Department of Microbiology

Self Study

February, 2000

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Professor and Chair

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B. School: Medicine

C. Degrees offered: Bachelor of Science
Masters of Science (Terminal)
Doctor of Philosophy

D. Brief description of the field and its history at the University of Washington

What is now the Department of Microbiology began as a Department of Bacteriology created by the School of Arts and Sciences in 1915, after originally being part of the Department of Botany. In 1946, the University decided that the Department of Bacteriology would be incorporated into a new Department of Microbiology in the recently established School of Medicine. Dr. Charles Evans was recruited as Chair of this new department, which at that time consisted of 6 faculty members. Dr. Evans served as Chair until 1970. His successor, Dr. John Sherris, chaired the department from 1970 to 1980. Dr. Neal Groman served as Acting Chair in 1980 and 1981. At this point, Dr. Eugene Nester took over as Acting Chair until 1982, at which point he became Chair. In 1997, Dr. Nester retired as Chair, and Dr. Jim Mullins served two years as Acting Chair, until being named Chair in May of 1999.

Over the years, the members of the department have made a number of significant scientific contributions. In particular, Dr. Evans' early observations on the growth of the polio virus in non-nerve tissue contributed to the development of the Salk polio vaccine. The studies on yeast carried out by Dr. Howard Douglas of Microbiology, and Drs. Herschel Roman and Don Hawthorne of Genetics set the stage for today's explosion of research on this organism. Dr. Neal Groman's work on bacteriophage-bacteria interactions, led to his discovery that phage DNA, integrated into the genome of the bacterium, can alter its properties. In the area of biotechnology, Helen Whiteley cloned the gene of toxin synthesis from *Bacillus thuringiensis*. Eugene Nester, collaborating with Dr. Milton Gordon in the Department of Biochemistry, was the first to demonstrate that a bacterium could transfer and integrate its DNA into plant cells. These observations formed the basis for genetically engineering plants resistant to herbicides, insects, and viruses.

In 1974, the department name was changed to "Microbiology and Immunology", and in 1977 a distinct division of Immunology was formed. Between 1982 and 1987, five new junior faculty members were appointed: Drs. Timothy Wong, Stephen Lory, Stephen Moseley, Julie Overbaugh, and John

Leigh. In 1986, the School of Medicine established an independent Department of Immunology, and the renamed Department of Microbiology retained only one immunologist, Dr. Edward Clark. In 1990, the Board of Regents approved transfer of the degree programs to each department, with Microbiology granted authority to offer the B.S., M.S., and Ph.D. degrees.

In succeeding years, several additional faculty appointments were created. These were filled by Drs. Kelly Hughes, James Mullins, and joint appointees Mary Lidstrom and Samuel Miller. The passing away of two active faculty members - Dr. Helen Whiteley in December, 1990, and Dr. Fritz Schoenknecht in April, 1996 - resulted in the appointment of two new faculty: Dr. Beth Traxler (Whiteley) and Dr. Brad Cookson (Schoenknecht). New faculty in the past two years include joint appointees Drs. Nancy Haigwood and Shiu-Lok Hu. Dr. Roger Bumgarner joined the research faculty in a position jointly sponsored by the Department of Molecular Biotechnology and the Washington Regional Primate Research Center.

Some recent departures from the faculty in our Department include Dr. Julie Overbaugh, who accepted a position as Full Member of the Fred Hutchinson Cancer Research Center. Dr. Overbaugh retains an affiliate appointment in Microbiology and continues to mentor Microbiology graduate students. Dr. Stephen Lory announced his acceptance of a position at Harvard Medical School, which he will take up in the summer of 2000. Faculty retirees during the current year include Drs. Timothy Wong and Marie Coyle, and Senior Lecturer Mary Bicknell.

Additional recent changes in the Microbiology Department include the addition of an interdisciplinary training program in Astrobiology - one of the first of its kind. This program is headed by Dr. Jim Staley of Microbiology. The Astrobiology program joins the list of several interdisciplinary programs in which the Microbiology Department plays an active role (These are further detailed in Appendix C). In addition, Microbiology is poised to play a major role in the development of the State Legislature funded Advanced Technology Initiative in Infectious Diseases (described below).

II. Unit Roles and Responsibilities

A. Principal roles and responsibilities within the Institution.

The study of microbiology plays a central role in our efforts to understand the functioning of cells, the mechanisms of infectious diseases, and a variety of other aspects of our environment, all from a molecular perspective. The discipline bridges numerous fields of study, from clinical medicine and epidemiology to the basic sciences, including biology, chemistry, and mathematics. Microbiology has been at the heart of the revolutions in molecular biology and the genomic sciences, enterprises which are transforming the world we live in. At the University of Washington, the Department of Microbiology is in the process of expanding its research emphases in the areas of infectious diseases (bacterial and

viral agents) and microbial physiology, against the backdrop of our more basic exploration of the diversity of the microbial world.

As part of the School of Medicine, and with an undergraduate as well as graduate school major, the Department of Microbiology has several unique roles at the University of Washington. We participate in teaching non-scientists as well as Pre-Medical and Microbiology majors at the undergraduate level. At the graduate level we provide instruction to Medical students preparing for clinical medicine, medical technologist trainees, and have a very active group of graduate and postgraduate trainees being prepared for careers in the basic and translational science in academia and industry.

Faculty

The department currently has 18 state funded, core faculty positions. Of these, 11 are tenure-line faculty (all are Associate or Full Professors), 3 are open tenure-line faculty, and 4 are Lecturers (Appendix D). Lecturer responsibilities include teaching all laboratories, advising undergraduate students, serving on departmental committees and lecturing in undergraduate courses. Two senior faculty members are also core members of the University of Washington's Regional Primate Research Center. Another is Director of the Office of Technology Transfer. We have four UW-based research faculty members, one with a commitment of space in the Primate Center, the other three without space commitment. Five faculty at the FHCRC have primary academic appointments in Microbiology, 3 of which are research and 2 with affiliate faculty appointments. Eight faculty members with primary appointments in other departments have joint appointments in Microbiology (Appendix D-2). The department provides partial salary support for 3 of these. 17 faculty hold Affiliate appointments in Microbiology (Appendix D-4). We also have a large number of adjunct and affiliate faculty, several of whom play significant roles in undergraduate teaching.

There are three major areas of research represented by our core faculty, including virology and immunology, bacterial pathogenesis, and general microbiology (bacterial physiology, biochemistry, microbial diversity and ecology, and parasitology). In addition, we have individual research faculty members focusing on bioinformatics and new technologies for studying gene expression in biological systems. Overall, including our FHCRC and joint appointees, 8 of our faculty focus on virology and immunology, 9 on bacterial pathogenesis, 5 on general microbiology, and 3 in other areas of microbiology.

Space

The department currently occupies a total of approximately 27,650 square feet in the Health Sciences Building. Approximately 3,500 square feet of this space is in the K Wing. Approximately

3,000 square feet is in the I Wing. The remainder is largely contiguous space on the third floor of HSB in the E, F, G & H wings.

Teaching Responsibilities

The most substantial teaching responsibility in basic sciences within the School of Medicine falls to the Department of Microbiology. This responsibility includes service courses for undergraduates, undergraduate and graduate courses for microbiology majors, and the human biology course for medical students. We also participate in the Biology 201 series. (Appendix F) The major time commitment of the faculty is skewed toward undergraduate teaching and micro major courses. There are currently 150 students enrolled in our major. The department also offers a minor in microbiology.

Financial Condition

The department generated approximately 5 million dollars in direct costs from research grants in the 1998-99 year. This amount excludes funds managed by collaborators in other departments. Approximately $1.6 million is provided annually by state funding. The department has no outstanding payback operations in effect and operated in the black in the past biennium.

Currently a staff of 10 personnel forms the administrative backbone of the department, assisting faculty and students, and ensuring smooth operations and compliance with University protocols. The department Administrator oversees the secretarial, fiscal, student advisory and other administrative support services for the faculty, students, fellows and Chair.

The Chair has organized a number of standing committees to implement, review, and modify various departmental functions and programs. The major committees include: Graduate Admissions and Policy, Undergraduate Program and Advising, and Appointments. The recommendations of these committees are subject to faculty approval.

