



Molecular Medicine Graduate Certificate Program
University of Washington School of Medicine

Certificate Offered: Graduate Certificate, to be awarded with the PhD degree
Initial Approval Date: November, 2005
Director: Nancy Maizels, PhD
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BACKGROUND INFORMATION

I: Overview of Organization

Mission & Organizational Structure

Mission: Molecular Medicine is an interdisciplinary approach to human biology and disease that integrates and applies advances in the basic biomedical sciences and in biotechnology to understanding, diagnosing and treating human disease. Molecular Medicine is a recognized area of excellence at the UW, reflecting an institutional culture which encourages interdisciplinary science and translational research. The Molecular Medicine Training Program (MMTP; <http://depts.washington.edu/molmed/>) educates PhD students to use this interdisciplinary approach to solve problems relevant to human disease; and, conversely, to use insights from human disease processes to solve fundamental biological problems.

Molecular Medicine Training and the Institutional Culture of the UW

The UW is one of this country's leading biomedical research institutions, and a natural home for Molecular Medicine training. The UW is recognized for the scope and size of the biomedical research enterprise, and for its record as a leader and innovator. Some features of the leadership role of the UW in biomedical research are:

- continuous ranking of the UW among the very top public institutions in federal funding
- collaborative culture reflected in a long history of productive collaborations between basic scientists and clinicians
- unique interdisciplinary interactions among the biomedical, engineering and computational communities
- the outstanding affiliated Seattle biomedical research institutes where UW PhD students can train, including the Institute for Systems Biology, Children's Hospital Research Institute, Benaroya Research Institute, and Seattle Biomedical Research Institute
- the excellence of Seattle's scientific environment, as evidenced by the presence of 6 Nobel laureates (5 awarded since 1990); 8 Gairdner Award recipients, 5 Lasker Award recipients; 60 members of the National Academy of Sciences; 48 members of the National Institute of Medicine; 17 HHMI Investigators and 3 HHMI Early Career Awardees
- the cutting-edge instrumentation available at the UW and affiliated institutes
- active involvement in research training of the Institute for Translational Health Sciences (ITHS), funded by an NIH Clinical and Translational Sciences Award (CTSA)
- the constellation of large and small biotechnology firms in Seattle that maintain close relationships with the UW, many started by UW faculty
- the extraordinary generosity of the local community in providing funds for construction, research and education

UW faculty have transformed health care with innovations including the "Scribner shunt" and simplified instrumentation for kidney dialysis (Belding Scribner); definition of the blood clotting pathway (Earl Davie); bone marrow transplantation (E. Donnall Thomas; Nobel laureate, 1990); the first genetically engineered vaccine (Ben Hall), and identification of genes key to cancer (Lee Hartwell, Nobel laureate, 2002), and the HPV vaccine for prevention of cervical cancer (Denise Galloway).

Degree offered: The MMTP offers a single degree, a Molecular Medicine Graduate Certificate, to be awarded along with the PhD. The Certificate Program is open to PhD students in any of the basic science departments or interdisciplinary programs at the UW School of Medicine. Trainees participate in formal coursework and programmatic interactions with physician-scientists and clinicians working at the interface of basic science and human disease. Students completing the interdisciplinary Molecular Medicine Graduate Certificate Program have the information, intellectual tools and practical experience in to develop imaginative new solutions to problems relevant to human disease. Our trainees are well-positioned to assume leadership roles not only in academia but also in biotech and the pharmaceutical industry, both of which play important roles in the Washington State economy.

History of the MMTP: In 2004, the Dean of the Medical School appointed a Molecular Medicine Leadership Committee to review and report on establishment of molecular medicine training, with the goal of developing opportunities in training that would complement the expansion of faculty and space dedicated to translational research. That Committee included Nancy Maizels, now Director of the MMTP, and several other members of the current MMTP leadership. The Committee reported to the UW Medical School Executive Committee (composed of the Dean, Executive Leadership, and Chairs of the basic science and clinical departments) on the educational goals, curriculum and training requirements within the context of our own institution and related programs being developed nationally. There was a strong consensus to support this training program. A Molecular Medicine Executive Committee was formed, with Dr. Maizels as Chair, and charged with design of the program. Building on faculty and student input, the institutional report, internal assessment and external review, we defined a coherent curriculum and solid infrastructure for an interdisciplinary Molecular Medicine Training Program leading to a Graduate Certificate. The UW Board of Regents approved the Graduate Certificate in Molecular Medicine in November, 2005. Students immediately enrolled, and the program has been expanding ever since.

Governance: The MMTP is led by a Program Director (Nancy Maizels, PhD), who works closely with two Co-Directors (Peter Byers, MD, and Henry Rosen, MD) and with an Executive Committee composed of faculty involved in both basic and clinical research (Appendix A). The Directors, Co-Directors and Executive Committee establish long-range goals and program direction. The Executive Committee meets 3-4 times/year, and communicates regularly by email. The Director and Co-Directors are responsible for day-to-day decisions, consulting with members of the Executive Committee as appropriate. The MMTP reports to the Vice Dean of Research and Graduate Education, and maintains close lines of communications with departments that are natural stakeholders in biomedical research training. Members of the MMTP

leadership team have all demonstrated a long-term commitment to research at the basic science/clinical interface and to training physicians and/or basic scientists.

Faculty: The MMTP is an interdisciplinary educational program that draws on the talents of a great variety of faculty, who participate in the leadership of the program and as teachers, thesis research advisors, and Clinical Mentors for research projects (Appendix C). Faculty hold primary appointments in basic science and clinical departments and at affiliate institutions. Those with graduate school appointments have strong records in PhD training and research funding. Those with primarily clinical focus are physicians with distinguished records in medical research and training who have revealed great talent and enthusiasm for teaching PhD trainees.

Molecular Medicine Courses: The MMTP has launched five new courses, which comprise the core of the Certificate Program. Courses are taught by faculty from basic science and clinical departments at the UW School of Medicine. Molecular Medicine courses are designated by the prefix MolMed. These courses are open not only to Certificate students but also to students enrolled in any UW PhD program or the MD/PhD program. Molecular Medicine courses have been tremendously successful based on student enrollment (Appendix E) and on course reviews. The value of offering key elements of molecular medicine training to the broadest spectrum of students has been continually reinforced by students, faculty and colleagues. New collaborative interactions and collaborations have arisen out of participation of students and faculty in Molecular Medicine courses.

Enrollment Information: There are currently 28 students pursuing a Molecular Medicine Graduate Certificate, from seven different departments (Biochemistry, Bioengineering, Immunology, Microbiology, Pathology, Pharmacology) and the interdisciplinary MCB program (Appendices F and G). Five of the current trainees (18%) are under-represented minority students. The strong representation of individuals representing groups who are not proportional participants in biomedical research attests to the specific appeal of Molecular Medicine training to those who wish to put their talents to work in an area that is intellectually challenging and provides the opportunity to address important issues in human health and disease.

Interfaces with External Constituents: Sustainability of the MMTP and success of our program depends upon close interfaces with federal and private funding agencies. The mission of the MMTP resonates with the emphasis of the US National Institutes of Health on promoting research that can directly benefit human health. Biomedical Research Training is part of the portfolio of the National Institute for General Medical Sciences (NIGMS), and the initial steps toward establishing the MMTP were taken in 2004, shortly after two founding members (Drs. Maizels and McKnight) attended an NIGMS-sponsored meeting where the commitment to future support of PhD training in the area of Molecular Medicine was explicitly articulated. We have continued to maintain close ties with the NIGMS Biomedical Research Training Program, which now funds our Molecular Medicine T32 Training Grant. The Molecular Medicine leadership team has also kept abreast with national goals and trends for PhD training in the biomedical sciences by attendance at an annual meeting of MedIntoGrad Program Directors, held at HHMI

Headquarters in Chevy Chase, MD. These meetings provide details on all HHMI-funded MedIntoGrad Programs, as well as opportunities to develop personal connections with colleagues committed to those training programs. Most meetings include a presentation on long-term commitments to PhD training by a representative of the NIH.

