration their suggestions for improvement.

Undergraduate Program

Our department offers three undergraduate degrees: Immunology and Infectious Disease (IID), Pharmacology and Toxicology (PCTX), and Veterinary and Biomedical Sciences (VBSC). All three majors are thriving and attracting excellent students. IID and VBSC continue to be popular and with the anticipated combination of PCTX, we look forward to increasing the number of undergraduate students in the Tox (PCTX) major. Our enrollment numbers for all the undergraduate majors have shown a steady increase from Fall 2015 to Fall 2019, and we are looking forward to those numbers to further increase with the addition of "Pharmacology" to the PCTX major and a new minor in One Health. The One Health minor examines the well-being of humans and animals through the integration of human and veterinary medicine and environmental science. This minor was developed, and as of Spring 2020, is accepting new students. VBSC remains a major of choice for pre-veterinary students and to those that enter the biomedical research field and other pre-professional students. All our majors are adept at preparing students destined for professional and graduate schools or private industry.

Veterinary and Biomedical Sciences Learning Objectives

Students will be able to:

1. Search, critically evaluate, and discuss the scientific literature and popular press articles in the field of veterinary medicine and biomedical sciences.
2. Exhibit competency in the physical and life sciences, including anatomy, physiology, chemistry, cell biology, microbiology, and immunology.
3. Apply research data and their knowledge from the physical and life sciences toward the management of health and diseases of animals.
4. Demonstrate effective oral and written communication to both professional and lay audiences.

5. Know career options within the VBSC major and be prepared to succeed in post-graduate jobs and in professional or graduate schools.

Learning objective selected:

During 2019-2020, we selected PLO #2 to evaluate (PLO #2. Life & Physical Science Competency Students will exhibit competency in the physical and life sciences, including anatomy, physiology, chemistry, cell biology, microbiology, and immunology). Specifically, we focused our efforts on VBSC 421 (Comparative Anatomy). Our benchmark for performance in this course is that >75% of the students in VBSC 421 will receive a B or higher.

Data Collection:

To address this PLO, we implemented clicker-quizzes throughout the lecture portion of VBSC 421 during the Fall 2019 semester with the goal to encourage students to keep up with the material in the course and achieve PLO 2 (competency in anatomy). We will assess the student performance relative to the benchmark (above), between laboratory and lecture sections of the course, and student performance this year versus previous years

Pharmacology and Toxicology

Learning Objectives

Students will be able to:

1. Students will have access to meaningful research experience and the professional development that accompanies such training including the ability to formulate a research question and design experimental procedures. (Research Experience)
2. Graduates will demonstrate collaborative learning, critical thinking, and research skills, as well as skills to communicate effectively to professional and lay audiences. (Collaborative learning, critical thinking and communication)
3. Graduates will be prepared to succeed in industry, government, academic research, and in graduate and professional study. (Career planning and advancement)
4. Students will apply ethical principles in conducting scientific research and apply their expertise to a broader health and societal context. (Ethics and toxicology outreach)

Learning objective selected:

Knowledge (Physical, biological and toxicology competencies)

Data Collection:

Students enrolled in VBSC/BMB 433, the final PCTX course taken by most students in the program, were evaluated on an exam in order to measure the objective. A complicated question that requires understanding of basic toxicology principles and integration with exposure and genetics has been utilized. Proficiency is expected from 75% of the students in this class (7 out of 10 points is deemed proficient.)

Immunology and Infectious Disease

Learning Objectives

Students will be able to:

1. Read the scientific literature and write critical reviews in the Immunology and Infectious Disease discipline.
2. Present and discuss scientific data and analysis in the field of Immunology and Infectious Disease.
3. Be familiar with potential careers in biomedical science, learn to prepare a resume, and obtain skills critical to successful acceptance in and preparation for professional schools.
4. Obtain quantitative skills that allow them to analyze experimental data sets.

