**CONCEPT PAPER**
**GOAL 2: BE AT THE FOREFRONT OF HIGH-IMPACT TRANSDISCIPLINARY RESEARCH**

**Background:** The UC Davis School of Veterinary Medicine (SVM) promotes high-impact research defined by three metrics: (1) investments in state-of-the-art technologies and infrastructure, (2) hiring, mentoring, and promoting faculty pursuing timely disciplinary and interdisciplinary approaches to understanding challenges at the interface of animals, humans and environment - from single molecules to populations, and (3) emphasizing and rewarding research success based securing extramural funding to support individual and multi-investigator programs. The School is #1 among American Association of Veterinary Medical Colleges (AAVMC) accredited institutions in total research expenditures, estimated to be $85 million for the year 2017-2018. The School supports a significant number of outstanding faculty who are recognized by national and international scientific societies e.g., National Academy of Medicine. The productivity of the faculty as measured by peer-reviewed publication impact have been a major source for the School's reputation metrics e.g., ranked #1 in QS World University Rankings in veterinary sciences for the past 3 years. An overarching strategic goal of SVM is to foster high-impact discoveries published in top peer-reviewed journals and books, participation at national and international meetings and garnering awards from organizations that sponsor them, and service on major scientific review panels and boards.

**Research Infrastructure and Grant Facilitation**

Investments in research support: *Basic and preclinical infrastructure:* Over the last 15 years, investments in physical infrastructure has included new research buildings (VM3A and VM3B). These buildings have co-localized basic, para-clinical and clinical faculty members and their programs, not only within the School, but with relevant collaborative partners in the School of Medicine, and Department of Biomedical Engineering. Specifically, co-localization and more modern open research architecture has fueled new discoveries that are published in top-quartile (Q1) disciplinary and inter-disciplinary journals, increased co-authorship by both DVM students and graduate students. The School's research enterprise has grown to near-record levels of extramural funding. Increased competitiveness of individual research grants is clearly a major contributor, but we also recognize the impact made by a significant increase in the number of transdisciplinary collaborations that have led to large externally funded program projects, centers of excellence, and institutes including: USAID PREDICT, NINDS CounterACT, CDC Center of Excellence in Vector-Borne Diseases, NIA Healthy Aging Program, NIEHS Children's and Core Centers, and training programs. In addition, the School's faculty are actively participating on at least eight NIH funded institutional graduate training programs (T32 grants), four are led by SVM faculty. The administrative staff for the Graduate Groups in Epidemiology, Immunology, Integrative Pathobiology, and Preventative Medicine are now housed within the new Veterinary Medicine Administrative and Student Services Center commissioned in 2017, improving efficiencies and communication between the School's research and mentoring programs and Graduate Group administration and their students.

Clinical research infrastructure*:* The VMC capital campaign formally launched in November 2017 will refocus its development efforts and make significant investments in modernizing its clinical infrastructure ($115 million in phase 1 of a $508,000 total master plan). The primary goals of the VMC strategic plan (see Goal 3) is to meet the critical need to increase and modernize existing clinical facilities to better serve more than 50,000 patients annually by faculty, house officers, students and staff.

Integration of new shared research laboratories and dedicated technical support staff are expected to further facilitate and promote translational research among clinical and basic scientists, their house officers, DVM students and graduate students. Translational research and clinical trials are essential components of identifying innovative high-impact solutions for complex disorders and diseases facing animals, humans and environmental health. To address this opportunity the School created the Veterinary Center for Clinical Trials (VCCT) in 2012. The VCCT is located within the Veterinary Medicine II Building, and works closely with other campus institutions including the School of Veterinary Medicine's academic departments, School of Medicine, the Clinical and Translational Science Center, Center for Companion Animal Health, and Center for Equine Health, to name a few. Clinical investigators have active trials aimed at advancing medical care for their veterinary patients in a variety of disciplines, including (but not limited to) oncology, neurology/neurosurgery, ophthalmology, and cardiology.

UC Davis School of Veterinary Medicine values not only individual research attainment, but strongly promotes collaborative programs that involve interdisciplinary and transdisciplinary teams that investigate and identify solutions to the world's most complex challenges. Such collaborative teams have been established that bring together researchers from across the UC Davis campus, UCD Health Systems (UCDHS), Lawrence Livermore National Laboratories (LLNL), and Bodega Marine Laboratory. The School is home to 36 Centers of Excellence, Institutes, and Program Projects that represent sponsored and organized multidisciplinary research activities led by our faculty, and highlight the broad impact our faculty are having in One Health, Oncology, Biodefense, Equine Health, Wildlife Health, Companion Animal Health, Aquatic Health, Children's Health, etc. The School supports and helps administer three major centers or institutes that promote and fund research; the Center for Companion Animal Health (CCAH), the Center for Equine Health (CEH), and the One Health Institute (OHI). Collectively, these programs provide millions of dollars to fund topic specific areas relevant to the mission of the School.