Biotech and Pharma are also key external constituents, as they are potential future employers of our students either immediately upon graduation, or — more likely — after postdoctoral training. We have developed a formalized interaction with industry that promotes a very useful dialogue. Patrick W. Gray, PhD (CSO, Accelerator Corporation; Affiliate Professor of Biochemistry), serves as chair of one of our courses, Scientific Ideas at Work (MolMed559), working with Nancy Maizels, Director of the MMTP, as co-chair. Dr. Gray has a long history in biotech, and he is well-positioned to be aware of new advances and trends in his current position. MolMed559 consists of ten sessions focused on major advances in drug development by basic scientists working in industry, featuring lecturers who have been closely involved in development of well known drugs. Faculty and students have an opportunity to interact with the visiting speakers, and to visit Accelerator as guests of Dr. Gray.

Budget & Resources

Budget: Past and future impact of the MMTP and the enthusiastic support of leadership of the UW is evidenced by commitments specifically in support of this program totaling \$60,000/year, from the Dean of Graduate Education and Research and participating clinical and basic science departments. These funds are available to support MMTP infrastructure, including a fraction of salary for the Program Manager; office space; server space; publicity for Molecular Medicine courses and the MMTP; and recruiting of minority students interested in molecular medicine.

We have leveraged those institutional commitments whenever possible. Our current budget (Appendix B) is almost entirely provided by funds from HHMI and the NIH. The budget supports MMTP infrastructure, including a Program Manager (50% time). NIH funds provide stipend, tuition and benefits for two second year PhD students; and HHMI funds provide partial support for students in the program, typically for one quarter at the end of Year 2 and one quarter at the end of Year 3 of graduate school. HHMI funds also contribute to salary support of faculty with administrative or teaching responsibilities not covered by their UW positions.

Validation of Our Use of Resources: Primary metrics of our productive use of funding and resources are the quality of training, the success of our students, their continuing commitment to molecular medicine, and our ability to compete with other similar programs nationally for limited private and federal resources. We have been successful by these metrics since our program was launched. This success has made the Molecular Medicine Certificate Program financially self-sustaining, and brought a continuous revenue stream to the UW from sources that might not otherwise be tapped. Successes in external funding include:

- 2006-2010: Howard Hughes Medical Institute (HHMI) MedIntoGrad funding; one of 13 institutions from a total of 78 applicants to be awarded funds.

- 2010-2014: HHMI MedIntoGrad funding renewed; one of 23 institutions from a total of 103 applicants to be awarded funds.
- 2011-2015: NIH NIGMS Molecular Medicine T32 funding awarded. These training funds are from a national pool of funds for interdisciplinary PhD training that has been held constant over the past 3 years. Thus, our new program is seen as an important direction for the future. Of the 23 institutions currently supported by HHMI MedIntoGrad funds, the UW is one of only three that have thus far been successful in obtaining NIH Molecular Medicine T32 funding.

Plans for Additional Sustainable Funding: We are committed to the continued success of our program that will enable renewal of our NIH Molecular Medicine T32 Training Grant funding in 2016. We also hope to leverage our success with HHMI and NIH funding into additional support, ideally with help from the UW Development Office.

II: Teaching and Learning

Student Learning Goals & Outcomes

Student Learning Goals: Graduates of the MMTP are able to bridge the gap between medical understanding and basic science. They can independently identify important questions in human health and disease and develop experimental strategies to address these questions. They are comfortable using the concepts and language of medical science, and they have the rigorous and deep understanding of basic science necessary to solve critical problems.

To promote these learning goals, the MMTP adds three key elements to traditional graduate training: case-based courses, clinical interactions, and dual mentorship of PhD research by a basic scientist and a clinician scientist.

- **Coursework.** The MMTP requires each student to fulfill all courses required by the home department or interdisciplinary program, and 15 additional credits, which must include the centerpiece course, *Molecular Medicine* (MolMed514) and either *Molecular Basis of Disease* (Path500; physiology and pathophysiology) or *Clinical Medical and Human Genetics* (MolMed513, a mentored clinical rotation in human genetics). Students must also demonstrate proficiency in statistics.
- **Dual Mentorship Connecting Basic Science and Clinical Research.** The Thesis Committee of each Molecular Medicine trainee includes a “Clinical Mentor” who is directly involved in clinical medicine (Appendix G). This “Clinical Mentor” contributes a clinical perspective on the research project, facilitates interactions with clinicians and access to clinical samples, and provides scientific guidance. The Clinical Mentor is typically identified by the beginning of the third year of training, when the focus of the thesis research is clear. The MMTP Co-Director, Henry Rosen, works with each trainee to identify a Clinical Mentor with expertise most appropriate to the trainee's interests and research.
- **Capstone Presentation.** Each trainee delivers a Capstone Presentation in Year 4. The goal of the Capstone Presentation is to place the significance of thesis

research in the context of both basic science and clinical medicine. It emphasizes impact and relevance to health more than experimental rationale, design and detail, and it is thereby distinct from the thesis defense. The audience includes the student's mentors, other Molecular Medicine trainees, and faculty from the MMTP leadership team.

Students: The Molecular Medicine Graduate Certificate Program is open to students studying for the PhD degree in the interdisciplinary MCB Program or one of the eight department-based basic science programs at UW Medical School — Biochemistry, Bioengineering, Genome Sciences, Immunology, Microbiology, Pathology, Pharmacology, and Physiology & Biophysics. (Students enrolled in the MD/PhD Program are not eligible for the Graduate Certificate, which is deemed redundant with their dual degree.) Recruitment to the MMTP from this very broad pool means that our students have diverse outlooks, as some have chosen very focused departmental-based curricula while others wish to take full advantage of the very flexible curriculum offered by the MCB Program. One level of training within the MMTP occurs as students from these different disciplines and perspectives learn from each other, and become better at explaining the rationale for their research and at communicating their interests.

The students who apply for training in biomedical research at the UW have excellent undergraduate records from top-notch institutions. A significant fraction have taken a year or more working in biomedical research, in academia or biotech, so they are committed to their professional goals and skilled at the bench. A large fraction of students who matriculate in graduate programs in basic sciences at the UW School of Medicine are interested in clinically-oriented research. We interview carefully to identify highly motivated, creative students who expect to work hard.

The 28 students currently participating in the Molecular Medicine Graduate Certificate Program represent seven different departmental programs and the interdisciplinary MCB Program. Five of our trainees (18%) are under-represented minority students. Trainees have a clear sense of direction and an unusual commitment to their research, and are among the hardest-working of UW students. They are carrying out their thesis research in a great variety of areas relevant to human health and disease. Their future plans in almost all cases involve translational research, with equal numbers specifying biotech/pharma or academic careers.

Student Outcomes: The eight students who have graduated with Molecular Medicine Certificates are currently in academic postdocs (5), biotech (1), science policy (1) and teaching (1). Anecdotally, our students attest to the importance of Molecular Medicine training in their career paths. Two students provide interesting vignettes:

- Brian Kidd (PhD Bioengineering, 2009) anticipated returning to biotech immediately after receiving his PhD. He found the Clinical Rotation in Genetics to be a life-changing experience, and is currently in an academic postdoctoral position at the Stanford Institute for Immunity, and volunteering at the Palo Alto Children's Science Museum on Saturdays.
- Sarah Domnitz (PhD Physiology & Biophysics, 2011) is currently a Christine Mirzayan Science and Technology Policy Graduate Fellow at the National Science Foundation. She discovered in the course of her Molecular Medicine

training that she could master the skills necessary to interface successfully among disciplines, and this stimulated her to pursue her interest in science policy. She is now working with the National Cancer Policy Forum and Board on Health Care Services to write a review of omics-based tests for predicting patient outcomes in clinical trials, in an effort jointly funded by the NCI, FDA and CDC.

Evaluation of Student Learning and Progress: The MMTP evaluates student learning using two independent sets of milestones, one specific to the MMTP and the other based on a student's progress in the home department or program.

- **Capstone Presentation.** The MMTP evaluates the capstone presentation as representative of the student's success in identifying the links between his or her research project and human disease, and conveying those links to an interdisciplinary audience.
- **Progress toward the PhD.** The Molecular Medicine Graduate Certificate is awarded along with the PhD degree and cannot be pursued or awarded independent of that degree. The MMTP therefore also tracks student progress as monitored by the milestones set by the home department or program, as described in detail below.

