Designated Emphasis in Host-Microbe Interaction
Proposal date: October 28, 2015
Grad council approval date: December 12, 2015

Designated Emphasis in Host-Microbe Interaction (DE-HMI)
Administrative Home: Office of the Dean, School of Veterinary Medicine

1. Description of the Designated Emphasis

Scope of DE-HMI: We live in a world teeming with microbes. One of the most influential areas of modern biological science is elucidating the ramifications and complexity of host-microbe interactions that affect animal and plant health and dramatically influence micro- and macro-ecosystems. Fueled by technological advances, we are entering a new era of interdisciplinary approaches that enable investigators to delve deeply into the reciprocal influence of host and microbes. Training new scientists in this area will fill an unmet potential for UC Davis graduate education. The DE-HMI will synergize the campus’ scholarly power to train scientific leaders that will drive new technological transformation both in the academic and private sector arenas. In addition, training students to work within an arena of interdisciplinary investigation will enable them to tackle pressing and difficult problems that they will encounter throughout their scientific careers.

The proposed training is especially timely because globally we face daunting challenges to understand how the well-being of humans and other animals, plants and other organisms are influenced by consortia of intimately associated microbes. For example, the emergence of multidrug-resistant bacteria in hospitals or phytopathogenic fungi overcoming plant resistance in intensively managed crop systems has heightened concern about available antibiotic therapies or disease-resistant germplasm, making evident an urgent need for cross-disciplinary research to lay new paradigm-shifting foundations for the development of future approaches to infectious diseases. In addition, recent breakthroughs have made clear the profound influence on host health of the colonizing microbiota, e.g. the approximately $10^{14}$ bacterial cells that colonize the body of humans and other animals, the estimated $10^{26}$ bacteria that colonize plant and tree foliage worldwide, and even the greater complexity of soil environments in which plants forage. Consider for a moment that while macro-organisms such as humans, animals, and plants have coevolved over an evolutionary timescale to coexist in a mutually beneficial, symbiotic relationship with colonizing microbes, rapidly mounting literature clearly shows that alteration in the composition of these microbiota can render the host susceptible to disease. Not only does this include susceptibility to infection, but also to a multitude of other complications, e.g. the inability of plants to grow under harsh conditions or to acquire vital nutrients without microbial partners, or chronic inflammatory disorders in humans that have now overtaken infections as the most important causes of worldwide morbidity and mortality, including obesity, diabetes, atherosclerosis, asthma and inflammatory and malignant diseases of the bowel. Meaningful inroads into understanding mechanisms governing these phenomena are only possible through interdisciplinary science.

The DE-HMI will train students with various backgrounds to engage in science that requires a multidisciplinary approach. No graduate program at UC Davis provides the necessary educational background to enable students to rigorously investigate
the complex mechanisms that underlie animal host-microbe interaction. The DE-HMI fills that need.

Several years ago, a small group of faculty representing several Schools on campus recognized this need and set into motion an infrastructure of meetings and new (or re-configured) courses that comprise the essence of the proposed DE-HMI. Graduate students (from several different graduate groups) performing their dissertation research in the laboratories of these professors informally had engaged in the activities and "curriculum" described below. We now wish to provide official structure for this training and provide formal recognition to the students who complete the proposed program.

The focus of the DE-HMI will be integrative, providing education in both host responses to microbes, as well as microbial adaptations to their interaction with hosts. What molecular strategies do microbes use to colonize, persist, propagate and transmit to new hosts in the face of host countermeasures and other competing microbes? Conversely, how does the host recognize an impending danger imposed by noxious microbes, and mount a measured response to counteract the threat? How is homeostasis between host and colonizing microbes maintained, and what underlies an offensive action by either microbe or host to perturb this balance? What are the evolved features of favorable commensal host-microbe and microbe-microbial community interactions, and what underlies the resiliency or fragility of these collaborations? This program represents a synthesis of modern mechanistic research that transcends the single disciplines of microbiology, immunology, cell biology, pathology, biochemistry, genetics, nutrition, biomedical engineering and pharmacology.