Learning objective selected:

This assessment specifically addresses learning objectives #1,2 and 4 and uses the capstone course, VBSC 448W as a mechanism for evaluating proficiency in these areas. Students are expected to demonstrate:

- a. the ability to read and interpret scientific literature
- b. the ability to assess the quality and potential impact of scientific articles
- c. the ability to clearly articulate thoughts through written and oral communication
- d. the ability to think critically
- e. the ability to understand and assess statistical analysis

Data Collection:

To facilitate this assessment for objective #1, students will be evaluated on their final paper using the following rubric:

Criteria:

1. Summary turned in, comments turned in and all rough drafts and reviewers notes turned in
2. Length and format of text: 8-10 pages, Times or Arial 12 points, double spaced, 1 inch margins on all sides and page numbers
3. Citations: at least 15 original research articles cited, format standardized, all papers cited in the text are in bibliography and vice versa
4. Corrections and revision: Incorporation of corrections/suggestions from previous drafts

Criteria:

1. Is the introduction interesting? Does it capture the reader's attention? Does it prepare the reader for your paper?
2. Is the hypothesis stated clearly? Is it clear what the point of your paper is?
3. Did you explain what happened in each paper in your own words? Are the results interpreted correctly? (i.e. What did the authors do? How did they do it? Why did they do it? What did they find? Why is that relevant to your paper?)

4. Flow of ideas (telling a story)
5. Within each paragraph: Does each paragraph start out with what the point of the paragraph is? Do you support that point with the literature in the paragraph? Do you summarize each paragraph at the end of each paragraph
6. Within the overall paper: Does the paper introduce the main point of the paper effectively? Does the paper address the main point? Do you summarize what you found and draw conclusions at the end?

ABSTRACT

Criteria:

1. Does the abstract highlight the important points of the paper
2. State the overall hypothesis?
3. And conclusion?
4. Format, <300 words, grammar

Graduate Program

In addition to Pathobiology, our faculty are also actively involved in several inter-college graduate programs such as Molecular, Cellular, and Integrative Biosciences (MCIBS), Bioinformatics and Genomics, Biochemistry and Molecular Biology, Plant Science, Animal Science, Nutrition, and Physiology. The knowledge gained by our faculty, who serve on various committees in some of these programs, is used in the improvisation of the learning objectives within the departmental graduate program.

Pathobiology

Learning objectives

Students will be able to:

1. Demonstrate specific mastery of core concepts related to molecular mechanisms of disease in humans and animals, as well as evidence-based decision making in general.
2. Demonstrate ability to identify a knowledge gap based on reading and understanding the current scientific literature, to create a research plan that addresses the gap in knowledge, and to execute that research plan so that the result is a meaningful contribution to the understanding of disease mechanisms.
3. Demonstrate ability to effectively communicate scientific ideas, proposals, and research findings using both written and oral formats.
4. Demonstrate ability to critically analyze and assess scientific ideas and results related to the area of human/animal disease research.
5. Demonstrate knowledge and understanding of core ethical values and proper conduct in research and maintain the highest ethical standards in their own research.

Learning objective selected:

This assessment specifically probes learning objectives #1, #3, and #4, and uses the Qualifying Exam as the mechanism for evaluating program proficiency in these areas. The Qualifying Exam is completed by doctoral students during the second year. Students are assigned a paper from the scientific literature. Students prepare a written critique of the paper, then present and discuss the findings of the paper with the Exam Committee. To successfully complete the Exam, students must demonstrate:

- a. mastery of fundamental core concepts;
- b. ability to read and understand papers from the scientific literature;
- c. ability to critically analyze and discuss papers from the scientific literature;
- d. proficiency in written communication skills; and
- e. proficiency in verbal communication skills.

Data Collection:

To facilitate this assessment, a Pathobiology Qualifying Exam Report Form was created. This Report Form is used in conjunction with the University-standard Qualifying Exam outcome form. The University-standard form allows tracking by the Graduate School and is principally meant to accurately assess whether the result of the Exam is pass or fail. In contrast, the Pathobiology Qualifying Exam Report Form allows minor deficiencies / opportunities for improvement in any of the five above-listed areas to be noted, even among students who pass the Exam. If minor deficiencies are noted, the Exam Committee can recommend that steps be taken to address them, such as enrollment in specific courses or increased participation in data clubs and journal clubs.

The Pathobiology Steering Committee meets once annually to review all Qualifying Exam Reports from the prior year and determines if program changes are needed on the basis of these results. It is expected that at least 75% of students will pass the exam within the second attempt (calculated using a three-year rolling average to ensure adequate sample size).