Assessment of Student Satisfaction

- **Enrollment.** Enrollment has been the primary gauge of student satisfaction. The Molecular Medicine Certificate Program is entirely optional. If students did not find value in the program, word of mouth would limit future enrollment.
- **Under-represented groups.** Enrollment of under-represented minorities in the MMTP is 18%, significantly higher than in UW or national biomedical PhD training.
- **"Town hall" lunches.** To stay ahead of the curve in getting good ideas from our students and addressing their concerns, the MMTP holds student lunch meetings twice a year, open to all students and attended by the Director, Co-Directors, and other faculty from the Exec Comm. This provides an open forum for discussion of the program and its courses. The lunch meetings are especially useful because we learn immediately whether a criticism or idea resonates among students.
- **Course evaluations.** The MMTP has launched five new courses (Appendix H). One measure of student satisfaction is formal course evaluations (see below). Students uniformly praise the content and give high marks to the standard of teaching.
- **Evaluator.** A professional evaluator recently began working with our students to develop questions for assessment of program success in an on-line format. This is supported by funds from HHMI.
- **Awards.** A Provost's Commendation was awarded to the UW MMTP course *Challenges in Molecular Medicine* (MolMed504), in recognition of its novel format and enthusiastic reception (2007). This course is organized on a new model: a seminar by an eminent researcher, open to the entire Seattle research community (attendance 80-100), is followed by detailed discussion with the speaker for enrolled graduate students.

Instructional Effectiveness

To assess effectiveness of instruction, formal course evaluation forms are solicited from students in all Molecular Medicine courses. Note that the Molecular Medicine Program offers courses that are open not only to students pursuing the Molecular Medicine Certificate, but to all PhD students in basic sciences at UW School of Medicine.

Courses undergo dynamic evolution based on results of evaluations. Either the Course Chair or the Program Director oversees changes that will increase the effectiveness of teaching and learning. Based on information in evaluations, we have added new topics to courses, eliminated others, and modified course direction by rotating course chairs.

Opportunities for Training in Teaching: One of our goals is to provide examples of excellent teaching in our courses, as we believe this is both highly motivating and instructive to graduate students who are themselves learning to teach. Molecular Medicine courses draw on a great variety of teaching talent, from the UW, affiliated Seattle institutions, biotech, and pharma, as well as visitors invited specifically to teach in the Challenges course. This broad and deep pool of talent allows us to select lecturers for our courses based on their ability to teach effectively. Thus, the students are exposed to teachers who have honed their teaching skills in many different ways.

Molecular Medicine Public Lectures — Science and Outreach: Students in the Molecular Medicine Certificate Program serve as TAs for either one or two quarters, as required by the home PhD department or program. We do not require other or additional formal teaching. Molecular medicine trainees also participate in a unique teaching/outreach activity in connection with the Molecular Medicine Public Lectures. This is a very well-received series of evening lectures that the MMTP hosts each year, supported in part by the HHMI MedIntoGrad initiative. Each lecture features a Seattle researcher who has made an important contribution to diagnosis or treatment of human disease. Lectures are typically attended by a live audience of 100-400 individuals from the Seattle and UW communities. Lectures are broadcast on UW TV and the Research Channel, and available via our website (www.depts.washington.edu/molmed/seminars/index.html). Several have appeared as educational resources on the HHMI Cool Science website (www.hhmi.org/coolscience/). These lectures are extremely popular with not just the local audience, but individuals from all over the world. The 2009 lectures have thus far received more than 100,000 hits on our website. Attendance at the Molecular Medicine Public lectures provides our students with valuable insights on how to present science to a lay audience, preparing them to be spokespeople for the scientific community as they proceed in their careers. A class of local high school science students is invited to each lecture, as part of our pipeline/outreach efforts. Prior to each Public Lecture, our students host the high school visitors and their teacher at laboratory tours, followed by an informal pizza dinner with the speaker.

Teaching and Mentoring by Faculty Outside the Classroom

The faculty advisor plays a key role in guiding trainee research at the bench, as is typical of PhD training. Faculty advisors of MMTP students fulfill the following criteria:

- Relevant research area and excellent research record in an area relevant to Molecular Medicine.

- Graduate school appointment, as required by the university.
- Active participation in graduate training, including formal and informal teaching.
- Active participation in graduate recruiting.
- Ability to provide effective training in responsible conduct of research.

The Clinical Mentor plays a role unique to the MMTP. The Clinical Mentor contributes a clinical perspective on the research project, facilitates interactions with clinicians and access to clinical samples, as well as scientific guidance.

Recruiting Students to the UW and the MMTP: Candidate trainees apply to and matriculate at the UW through the interdisciplinary graduate program in Molecular and Cellular Biology (MCB); or through any of the eight participating departmental graduate programs in Biochemistry, Bioengineering, Genome Sciences, Immunology, Microbiology, Pathology, Pharmacology, or Physiology and Biophysics. The MMTP participates actively in student recruitment to the UW. All prospective students are invited to an interview/visiting day, and visiting students receive an MMTP brochure (Appendix J), directing them to our website, <http://depts.washington.edu/molmed/>, enabling them to become familiar with our mission and our unique program elements. Students are encouraged to contact the Program Director prior to their visit if they have questions or if they wish to schedule a specific meeting with faculty or students involved in the program. The Program Director frequently receives email correspondence from students interested in the UW because of this program, and actively encourages applications from highly-qualified candidates. At the beginning of the visit, a faculty member (usually an MMTP Executive Committee member) briefly discusses Molecular Medicine courses and the Certificate Program, and encourages students to contact MMTP faculty or trainees to learn more. MMTP faculty are often asked about the program during the recruiting dinner that follows interviews. The MMTP has had a very positive effect on graduate recruiting in the biomedical sciences. About 15-20% of applicants report that the unique course offerings and the possibility of participating in the Molecular Medicine Certificate Program were among the top reasons they decided to apply to the UW, and a comparable fraction of matriculated students report that the opportunity to participate in the MMTP — either as a Certificate Trainee, or simply by taking one or more of the new courses that we have launched — was an important reason to accept the UW's offer of admissions.

Introductory Lunch. Matriculated students are invited to learn more about the MMTP and its courses at an Introductory Lunch held during Fall Quarter. This lunch is typically attended by 40-50 first year students. At the lunch we provide an overview of our courses and the Molecular Medicine Graduate Certificate Program. We obtain a list of email address of attendees, and we keep all these students informed of courses, relevant seminars, etc. We also offer an on-line sign-up on where students can indicate their interest in Molecular Medicine. We emphasize that our courses are open to everyone, and encourage interested students to take advantage of this. We also emphasize that working toward a Molecular Medicine Certificate requires a significant commitment of intellectual effort and time, and that students must carefully weigh the benefits relative to this commitment as they plan their courses and projects.

Spring Lunch. We host a second lunch in May for students who have completed the Molecular Medicine course and are interested in the Certificate Program. Attendance is typically 15-20. At this lunch we discuss in detail the key elements of training: exposure to the clinic via *Clinical Medical and Human Genetics*, the opportunity to work side-by-side with medical students in *Molecular Basis of Disease*; and the dual mentorship requirement. At this second meeting faculty are again very explicit about the extra time required to pursue the Certificate, to ensure that only the most committed students decide to participate.

Overseeing and Ensuring Student Progress: The Molecular Medicine Graduate Certificate is awarded along with the PhD degree and cannot be pursued or awarded independent of that degree. We rely on the mechanisms in place in the home department to ensure student progress.

Qualifying examination. Participating departments and the MCB program all require a qualifying examination for admission to candidacy. Although the format and timing of the qualifying examinations differ in detail, the goals are the same, to determine whether a student has reached a level of intellectual and technical sophistication sufficient to proceed with thesis research, and participating departments and programs apply comparable criteria for deciding whether a student may advance to candidacy. In most cases, qualifying exams require a student to write and defend one (or in some cases two) proposals before either the Thesis Committee or a specially appointed faculty committee.

Thesis Committee. Each student is supervised by a Thesis Committee, which is chaired by the Thesis Advisor and includes the Translation Mentor. The Thesis Committee monitors trainee progress in three areas: bench research, intellectual growth as measured by attendance and participation at seminars and courses; and clinical awareness, as measured by growth in understanding of the relation of the project to human health and disease. Each trainee meets with the Thesis Committee at least once a year, and more frequently during later years of training. After each meeting, the Thesis Advisor documents trainee progress in a report that is retained in the student file. To obtain a PhD, students typically carry out independent research leading to at least one significant first-author paper.