The DE-HMI complements existing programs: Students interested in this field are currently admitted through a variety of other programs, most notably, the Graduate Group in Immunology (GGI), the Microbiology Graduate Group (MGG), the Graduate Group in Comparative Pathology (GGCP) or the Graduate Program in Plant Pathology (GPPLP). Other portals include the Biochemistry, and Molecular, Cell, Developmental Biology Graduate Group (BMCDB), Biomedical Engineering Graduate Program (BME), Graduate Group in Nutritional Biology (GGNB), the Animal Biology Graduate Group (ABGG), the Plant Biology Graduate Group (PBI), the Entomology Graduate Group (EGP), and the Integrative Genetics Genomics (IGG) graduate group. Closest to the goals of the DE-HMI, are the curriculum goals of the GGI, MGG and GPPLP. These programs provide outstanding training in the general principles of immunology, microbiology, and plant pathology respectively, but mechanistic experimental approaches from the reciprocal perspectives to engage in cutting-edge research must be sought out by students by taking elective courses. Even in those cases, active training through an ongoing cross-disciplinary research-in-progress meeting may not be available. GGCP, BMCDB, BME, GGNB, ABGG, PBI, IGG and EGP offer strong curricula in areas relevant to host-microbe interaction, but the course offerings are, at best, quite limited in this area.

In contrast to any of these programs individually, core training in HMI at UC Davis
will provide, from an interdisciplinary perspective, a curriculum and ongoing mechanistic training focused on host microbe interaction.

**The DE-HMI meets a timely need and is distinct from other existing programs:**
DE-HMI targets emerging challenges to global health, interests of students, and new research opportunities by focusing on the dynamics of host-microbe interactions using an interdisciplinary approach. This new DE is thus distinct from other existing programs at UC Davis, but will compete directly with programs at other universities in the San Francisco Bay Area and elsewhere throughout the country.
2. Description of the Academic Nature of the Designated Emphasis

A. Affiliated Graduate Programs

Immunology Graduate Group
Microbiology Graduate Group
Comparative Pathology Graduate Group
Graduate Program in Plant Pathology

B. Dean’s Letter

See Appendix 1

C. Grad Group Chair’s Letters

See Appendix 2

D. Affiliated Faculty

See Appendix 3 for signed individual letters

School of Veterinary Medicine

Pathology, Microbiology and Immunology

Stephen Barthold  
Nicole Baumgarth  
Patricia Conrad  
Dori Borjesson  
Brian Murphy

Anatomy, Physiology and Cell Biology

Stephen McSorley  
Helen Raybould  
Reen Wu

Population Health and Reproduction

Bart Weimer

School of Medicine

Microbiology and Immunology

Andreas Bäumler  
Charles Bevins  
Satya Dandekar  
Kathy DeRiemer
E. Admission Criteria

Admission will be open to graduate students in affiliated programs in good standing. The primary criteria for admission will be a commitment to pursue a dissertation topic that is interdisciplinary in nature and aims to develop a mechanistic understanding of the dynamic interactions of microbes and their host. Required
courses must be taken prior to the PhD qualifying exam, and students must have a DE representative on the QE committee. Interested students should thus apply to the DE as soon as possible after being admitted to their PhD program so they can complete the DE-HMI requirements in the appropriate time frame.

F. **Curriculum**

1. **REQUIRED COURSES:**

   a) MMI 200D: Mechanisms for Microbial Interactions with Hosts (Winter, 3 credits, existing course)
   Study of mechanisms involved in microbial interactions within a host environment. The following principles are basic to understanding these interactions: host and microbe recognition, invasion, competition and growth, and host response (defense or symbiosis).

   b) Choose at least one of the following two courses:

   IMM 201 Basic Immunology (Fall, 4 credits, existing course)
   This course is a comprehensive introduction to basic principles of immunology. Course content includes lectures based on immunology textbooks, in addition to discussion of concepts and current literature pertinent to lecture topics. Letter grading is based on discussion participation, one midterm and a comprehensive final exam.

   PLP 210 Biochemistry and Molecular Biology of Plant–Microbe Interaction (Winter, 4 credits, existing course)
   Discussion of plant–microbe interactions, focused on the underlying cellular, biochemical, and molecular events that determine the diseased state.

2. **ELECTIVE COURSES AND SEMINARS:**

   Students will complete three additional elective courses (6-10 units total) and two seminars, which may also serve to fulfill course requirements of the affiliated PhD program. All electives listed are pre-existing courses. Courses should be selected to complement the integrative nature of the student’s dissertation research and must span (that is, include at least one course from each of) the two topics listed below. Students will be allowed to select courses or seminars from the list provided or petition to use other courses as electives subject to approval by the Executive Committee.

