Washington State University NIH Training Program in Biotechnology

Emphasis on Protein Chemistry

GUIDELINES FOR TRAINEES

You have been chosen on the basis of your talents, accomplishments and potential to be part of an innovative, interdisciplinary training program in biotechnology, funded by the National Institutes of Health with the goal of producing a cadre of uniquely trained scientists and engineers. The program will succeed through your energy and efforts.

EXPECTATIONS

We expect Biotechnology Trainees to excel in all aspects of their graduate careers. This includes course work, research and the specific activities of the Training Program.

RESPONSIBILITIES

1. To pursue the program for a Ph.D. in one of the following areas: Molecular Biosciences (Biochemistry/Biophysics/ Genetics and Cell Biology/Microbiology), Chemical Engineering and Bioengineering, Chemistry, Molecular Plant Sciences, Immunology and Infectious Disease (Paul G. Allen School for Global Animal Health, or Veterinary Microbiology and Pathology). The research project should be in the broad area of protein chemistry, under the supervision of one of the faculty Trainers for the Training Program. Pursuit of such a research project requires extensive effort, at least a nominal 20 hours per week while taking courses and at least 40 hours per week after course requirements are completed. Successful graduate students invest more time than these nominal values.

2. To take course work that provides a solid base in protein biotechnology. The particular courses are determined in the context of the specific degree program by consultation with the mentor and the Program's Selection Committee. Descriptions of relevant courses can be found in "Guidelines for Course Work" below.

3. Trainees are required to <u>actively participate</u> in specific Program activities and events including:

    a. Laboratory rotations. In consultation with the Selection Committee, entering Trainees should select a minimum of three rotations that provide interdisciplinary exposure. Both the Trainee and hosting Trainer are required to turn in a written report on each rotation to the Program's Executive Committee for evaluation. Once a prospective thesis lab has been identified, a Thesis Lab Selection Form must be submitted and approved by the Program Director.

b. Submit an annual written report to the Executive Committee outlining progress toward meeting degree and program requirements, including a summary of research accomplishments and plans for the coming year. This report must include a completed form/checklist outlining Program requirements as distributed by the Executive Committee.
c. Take General Biochemistry I (MBIOS 513; 3 cr) and three related 1-cr five-week modules in Topics of Biomedical Experimentation (MBIOS 564 or equivalent number in other units), specifically focused on Biomedical Ethics, Responsible Conduct of Research, and Experimental Design. These are given each Spring semester. Take Protein Biotechnology (MPS/MBioS/ChE 574; 3 cr), which is offered on alternate years in the Spring. In addition, you must take one course with content relating to various aspects of protein biochemistry or biotechnology, chosen from a list of electives (see below).
d. Attend all activities of the Biotech Forum throughout the graduate training period.
e. Assist in organizing the annual "Biotechnology Symposium"; with the exception of first-year students this usually includes presenting a poster on research in progress.
f. Attend seminars offered by visiting speakers that are sponsored by the training program.

4. To complete an internship of 2-3 months (longer times may be possible) at a Biotechnology firm. The internship should be arranged by Trainee and mentor with assistance as required from the Director. Internship arrangements and scheduling are flexible but must be approved by the Director via an Internship Approval Form.

5. To contribute to the continued development of the interdisciplinary Biotechnology Training Program at WSU by interaction with other Trainees and with training faculty.

In exceptional cases there is the possibility for PhD students to participate as unpaid Trainees (‘walk-on’) in the program at any point during their graduate career. The prospective Trainee must be nominated by their home department or Trainer by submission of admission material to the Program Director. Granting of Trainee status will be decided by the Executive Steering Committee without the guarantee financial support. The ‘walk-on’ Trainee must follow all the guidelines and requirements (rotations, internship, coursework, and program participation) as outlined in these guidelines in order to be eligible for the Graduate Certification in Protein Biotechnology.