Career Preparedness: Typically, the research mentor and the home department or program assist students with career plans. Experience in the Molecular Medicine Program often informs students' interests, and students often seek informal advice from faculty they have come to know in the Molecular Medicine Program.

III. Scholarly Impact

Faculty: Faculty trainers of students in the MMTP work in diverse areas of exceptional strength at the UW, including genetic disease and gene therapy, development of new drugs and diagnostics, cancer, infectious diseases, immunodeficiency and autoimmune diseases, inflammation, neurological disorders, aging, and stem cell research and regenerative medicine. The faculty participating in student training are committed

educators, generous citizens, and highly respected members of the scientific community, who effectively convey the goals of the MMTP to colleagues, students and the public. Faculty trainers all hold primary or affiliate appointments in one of the participating UW PhD programs, enabling them to serve as the thesis advisor of a UW PhD student. Many of the trainers of our students actively collaborate with other faculty, as evidenced by joint appointments and the participation in program project grants, research consortia, and center grants.

Students: Students in the laboratories of trainers work on interesting and novel problems, and are productive young scientists who publish the results of their thesis research in respected peer-reviewed journals. The publications of Molecular Medicine trainees provide evidence of this (Appendix I).

Trainee Impact on the field: Our first trainee graduated less than two years ago and is currently in postdoctoral training, so it is early to assess impact on the field. Nonetheless, their accomplishments, enthusiasm and dedication lead us to predict that they will go far and be a credit to the UW and the MMTP.

IV. Future Directions

The UW has seen recent expansion of both faculty and research space in areas that directly benefit from students with training in Molecular Medicine. Thus a strong institutional commitment to the MMTP and Molecular Medicine training is timely, and warranted by program impact and the demonstrated sustainability of this training area. The impact of the program on the UW and the respected position we have achieved nationally create confidence that we are headed in a good direction, and provide momentum for the future.

Molecular Medicine Program Impact at the UW: The MMTP has had a profound impact on UW students and faculty. We have launched new courses open to all UW students, enabling them to adapt the tools of the biomedical sciences to advance the understanding, diagnosis and treatment of disease. Thus far, 272 students from 21 different departments and interdisciplinary programs have participated in one or more of our courses (Appendix E). Physicians and physician-scientists teach in our courses, expanding their educational horizons and providing new opportunities for collaborations. The MMTP has also assumed an important role in recruiting top-notch graduate students to the UW. Based on the accomplishments, enthusiasm and dedication of our graduates and trainees, we predict that they will go on to assume leadership positions in molecular medicine. These highly trained, self-motivated individuals are a unique resource that will contribute to the economic and technical development of Washington State.

Expansion of our course offerings is on the agenda for future discussion. This may benefit from further institutionalization of the program that includes incentives that recognize interdisciplinary teaching.

Molecular Medicine: an Expanding and Self-Sustainable Training Area

The success of the MMTP in obtaining independent and sustainable funding speaks to the future importance of training in the emerging area of Molecular Medicine. Since 2006, the MMTP has brought in or secured commitments totaling more than \$1.8 million in direct costs from HHMI and the NIH combined. These are new sources of funds that would not have been accessed without the MMTP, and that reflect the commitment of Molecular Medicine Program Leadership to leveraging the success of this educational opportunity.

B. UNIT-DEFINED QUESTIONS

1. How broad is the impact of our program, in terms of numbers of students, departments and interdisciplinary programs involved?

The MMTP was conceived as a new educational path for a subset of PhD students, but expanded as it became evident that there was a broader audience of students and eager faculty participants alike. Measures of student and faculty participation and of courses developed show that molecular medicine training has broad impact, but that there are also opportunities that may be missed.

- Breadth of participation by students. One measure of success is the diversity of students participating in our courses and the Certificate Program. Thus far, 272 students from 21 different departments and interdisciplinary programs have enrolled in our courses (Appendix E), and 36 students from 8 different departments and programs have completed (8) or are participating in (28) the Certificate Program (Appendix G).
- Breadth of participation by faculty. All of our courses are interdisciplinary: chairs, co-chairs and lecturers derive from multiple departments to participate in the collaborative teaching effort. Faculty involved in curriculum development derive from all eight basic science departments — Biochemistry, Bioengineering, Genome Sciences, Immunology, Microbiology, Pathology, Pharmacology, and Physiology & Biophysics — and three clinical departments — Medicine, Pediatrics and Radiology. Medicine has been an especially active and supportive participant.
- Courses developed. Since its inception, the MMTP has developed a series of new interdisciplinary courses, designated by the prefix MolMed. Those course offerings are listed below, with more extensive descriptions available in Appendix H and on our website (<http://depts.washington.edu/molmed/courses/index.html>).
 - *Molecular Medicine* (MolMed514, the centerpiece course, uses patient case histories to introduce key areas of clinical research and investigative medicine.
 - *Clinical Medical and Human Genetics* (MolMed513).
 - *Challenges in Molecular Medicine* (MolMed504), a topical course focusing each year on a different, difficult but exciting problem in biomedical research.
2011 — Genetics of Addiction

- 2010 — Stem Cells
- 2009 — Hepatitis C
- 2008 — Gene Therapy
- 2007 — Malaria
- *Scientific Ideas at Work* (MolMed559).
- *Molecular Targets in Cancer Therapy* (MolMed583)

Challenges and Opportunities: Demographics of student participation are uneven. We have had no Genome Sciences students enter the MMTP, and only a few students from Bioengineering, even though those are relatively large graduate programs. We suspect that this may reflect that specific requirements in those departments are significantly more extensive than those in some of the departments with greater student participation. We would like to enhance involvement of faculty, especially junior faculty. We suspect that, because of the current financial situation, this may be an especially difficult time to advocate faculty involvement in what is in effect a voluntary activity, especially within the context of the relatively minimal teaching loads that are the norm in many medical school departments. The roster of courses is excellent, but we would welcome additional courses, particularly courses that involve clinical interactions or that include both graduate students and medical students. Again, this may need to be deferred until funding pressures abate.

2. What is the quality of our courses and our training program, and where is there need or room for improvement?

Based on student evaluations, the quality of current courses and teaching is excellent. We are also able to calculate that we rank nationally in the top 15-20% of comparable programs, based on our success in obtaining funding from both HHMI and NIH.

Challenges and Opportunities: We anticipate that we will get excellent suggestions from the more detailed online format for student assessments of the entire program that we are now putting in place. We also have ideas for improvements that arise from seeing course options and curricula available in other MedIntoGrad Programs, via the annual Program Directors' meetings at HHMI. Several programs offer more opportunities for interactions with patients, and we would like to try this here. We would also like to initiate a course that focuses on what a medical history is meant to be, so that students can see the elements as a part of a puzzle waiting for a reasonable explanation.

3. What is the value to the students of Molecular Medicine training?

Students find that Molecular Medicine enables them to discuss clinical questions more knowledgeably. Trainees think about how to design an experiment that uses patient samples with an appreciation of how samples are obtained and why obtaining access to such samples can be difficult. They have a clear sense of the value of statistical power calculations that tell them if there are sufficient participants of samples available for a

meaningful experiment. Most importantly, they become aware that they are able to make a contribution that is truly important to human health and disease, and this motivates them to work with real dedication and focus despite the daily difficulties inherent in all bench science.

Challenges and Opportunities: The students have responded enthusiastically to their opportunity to interact with clinicians and patients in the Clinical Medicine and Human Genetics rotation. We would like to develop more opportunities along these lines involving other patient populations: for example, those with diabetes and obesity, cardiovascular disease, or cancer.

4. What roles are we fulfilling in the university? Which of these roles is unique?

How to educate a new generation of clinically aware basic science researchers is a consuming question in the US and elsewhere in the developed world. The UW MMTP is unique among national programs in its emphasis on not only providing intensive interdisciplinary training to a small group of students, but also in extended training to all other interested PhD students. The MMTP does not overlap with other programs at UW. The MMTP has carefully positioned its requirements and course offerings so that we emphasize interdisciplinary areas that are complementary to and not redundant with existing programs.

Perhaps the most comparable interdisciplinary program at the UW is the Molecular and Cellular Biology Program. However, that program does not include training elements that promote interactions with patients, physicians or medical students, nor does it have a requirement for dual mentorship of training by a basic scientist and a clinician. The trainees who gravitate to the MMTP also tend to have a different perspective from MCB students. MMTP students frequently have discovered their interest in research at the interface of science and medicine from personal experience, sometimes an exciting lab project, sometimes experience of disease personally or in the family.