   *(Note that the time to complete the affiliated PhD program will not be affected because, electives may also meet the students’ PhD program requirements.)*

   **ELECTIVE COURSE TOPICS:**

   *A total of three is required*
A. Host Response to Microbes

IMM 204 Topics in Innate Immunity
IMM 293 Advanced Concepts in Immunology
IMM 295 Cytokines
IMM 297 Mucosal Immunology
PMI 202 Integrated Pathobiology Core 2 (course pending)
PLP 201A Impacts, Mechanisms and Control of Plant Disease

B. Microbiology

MIB 200A Microbial phylogeny, structure, and metabolic diversity
MIC 262 Advanced General & Molecular Virology
MMI 215 Medical Parasitology
MMI 280 Molecular Pathology
EVE 298 Microbial Phylogenomics
PLP 224 Advanced Mycology
PLP 228 Plant Bacteriology
PLP 230 Plant Virology

SEMINAR TOPICS:

A total of two is required.

MIC 292 Bacterial Effector Proteins
MIC 298 Current Topics in Host-Microbe Interactions
MMI 291 Seminar Series, Emerging Challenges in Microbiology and Immunology
CDB 298 Eukaryotic Cell Signaling Systems
PMI 290 What’s up at the CCM
PLP 290 Plant Pathology Seminar Series
PLP 291 Seminar in Molecular Plant Pathology

3. PARTICIPATION REQUIREMENTS AND EXPECTATIONS

a) HMI Work-In-Progress Meetings. Students in the DE-HMI are expected to participate regularly in one or both of two Work-In-Progress meetings (explained below) and to present their own research to these group at least once during their graduate studies. The expectation for regular attendance will be considered 50 meetings, which is roughly 40% of meetings over a five-year period (or approximately 90% of meetings over a two-year period, i.e. prior to typical scheduling of the QE exam). The first is the ongoing biweekly Host-Microbe and Pathogenesis Work-In-Progress Meetings, which was established in 2005 and is coordinated by Dr. Bevins (Proposed Chair of the DE-AHMI). Many DE-AHMI faculty, including Drs. Barthold, Baumgarth, Bäumler, Bevins, Dandekar, DeRiemer, Luckhart, McSorley, Navarro, Simon, Solnick, Tsolis, Young, and Zhou and members of their laboratories, now regularly attend this meeting. This group of faculty, students and post-docs meets every other week for hour-long research project updates by a student or post-doc, or occasionally for special visiting guests. As of Autumn 2011, we video-cast the meeting to UC Merced, so that Dr. David Ojcius and his
faculty and student colleagues can participate in the discussion of ongoing research on animal host-microbe interaction. The responsibility for presentations is shared among the participating laboratories on a rotating basis. This is a highly successful venue, which is often standing room only. The other meeting is the one organized by Dinesh Kumar and focuses on plant-microbe interactions.

b) Regional Symposia, Retreats and Meetings. Faculty and students at UC Davis are fortunate to be in close proximity to several outstanding local meetings that focus on topics relevant to host-microbe interaction. Students are expected to attend, on average, one of these conferences annually throughout their graduate training. Students may substitute attendance at these local meetings with attendance at a national or international meeting or any one of the venues listed below.

UC Davis HMI Retreat. This annual retreat, sponsored by the Department of Microbiology and Immunology in the School of Medicine, brings together UC Davis researchers interested in the interactions of microbes with vertebrate, invertebrate or plant hosts. The retreat, which began in 2006, has a goal to foster multidisciplinary work, exchanges and collaborations. The scientific program includes oral presentations from faculty, students and postdocs, as well as a keynote speaker sponsored by the Animal Models of Infectious Disease T32 training grant. The venue for this event has traditionally been the Granite Bay Conference Center & Lodge at Lake Tahoe. An overnight stay at this setting provides opportunities for scientific interaction between faculty, postdocs and students during their joint meals and at the evening poster session.

BAMPS. The Bay Area Molecular Pathogenesis Symposium meets annually at the Mission Bay Campus of UCSF. Approximately 300 faculty and students attend this free one-day symposium from UCSF, UCSC, UC Berkeley, Stanford, and UC Davis. Typically, the participation of UC Davis faculty and students is approximately 20-25% in terms of talks, posters and attendance.