BENEFITS

1. Financial support. Trainees in good standing will be supported by a combination of NIH, institutional and mentor-provided funds for their entire graduate career. This involves direct financial support equivalent to a research assistantship, waiver of out-of-state tuition and payment of in-state tuition. In general, the first two years are supported by institutionally supplemented NIH funds and subsequent years are supported by funds from the Trainer. Employment as a teaching assistant will occur only in conjunction with a specific teaching requirement of the Trainee's Ph.D. program.

2. Laboratory rotations. Trainees appointed as entering graduate students become involved immediately in graduate research through laboratory rotations because Trainee support does not involve the time demands of a teaching assistantship.

3. Travel stipends. Up to $300 per year is available by application for each Trainee to defray part of the cost of attending a scientific meeting. Preference is given to Trainees presenting results of their own research, but Trainees at all stages of their careers are eligible to request this support. Application can be made at any time to the Director and involves only a brief written statement of the meeting to be attended, identification of other attendees from the Trainee's laboratory, description of the results to be presented and the format of the presentation (poster, short talk, invited talk by mentor, etc.). After return from the meeting, a 1-2 page report must be submitted to the Director. An individual report is not needed if the meeting is attended by a number of Trainees, like meetings sponsored by Life Sciences Washington.

4. Internship. The Training Program alumni have an ever-growing network of contacts with biotechnology firms in Seattle and the San Francisco Bay Area as well as across the country. These contacts, plus the initiative of Trainee and Trainer, provide a wide range of opportunities for Trainees to complete an internship. The Training Program requires that the internship firm provide financial support to the Trainee doing the internship, in the form of salary or another mechanism that covers, at minimum, all living expenses incurred by the Trainee during the internship. In addition, during the internship, the Trainee continues to receive a stipend/assistantship through WSU.

5. Interactions with distinguished guests. For the annual Biotechnology Symposium and at various times throughout the academic year, the Training Program sponsors visits by distinguished scientists and engineers. Besides hearing formal presentations from these guests, Trainees have the opportunity for informal contact at receptions and dinners in conjunction with the visits. Trainees with special interests in particular guests should contact the Director or the appropriate member of the Training Faculty to ensure that there is an opportunity for such informal contact.

6. Unique opportunities and membership in a select group. The Biotechnology Training Program provides opportunities for cross-disciplinary contacts and for educational experiences beyond conventional graduate training (e.g., engineering, chemistry and biological sciences). Your training will prepare you for a promising future and your participation in this innovative program will mark you as one of a select group of talented, specially trained scientists and engineers.

7. After completion of all of the above activities, the Trainee is eligible at graduation for a Graduate Certificate in Protein Biotechnology through the WSU Graduate School. Applications for the Certificate must be submitted to the Graduate School at least 6 weeks before graduation and requires signed approval from the Program Director.

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GUIDELINES FOR COURSEWORK

Required Courses

1. **Protein Biotechnology** (**MPS 574 or MBIOS 574 or Ch E 574 - 3 cr.**) Alternate spring semesters, taken in spring of year 1 or 2. Created for our Training Program, this course is organized around the development of interdisciplinary biotechnology proposals by teams of students with varied backgrounds. Selected Training faculty and invited guest speakers from academia and industry lecture on their specialties.

2. **General Biochemistry I** (**MBIOS 513 - 3 cr.**) Fall semesters, usually taken in fall of year 1. Structure and organization of proteins and nucleic acids; protein folding; fundamental principles of enzymology; lipids, membranes and polysaccharides; experimental techniques and strategies. Trainees with engineering or non-biological science can take MBioS 303 Introductory Biochemistry (4 cr.) and then, as appropriate, MBIOS 513.