Challenges and Opportunities: Maintaining and enhancing the unique focus on training students for basic science careers tightly interfaced with clinical medicine.

5. What resources are we using? How effectively are we leveraging those resources?

The MMTP has been self-sustaining essentially since its inception: it was approved in November, 2005 by the UW Board of Regents, and we received word of success in HHMI funding in February, 2006. Initial funding leveraged commitments from individual chairs of Medicine and basic science departments as evidence of grass roots enthusiasm at the UW. Since then, more than \$1.8 million in training funds have come in through the MMTP, including money from HHMI and also NIH.

Challenges and Opportunities: We currently use NIH funds to support two students in their second year of training. We would like to obtain additional funding commitments that enable us to support a critical mass of trainees, in the range 4-6. Possibilities include securing additional federal funding, obtaining funds from institutional sources either at the UW or affiliated institutions, and working with the UW Development Office to secure a funding commitment from private donors or foundations.

6. What do we anticipate will be the future role of Molecular Medicine Certificate Training? Would an interdisciplinary PhD program in Molecular Medicine (to complement, not replace the Certificate Program) benefit the institution and our trainees?

The Molecular Medicine Certificate Program answers the needs of students who wish to obtain focused training in a single discipline while learning about its interface with medical science. We anticipate that it will continue to be important, even as departmental or interdisciplinary programs increase their focus on disease mechanisms. We also anticipate that teaching interdisciplinary courses open to all students will continue to be central to the mission of the MMTP.

The UW MMTP is well-positioned to expand to a free-standing PhD program. We have had thorough and pragmatic discussion about the curriculum that would constitute the core of such a program. We have dedicated faculty, enthusiastic students, excellent infrastructure, and a strong national reputation for training. We anticipate that faculty could readily be recruited to teach in such a Program, especially MD PhDs who could thereby gain access to graduate trainees.

The interdisciplinary nature of the Molecular Medicine Program makes it attractive to many students, who are eager to have a menu of choices and gravitate toward "umbrella" programs rather than departmental programs for PhD training. The NIH is enthusiastic about funding in the general area of Molecular Medicine. Peer institutions have begun to mount interdisciplinary PhD programs in Molecular Medicine, and those PhD programs will compete with the UW for top students and for the essentially fixed pot of NIH training funds in the very near future.

Challenges and Opportunities: The economic issues of the past few years at both the federal and state levels makes it very challenging to initiate a new graduate program which would require base funding from the University, approval by the State of Washington, and increased federal funding. Nevertheless, the momentum of the Molecular Medicine program is strong and it is tapping into a new direction in graduate student interest. This appears to be the time to lay a foundation for a free-standing graduate program in Molecular Medicine that will attract the best students interested in clinically relevant research to our institution in the future.

UW School of Medicine
Vice Dean of Research and Graduate Education

UW Graduate School

MMTP Director:
Nancy Maizels, PhD, Professor, Immunology and Biochemistry

MMTP Co-Directors:
Peter Byers, MD, Professor, Pathology and Genome Sciences
Henry Rosen, MD, Professor and Associate Chair, Medicine

MMTP Executive Committee:
Janet Eary, MD, Professor, Radiology and Orthopedics
Stan Fields, PhD, Professor, Genome Sciences and Medicine
Michael Lagunoff, PhD, Associate Professor, Microbiology
Stan McKnight, PhD, Professor, Pharmacology
Ray Monnat, MD, Professor, Pathology and Genome Sciences
Andy Scharenberg, MD, Professor, Pediatrics and Immunology
John Scott, PhD, Professor, Pharmacology

MMTP Program Manager:
Christina Larmore

Department of Medicine

Departments of Biochemistry, Bioengineering, Genome Sciences,
Immunology, Microbiology, Pathology, Pharmacology, Physiology
& Biophysics

Appendix A: Organizational Structure

Funding History				
	2006 Biennium 4/1/06-6/30/07	2008 Biennium 7/1/07-6/30/09	2010 Biennium 7/1/09-6/30/11	Total 4/1/06-6/30/11
Funds Received				
Howard Hughes Medical Institute	\$132,789	\$249,803	\$322,491	\$705,083
UW School of Medicine	\$15,334	\$26,222	\$30,000	\$71,556
Total Received (through 6/30/11)	\$148,123	\$276,025	\$352,491	\$776,639
Expenditures				
Faculty				
Faculty Course Development, Salary, Benefits	\$0	\$24,358	\$67,459	\$91,817
Curriculum & Educational Resources				
Conferences/ Symposia/ Public Lectures/Courses	\$3,523	\$39,491	\$54,027	\$97,040
Website/Computers/Webcasting	\$7,038	\$2,891	\$12,973	\$26,840
Graduate Students				
Grad Student Stipend, Health Insurance, Tuition, Travel Awards	\$0	\$51,185	\$354,041	\$405,225
Student Events and Recruiting	\$996	\$1,424	\$2,576	\$4,996
Administration				
Program Admin Salary & Benefits	\$21,935	\$59,124	\$62,907	\$143,967
Program Assessment				
	\$0	\$1,388	\$0	\$1,388
Total Expenditures (through 6/30/11)				\$771,273

Funds Committed to the MMTP (7/1/11-6/30/17)				
	2012 Biennium 7/1/11-6/30/13	2014 Biennium 7/1/13-6/30/15	2016 Biennium 7/1/15-6/30/17	Total 4/1/06-6/30/17
Howard Hughes Medical Institute	\$390,303	\$391,651		\$1,487,037
NIH - National Institute of General Medical Sciences	\$174,750	\$209,700	\$104,850	\$489,300
UW School of Medicine	\$60,000	\$60,000	\$30,000	\$221,556

Name/Degrees	Title / Rank	UW Appointments	Role in Program	Research Interest
Aderem, Alan, PhD	Director, Institute for Systems Biology	Immunology	Trainer	Molecular definition of immune cell pathogen response by the host
Bettelli, Estelle, PhD	Assistant Member, Benaroya Research Institute	Immunology	Trainer	pathogenic T cells in tumor immunity and autoimmunity
Bevan, Michael, PhD	Professor	Immunology	Trainer	T-lymphocyte differentiation in the thymus; T-cell response to infection
Byers, Peter, MD	Professor	Pathology and Medicine (Medical Genetics)	Co-Director; Trainer	Collagen gene mutations and connective tissue disorders
Campbell, Daniel, PhD	Associate Member, Benaroya Research Institute	Affiliate Associate Professor, Immunology	Trainer	Lymphocyte homing and function; regulatory T cell localization; tolerance in transplantation
Campbell, Jean, PhD	Research Assistant Professor	Pathology	Trainer	Cytokine signaling in the liver
Chavkin, Charles, PhD	Professor	Pharmacology	Trainer	Opioid peptide functioning in the nervous system
Chin, Michael, MD, PhD	Associate Professor	Medicine (Cardiology)	Trainer	embryonic stem cells for cardiac regeneration
Cirulli, Vincenzo, MD, PhD	Associate Professor	Medicine (Metabolism, Endocrinology & Nutrition)	Trainer	mechanisms of islet cell development and function
Clark, Edward, PhD	Professor	Microbiology and Immunology	Trainer	Activation of B lymphocytes to survive, proliferate or undergo programmed cell death
Dichek, David, MD	Professor and Associate Director for Research	Medicine (Cardiology)	Trainer	Gene transfer to blood vessels, gene therapy for cardiovascular disease
Eary, Janet F., MD	Professor	Radiology (Nuclear Medicine) and Orthopedics	Executive Committee	Molecular imaging
Elkon, Keith, MD	Professor	Medicine (Division Head, Rheumatology) and Immunology	Trainer	Molecular and genetic basis of autoimmune disease
Fields, Stanley, PhD	Professor; Investigator, HHMI	Genome Sciences and Medicine	Trainer, Executive Committee	Genomic analysis of protein function