Contributing Towards PSU Goals for Sustainability

The VBS Department follows the College and University guidelines for sustainability to the extent allowable with our outdated facilities. We have areas in which we can improve and will look to continue to improve so that we may improve our carbon footprint. We plan to go garbage can-free, so that all recyclable material will be placed in the appropriate receptacles. Our facilities were built prior to when sustainability technologies were introduced and have never been retrofitted, and therefore, we are somewhat constrained in that regard. We will continue to monitor our resource usage in the laboratories and offices and look for ways to reduce our ecological footprint. Additionally, as we plan events in the future, we will look for ways to rely on others to bring their reusable drinkware or cutlery, so that we are not generating so much one-time waste. Finding ways to complete day to day activities with less paper is another way that our admin staff can help reduce the amount of paper we use and decrease the cost for the department in terms of paper overall. Finally, we will work with the Center for Sustainability, Penn State University, to identify areas for improvement.

VBS and One Health

Introduction: Research, diagnostic, and extension faculty in the Department of Veterinary and Biomedical Sciences (VBS) have long recognized the importance of integrated and cross-disciplinary approaches to address human and animal diseases. Accordingly, they have been active in incorporating the One Health framework in research, outreach, and training. With a diverse and complimentary expertise in detecting and monitoring, understanding the pathogenesis and underlying conditions, and developing prophylactic and therapeutic strategies, VBS faculty are well-placed in playing a critical role in applying One Health approach to mitigate the existing and emerging animal and human diseases. For the next strategic plan duration, VBS will lead the college- and campus-wide efforts to address challenges of rapidly changing global market, climate, and social and cultural influences in One Health approaches in three key interconnected areas:

- 1) Emerging infectious diseases**
- 2) Lifestyle change-associated diseases**
- 3) Environmental change-associated diseases**

Area 1: Emerging infectious diseases of animals and humans

Increased contact with domestic and wild animals due to the growing human population and habitation in previously stable ecologic zones has led to several spillover events of infectious diseases. Changes in the climate leading to expansion of vectors and increased trade and travel have also led to rapid spread of these infectious agents. Even though many have been contained, several have raised to global pandemic level leading loss of life and food supply with a significant impact to local and global economy. Recent emergence or global spread of COVID-19, Zika, and African Swine Fever provide a good evidence for the impact of such infectious diseases on health and food security. Understanding the ecologic basis of diseases is central to developing prevention and control programs VBS will address these challenges with focus on four areas:

1) Diagnosis:

Objective: To develop capacity to detect and monitor the emergence and spread of infectious agents.

2) Epidemiology of Infectious Diseases

Objective: To understand the descriptive, analytic and molecular epidemiology of infectious diseases as it relates to animals, humans and the environment

3) Disease pathogenesis:

Objective: To understand the pathogenesis of infectious diseases and develop strategies to prevent, manage and treat infectious diseases.

4) Prophylactics and Therapeutics:

Objective: To develop pre-clinical models of infectious to test and optimize novel therapeutics and prophylactics.

Approach: Faculty and personnel at Animal Diagnostic Facility will lead the effort in developing novel diagnostic assays in early detection of these diseases. ADL faculty will

collaborate material and engineering science experts to develop rapid bench-side diagnostic assays. They will collaborate with extension faculty for effective outreach programs. One Health approach of simultaneous monitoring infectious agents in animals, humans and the environment will be employed to address one health related issues. VBS faculty with expertise in molecular immunology and infectious diseases will lead the efforts to develop new models of emerging diseases, understand the pathophysiology of the diseases, and develop new therapeutic and prophylactic strategies. In addition, by leveraging the existing expertise in the areas of nutrition and micronutrients in the department and across the university, VBS will lead the efforts in nutritional management of infectious diseases. VBS will bring together a college-wide diverse expertise in the vector biology, social sciences, cyber and data sciences in these efforts. By strengthening the existing collaboration with infectious disease modelists, these approaches are likely to be able to forecast the emergence and spread of new infectious diseases, better understanding of principles of pathogenesis, and new management strategies.

Milestones:

- Development and validation of diagnostic kits/tests for pathogen detection and surveillance
- Development of new animal models of infectious diseases
- Development of novel therapeutics
- Development of effective vaccines

Area 2: Lifestyle change-associated diseases

Rapidly advancing technology and increased demands of new trade and commerce practices have led to lack of physical activity. Better and efficient global food supply and economic prosperity have led to increased processed food consumption. Both have resulted in increased obesity and associated cardiovascular diseases, diabetes, and autoimmune diseases. In addition, the increased stress and demands of modern lifestyle have led to serious mental health issues and substance abuse and addictions. These in turn have serious effects on global health. Similarly, modern livestock practices have led to antimicrobials misuse and emergence and spread of antibiotic resistance. Therefore, it is imperative to address the underlying causes and mechanism of these life-style associated diseases to develop preventive and management strategies for both humans and animals. VBS will focus on two key areas to address these global problems.