3. **Topics in Biomedical Experimentation (MBIOS 564 and equivalent numbers in other units)** Spring semester. Trainees must take three 1 credit modules, each five weeks long: **Biomedical Ethics, Responsible Conduct of Research, and Experimental Design.** Biomedical Ethics covers ethical theory and reasoning as applied to problems of biological and biomedical interest including the use of various novel technologies. Responsible Conduct of Research covers topics including scientific misconduct, authorship and reviewing, mentoring, ethical behavior in the scientific workplace, and intellectual property. Experimental Design covers topics like hypothesis development and testing, data gathering and management, and reproducibility of research results.

Plus a minimum of 3 credits of elective courses from the following list:

1. **Cellular Bioengineering (BIO_ENG 550 – 3 cr.)** Cellular biology integrated with engineering science; cellular phenomena from an engineering perspective; quantitative engineering principles for cellular-based materials, diagnostic devise and sensor designs. Typically offered Fall.

2. **Biochemical Engineering (CH E 560 – 3 cr.**) Chemical engineering applied to biological systems; fermentation processes, biochemical reactor design, downstream processing, transport phenomena in biological systems, biochemical technology. Typically offered Spring.

3. **Biofilms (CH E 581 – 3 cr.)** This class covers medical and environmental biofilms and provides fundamental knowledge needed to understand biofilm processes and biofilm control. This class targets students from life sciences to engineering.

4. **Molecular Dynamics Simulations for Bioengineers** (**CHE 581- 07)** Using models and computation to analyze protein structure and function, especially in biomedical contexts.

5. **Bioorganic Chemistry (CHEM 543 – 3 cr.)** Chemistry of biological systems, medicinal chemistry, protein chemistry, enzyme mechanisms and inhibitors.

6. **Enzyme Reaction Mechanisms (CHEM 572 – 3 cr.)** Methods used to explore enzyme mechanisms; how enzymes catalyze reactions; overview of enzyme co-factors and exploration of differing classes of enzyme catalyzed reactions. .

7. **Special Topics and Projects in Electron Microscopy (E MIC 586/587 – 3 cr.)** Practical training in one or more areas of electron microscopy; TEM, SEM, ultramicrotomy, specimen processing; confocal fluorescent microscopy. Note, these courses are taken as a set of lecture/lab. Typically offered Fall and Spring.

8. **Postharvest Biology and Technology (HORT 518 – 3 cr.)** Physical and physiological basis for handling and storage practices; perishable organ ontogeny and physiological disorders; post-harvest environment requirements. Field trip required. Typically offered Fall.

9. **Cell Biology (MBIOS 501 – 3 cr.)** Cellular structure and function; membrane biochemistry and transport; cell-cell communication; regulation of cell cycle and apoptosis; cell signaling; cancer biology. Recommended preparation: introductory genetics and biochemistry. Offered Spring semesters (in person section only, not online)

10. **Advanced Molecular Biology** (**MBIOS 503 – 3 cr.**) DNA replication and recombination, recombinant DNA methods, host/vector systems, genome analysis and transgenetic organisms.

11. **General Biochemistry II** (**MBIOS 514 – 3 cr.**) Carbohydrate, amino acid and lipid metabolism and its control; biochemistry of vitamins; bioenergetics; photosynthesis; nitrogen fixation.

12. **Immunology (MBIOS 540 – 3 cr.**) Principles of the immune system at the animal, cellular and molecular levels.

13. **General Virology (MBIOS 542 – 3 cr.)** Graduate level coverage of the structure, function and biology viruses that infect eukaryotic cells and organisms.

14. **Bioinformatics** (**MBIOS 578 – 3 cr.)** Computer analysis of nucleic acid/protein sequences and structures.

15. **Plant Molecular Genetics (MPS 525 – 3 cr.)** Introduction to plant genome organization and gene expression while acquiring knowledge of modern molecular techniques and experimental approaches.

16. **Molecular Genetics of Plant and Pathogen Interactions (PL P 535 – 3 cr.)** Genetic and molecular biological aspects of host-pathogen interactions. Typically offered Even Years - Spring.

17. **Design and Analysis of Biomedical Experiments (VPH 505 – 4 cr.)** Design of experiments with application to clinical and basic biomedical research; choosing, applying, and evaluating appropriate data analysis methods.