Strengths of the Department

In the most recent ranking of Microbiology programs in the country by *US News and World Report*, the Department of Microbiology rated seventh in the country. Our major strength is the high quality of our faculty - both in research and teaching. All of our senior faculty members are internationally recognized for their individual research contributions, and all have outside research support. All currently serve or have served on study sections and editorial boards of major journals, one is a member of the National Academy of Sciences, and one recently received an NIH Merit Award.

At the Associate Professor level, all but one faculty member has extramural funding. The lecturers, and the one Associate Professor without research grants, do a particularly outstanding job teaching, as evidenced by the extremely high ratings they achieve on student and peer evaluations. They also relieve the research-oriented faculty of responsibility for the laboratory teaching of undergraduate

students. One of our senior faculty members received the Distinguished Teaching Award from the University in 1998. Our undergraduate program is currently a semifinalist for the University of Washington's Brotman Award for Insturctional Excellence.

Another strong point of our department is the cohesiveness of the faculty's research interests. While these interests range as far afield as ecology and virology, virtually everyone is concerned with the molecular analysis of bacterial and viral functions, and thus we all speak the same language. Additionally, the ties with other research departments at the University of Washington have strengthened considerably in the last several years. Several faculty have joint appointments with different departments, which include Chemical Engineering, Medicine, Laboratory Medicine, and Pathobiology. Many of our own faculty have adjunct appointments in other departments where they play important roles, and we in turn have many adjunct and affiliate faculty. Our ability to attract faculty from the Regional Primate Research Center and the Fred Hutchinson Cancer Research Center has strengthened our virology program enormously. In fact, all of these varied relationships indicate the important role the study of microbiology plays in the progress of diverse scientific fields.

B. Opportunities these roles have provided

The biological sciences are increasingly focusing less on the study of individual genes and more on systems biology - the quantitative definition and integration of numerous genes and gene products. Not only has the Department of Microbiology kept pace with this shift to a broader focus of study, it is now poised to play an important role in these new developments at an international level. We have created within the department a DNA Array facility, and are now in the process of recruiting three junior faculty members to further stimulate and broaden our research perspectives. On a larger scale, the University of Washington, already at the forefront of infectious diseases and genomic research, is becoming a leader in the new field of microarray technology. The School of Medicine, with active participation from the Department of Microbiology, was recently awarded an Advanced Technology Initiative (ATI) faculty cluster in Infectious Diseases. This program enables us to intensify our research into the cellular and molecular biology of pathogen-host interactions and Bioinformatics, and so become a leader in these fields as well. The ATI proposal was funded by the State Legislature in July of 1999. It provides $500,000 annually for three additional tenure-track appointments to form the nucleus of the ATI. The recruitment process is now underway, with Dr. Mullins and other Microbiology faculty members playing leading roles. First and foremost we are seeking a candidate with incisive understanding of the fundamental mechanisms of bacterial or viral disease and host responses to pathogens. Qualified candidates could include exceptional cell biologists and mathematicians focused on the study of infectious diseases. One or more of the faculty recruits will likely have a primary or joint appointment in the Microbiology Department.

C. Differences between the University and our views of the role of Microbiology

The School of Medicine has been very supportive of an enhanced role for the Department of Microbiology is providing leadership in setting research directions. This is most evident in the development of the ATI, as well as in the expansion of the Medical School Basic Sciences onto the Harborview and South Lake Union sites.

D. Changes during last decade

The field of Microbiology has undergone many transformations over the past several decades. As described above, the current transformation is from genome sequence definition to the post-genomics era of biological systems analysis and functional genomics. The perceived importance of Microbiology to public health has been high since its inception. However, the *E. coli* outbreak at the 1998 Puyallup Fair is a fresh reminder that infectious diseases continue to be a major cause of illness and death. Infectious diseases, such as pneumonia and influenza, are among the leading causes of death in the United States; globally they accounted for 20 million deaths in 1997 alone. New infectious diseases are being discovered at an alarming rate. In just the past 20 years, more than 30 new disease-causing microorganisms have been discovered, and many of these have spread explosively. The AIDS virus has infected an estimated 50 million people worldwide, claiming 16 million lives so far. The hepatitis C virus, unheard of 10 years ago, now infects 170 million people worldwide, with 4 million of those cases in the United States. Clinical microbiology has succeeded in producing antibiotics for many diseases, but many bacteria and viruses eventually become drug-resistant. Recently, drug-resistant strains of tuberculosis, malaria, AIDS, and pneumonia have been identified. Basic microbiological research and clinical studies are essential if we are to remain a step ahead of these killers. This is one of the most important challenges facing modern medicine.

Microbiology departments have sought to keep pace with these events through a multidisciplinary interest and activity in pubic health, research of disease causing agents, and through development of multidisciplinary research efforts. At the University of Washington, in particular, we view our department to function at the critical interface between the biotechnology discovery engine embodied by our department of Molecular Biotechnology and the clinical sciences. We speak the language of both of these other units are able to function as conduits bringing advanced technology to problems of public health and biological importance.

E. Criteria typical in field for measuring success

Typical standards of success in the field of Microbiology, as in most scientific fields, include publications (number and quality), grants (number and size), faculty teaching recognition, and awards.

F. Leadership in field

Precise leadership information is provided in the attached biosketches of our faculty. However, and as outlined within this document, we seek to enhance our leadership positions through the juxtaposition of state-of-the-art molecular biotechnology and awareness and activity in areas of critical public health importance.

G. Ways that changes in the field over the last decade have affected our view of Microbiology's role

During the past two decades, biological research has focused on deciphering the linear information encoded in DNA. The resulting mass of data concerning the structure and function of individual genes and their products has revolutionized biology, medicine, and the pharmaceutical industry, as well as virtually creating the new biotechnology industry. Now, with several successful genome sequencing projects completed and many more underway, the methods of biological research are changing again. For the first time, biologists can base their research on the knowledge of the complete genomic information of a species, essentially broadening the study of individual genes to include the dynamic contexts in which they operate. The resultant comprehensive understanding of biological systems and relationships will create new opportunities in research, medicine, and industry; in fact, these changes have already begun. Biology is shifting from a descriptive science to a quantitative one. Biologists are working towards a level of understanding that will enable the design of concise mathematical, predictive models of immensely complex biological processes. These models will revolutionize the field of medicine, for example, because they will enable an understanding of the causes and consequences of diseases at the molecular level, and to an exacting degree. As another example, pharmaceutical and biotechnology companies will be able to define optimal pharmacological targets based on knowledge rather than chance screening.

The realization of these opportunities critically depends on new and emerging technologies for the generation and analysis of the data describing biological systems. Additionally, emphasis must also focus on new facilities and management structures for the coordinated application of these technologies. The UW Department of Microbiology is attempting to meet these challenges directly, through in-house development and broad collaborative interactions with investigators at other research, health and science organizations throughout the world.

Apart from direct work on infectious diseases, microbiological research continues to provide insights into fundamental life processes. The molecular functioning of cells and viruses, the discovery of new forms of life, the mapping of the genetic codes of life - these and other avenues of research pursued by the Department of Microbiology have both immediate application and immense future potential.

H. Collaborations with related areas on campus.

The UW School of Medicine is one of the top infectious diseases research centers in the world. It provides an incredibly fertile environment for the development of new research technologies. UW researchers are also leaders in DNA sequencing research. Maynard Olson's genome center, for example, is working with Microbiology, the Cystic Fibrosis Foundation, and the PathoGenesis Corporation to sequence the genome of Pseudomonas aeruginosa, a bacterium that is a major source of life threatening respiratory infections in CF patients. Currently, three Department of Microbiology faculty members are studying *P. aeruginosa*.

The next level of the new paradigm involves the development of analytical methods for understanding complete biological systems. More specifically, the goal is for a comprehensive exploration of the molecular structures within microorganisms. DNA microarrays are spearheading this endeavor. This innovative new technology enables scientists to simultaneously study the functioning of the entire genetic code of a microorganism and, when appropriate, the eucaryotic cells it infects. Again, UW researchers within the Departments of Molecular Biotechnology and Microbiology have played a leading role in developing this critical technology.