Annual Bay Area Symposium on Viruses. Similar to BAMPS, this one-day symposium is aimed at strengthening interactions among Bay Area scientists who share a strong interest in virology, including those from academia, industry and government. The free symposium features presentations by leading university and industry scientists, a session of postdoc / grad student talks, poster session, and opportunities for networking.

The Annual Microbiology Student Symposium at UC Berkeley. The symposium includes talks by students, poster presentations, and two nationally recognized keynote addresses. Registration is free and includes a catered lunch and coffee breaks. The symposium is an excellent opportunity to interact with microbiology researchers from the entire region. Typically, attendees include 150 students, postdoctoral fellows, and faculty from UC Davis, UC Merced, UC San Francisco, Stanford, twelve departments at UC Berkeley, The Joint Genome Institute, the US Department of Agriculture, and the Lawrence Livermore and Lawrence Berkeley National Labs.

Annual "Infection & Host Response: From Basic Science to Global Health" Symposium. Sponsored by the UC Berkeley Center for Emerging & Neglected Diseases, this one-day free symposium features five lectures presented by internationally recognized investigators.

Mid-winter Conference of Immunologists. Held annually in the Asilomar Conference Center, this conference was founded in 1961 with a goal to provide a forum where the newest developments in immunology can be shared in a relaxed environment. The conference aims to stimulate interaction between graduate students, postdoctoral fellows
and established immunologists. Topics vary, but often include areas of immunology very relevant to animal host-microbe interaction. Plenary sessions are scheduled in the mornings and evenings with poster sessions in the late afternoons. Posters are on display for the duration of the conference and two evening receptions take place in the same rooms as the posters. This facilitates interactions among the attendees and encourages students to present their work.

Other regional meetings include the Conference on Soilborne Plant Pathogens, formerly known as the Soil Fungus Conference and held annually in locations in the western U.S. and the Plant Pathology Annual Graduate Retreat (UC Davis campus).

4. QUALIFYING EXAMINATION REQUIREMENTS

In consultation with the student and the appropriate affiliated PhD program, the Executive Committee will recommend one DE-HMI faculty member to the Qualifying Examination Committee to examine the student on their level of knowledge within the area of the DE. Satisfactory performance on the QE for the PhD will be judged independently from performance on the DE. Thus, an allowable outcome of the QE is that the student’s performance may be “passing” for the PhD but “not passing” for the DE. In the event that a student passes the PhD portion of the QE, but receives a “not pass” for the DE, the DE Executive Committee will define a plan for remediation. The plan may include, but not be limited to, reexamination by the DE Executive Committee, coursework, teaching, or preparation of a paper. If the student is reexamined, the outcome is limited to “pass” or “fail”. If the student receives a “fail”, the Executive Committee disqualifies the student from the DE.

5. DISSERTATION REQUIREMENTS

The dissertation topic shall incorporate study within the DE. The student’s Dissertation Committee shall be selected in accordance with the regulations of the PhD program, but must include at least one member of the DE. The major professor may be a member of the HMI DE. If this is not the case, in consultation with the student and the appropriate affiliated PhD program, the Executive Committee will recommend a DE-HMI member to the Dissertation Committee.

6. DEGREE CONFERAL PROCESS

The DE will be awarded solely in conjunction with the PhD and will be signified by the degree designation PhD in ‘X’ with Emphasis in Host-Microbe Interaction, where ‘X’ is one of the affiliated graduate programs.

G. Student Advising

The DE Chair will serve as an advisor for the DE students. In this role, the DE Chair will review the academic progress towards DE requirements for each student on an annual basis. Working with the DE Chair, each student will be required to develop an annual work plan to direct progress towards the completion of the DE requirements. This work plan will be evaluated and revised annually to ensure that the student is making adequate progress towards DE completion. The DE Chair
will confirm to Graduate Studies and the student’s PhD program that the student has fulfilled all the DE requirements prior to graduation by signing the DE Final Verification Report Form.

3. Administrative Matters

A. Bylaws

The DE shall be governed by Bylaws, which will direct its administration, and define the requirements for both student and faculty participation in the program. See Appendix 4.

B. Resources

Administrative support will be provided by the Dean of Veterinary Medicine, which will serve as its administrative home (see supporting letter – Appendix 1).