Investments in research equipment and shared facilities: The school has and will continue to invest in state-of-the-art tools to empower its research missions in a number of ways: (1) incorporate equipment costs in start-up and retention packages, (2) provide matching funds for Shared Instrumentation Grants (SIG) and multi-PI programs (sponsored by NIH, NSF, CDC, USAID, and private foundations), and (3) enhance leadership in the establishment of shared facility initiatives, exemplified by the Health Sciences District Advanced Imaging Facility (HSDAIF) established in 2015. Investments in high-end equipment, many unique to the UC Davis campus; several not found elsewhere system-wide (e.g., Super-resolution microscopy (STED) and multiphoton microscopy with CLARITY, FLIPR TETRA, ImagExpress, and Seahorse systems for high throughput functional and morphometric analyses), modern infrastructure to house them, and the technical staff to assure their effective and sustainable use, have proved invaluable for maintaining faculty research competitiveness. The School has worked with the Office of the Vice Chancellor of Research to establish a Campus Core Facilities Program and has provided leadership through its Research Core Advisory Committee (RCAC), which established 17 designated campus cores in 2016.

Investments in grant and research facilitation: The school has been on the leading edge of developing digital systems for grant submission and tracking to meet UCD Office of Research policies as well as the need to harvest and summarize grant information for internal accounting and reporting as well as

reporting to external accreditation committees including the AVMA, AAVMC, commodity groups and other stakeholders. In 2012, the School's Office of Research and Graduate Education (ORGE) launched an Electronic Grant and Research Tracking (EGReT) system to simplify and accelerate the submission, management and tracking of contracts and grants. The School has been working closely with OVCR staff to implement Cayuse SP and meet campus-wide requirements and harvest vital information specific to the School.

Investments in research networking*:* Beginning in 2014, the School began major restructuring of its Research and Graduate Education websites with an overall goal to improve and facilitate access to critical information needed by faculty, research staff, postdocs, and students undertaking research. Since its launch, the website has been regularly updated and expanded monthly to update new resources to improve connectivity and efficiency. One example is the Research Horizons link (http://www.vetmed.ucdavis.edu/research/news/publications.cfm), which provides a quarterly update of titles and abstracts of all publications authored by SVM researchers. In 2014, the School launched the SciVal/PURE digital tool to improve our researchers' networking capabilities. A joint project with the SOM and the SON, SciVal Pure has Fingerprint Profiles for >100 SVM researchers including their expertise, grant support and current and past collaborations. Workshops on the use of digital networking tools (SciVal, ISI Web of Science and NCBI) have been to faculty, students, and staff.

Investments in grant proposal mentoring*:* Beginning in 2013 ORGE launched several new grant mentoring opportunities for faculty at all career stages, including targeted nominations for enrollment in grant writing workshops sponsored by the Office of Graduate Studies, the OVCR, and external experts. The overall strategy was for ORGE to minimize duplication with the ever-expanding opportunities available through campus units outside SVM, and to focus on personalized follow through with one-on-one mentoring from first draft through submission with the singular aim to improve the quality and competitiveness of grant proposals submitted by our faculty, postdocs and graduate students. Since the launch of the ORGE Grant Mentoring Program, several dozen faculty and postdoctoral researchers have participated grant writing workshops and many have worked one-on-one with mentors to optimize the structure and clarity of their grant proposals from first draft through submission. The impact of investments in the grant writing programs is quantifiable using either total expenditures or total grant support as metrics.

**DVM and Graduate Student Research Mentoring**

Investments in DVM research training: The School's investment in DVM research training is amongst the largest in the country. In 2017, over 70 students submitted grant proposals to compete for the opportunity to participate in our Advanced Training in Research (STAR), International Summer Externships, and Global Fellowship Programs. In 2017, investments in pre-DVM research mentoring totaled $314,000 funded from external sponsors and the School's endowments targeted for this purpose. Importantly new grant mentoring programs have also benefited our VSTP and post-DVM students. Since 2016, eight NRSA proposals and one MAF proposal have been submitted by VSTP and PhD students working with our faculty. Before 2012, virtually no NRSA proposal were submitted to NIH from the School. One proposal has been funded (MAF), and another score on the first submission. The School also invests yearly in stipend support of VSTP and post-DVM students working on their PhD dissertations. The Graduate Student Stipend Program (GSSP), and the NIH T32 YEAR Program are

competitive fellowship opportunities for DVM students working on their PhDs and supports the stipends of 10-15 students annually with an annual budget ranging from $450,000 to $600,000 each year. Many of our students publish peer reviewed papers in major thematic journals, present their work at national and international meetings, and are recognized with major awards for their research. Between 2012 and 2017 DVM students co-authored many peer reviewed publications, and garnered more than 30 national and international awards stemming from work performed under the mentorship of SVM faculty.