DNA microarrays create a massive amount of information, and when this is combined with our burgeoning knowledge of entire genome sequences, it is clear that we have an urgent need to assimilate all this data in order to comprehend it. These developments have necessitated the creation of the new field of Bioinformatics, in which biologists and mathematicians come together to develop rigorous quantitative descriptions of biological systems. The result of these interdisciplinary efforts, combined with the latest technological advances, will be a profound increase in our understanding of microbe functioning. This in turn will facilitate the development of new therapies against harmful microbial agents. To this end, the University has developed a multi-user DNA Microarray Center based in Microbiology, and the department has an active role (and faculty presence) in the burgeoning UW Computational Molecular Biology Program. For our plans to succeed we require energetic and visionary faculty and the cooperation of other investigators and administrators at our institution. There are many indications that these basics are in place.

III. Degree programs

A. Bachelor's program

1. Objectives

The Department of Microbiology established its Undergraduate Program in 1946 when it was incorporated into the School of Medicine. Since then, the program has remained a part of both the School of Medicine and the College of Arts and Sciences. The Department offers a Bachelor's of Science Degree in Microbiology, a double degree in Microbiology and Medical Technology with the Department of Laboratory Medicine, and a Minor in Microbiology. In addition, the department awards a BS with Honors in Microbiology through the College of Arts and Sciences Honors Program, and also grants a BS degree in Microbiology with Distinction. The curricular offerings include a variety of courses for both the undergraduate major and non-major. Twelve undergraduate lecture courses, two lecture/lab courses, four independent laboratory courses, and a library research course are offered. The department also provides research opportunities for both the major and Honors / Distinction students. As part of the department's commitment to undergraduate education outside the major, the department has offered a summer laboratory course for Howard Hughes Undergraduate Research students, and most recently, for minority students selected via the Health Sciences Center Bridges[4] Program. A total of 1834 undergraduates enrolled in these courses for the academic year ending Summer Quarter 1999 (Appendix A). If one adds to this number the 350 medical students taught during the academic year and the graduate program, the department has a substantial number of student contacts per year.

Over the past two years the department has averaged 133 undergraduate majors (juniors and seniors). To complete the Bachelor of Science Degree in Microbiology, a total of 94 science course credits are required (Appendix B) which includes 36 credits in required microbiology courses and approved elective courses. Students must maintain a cumulative GPA of 2.25 and a minimum grade of 1.8 in all required and elective courses used towards graduation. Courses for which a grade of 1.7 or less was received must be repeated. Our undergraduate program is regarded as demanding and highly competitive. In the past three academic years, beginning with the academic year 1996-1997, 54, 59, and 71 students have received their BS degree in Microbiology.

2. Standards of Success

The Department's Undergraduate Admissions and Curriculum Committee reviews the Undergraduate Program periodically in an effort to improve and strengthen its undergraduate offerings

and address issues associated with changing student interest in our courses and a pattern of decreasing laboratory space available to the department.

- 1989-1990 Review: Prior to its most recent review in Spring Quarter 1999, significant changes to its curriculum occurred during the 1989-1990 academic year and coincided closely with the division of the department into the Department of Microbiology and the Department of Immunology. Changes included revising the medical microbiology series so that immunology was expanded from a 7 week course to a full-Quarter course (Microm 441) with the Department of Immunology assuming teaching responsible for this course. Microm 442, which was a medical bacteriology and virology course, was modified to be a full-Quarter of medical bacteriology taught by members of this department and Laboratory Medicine, and a new 2-credit medical virology course was developed (Microm 445). Moreover, a 5-credit microbial genetics lecture/lab course (Microm 411/Genetics 411-Gene Action) was established that would complement the Procaryotic Recombinant DNA Techniques course (Microm 431) established a year earlier. To attract some of the university's more promising undergraduates, the department implemented an early admission program for highly qualified sophomore students in 1994 and a year later developed its "Minor" program in microbiology. Because of the rising number of majors and students wishing to take our laboratory courses and our inability to negotiate additional laboratory space, priority registration for our majors was implemented for Microm 411, 431, and 443 in 1994. Although not currently a problem, in the years 1991-1994 Microm 301 Fall and Spring Quarter and Micro 410 reached room capacity and we were unable to accommodate all interested students.

- 1998-1999 Review: Key problematic issues identified in our Spring Quarter 1999 review were:

  (1) The lack of commitment of many microbiology faculty to participate in the undergraduate curriculum has limited development and consideration of new courses,
  (2) the increasing number of courses being taught by people who have their primary appointment outside of the department,
  (3) the shortage of graduate students who fulfill their teaching requirement by overseeing a section of a laboratory course, and
  (4) the imminent retirements of Marie Coyle, Mary Bicknell, and Tim Wong, each of whom have a significant role in our undergraduate program and the teaching of medical students (M. Coyle).

  The uncertainty of increased faculty participation in the curriculum led the committee to focus its review recommendations on how it could improve, "streamline", and/or make the curriculum more attractive to students without adding more courses. Issues related to entry/exit requirements to the

major, and how best to inform students of their satisfactory or unsatisfactory progress were discussed. Some of the recommendations / changes made were:

- To modify the course descriptions for Microm 410 and 412 to better reflect the content of these courses,
- to develop a new course, "Undergraduate Peer Teaching" to meet the shortage of graduate TA's,
- to have Lecturer Mark Chandler give two lectures in the Medical Bacteriology course starting Winter Quarter 2000,
- to give Jim Champoux sole responsibility for teaching the Molecular Virology course (Microm 450) (unfortunately, this will be at the expense of him teaching Biology 201 which we view an important recruitment vehicle to the major),
- to have, at least for this coming year, Jim Mullins give the lectures formerly given by Tim Wong in the Medical Virology course (Microm 445),
- to have faculty develop instructor course descriptions available to students via the internet,
- to update undergraduate materials that students can access through the departments' "Home Page",
- to change the cumulative GPA in all required and elective courses (those applied towards graduation) from its current GPA of 2.25 to 2.4, and
- to revise the letters sent to students who have not achieved the minimum grade point average in a required course and/or who have fallen below minimum grade point average needed for graduation.

We believe our early academic advising program and our ability to address student needs results in very few students who do not graduate from our program once they have been formally accepted to the program. We have no record of a microbiology major having been denied graduation status who applied for graduation. A review of the 71 students who graduated this past year indicated that they had an average GPA in micro required and elective courses of 3.03 and a cumulative GPA of 3.17. In addition, it is only the rare student who takes more than two years to complete degree requirements. When such an individual has come to our attention it is because they take more courses to increase their breadth of knowledge or increase their competitiveness for acceptance to a graduate/health professional program, or want to devote additional time to their research project. Students who encounter academic problems early in the program are advised/counseled or, if needed, are encouraged to explore an alternative major more appropriate to their abilities and interests. The Minor in Microbiology offers an alternative for some of these students. Student evaluations are routinely conducted for most of our courses and used to monitor success of the course as a whole and faculty contributions. In addition, an exit survey is given to all graduates asking them to comment on

microbiology course work, faculty, advising, counseling, future plans, and suggestions to improve the program. For the most part, student comments have been complementary, with no major weaknesses noted. In a 1995 report published by the University of Washington Office of Education Assessment entitled "The University of Washington Graduate Survey: Differences in Learning Outcome and Evaluative Ratings by Year, Major, and Sex," microbiology garnered one of the highest evaluations in several areas including "quality of instruction in major field." More recently a student course rating report published in the student newspaper (data from the UW Educational Assessment Office), indicated that Microbiology had the highest student evaluation score of any science program at the university.

A key factor in determining how well students perceive us lies in their responses to the outstanding contributions the Lecturers' have made to our program. Lecturers relieve research-oriented faculty of all responsibility for undergraduate laboratory teaching They provide excellent laboratory instruction, as evidenced by their high teaching ratings, advise/counsel students, provide valuable assistance to lecture course faculty, and bring course-related problems/issues to the attention of course chairs. The department will continue to demonstrate its commitment to the undergraduate program by protecting the Lecturer positions it has. The Department also helps students by providing two awards prior to graduation, one based on financial need and the other on merit (Bassett and Chiller Awards), and by recognizing the graduating student with the highest cumulative GPA (Evans Award).