Appendix C: Faculty

Fuller, Deborah, PhD	Associate Professor	Microbiology	Trainer	virology, vaccines, transdermal drug delivery, HIV, influenza
Gardner, Richard, PhD	Assistant Professor	Pharmacology	Trainer	cell regulation of protein function
Grandori, Carla, MD, PhD	Research Associate Professor	Pharmacology	Trainer	Functional genomics and high throughput screening to identify new targets for cancer therapy
Hawn, Tom, MD, PhD	Assistant Professor	Medicine (Allergy and Infectious Disease)	Trainer	Immunological mechanisms of disease pathogenesis
Hurley, James, PhD	Professor	Biochemistry	Trainer	photoreceptor signal transduction
Kennedy, Brian K., PhD	Associate Professor	Biochemistry	Trainer	Molecular basis of eukaryotic aging
Kiem, Hans Peter, MD	Member, FHCRC	UW Medicine (Oncology) and Pathology	Trainer	stem cell biology
Klevit, Rachel, PhD	Professor	Biochemistry	Trainer	protein structure, protein/protein, protein/DNA interactions
Lafamme, Michael, MD, PhD	Assistant Professor	Pathology	Trainer	cardiac applications for human embryonic stem cells
Lagunoff, Michael, PhD	Associate Professor	Microbiology	Trainer, Executive Committee	Molecular virology of Kaposi's Sarcoma-associated herpesvirus
Lord, James, MD, PhD	Physician, Virginia Mason	Medicine (Gastroenterology)	Trainer	Immunological disorders of the bowel
Maizels, Nancy, PhD	Professor	Immunology and Biochemistry	Director; Trainer	Immunoglobulin gene diversification; DNA repair, genomic instability, and cancer
McClelland, R. Scott, MD, MPH	Associate Professor	Medicine (Allergy and Infectious Disease), Global Health, Epidemiology	Trainer	epidemiology, prevention, and treatment of HIV-1 and sexually transmitted diseases in resource-limited settings
McKnight, G. Stanley, PhD	Professor	Pharmacology	Trainer, Executive Committee	Study of PKA regulatory system by introduction of novel genetic mutations
Miller, Dana, PhD	Assistant Professor	Biochemistry	Trainer	Physiological response to hypoxia and to hydrogen sulfide
Monnat, Raymond J., Jr., MD	Professor	Pathology and Genome Sciences	Trainer, Executive Committee	Angiogenic stem cells for tissue regeneration
Overbaugh, Julie, PhD	Member, FHCRC	Microbiology	Trainer	Mechanisms of HIV transmission and pathogenesis
Paddison, Patrick, PhD	Assistant Member, FHCRC	Molecular and Cellular Biology	Trainer	stem cell biology
Park, Julie, MD	Associate Professor	Pediatrics	Trainer	Neuroblastoma, Post-transplant lymphoproliferative disease

Appendix C: Faculty

Press, Oliver, MD, PhD	Member, FHCRC	Medicine (Oncology)	Trainer	novel treatments for hematologic malignancies
Pun, Suzie, PhD	Assistant Professor	Bioengineering	Trainer	Non-viral gene delivery; Delivery of drugs & molecular contrast agents; Intracellular trafficking
Rabinovitch, Peter, MD, PhD	Professor	Pathology (Joint member, FHCRC)	Trainer	genomic instability in aging and neoplasia
Rawlings, David, MD	Chief, Division of Immunology, Seattle Childrens Research Institute	Pediatrics and Immunology	Trainer	Dysregulated B signaling in immunodeficiency, autoimmunity, or malignancies; gene therapy for primary immunodeficiencies
Rosen, Henry, MD	Professor and Associate Chair	Medicine	Co-Director	Neutrophil-mediated innate immunity
Scharenberg, Andrew, MD	Professor; Seattle Childrens Research Institute	Pediatrics; Immunology	Trainer, Executive Committee	Signal transduction mechanisms and cation channel function in the immune system.
Scott, John D., PhD	Professor; Investigator, HHMI	Pharmacology	Trainer, Executive Committee	Anchoring proteins and rapid signal transduction
Sokurenko, Evgenii, MD, PhD	Associate Professor	Microbiology	Trainer	Adaptive evolution of genes in bacterial pathogens
Stetson, Daniel, PhD	Assistant Professor	Immunology	Trainer	Mechanisms of detection and response to viral infection
Tewari, Muneesh, MD, PhD	Assistant Member, FHCRC	Molecular and Cellular Biology	Trainer	MicroRNA regulatory networks in cancer; RNA as a hormone
Thomas, Wendy, PhD	Assistant Professor	Bioengineering	Trainer	Mechanics of biological adhesion
Torok-Storb, Beverly, PhD	Member, FHCRC	Molecular and Cellular Biology	Trainer	Regulation of Hematopoiesis
Urdahl, Kevin, MD, PhD	Assistant Member, Seattle Biomedical Research Institute	Immunology and Pediatrics	Trainer	T cell responses to Mycobacterium tuberculosis
Wener, Mark, MD	Associate Professor	Laboratory Medicine	Trainer	Immunoassays, Antibodies to C1q in lupus
Wordeman, Linda, PhD	Professor	Physiology & Biophysics	Trainer	Cell division; molecular motors
Yeh, Matthew, MD, PhD	Associate Professor	Pathology	Trainer	hepatitis C, hepatocarcinogenesis, pathology in liver transplantation
Zielgler, Steven, PhD	Member and Director, Benaroya Research Institute	Immunology	Trainer	Fox P3 and T cell development and function; TSLP and allergic inflammation

Existing Program Review—HEC Board Summary

Name of unit: Molecular Medicine Graduate Certificate Program
Name of school/college: University of Washington School of Medicine
Degree title(s): Graduate Certificate in Molecular Medicine
Year of last review: Certificate approved November, 2005
Current date: September 1, 2011

A. Documentation of continuing need, including reference to the statewide and regional needs assessment (you may cut and paste from Part A, Section IV, above).

Student enrollment in the Molecular Medicine Certificate Program has grown since its inception (Appendix F). Top students now cite this program as one reason that they have decided to matriculate at the UW. All eight of our graduates thus far have readily found employment in their area of choice, despite the generally difficult job market. This is a small number from which to generalize, but we believe that it provides evidence of the importance of this area, especially when coupled with the continued success of the MMTP in obtaining external funding. Graduates of the MMTP constitute an invaluable pool of skilled individuals that fuel the success of the local academic and industrial research enterprise.

B. Assessment information related to expected student learning outcomes and the achievement of the program's objectives (you may cut and paste from Part A, Section II, above).

Student Learning Goals

Graduates of the MMTP have achieved the program's learning goals, as assessed by the Capstone and by research progress:

- They are able to bridge the gap between medical understanding and basic science
- They can independently identify important questions in human health and disease and develop the experimental strategies to address these questions.
- They are comfortable using the concepts and language of medical science, and they have the rigorous and deep understanding of basic science necessary to solve critical problems.