18. **General and Cellular Physiology (VPH 555 – 3 cr.)** Physiochemical mechanisms of cellular function. Recommended preparation: MBIOS 513. Typically offered Spring.

Required Participation in the:

1. **Biotech Forum**. Trainees themselves organize to meet several times each semester, usually on a monthly basis, to learn about each other's research, internship experiences, etc. and to discuss the latest advances in the field of biotechnology. The Forum is also responsible for planning and hosting the annual Biotechnology Symposia, holding occasional Career Fairs and workshops, and for regularly publishing the Biotechnology Newsletter, in addition to other activities. The Forum is not a formal course, but serves to keep Trainees in contact with each other and to unify the members of the Program who are situated often widely separated on campus. Thus, all Trainees are expected to attend and participate in Forum meeting and activities throughout their graduate careers. Such continued participation is a requirement for receiving the Certificate of Training in Protein Biotechnology upon graduation.

2. **Biotech-sponsored Symposia, Seminars and Workshops**. Specific biotechnology speakers, sponsored or co-sponsored by Training Grant funds, present seminars throughout the academic year. Subjects include the range of basic and applied areas relevant to biotechnology as well as issues of practical interest to Trainees (for example employment possibilities). Trainees will be notified of these seminars and are expected to attend.

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GUIDELINES FOR LABORATORY ROTATIONS

Trainees appointed as incoming students are expected to complete a minimum of three laboratory rotations during the first academic year, with the option of performing a fourth rotation. Each rotation is generally for approximately one-half of a semester, a period of approximately 8 weeks. Note that a semester includes 15 weeks of classes and 1 week of vacation (Thanksgiving or Spring break) while laboratory activities routinely continue through those vacation periods. Rotations should be used to obtain meaningful interactions with possible thesis laboratories and to broaden experience in the spirit of the cross-disciplinary goals of the training program. Thus, Trainees are expected to rotate through three different laboratories for a period of time negotiated with the training faculty member. At least one rotation should involve a discipline distant from a Trainee's previous background and experience.

ARRANGING ROTATIONS

Rotations are arranged by individual efforts of a Trainee in consultation with the Director of the Training Program and are subject to approval by the Director and the Executive Committee. Entering Trainees are provided with information about research activities of the training faculty before beginning of the fall term, and are expected to talk directly with faculty in whose laboratory the Trainee might consider doing a rotation. The initial rotation should be defined in the week before the fall term commences and subsequent rotations two weeks before they begin. Although it is appropriate to develop a plan for the entire series of rotations, it is important that the Trainee be receptive to new possibilities as more information is gained about the training faculty in the course of the first few months of graduate school. It is important to maintain flexibility and an open mind. In arranging rotations, the Trainee should ensure that the prospective laboratory can provide an appropriate project, adequate direct supervision (often by a senior graduate student or postdoctoral researcher) and regular contact with the faculty member during the period of the rotation.

ROTATION ACTIVITIES

During a rotation, the Trainee should perform as a full member of the rotation laboratory. The Trainee should have a desk and laboratory bench and a defined project supervised and guided by a member of the laboratory. One-half of the Trainee's time and effort should be directed toward the rotation project, the other half toward course work. This means a nominal 20 hours per week working in the laboratory, but because successful graduate students and successful scientists usually work much more than 40 hours a week, Trainees should be prepared to invest greater effort. The rotation laboratory should serve as an academic home and the Trainee should participate in all usual laboratory activities, particularly weekly group meetings. In most cases, the Trainee will present a report on the research pursued to the host laboratory at the end of the rotation period.

MONITORING AND REPORTING

At the completion of each rotation, the Trainee will submit a brief summary of the rotation research (including relevant data). This report should be submitted no later than one week after the rotation is completed.

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GUIDELINES FOR CHOOSING A THESIS ADVISOR

One of the most important decisions in a graduate career is choosing a thesis advisor. These guidelines identify some of the important issues involved in the choice and define the special features provided by the Training Program.