3. Undergraduate Involvement

B.S. in Microbiology. The B.S. in Microbiology is offered as a degree in the College of Arts and Sciences. Our objective is to provide undergraduate majors with the best instruction possible in the broad area of microbiology so that they will qualify for a wide variety of positions with a terminal B.S. degree or be qualified to pursue advanced degrees at premier graduate or professional schools. The courses, both lecture and laboratory, cover all aspects of microbiology with a strong emphasis on principles and understanding. An undergraduate curriculum committee continually evaluates our course offerings for changing opportunities and challenges for microbiologists with a B.S. degree. Our curriculum is modified in light of these changing needs, as well as new developments in the discipline. For example, we recently expanded our undergraduate requirements to include a one-quarter lecture course in microbial genetics as part of a three-quarter sequence in general microbiology. To accompany these lectures, we substantially modified an existing laboratory course to include prokaryotic molecular genetics and recombinant DNA technology, the only such course on campus. Both courses are extremely popular and prepare students for employment in, for example, the 30 odd biotechnology firms in the Seattle area, as well as giving them a solid foundation for graduate work in microbiology-related fields.

All microbiology majors are required to take a course in library research, which consists of literature review and the writing of a report, under the supervision of individual faculty members. Students considering graduate or professional schools are encouraged to take a year of research with individual faculty members. Most faculty mentor one or more students.

In conjunction with the Biology Program on campus, the department also participates in a yearly two-day symposium on a variety of subjects of current interest to community college instructors and high school science teachers in the Northwest. This is given prior to the Fall quarter. It is noteworthy that our senior faculty have been very willing to participate in such courses for high school and community college teachers. A strong feeling exists among all faculty that the exciting events occurring in numerous areas of microbiology today should be enthusiastically transmitted to nonscientists.

Another strength of our program is providing opportunity for undergraduates to engage in an independent research project. In any given year, approximately 30-35 students are enrolled in our undergraduate research program (Micro 499/495). This past year, 1998-1999, 19 faculty members served as research mentors for our majors, as well as for students from other departments, Howard Hughes Undergraduate Scholars, and BRIDGES[4] Program students. In addition, one of our faculty (J. C. Lara) serves as a mentor for a science/health professions Freshmen Interest Group (Fall Quarter), and is course co-ordinator of our Freshmen Seminar Series (Winter Quarter) where he attempts to convey the importance of research to the student's educational training and development. From this effort, in the past three years, a total of 6 freshmen have been placed in research labs within the department. Finally, every year an award is presented (Ordal Award) to the most outstanding research paper submitted for review following an independent study under the direction of a member of the Department's faculty.

The Microbiology Department's Program Coordinator and the Biology Program's lead Adviser recently organized an employer career panel, "Certified Organic", as part of the University's Career Connections week. The following employers were invited to participate in the panel: Targeted Genetics, FDA, UW Medical Center (Medical Genetics), The Nature Conservancy, UW Department of Medicinal Chemistry, Immunex, and LabTemps. The event was held on January 31, 2000 in the Health Sciences Building. Approximately 70 students attended, and their feedback was very positive.

4A. Compliance with state-mandated accountability measures

The Department of Microbiology's faculty advisers and the Program Coordinator work closely together to help microbiology students to graduate in a timely manner. We recommend that students meet with an adviser early to discuss and plan their coursework. Students enter the Microbiology program when they are upper division sophomores or juniors, because we require prerequisite courses in biology and chemistry before admission. Students are also advised to apply for graduation

early, which gives them priority registration status. Plus we have priority registration (Micro majors only) for courses that fill quickly. This assures that our majors will be able to register for the required courses. In the past when classes have been filled to capacity, instructors have added extra class sessions to accommodate more students. Our faculty announce their office hours at the beginning of the quarter to encourage students to meet with them to discuss and ask questions about the course material. We also track how our students are doing in many of the microbiology courses and send letters to students having problems requesting that they come in for advising.

4B. Steps to improve the overall quality of the undergraduate program

We believe we have a very strong program. In the coming year, however, the Department will face the following challenges:

(1) How will we maintain our teaching commitment and excellence without compromising our research mission?
(2) Will new faculty appointments be required to participate in undergraduate education, and if not, who will fill void created by the departures of M. Coyle and T. Wong?
(3) If Microbiology Lecturers are asked to be more involved with lecture courses, will this compromise the success of our laboratory courses?
(4) If we again see an increase in students wishing to take microbiology lecture and/or laboratory courses, as is predicted, will we be able to accommodate them given the fact that one of the Lecturer positions was eliminated to hire a research oriented faculty member?
(5) Our inability to accommodate more students is also hampered by our inability to negotiate more laboratory teaching space, and lecture rooms large enough to accommodate over 200 students at the times courses are offered (Microm 410, Microm 411, and potentially Microm 431).
(6) What is the department's responsibility regarding teaching the introductory course for all biology majors (Bio 201)?
(7) Better placement/acceptance monitoring of our graduates into work positions or graduate/professional programs is needed.
(8) Recognition that undergraduate research training has become a de facto requirement for acceptance into graduate school - steps are being contemplated to provide greater opportunities to our students include the Chandler research lab course and expanded Molecular Biology course offerings.

B. Master's program

Not applicable. We offer only a terminal Master's, in line with peer programs at other institutions.

C. Doctoral program

As a research training discipline, microbiology provides many of the tools of molecular biology, now central to all areas of investigation of biology. In addition, and particularly important for the future, will be developing and training investigators in the identification of new infectious agents in both medical situations and extreme, perhaps extraterrestrial, environments.

Currently, there are 28 graduate students and all tenure-line faculty except for one serve as preceptors for one or more of these students. First year students are usually supported in teaching assistantships of which we currently have 8, including one from Biology. In subsequent years, graduate students are supported by individual fellowship awards, training grants, or research grants to their laboratories.

The objective of our graduate program is to graduate students with Ph.D.s who have demonstrated the ability to carry out significant research and have the desire, knowledge and potential for future intellectual growth. Students are carefully screened and selected before being admitted into this program. Applicant pools and the numbers of students accepted and enrolled are provided in Appendix A. Didactic courses in Microbiology include Virology, Microbial Physiology, Ecology, Pathogenesis, and Immunology. All students take graduate courses in Genetics, Biochemistry, Molecular and Cell Biology, as well as other specialized courses in a variety of departments depending on their interests. The course requirements and evaluation of graduate students are under continual review, especially in light of our participation in the Interdisciplinary Molecular and Cell Biology Program, the formation of the Department of Immunology, the broadened interests of graduate students, and our experience that many excellent candidates apply with a minimal background in formal microbiology courses.

We attempt to take full advantage of the faculty at the affiliated institution at the Fred Hutchinson Cancer Research Center by allowing selected members to mentor graduate students, develop graduate courses, and participate in the examination of students.

There is general agreement among the faculty that graduate students need as much experience as possible in presenting data verbally as well as thinking on their feet. Therefore, we have instituted a weekly journal club at which all graduate students present once a year. Each graduate student is formally evaluated once a year by his/her committee. The student must write a research progress report and answer committee members' questions.

Since the Ph.D. degree is a research degree, multiple papers published in a refereed journal with the student as first author is required for graduation. Since most of our students proceed to postdoctoral positions, we want to graduate students who will be a credit to this department, get their

first choice of a postdoctoral position, and be able to compete successfully for federal or privately funded postdoctoral fellowships. We expect our students to eventually qualify for the types of positions they desire, and hope that many will choose positions in major research universities.

PROGRAM DESCRIPTION

Initial Advising and Workshops

In the week or two before classes start, first year students attend a series of workshops (TA orientations, safety seminar, etc.). The group of incoming students collectively meet with their temporary advisor and the Graduate Admission and Policy Committee to discuss their course options for the upcoming year. See Graduate Curriculum (p. ***23***) for the list of required courses. Prior to this meeting the students review the requirements in relation to their undergraduate courses and prepare a tentative plan.