C. Plans to improve the quality and productivity of the program (you may cut and paste from Part A, Section IV, above).

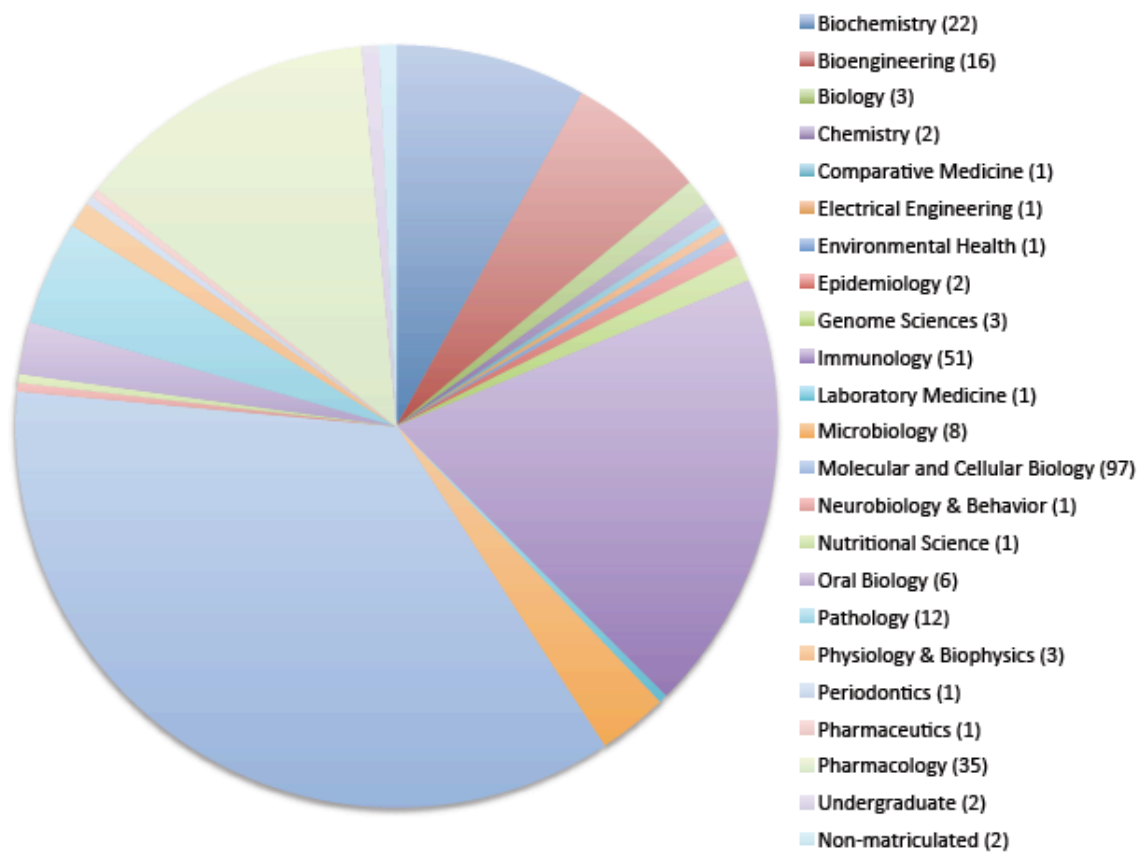
The impact of the program on the UW and the respected position we have achieved nationally create confidence that we are headed in a good direction, and provide momentum for the future. The UW has seen recent expansion of both faculty and research space in areas that directly benefit from students with training in Molecular Medicine. Thus a strong institutional commitment to the MMTP and Molecular Medicine training is timely, and warranted by the demonstrated sustainability of this training area. Expansion of our course

offerings is on the agenda for future discussion. This may benefit from further institutionalization of the program, including incentives for recognition of interdisciplinary teaching.

Number of instructional faculty, students enrolled, and degrees granted over last three years (Autumn-Summer)

	2008-2009	2009-2010	2010-2011
FTE instructional faculty*	.11	.15	.17
FTE graduate TA's	0	0	0
Degree Program	Molecular Medicine Certificate	Molecular Medicine Certificate	Molecular Medicine Certificate
Headcount of enrolled students	20	20	28
Number of degrees granted	1	1	6

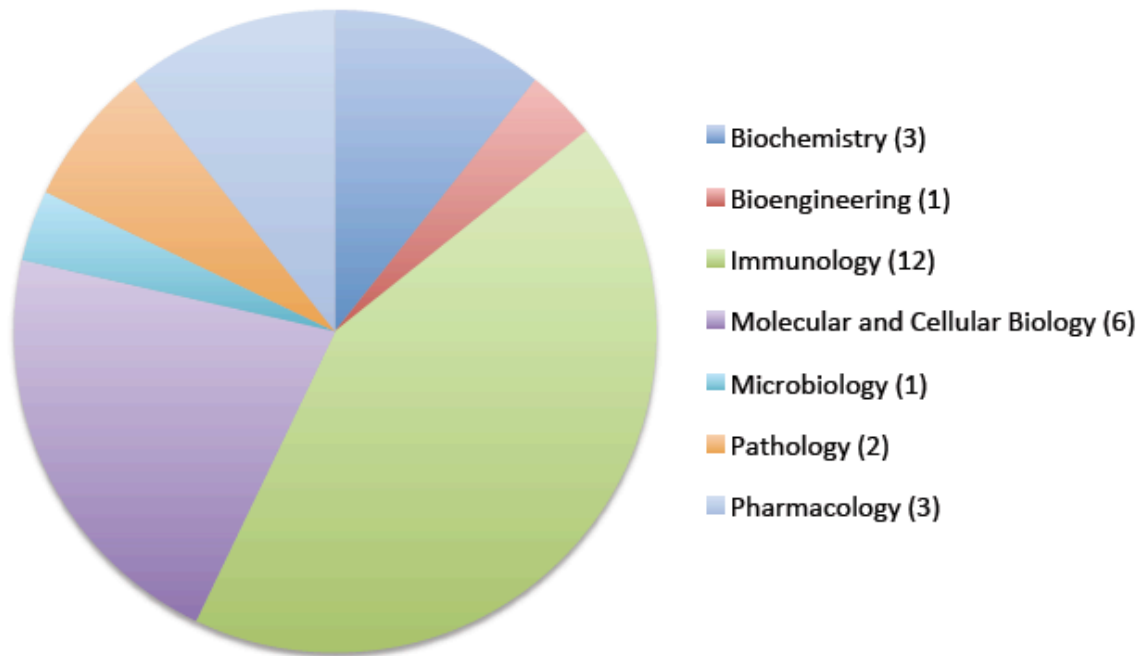
*Based on time devoted or percent of annual salary paid to faculty for teaching Molecular Medicine courses



Students who have enrolled in one or more Molecular Medicine courses, by Department.

Total number of students: 272

Total number of departments or programs (excluding undergrad): 21



Molecular Medicine Certificate Program Trainees, by Department

Number of students: 28

Number of departmental and interdisciplinary PhD programs represented: 7

Current Students

Entered	Last Name	First Name	Department/Program	Basic Science Mentor	Clinical Mentor
2005	Ma	Daphne	Immunology	Ed Clark	Keith Elkon
2006	Killebrew	Justin	Immunology	Dan Campbell	Peter Byers
2006	Larson	Ryan	Immunology	Steve Ziegler	David Rawlings
2007	Brunette	Rebecca	Immunology	Dan Stetson	Kevin Urdahl
2007	Gilbert	Merle	Pharmacology	Stan McKnight	David Dichek
2007	Lindsay	Ken	Biochemistry	James Hurley	Phil Morgan
2007	White-Moyes	Kara	Pathology	Michael Laflamme	Michael Chin
2008	Chen	Xiaoji	Molecular and Cellular Biology	Patrick Paddison	Beverly Torok-Storb
2008	Cortez	Valerie	Molecular and Cellular Biology	Julie Overbaugh	R. Scott McClelland
2008	Hayes	Brian	Pathology	Jean Campbell	Matthew Yeh
2008	Jacoby	Kyle	Molecular and Cellular Biology	Andy Scharenberg	David Rawlings
2008	Richard	Lauren	Molecular and Cellular Biology	Carla Grandori	Julie Park
2008	Shi	Julie	Bioengineering	Suzie Pun	Oliver Press
2008	Smigiel	Kate	Immunology	Dan Campbell	James Lord
2008	Wiedeman	Alice	Immunology	Keith Elkon	Mark Werner
2009	Eckard	Sterling	Immunology	Dan Stetson	
2009	Srivastava	Shivani	Immunology	Dan Campbell	Kevin Urdahl
2009	Woodward-Davis	Amanda	Immunology	Mike Bevan	
2010	Arbelaez	Carlos	Immunology	Estelle Bettelli	
2010	Barr	Angela	Molecular and Cellular Biology	Muneesh Tewari	
2010	Dove	Katja	Biochemistry	Rachel Klevit	
2010	Horsman	Joseph	Biochemistry	Dana Miller	
2010	Levin	Jamie	Pharmacology	Charley Chavkin	
2010	Metzler	Genita	Immunology	David Rawlings	Andy Scharenberg
2010	Senn	Tennille	Immunology	Steve Ziegler	
2010	Toledo	Chad	Molecular and Cellular Biology	Patrick Paddison	
2010	Treants	Merika	Microbiology	Deborah Fuller	
2010	Yang	Wendy	Pharmacology	Vincenzo Cirulli	

Graduates

Trained	Last Name	First Name	Department / Program	Basic Science Mentor	Clinical Mentor	Current Position
2004-2009	Kidd	Brian	Bioengineering	Wendy Thomas	Evgeni Sokurenko	Sr. Bioinformatics Research Specialist, Institute for Immunity, Transplantation and Infection, Stanford University
2005-2010	Astrakhan	Alexander	Immunology	David Rawlings	Hans-Peter Kiem	Postdoc, Seattle Childrens Research Institute
2005-2010	Burtner	Christopher	Biochemistry	Brian Kennedy	Peter Rabinovitch	Postdoc, UW Dept of Pathology Center for Cardiovascular Biology
2005-2010	Nichols	Blake	Pharmacology	Stan McKnight	David Dichek	Postdoc, UC Davis Dept of Pharmacology
2005-2010	Warren	Sarah	Immunology	Alan Aderem	Tom Hawn	Director of Discovery and Validation, Oncofactor Corp.
2004-2011	Caracol	Amber	Molecular and Cellular Biology	Nancy Maizels	Peter Rabinovitch	High School Science Teaching Internship Program
2004-2011	Domnitz	Sarah	Physiology and Biophysics	Linda Wordeman	Peter Byers	Christine Mirzayan Science and Technology Policy Graduate Fellow at the National Science Foundation
2006-2011	Pyott	Shawna	Pathology	Peter Byers	Richard Gardner	Postdoc, UW Dept of Pathology, Funded by Osteogenesis Imperfecta Foundation

Molecular Medicine Courses

Molecular Medicine (MolMed514; Dr. Rosen, Medicine), the centerpiece course, uses patient case histories to introduce key areas of clinical research and investigative medicine.