1) Antimicrobial Stewardship:

Objective: To monitor and limit the spread of antimicrobial resistance and develop new antimicrobials.

2) Impact of substance abuse on health:

Objective: To determine the adverse effects of various addictive substances such as opioids on immunity and chronic conditions.

Approach: Faculty in ADL, Extension, and Immunology and Infectious disease emphasis area, and extension will lead a coordinated effort to survey the prevalence of antimicrobial resistant bacteria in farms and hospitals. In collaboration with college-wide groups and College of Medicine working in similar areas, VBS will develop strategies to promote the judicious use of

antimicrobials in food animal operations and health care facilities. Experts in Microbiome research will lend their expertise to better understand the interaction of antimicrobial resistant bacteria and resident microflora. In addition, by undertaking basic studies aimed at pathogen virulence and metabolisms, VBS will collaborate with the groups in the departments of Food Science, Biology, and Biochemistry and Molecular Biology, and Biomedical Engineering to develop new and resistance proof antimicrobials or novel strategies. Faculty in Immunology and Infectious disease area will establish new studies related to understanding the interaction of substances of abuse and immunity in relation to infectious diseases and chronic conditions. Expertise in VBS in using large scale patient record data will be used to further validate the basic science research. VBS will also coordinate with various Penn State initiatives that are engaged in socio-economic side of substance abuse problem.

Milestones:

- Database on antimicrobial resistance patterns across Pennsylvania
- Development and commercialization of new antimicrobial or strategies
- Development of biomarkers for substance abuse impact on health and immunity.

Area 3: Environmental change-associated diseases

With expanding industrialization, pollution, and reduction in natural resources, exposure of humans and animals to environmental toxicants have led to serious health consequences such as cancer, impaired immunity, and metabolic diseases. In addition to direct exposure, humans can also be exposed to pollutants and carcinogens contaminated water and food. These problems, thus, require a One Health holistic approach to mitigate and prevent exposure related toxicity. While the carcinogenesis and toxicology of environmental toxins have been extensively studied within and outside of VBS, incorporating One Health guiding principles will provide a novel view of the 21st century challenge and will be one of the emphasis areas during the new strategic plan duration. VBS will focus on two main problems in this area:

1) Biomarkers for early detection of cancer, inflammatory diseases, and metabolic disorders:

Objective: Establishment of biomarkers for early detection of toxin-induced cancer and chronic diseases, including autoimmune diseases, diabetes, autism spectrum disorders.

2) Livestock productivity:

Objective: To improve the quality and production of farm animal products by decreasing the environment-induced stress.

Approach: VBS will adopt ecologic-approach (environment-animal-human) to address the clear and present danger of environmental pollution by leveraging present expertise in molecular studies of carcinogenesis and toxicology, metabolomics, genomics, and biomedical informatics and collaborating with extension faculty and other college-wide expertise, including insect toxicology, plant pathology, aquaculture (and watershed management), and food and animal sciences. By developing set of biomarkers indicative of exposure to specific toxicants, farm managers and health care providers can rapidly diagnose or forecast serious health consequences or improve productivity. These initiatives will be taken up by using the resources of newly

created Institute for Sustainable Agriculture, Food, and Environmental Science, Huck Institute, Institute of Energy and the Environment, Social Sciences Research Institute, and Penn State Cancer Institute.

Milestones:

- Database of biomarkers specific to exposure to environmental toxins.
- Development of countermeasures to mitigate the adverse effects of environmental toxins on human and animal health.

Summary: VBS is well-positioned to lead the college-wide initiatives to apply One Health approaches to meet the present day and future challenges for human, animal, and environmental health. Our focus areas within VBS Department that are integral to One Health issues include zoonotic diseases, antimicrobial resistance, food safety and food security, vector-borne diseases, environmental contamination, nutrient deficiencies, and other health threats shared by people, animals, and the environment. Such interlinked areas, influenced by each other, will be focused by leveraging the existing expertise, recruiting new faculty in the areas of deficiency, collaborating within and outside college groups and institutes, and timely dissemination of information and guidance to stakeholders. In addition, by way of One Health minor program and International One Health Programs, VBS hopes to train next generation of problem solvers and proponents of One Health for biomedical and agricultural well-being.