Department Retreat

Just prior to the beginning of autumn quarter, the Department holds a two-day research retreat. Besides providing a forum for the faculty and their research groups to discuss recent research developments, the retreat provides an opportunity for first year students to review the faculty interests before they decide on their rotations for the year. After the retreat, the first year students are then asked to talk to faculty with whom they wish to rotate and indicate their first, second and third choices for rotations in autumn quarter and their tentative choices for winter quarter. Prior to winter quarter, the students will have an opportunity to resubmit their choices for winter quarter rotations.

Laboratory Rotations

Graduate students must rotate through at least three laboratories during their first year, with each rotation lasting one quarter. The primary purpose of the rotations is to acquaint the students with faculty members and their labs in order to provide a basis for choosing an advisor for Ph.D. thesis research. A student will also do rotations to learn techniques or procedures that might be helpful later in their research. At the end of each rotation students will give a brief presentation of their rotation projects during the Thursday Journal Club. In addition, the lab supervisor will write a brief evaluation of the student's performance during his/her rotation. Furthermore, after each rotation the first year students will meet individually with members of the Graduate Admission and Policy Committee to discuss future plans and potential problems.

It is important to note that participation in a rotation does not imply that there will be funding or space within the lab for thesis research.

Choosing an Advisor

The choice of a thesis advisor is obviously an important one and is worthy of considerable care and thought both during and after rotations. The first year students discuss thesis research opportunities with those faculty members with whom they rotated and who are doing work in their areas of interest. Students meet with appropriate faculty members on several occasions to explore the kind of research projects available and to get a feel for the chemistry of the lab and the way the faculty member approaches research problems. First year students choose their thesis advisor at the end of spring quarter. No commitments are to be made by either the students or the faculty before this time. Students realize that the selection of an advisor depends on numerous factors and is not a unilateral decision on either the student's or faculty member's part.

Support

Most graduate students are supported as TA's in their first year. The amount of TA responsibility depends in large part on the teaching responsibilities of the Department in any one quarter. The few students that have RA support the first year still must meet the laboratory teaching requirement (TA for two quarters) sometime in the first two years. In autumn quarter, all eligible first year students should apply for both an NSF fellowship and a Howard Hughes fellowship. After the first year, all students are supported either as a RA on a research grant or as a trainee on a training grant (or as an NSF or Hughes fellow). The training grant stipend is supplemented from faculty research grants up to the level of the RA salary.

At the present time, all Ph.D. students can expect financial support for a maximum period of up to six years. Both the advisor and the student are aware that following 6 years of residence in the Department of Microbiology, the students are not eligible for financial support from departmental sources. A student may be supported from research grants at the advisor's discretion after 6 years.

Seminars

All graduate students are expected to sign up for and attend the weekly departmental Journal Club [Thursdays at 11:30 (Micro 522)] and Departmental seminar [Tuesdays at 4:00 (Micro 520)]. Graduate students are not asked to present papers at Journal Club until their second year. General exam questions may be based on information taken from Journal Club and/or the Departmental Seminars.

Teaching

Acquiring good teaching skills is an important part of graduate training. Besides the two quarter TA requirement, all students are required to present at least two lectures in an undergraduate course

in their third or fourth years. Arrangements for giving these lectures can be made by contacting individual faculty members. Students with a particular interest in teaching are advised to take Dr. David Irby's teaching methods course offered winter quarter.

Ph.D. Supervisory Committee

At the beginning of the second year, a six person Ph.D. Supervisory Committee is appointed. One member of the committee must be a member of the graduate faculty from another department and is called the "Graduate School Representative" (GSR). This member is appointed at random by the Graduate School and likely will be in a completely unrelated field, e. g., physics or oceanography. The remaining five members of the committee include a minimum of 3 Microbiology faculty members (including the student's advisor who is the chair of the committee). It is expected that at least one of the remaining two members be from outside the Department. This also can include faculty from the Fred Hutchinson Cancer Center who are not members of the Department. At least two of the remaining five committee members must be members of the graduate faculty. The make-up of the committee is determined by the student and his/her advisor with final approval by the Graduate Admissions and Policy Committee. A well-balanced committee is of tremendous benefit to the students and their advisors. Thus, there should be adequate representation of faculty representing both prokaryotic and eukaryotic research areas.

Guidelines for Thesis Supervisory Committee Meetings

It is recognized that research by its very nature is not always predictable and cannot be rigidly programmed. In addition, it is not always possible to anticipate potential problems at the outset. However, a general series of guidelines seems appropriate to provide both students and faculty with a set of standards against which progress can be measured. The following are the recommendations of the Graduate Admissions and Policy Committee for monitoring the satisfactory progress of graduate students towards completion of the thesis research requirement of the Ph.D. degree program in the Department of Microbiology:

(1) The supervisory committee meets with individual students annually near the end of the spring quarter of each academic year. It is the responsibility of both the student and advisor to see that the annual meetings are scheduled.

(2) Each graduate student before graduating must be first author on multiple papers related to thesis research which are published or accepted for publication in refereed journals. Under unusual circumstances, one first-author publication will satisfy this requirement. (For students starting prior to Fall 1997, one first author paper is required although students are nevertheless encouraged to be first author on multiple publications.)

(3) It is generally expected that students will complete all of the requirements for the Ph.D. thesis in 5 years or less.

Meeting at the end of the second year.

This is the first committee meeting. The committee reviews course work with the student to ensure that departmental requirements have been met and the Graduate School requirement of 18 graded credits has been fulfilled. It is expected that the student will submit a detailed written progress report (2-3 single spaced pages) to members one week prior to the meeting. The report should include the Specific Aims for the proposal to be written for the general exam. This meeting focuses on the student's progress and future plans to help the student prepare his/her NIH grant proposal during the summer. The student prepares a semi-formal 30-45 minute presentation on his/her research progress and future plans. It is expected that this meeting will take 60-90 minutes.

The oral component of the general exams is given at the beginning of the third year:

See below.

Meeting at the end of the 3rd year.

At this meeting the committee reviews any deficiencies or problems that necessitated a retake of the general exams (if applicable). The student is expected to present the committee members with at least a detailed outline of the first manuscript at this meeting. The student, with the help of his/her committee, then discusses the immediate direction of the research in the context of the overall research plan, as proposed in the formal grant application. Any redirection of the research or serious problems will be discussed.

Meeting at the end of the 4th year.

By this time, the student should have one first author paper in press and another manuscript in detailed outline form. The meeting therefore centers around discussions relating to the completion of the thesis research, perhaps in the context of another paper. The student should provide an outline of

the experiments needed to be carried out during the final year. At this meeting, the student may present an outline of the proposed thesis to the committee. Any significant problems or lack of progress will lead to serious consideration of placing the student on probation with written guidelines spelling out what must be accomplished to avoid dismissal from the Ph.D. program with a Master's degree.

Meeting at the end of the 5th year.

This meeting, if necessary, is the final meeting before proceeding with thesis writing. Ideally, 2 to 3 first author papers should have been accepted or submitted for publication. This meeting should include presentation of a detailed thesis outline and a definitive time scale for the thesis defense. If progress is marginal, the committee will spell out what must be accomplished over a defined time frame for the student to avoid final probation and/or dismissal with a Master's degree. If there is no significant progress made over the past year, the committee will consider encouraging the student to immediately leave with a Master's degree.

Meeting at the end of the 6th year.

If the student is still not finished at this point, the supervisory committee will consider two alternatives at this meeting:

(1) The student should provide a firm date for their defense and final thesis outline. There should not be any further laboratory research necessary, beyond the summer following the meeting.
(2) In the event the research progress has not been satisfactory, the supervisory committee must consider placing the student on final probation or, if the student has already been placed on final probation, immediately dismissing the student with a Master's degree.

General Examination and Advancement to Ph.D. Candidacy

Topics are presented during the Spring quarter of the second year. The oral component of the general exam is then taken during the first half of autumn quarter of the student's third year of residence. The components of the general exam are as follows.