Clinical Medical and Human Genetics (MolMed513; Dr. Byers, Pathology and Genome Sciences) enables students to participate in clinics covering Pediatric Genetics, Biochemical Genetics and Adult Genetics, including Cancer Genetics. Students thereby develop a sophisticated, first-hand appreciation of the needs and challenges of clinical research.

Challenges in Molecular Medicine (MolMed504) is a topical course that focuses each year on a different, difficult but exciting problem in biomedical research. In Fall, 2011, its focus will be on Genetics of Addiction, and it will be chaired by Dr. Charles Chavkin (Pharmacology). *Challenges* has previously focused on Stem Cells (2010; Dr. McKnight, Pharmacology), Hepatitis C (2009; Dr. Gale, Immunology); Gene Therapy (2008; Dr. Scharenberg, Pediatrics and Immunology); and Malaria (2007; Dr. Monnat, Pathology and Genome Sciences). It is organized on a new model: a seminar by an eminent researcher, open to the entire Seattle research community (attendance 80-100), is followed by detailed discussion with the speaker for enrolled graduate students. *Challenges* received a special commendation for educational excellence from the Provost for its innovative and tremendously popular format.

Scientific Ideas at Work (MolMed559; Dr. Gray, Accelerator Corp. and Dept. of Biochemistry; Dr. Maizels, Immunology and Biochemistry). This course examines how basic science becomes intellectual property and then a commercially viable therapeutic or diagnostic. It introduces the vocabulary of commercialization, and explains how scientific expertise can be applied via consulting and collaboration.

Molecular Targets in Cancer Therapy (MolMed583; Drs. Maizels and Monnat). This course prepares students to identify opportunities for application of basic research to cancer therapies by acquainting them with different kinds of therapeutics (small molecules, monoclonal antibodies), the methods by which they are discovered, validated and developed for clinical trials, approval and use.

Publications of Current and Past Trainees

Alexander Astrakhan

Sather BD, Ryu BY, Stirling BV, Garibov M, Kerns HM, Humblet-Baron S, Astrakhan A, Rawlings DJ. Development of B-lineage predominant lentiviral vectors for use in genetic therapies for B cell disorders. 2011. *Mol Ther* 19:515-25.

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Marathe BM, Prislovsky A, Astrakhan A, Rawlings DJ, Wan JY, Strom TS. Antiplatelet antibodies in WASP(-) mice correlate with evidence of increased in vivo platelet consumption. 2009 *Exp Hematol*.37:1353-63.

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Astrakhan A, Omori M, Nguyen T, Becker-Herman S, Iseki M, Aye T, Hudkins K, Dooley J, Farr A, Alpers CE, Ziegler SF, Rawlings DJ. Local increase in thymic stromal lymphopoietin induces systemic alterations in B cell development. 2007. *Nat Immunol*. 8:522-31.

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Rebecca Brunette

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Christopher Burtner

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Kudlow BA, Stanfel MN, Burtner CR, Johnston ED, Kennedy BK. Suppression of proliferative defects associated with processing-defective lamin A mutants by hTERT or inactivation of p53. 2008. *Mol Biol Cell*. 19:5238-48.

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Sarah Domnitz

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Katja Dove

Jehle S, Vollmar BS, Bardiaux B, Dove KK, Rajagopal P, Gonen T, Oschkinat H, Klevit RE. N-terminal domain of alphaB-crystallin provides a conformational switch for multimerization and structural heterogeneity. 2011. *Proc Natl Acad Sci U S A* 108 :6409-14.

Merle Gilbert

Sweet IR, Gilbert M, Maloney E, Hockenbery DM, Schwartz MW, Kim F. Endothelial inflammation induced by excess glucose is linked to intracellular accumulation of glucose-6-phosphate. 2009. *Diabetologia* 52:921-31.

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Sweet IR, Yanay O, Waldron L, Gilbert M, Fuller J, Tupling T, Lernmark A, Osborne B. Treatment of diabetic rats with encapsulated islets. 2008. *J Cell Mol Med*. 12: 2644-50.

Gilbert M, Jung SR, Reed BJ, Sweet IR. Increased potency of calcium derived from L-type calcium channels compared to calcium from the endoplasmic reticulum on oxygen consumption and insulin secretion. 2008. *J Biol Chem* 283: 24334-42.

Brian Hayes

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Kyle Jacoby

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What is Molecular Medicine?

Molecular Medicine is a developing discipline that integrates and applies recent advances in basic science and technology to the mechanistic understanding, diagnosis and treatment of human disease. The University of Washington is at the forefront of research that takes molecular and mechanistic approaches to questions related to human health and disease.

Molecular Medicine Training Program (MMTP)

The University of Washington Molecular Medicine Training Program (MMTP) provides interdisciplinary training at the interface of basic science and human biology. Training is distinguished by three key elements: case-based courses, direct clinical exposure, and dual mentorship of Ph.D. research by a basic scientist and clinician scientist. Courses, programmatic events, and close interactions with faculty in medicine and the basic sciences encourage students to focus on potential applications of their research to human disease. Students completing this training have the information, intellectual tools and practical experience to develop imaginative new solutions to problems relevant to human disease, and will be prepared to become leaders in molecular medicine and translational research.

Molecular Medicine Graduate Certificate. To recognize training in Molecular Medicine, a Molecular Medicine Graduate Certificate is awarded to students who complete requirements of their home department or program as well as several specific MMTP courses and programmatic activities:

- **Molecular Medicine**, the core course of the program, in which physician-scientists and clinical investigators address advances at the crossroads of clinical medicine and basic sciences, using patient case histories to introduce key areas of clinical research and investigative medicine
- **Clinical Exposure**, either through a mentored rotation in human medical genetics, in which students participate in weekly clinics in areas such as pediatric genetic disease and cancer genetics under the guidance of a Medical Genetics faculty member; or through participation in a pathology course, working with physicians to learn to distinguish normal and diseased tissues.
- **Dual Mentorship** of thesis research by a basic scientist and a physician-scientist or translational research mentor. Through this dual mentoring, the clinical relevance of the student's work is emphasized in an ongoing manner, stimulating new experiments and clinical collaborations.
- **Capstone presentation** (Year 4), in which students present their ongoing research emphasizing its implications for understanding or treating human disease.

Eligibility. Molecular Medicine courses and the Molecular Medicine Certificate Program are open to Ph.D students enrolled in the Molecular and Cellular Biology Graduate Program, the Neurobiology and Behavior Graduate Program and the Departments of Biochemistry, Bioengineering, Genome Sciences, Immunology, Microbiology, Pathology, Pharmacology, and Physiology & Biophysics. Admission is through one of these home departments or programs.

For more information see <http://depts.washington.edu/molmed/> or contact: Dr. Nancy Maizels, Program Director (maizels@u.washington.edu) or Dr Peter Byers, Co-Director (pbyers@u.washington.edu)

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3**Complete the online enrollment form**

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4**Take either the *Clinical Rotation* or
*General Pathology*****5****Apply for an HHMI Molecular Medicine Scholarship**

Students are eligible to apply after completing the above steps

6**Choose a clinical mentor**

When you select your thesis committee

7**Complete the following at any time**

- Demonstrate proficiency with statistics
- Take an additional 5 credits of electives

8**Participate in Molecular Medicine student activities**

Including monthly lunches to discuss students' research

9**Give a capstone presentation during your 4th or 5th year**