The School continues a strong commitment to being a leader in graduate education. The School is the administrative home to four Graduate Groups (Epidemiology, Immunology, Integrative Pathobiology, Preventative Veterinary Medicine), and provides matching funds for their operation, including support for student recruiting. Never-the-less, one limitation in our graduate mentoring portfolio is the exclusion of fellowship resource for PhD students that do not have, or are not currently working on a DVM degree. Considering the escalating cost for graduate education currently passed on to the faculty (~$50,000 per year of support), and the integral importance of training PhD students within the leading SVM, to ease restrictions on existing endowments or prioritize the identification of new sources to support PhD students not pursuing the DVM, needs attention.

**Lessons Learned**

- Significant investments made in research infrastructure over the last 10-15 years have made measureable impacts on facilitating collaborations among faculty members and their students, identifying new programmatic strategies, and promoting interactions among research teams with complementary research approach to work on complex research topics.
- When considering trends and outcomes, there has been a consistent increase in total grant support/expenditures in the School, despite a general decline/stagnation of federal and state resources and a steadily increasing hyper-competitive environment for research funding.
- Strategic mentoring programs, especially individualized sessions, improve grantsmanship and competitiveness.
- Institutional training grants (T32/T35) are an essential component in our research support and mentoring tool box, however increased efforts are needed to promote submissions of individual training grants from VSTP and PhD students (F30/F31 NRSA) or their equivalents.
- Additional resources and programs are needed to facilitate research transition to independence awards from junior faculty, and incentives are needed to promote mid-level and senior faculty to lead calls for proposals for program project and center initiatives.

**National Trends**

- Funding levels from traditional federal and state sponsors will continue to stagnate for the foreseeable future.
- Demands will continue to rise for DVMs, PhDs, and clinician researchers capable to addressing complex research challenges and effectively lead multidisciplinary teams whose mission is to solve real word problems.
- More emphasis will be focused on performing translational research and clinical trials with animals that exhibit spontaneous diseases, especially those that map to human disease.

**Strategic Themes**

- Continue to lead the world in research funding and research impact.
- Sustain and promote diverse and internationally recognized research enterprises - build on our strengths, value innovations and new programmatic initiatives.
- Invest in innovative research that will lead to future solutions to societal problems.
- Promote and reward entrepreneurial initiatives and seek partnerships across the campus to promote innovation.
- Improve efficiencies – reduce redundancies in conducting research.
- Communicate discoveries and their relevance to society to the public to enhance competitiveness and gain reputational outcomes.
- Seek means to enhance technology transfer, licensure income, patents, and start-ups originating from SVM activities and intellectual properties.

**Options**

- When resources are limited diversify investments supporting our scientist, clinicians and the tools they need to remain competitive.
- Invest strongly in collaborative initiatives that will strengthen the school as a world leader in research and development.
- Foster transdisciplinary research to engage industry, academic, and government resources in partnership fashion.
- Focus strategic research investments around major themes, while seeking new opportunities in emerging areas of research.
- Funds have been invested in infrastructure over the past decade, perhaps a good time to allocate larger fraction of resources on people and their ways to promote their science.
- Engage in advocacy and public outreach to promote discoveries and gain national and international attention for our people and programs.

**Projected Costs**

- Invest in research through advanced planning in annual budgets provided through the university.
- Millions of dollars are need to maintain or expand infrastructure for research and must include multiple sources of funding to be maintained.
- The costs must include investments in mentoring and training of next generation of researchers and current faculty from multiple sources including industry and other private sources as partners.

**Short and long-term plans**

- Need to better define strategic areas of scientific focus e.g., major collaborative priorities that will receive School or campus support (vector-borne diseases, musculoskeletal initiative, pain management, etc.).
- Identify whether these strategic areas integrate with university-wide initiatives and which areas will our faculty lead as a priority.
- Major priorities must align with societal needs and major challenges facing California, the nation and the world.

- Major research priorities must inform and drive recruitment of faculty..
- The School must acknowledge the importance of fundamental and applied research as essential steps in solving complex problems.
- Need to establish attainable plans and timelines for maintaining and expanding basic, and clinical research infrastructure, core shared core equipment and shared flex laboratory.
- Need to more strongly support grant mentoring to improve competitiveness at all career levels.
- Educate and accept that the School leads the nation in training DVMs, PhDs, veterinary specialists, and undergraduates. Although we seek to be the best at training entry level DVMs, this cannot be our only mission. A great SVM must engage as a leader in training at all levels from undergraduate to PhD.
- Recognize and promote team science- especially leaders of new multi-investigator applications- reward success
- Better communication of scientific discovery at all levels to enhance School's reputation and foster new resources to reinvest.
- Recognize and promote the role of clinician-scientists and continue to leverage resources such as the Center for Veterinary Clinical Trials and from other campus partners such as the College of Engineering, School of Medicine, and College of Agriculture and Environmental Sciences.
- Integrate the mission and goals of major Centers and Institutes with the overall goals of the School in research and discovery by seeking partnerships and leverage opportunities.
- Foster development opportunities to help fund endowed chairs, graduate scholarships, research facilities, etc.