Two topic component

Two non-overlapping topics, outside of the students research field, are chosen by the student by the first day of autumn quarter of the second year, and require the approval of the student's advisor and the Graduate Policy Committee. Students are encouraged to submit for approval of more than two topics, listed in order of preference, in the event that a topic area is disapproved. Reasons for rejection may include topic overlap, topics being too narrowly or broadly defined, too close to the

students own research area, or not in the field of microbiology/molecular biology. Second year students meet with the Graduate Admission and Policy Committee at the beginning of November to discuss these topics. One week prior to that meeting the students are required to submit a one page outline for each topic to the Graduate Committee. Students then follow the literature during the Fall and Winter quarters in the two topic areas approved.

One topic will be presented by the student during the beginning of the Spring quarter of the second year during the Thursday Journal Club. The student will prepare a 20 minute presentation (+5 minutes for questions), where he/she will discuss the state of the art in the specific field, analyze the significance of the problem and suggest directions for the future research. Following the presentation, there will be a question/answer session.

The second topic will be presented near the end of the Spring quarter, before the Graduate Admission and Policy Committee and two members of the supervisory committee including the thesis advisor. Both topics will be formally evaluated by the attending faculty. If the student performs satisfactorily then this component of the general exam will be considered complete. Any deficiencies will be discussed with the student who will then have an opportunity to become proficient in that area. Additional examination in the topic area will then take place during the oral component of the general exam.

Research proposal

The research proposal, which will be focused on the students' thesis work, should follow the format specified for an NIH grant application. This proposal should be prepared as soon as possible during the summer between the second and third years. A set of guidelines is provided for writing the proposal, along with an example of a good proposal. The student should present a draft of the proposal to his/her advisor at least three weeks prior to the oral exam. The advisor will critique the draft proposal with the student and indicate any sections that need rewriting. The advisor will not, however, substantially rewrite the proposal. One week prior to the oral exam, the final version of the proposal will be given to each member of the student's Supervisory Committee.

Format for oral exam

Prior to the oral exam and in the absence of the student, the advisor will review the student's academic record and provide the Supervisory Committee members a written evaluation of the student's research performance and potential. This evaluation will also have been discussed with the student prior to the exam. The evaluation should include an assessment of the student's effort level, creativity, independence, lab techniques, ability to design and execute experiments, and ability to communicate. The performance on the outside topics component of the general exam also will be discussed at this time.

The oral exam will be chaired by a member of the Supervisory committee other than the advisor or the GSR. The advisor will not examine the student but will be present and available for comment or clarification when needed.

The grant proposal will provide the starting point for the oral exam, but the questioning can extend into related topics, including experimental techniques. The oral exam begins with a 30 minute presentation by the student summarizing his or her research progress and indicating future directions of the research. Although the length of the presentation is limited to a maximum of 30 minutes, an allowance will be made for interruptions by committee members who have brief questions. Following this presentation, members of the supervisory committee will examine the students in areas related to their research and when appropriate, areas outside. It is expected that the meeting may last up to a total of three hours.

If progress in the outside topics was not satisfactory, students will be reexamined in these areas following the discussion of their research program.

Final evaluation and advancement to candidacy

At the end of the oral exam, both the student and the student's advisor will leave the room. This allows the committee to freely discuss the performance of the student. The outcome of the general exam will be determined solely by the committee members in the absence of the advisor. At the end of the deliberations both the student and the advisor are called back into the room for discussion.

The decision made at the end of the oral exam is a cumulative one, taking into account the student's performance in all areas since entering graduate school. These include, in the order of relative importance:

(1) the performance on the oral exam in the area of the student's research,
(2) the quality of the research proposal,
(3) the advisor's written evaluation of research progress and potential,
(4) the performance on general topic areas, and
(5) the performance in course work.

The final decision must be one of the following: Pass, Fail, or Re-examine.

If the committee determines that deficiencies exist that need to be corrected, the "Re-examine" option must be chosen rather than awarding a "Pass", with stipulations concerning the deficiencies. Regardless of the outcome of the exams, the members of the Supervisory Committee as well as the advisor are responsible for providing feedback after the oral exam.

GRADUATE CURRICULUM REQUIREMENTS FOR THE PH.D.

The requirements listed below are the minimum requirements to be met by all students in the Ph.D. program. The student's supervisory committee may require or recommend additional courses as deemed appropriate, based on the student's background and research plans.

Required background courses

These are generally satisfied prior to entry into the graduate program:

(1) A one year course in biochemistry (equiv. to UW Bioc. 440, 441, and 442),

(2) a course in classical and molecular genetics (equiv. to UW Genet. 371 and /or 372),

(3) a course in general microbiology (equiv. to UW Micro. 410),

(4) a course in medical microbiology and basic immunology is recommended for those considering research in the area of medical microbiology or virology

Course requirements after entry into program

The Graduate School requires a minimum of 18 graded credits, most of which will be fulfilled by the courses listed below):

Either Genet. 551 (3) and 552 (3), or Genet. 552 and 553 (3), or Conjoint courses: Conj. 531, 532, 533, 536, 537, 539, 541, 542, 543. A minimum of 6 credits (4 modules, 5-6 weeks long) is required. Each course is equivalent to 1.5 credits and normally students register for 2 modules per quarter. It is recommended that students take additional conj. courses. Students planning to apply to the Molecular and Cell Biology Training Grant are required to complete 6 credits of conjoint courses from the selection above.

Of the following list (which includes 3 courses offered at the FHCRC), three courses must be chosen, one virology and one bacteriology course must be among those selected:

Micro. 450 (3) Molecular Biology of Viruses (Offered every Spr.)

Micro. 540 (3) Advanced Virology (Offered even years Wtr.)

Micro. 510 (3) Physiology of Bacteria (Offered alt. years, Wtr. 1999)

Micro. 530 (4) Advanced General Microbiology (Offered alt. years, Aut. 1998)

Micro. 553 (3) Molecular Mechanisms of Bacterial Pathogenesis (Offered alt. years, Aut. 1999)

Micro. 441 (4) Introduction to Immunology (Offered jointly with the Dept. of Immunology every Aut.)

Fred Hutchinson Courses (3 credits each):

Cell Cycle Control (offered Fall 1998)

Cell Signalling and Oncogenesis (offered Spring 1998)

Molecular Biology of Human Pathogenic Viruses (offered Spring 1999)

Lab Rotation:

Micro. 500, minimum of 3 quarters

Journal Club:

Micro. 522, Continuous enrollment

Seminar:

Microbiology 520 seminar series or attendance at Fred Hutchinson seminars. Students at the Hutch are also encouraged to attend the Micro seminars. To be taken every quarter unless a conflict with teaching exists.

Research Discussion Groups:

To be taken every quarter of enrollment.

Additional requirements:

TA in at least two lab courses for undergraduates (usually in the first and/or second year).

Give at least two formal lectures in an undergraduate course (third or fourth year).

Be first author on multiple papers related to thesis research which are published or accepted for publication in refereed journals. Under unusual circumstances, one first-author publication would satisfy this requirement. (For students starting prior to Fall 1997, one first author paper is required although students are nevertheless encouraged to be first author of multiple publications).

2. Standards of success

The average Microbiology Ph.D. student completes the degree program requirements in 5.73 years (calculated using advanced degrees awarded during Autumn 1998 through Autumn 1999. (Appendix E presents a list tracking the current employment status of former Microbiology graduate students.)

In addition to the in-lab mentoring that takes place on a continual basis, the department makes an effort to provide graduate students with a breadth of career choices. For example, the departments of Microbiology and Biochemistry co-sponsored a Career Day (careers in the biological sciences) for graduate students. Jim Champoux was the coordinator for the Department of Microbiology. Approximately 55 graduate students attended the all day event, held for the first time on March 25, 1995.

The purpose of the career day is to provide career information that will help students explore the widerange of opportunities available to them. This past year, 17 speakers participated, representing

biotech companies, research colleges, and teaching colleges. Organizations included Seattle Pacific University, the National Science Foundation, the Fred Hutchinson Cancer Research Center, Zymogenetics, Bristol Myers, Darwin Industries, Seattle Biomedical Research Institute, as well as Lake Side High School, and a law firm.