CONSIDERATIONS

The decision of choosing a laboratory in which to do your thesis work should include the following aspects:

1. The general subject of research in the laboratory, the potential projects available for you to pursue and the nature of the experimental manipulations involved.

2. Compatibility with your prospective thesis advisor and with the nature and character of the research group.

3. Availability of space, funding for the project and funding for research assistant support for you over the duration of your graduate career.

It is your responsibility to acquire as much information as you can about each of these aspects by discussion and interaction with training faculty and with members of research groups. Much of this can occur in the course of a laboratory rotation.

PROCESS

Choosing a thesis advisor is a mutual decision among Trainee, the training faculty member and the Biotechnology Training Program Executive Committee. The initiative lies with the Trainee, who by discussions with training faculty and by choices of rotation laboratories identifies laboratories of interest. Training faculty approached by a Trainee will consider the availability of space and funds as well as the compatibility of the particular Trainee with the research group in terms of interests, background, talents and personality.

The Program Director reviews the potential advisor submitted by the Trainee via the Thesis Lab Selection Approval Form, confirms the ability of the faculty member to provide long term support for the Trainee, and approves a thesis advisor, guided substantially by the Trainee's preference but also by wider responsibility for the Trainee's education and training.

PROCEDURES

1. Before you join a thesis lab, you must receive approval from the Program Director. A Thesis Lab Selection Approval form must be submitted to the Director with the appropriate information and signatures *prior* to joining the lab in which you will perform your thesis research. This form indicates the advisor's agreement to financially support the Trainee once Biotech support has ended (generally after two years) and to encourage performance of the internship in a timely fashion (generally within the first two years).

2. In the Spring of each year, the Executive Committee will evaluate the required annual written reports submitted by the Trainee and his/her mentor to determine whether the Trainee is making adequate progress toward their degree and decide whether they are to be reappointed to the Program. When required, the Executive Committee will meet with the Trainee and thesis advisor to review a Trainee's activities.

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GUIDELINES FOR INTERNSHIPS

Overview

Each biotechnology Trainee is required to complete an internship at a biotechnology firm. These internships may be linked to a collaboration between the mentor's laboratory at WSU and a particular laboratory in a biotechnology firm, or it may be independent of the Trainee's thesis project but instead supplement that individual's training in protein chemistry. We aim for substantial flexibility in the internships. The goal is that both the Trainee and the firm should profit from the internship, coordinating scientific progress and educational experience.

Responsibilities

The primary responsibility for arranging an internship is on the Trainee and mentor, with the arrangements subject to approval by the Director. Potential internship companies may be viewed on the WSU NIH Biotechnology Training Program website although a Trainee is not limited to that list. An internship should last at least two months and we suggest the summer of the first or second year in graduate school as an appropriate time, but both duration and timing can be different as considered appropriate by Trainee and mentor, subject to approval by the Director via the Internship Approval Form.

Financial Arrangements

During the internship, the Trainee continues to receive support through a WSU appointment, either a Traineeship stipend or an R.A. through the mentor's laboratory, depending on whether the internship occurs during the years of direct Training Funds support or after support has been shifted to mentor's funds. In addition, the Training Program requests that the host firm provide funds, in whatever way deemed appropriate, to cover the Trainee's travel and living expenses during an internship. The details of these arrangements should be determined by discussion among the host firm, the Trainee and the mentor. The most usual situation is for the firm to hire the Trainee in some sort of temporary appointment for the internship period, but other arrangements (e.g., donation of funds to the Training Program by the firm for support of the Trainee) are possible. If necessary, the Director can become involved these negotiations, but in most cases it should not be necessary.

Reporting

Within one month of the completion of the internship, the Trainee should submit a comprehensive report and evaluation of the experience. Also, returning interns give oral presentations at a Forum meeting to other Trainees and Trainers.