Students are also informed through email and postings of career oriented workshops, i.e. "What Can You do with a Ph.D." a two-day workshop covering dependable strengths, career options, developing employer contacts, interview tips, etc. given by the University of Washington's Center for Career Services.

In addition to a vibrant and successful graduate program, the department currently has 39 postdoctoral fellows supported by individual fellowship awards, training and research grants to their laboratories.

IV. Responses to change

A/B. Changes in teaching and learning last 10 years, plans to maximize effectiveness and impediments to these plans

The need to educate the non-scientifically trained population about the nature of infectious agents and transmission has only grown in the last decade. Our perception is that in addition to training new generations of microbiologists, we must also help raise the level of scientific sophistication of the general population. We thus seek to enhance our effectiveness in educating students at the University of Washington by meeting what we see as critical challenges to our educational mission.

We would like to create two new courses, at beginning and advanced levels, that we feel will meet critical challenges faced by many students at the University. The first would be a freshman level course, open to all students, that introduces them to both the wonders and the perils of the microbial world. The goal of this course is to raise the level of general appreciation of microbiology. We want students in all disciplines to be better capable of understanding the advances in Research and Medicine they will encounter throughout their lives. We want to raise their sophistication in dealing with the microbial world in their daily lives, through understanding of infectious diseases, including issues such as safe food handling and sexually transmitted diseases. We also want to raise the general level of sophistication about science and scientific method. We feel there is an urgent need to educate students to be better capable of recognizing scientifically valid information and, to distinguish it from the pseudoscientific claims increasing pervading our culture and media. For example, a recent advertisement for "Vitamin O" appeared in USA Today last week. A simple solution of salt water containing some dissolved oxygen was being sold with the claim of being able to enhance just about all manner of health.

The second course is designed to provide a genuine laboratory research experience to a larger number of undergraduates than can be accommodated by our research laboratories. A de facto standard of qualification that is now emerging for competitiveness in the graduate school application process is some research experience outside of the standard laboratory coursework. The reason for this de facto standard is that life as a Life Sciences Researcher is unique. Graduate School programs, and to some extent Medical School programs, wish to prescreen students through this experience for their aptitude, interest and ability in this realm. However, we are unable to provide this experience to a large fraction of interested students who arrive at our laboratory's doors each year, asking for space and a research training experience. Through the leadership of our faculty we would make laboratory classroom space available for research projects year round. A Lecturer on our faculty (Dr. Mark Chandler) would supervise certain research topics and the day-to-day laboratory experiences of participating students. Members of our tenure-line faculty would provide the design of other research projects and periodic input.

The impediments to advancing these initiatives are the availability of funds and space, and the need to cover our current teaching responsibilities. In the coming months, once our faculty recruiting process has clarified, we will review our current offerings for possible selective phasing out so that our current faculty could switch responsibilities. However, we have not identified any course candidates for phasing out thus far. We would also need financial assistance to provide faculty salaries, as well as for the equipment and supplies necessary to outfit the laboratory components. We will also need a research equipped laboratory available at all hours and throughout the year for successful implementation of the upper level research experience course. In terms of space, however, we are in the unfortunate position of having space that had been available for our use taken away recently through formation of a Neurobiology course. Thus, we will need to identify additional laboratory classroom space to be able to offer this course.

C/D. Influences of new developments on research activities and means of providing new services to the university

An enormous number of changes in our understanding of the functioning of cellular systems has occurred over the last decade. Furthermore, we are rapidly approaching the era of post-genomic, "functional genomics" for the understanding the biological systems. Massively parallel techniques for the study of gene transcription and translational changes through identification of proteins from accurate protein mass spectroscopy and genomic sequence information, as well as facilitated study of protein-protein interactions are rapidly transforming microbiology. These issues were discussed in more detail in the preceding sections. Our development of a DNA micro array facility and our current faculty recruitment in the area of mathematical biology are evidence of our approach to meeting these challenges. We propose to capitalize on the substantial, currently available resources for the

recruitment of multiple new faculty to the Department of Microbiology, the Advanced Technology Initiative in Infectious Diseases (ATI) and the UW Regional Primate Research Center (RPRC), as well as the desire of the School of Medicine to expand off campus to create a strong multidisciplinary; Center for the Prevention of Infectious Diseases (CPID).

This program reflects the shared visions of the Chairs for the Departments of Microbiology (Jim Mullins and Immunology (Chris Wilson), and the NIH-sponsored HIV Vaccine Trials Network coordinating center (headed by Larry Corey), as well as the interest of investigators in other departments and programs. Furthermore, over the past two years the Department of Pediatrics and CHRMC have developed a strategic plan for a substantially enlarged research program to improve the health of children. They envision a concerted effort with the SOM, with CHRMC helping to support capital expenditures related to participation of pediatric investigators in the proposed Centers. This initiative is particularly timely since it allows these visions to be executed with a synergy not otherwise possible. This initiative is proposed to be developed over two phases.

Phase I: The Center for Pseudomonas aeruginosa Pathogenesis

The UW is currently one of the top centers for the research and treatment of cystic fibrosis (CF) in the world. The CF program is headed by Bonnie Ramsey, who also directs clinical and epidemiological studies for the UW/CHRMC CF Center and for the CF Foundation-sponsored national Treatment Development Network. Working with her to direct basic studies of *P. aeruginosa* molecular pathogenesis are Steve Lory (Microbiology) and Maynard Olson (Medicine/Genetics), (e.g., the *P. aeruginosa* genome project) and to direct an NIH-funded CF-related gene therapy center is A.D. Miller (FHCRC). Although Steve Lory will depart the UW in mid-2000 for Harvard, we expect to maintain or enhance our leading position in this area. Sam Miller's group (Medicine-ID/Microbiology) has as a major focus Pseudomonas pathogenesis in CF, as does Jane Burns (Pediatrics-ID); they collaborate with Alan Aderem and Chris Wilson (Immunology) on studies of Pseudomonas-induced inflammation. These existing programs will be augmented substantially by the planned recruitment of new faculty. The ATI seeks to recruit Peter Greenberg, a highly regarded Pseudomonas expert (currently at the University of Iowa), to lead the ATI, and two junior faculty members to study host-pathogen interactions using bioinformatics and laboratory-based approaches. Maynard Olson anticipates working with the ATI program to further studies of Pseudomonas genomic diversity. The Department of Pediatrics is actively recruiting a senior CF cell biologist (Eric Sorscher, currently at UAB) to lead its basic research efforts in this area.

Key to attracting these new recruits is this initiative. We currently envision the relocation to the South Lake Union (SLU)/Rosen Building from CHRMC-rented space of B. Ramsey and her group of clinical investigators and ancillary staff, along with Peter Greenberg, the other ATI investigators, Eric Sorscher and a junior investigator in CF-research recruited by him, as well as our micro array center

and the laboratory groups of Drs. Bumgarner, Katze and Mullins. A major focus for the ATI and studies of host-pathogen relationships for this Center and the one described below will be post-genomic approaches to microbial pathogenesis and the bioinformatics of "systems biology." This fits well into a Rosen Building based activity and creates an attractive nucleus for the development of a substantial research center at SLU, which is expected to help forge important collaborative ties with the surrounding campuses and serve as a springboard for phase II of our proposed program:

Phase II: Center for the Prevention of Infectious Diseases

The top two infectious disease killers worldwide are tuberculosis and HIV. Another major cause of disease worldwide is Hepatitis C virus (HCV), which infects ~4% of the world's population, leading to substantial mortality and predisposing to the development of hepatocellular carcinoma, a major cause of mortality in adults in the developing world. None of these diseases can be effectively cured, and the prevalence of all three is increasing worldwide. Urgently needed are effective and safe vaccines, and until such vaccines are developed, new therapies. Traditionally, vaccine development has occurred in the private sector. However, in diseases in which the immunobiology of protection is as yet unknown, the private sector has stayed on the sideline, as the cost of research versus the perceived return on the investment is not high. Once a target or initial vaccine strategy is identified, improvements by the private sector then occur. Recognizing this, the NIH has established both a separate study section and increased funding to "prime the pump" for vaccines of medical importance. Agencies such as the World Health Organization and the United Nations are teaming up with governments to help get vaccines developed, tested and into the places they are needed most. Private foundations, notably the Gates and Rockefeller Foundations, have made vaccine development and global distribution a priority. Vaccine development and evaluation requires a team approach. Moreover, there is synergism between the technologies required to develop and evaluate vaccines: A vaccine center is greater than the sum of its parts. Thus, it is opportune from a funding and scientific perspective to develop a center for vaccine-based prevention of infectious diseases at the UW.

As presently envisioned, the program would have two thrusts: 1) To apply our knowledge in pathogen molecular biology, immunology, structural biology and genomics to design and test in small animals and primate models new vaccines and therapies. A later thrust, envisioned as a possible phase III, will be to apply our biotechnology experience and/or partner with local biotechnology companies to manufacture lots of vaccines that are ready for clinical testing, and to develop novel vaccination technologies that can be widely applied. Together, these programs will provide the scientific, technological and empirical basis for the development of safe and effective vaccines against AIDS, tuberculosis and HCV, and potentially malaria and herpes virus infections.

The UW has a research base that positions it well to play a major role in these efforts. Seattle is one of the top centers for the study of the virology, immunology, epidemiology, intercurrent

opportunistic infections and clinical outcomes of HIV infection. The UW has had a longstanding program in HIV vaccine development involving the SOM, RPRC and SOPH (Public Health). The program has focused so far on the testing of candidate vaccines in primates and humans. Recently, however, the Seattle community's involvement in HIV vaccines has markedly increased in scope. Under the leadership of Larry Corey and Steve Self, a program to coordinate the NIH (NIAID) Clinical Trials Program for HIV vaccines has been centered in Seattle (the HIV Vaccine Trials Network, HVTN). One of the central laboratories for this network will also be located in Seattle under the direction of Julie McElrath. This large program (now $8M/year and expected to increase) will be the focal point for the NIH supported clinical trials program for the US and internationally. With discretionary fund authority the HVTN seeks to: Introduce novel immunogens into clinical trials; develop new assays to assess immunity to HIV vaccines, and; oversee primate and human vaccine trials. The HVTN provides the academic leadership, statistical and clinical trials expertise that will attract and fund programs in vaccine development and conduct. It thus provides the nidus for other vaccine programs in Seattle.

We anticipate that the laboratory-based programs directed by Lisa Frenkel (Pediatrics-ID), would possibly relocate her Pediatric HIV research program from CHRMC to this site. Additional programs that might be based at SLU include the HVTN, planned junior faculty recruitments in the Department of Microbiology in viral pathogenesis and bioinformatics, and a joint recruitment by the Department of Immunology and the RPRC of an individual who will work on immunological processes relevant to vaccine design.

Though non-existent as little as 4 years ago, there is now a substantial community of investigators studying the biology and immunology of tuberculosis at the UW. These include components of Chris Wilson's and Mike Bevan's groups (Immunology) and of Wim Hol's group (Biological Structure) as well as Sherilyn Smith (Pediatrics) and David Sherman (Pathobiology, SOPH). Corixa Corporation also has an active program seeking to develop vaccines against this infection. This interactive group should soon be augmented by recruitment to the Department of Microbiology of promising junior faculty member(s) to study mycobacterial pathogenesis. It is expected that Sherilyn Smith and a component of Chris Wilson's program, along with the new recruit(s) in Microbiology, could be based at SLU.

The UW has an important research program in HCV pathogenesis and clinical research that involves multiple departments and investigators (Bob Carithers, Nelson Fausto, David Gretch, Michael Katze and Steve Polyak). While vaccine development is an area of interest, this is an area where new recruitment is needed to strengthen our efforts. HCV now has a high profile for funding at NIAID, and the proposed center would help us to get in on the ground floor and to recruit new faculty in this area.

In addition to the investigators noted above, this site makes a logical home for the Infectious and Immunological Diseases program of the Department of Pediatrics and CHRMC, since they share a common theme: Pathogenesis/Prevention of Infectious Disease and the immune response to infection.

The Pediatric ID/Immunology program is well funded by extramural grants to study bacterial and viral pathogenesis, antibacterial and antiviral resistance mechanisms, the development of the immune response in infants, host responses and immunity to specific microorganisms, pathogenesis of immunodeficiency and autoimmune disorders. Investigators who would relocate to SLU include in addition to the three mentioned above are Craig Rubens, Gary Darmstadt, Stuart Kahn, Hans Ochs and 2-3 new immunologists being recruited. Phase II at SLU will provide a stimulating environment of shared interests and place at their disposal tools to more fully define the genetic basis of host-parasite interactions and the genetic pathways that alter or regulate host susceptibility and influence development of immunity.

While much excitement is focused on the development of new initiatives in Infectious Diseases, the other major strength of the department of Microbiology, in microbial physiology, will not be left out in this process. The department has recently voted, unanimously, to offer an FTE at the full Professor level to Dr. Caroline Harwood, the wife of Pete Greenberg being recruited to the ATI leadership position. Dr. Harwood is a highly respected Bacterial Physiologist who would be expected to provide strong leadership to this segment of the department of Microbiology.

E/F. Strategies to address anticipated changes in next ten years

Over the course of the next year, much of our laboratory space will be rearranged, remodeled and brightened. One of our goals is to provide blocks of contiguous space for research groups. We acquired extra space when the former Immunology administrative suite in I-264 was added to the Microbiology Department space. Additional laboratory and office space will be provided by the Primate Center. With the large number of faculty recruits pending, the department has arrived at a critical decision point. Taking into account the impending departures of Drs. Timothy Wong and Stephen Lory, the ATI recruitments, and the remaining departmental appointments, we are in the process of filling approximately eight new faculty positions. A major issue we must address is space. Within the department, there is space enough (though of sub-standard to mediocre quality) available to recruit 2-3 faculty. However, no on-campus space is available to recruit the proposed ATI cluster. In order to attract top quality faculty, Microbiology, in consultation with the School of Medicine and its Planning Committees, needs to choose among several options. The first possibility is to recruit the ATI cluster to an off-campus location (most likely the Rosen building at South Lake Union). The second is to recruit ATI faculty to on-campus space and to move existing groups to off-campus location(s). The third is to develop the Microbiology department along with the ATI at two sites, potentially along programmatic lines. The ATI's central focus on Microbiology and the high quality of the junior faculty applicants we are entertaining provide compelling rationales for growth in the near future that substantially enhances the department's research contributions. However, we are unable to detail plans for a possible redefinition of department structure at this time.

G. Enhancement of personal productivity

The new departmental leadership has coincided with a number of changes in the financial structure of the SOM. Important among these has been a change in the salary structure for the faculty. The State Legislature has consistently provided low to zero cost of living increases each year for University faculty. One year ago our salaries we at the roughly 20% for peer institutions. Since that time, we have been able negotiate a "B" component to our salaries, which provides for an increase to roughly 50th percentile levels contingent on the availability of grant resources to the individual faculty member. Though this system is still evolving, we anticipate that the B component will be negotiated annually between each faculty member and the chair, subject to approval by the Dean of the SOM. Not all members of the faculty are able to take advantage of "B" component increases. We seek to enhance their compensation through merit based increases in the A component salary.

All faculty members are offered annual reviews with the chair to set and evaluate goals for research, teaching, student mentoring and participation in department and University service.

V. Goals

The goals of the Department of Microbiology are to maintain and enhance our excellent teaching and research programs as outlined above. These goals have not been reviewed regularly in the past, but are undergoing systematic evaluation, with our current focus on developing our research programs through multiple faculty recruitments. The next phase of this evaluation will be to create an equitable teaching responsibilities throughout the department and with the participation of our joint, adjunct and affiliate faculty.

VI. Strengths and Recommendations

The department enjoys great strength in its research program, many of which are interdisciplinary and at the cutting edge of their field. Virtually all faculty have external research funding and have research programs often in collaboration with other members of this department or other departments both within and outside the Medical School.

Our graduate student program remains very strong, both as a result of the high quality of the faculty programs and because of the major efforts put into recruiting high quality students. The training of graduate students represents an extremely important function of this department.