

# BIOCHEMISTRY AND MOLECULAR BIOLOGY, PHD

## Introduction

The PhD Program (<https://publichealth.jhu.edu/academics/phd-dept-of-biochemistry-and-molecular-biology/>) in the Department of Biochemistry and Molecular Biology (<https://publichealth.jhu.edu/departments/biochemistry-and-molecular-biology/>) is designed for students interested in graduate-level preparation for careers in biomedical and health sciences research. Emphasizing molecular studies of multiprotein systems, molecular and cellular biology, and biochemical nutrition, the research of our doctoral students has applications to cancer, aging, neurological diseases, and environmentally based diseases.

## Program Requirements

Course location and modality is found on the BSPH website (<https://publichealth.jhu.edu/courses/>).

## Required Coursework

All Ph.D. students in the training program have a common core curriculum during their first and second years as outlined in Table 1. Students who are supported by the National Cancer Institute training grant in their second year or beyond are also required to take **ME.510.760 Fundamentals in Cancer: Cause to Cure** offered by the Sidney Kimmel Comprehensive Cancer Center or an equivalent course. Students should consult with the departmental Academic Program Manager regarding course availability.

A rich array of seminar programs and journal clubs are also available to all students. Students may also elect, in consultation with their thesis adviser, to take additional coursework in their chosen area of interest. In addition to registering for required coursework, students also register for thesis research once they have chosen a thesis adviser.

All students, regardless of year, are required to attend the annual BMB Retreat. Students who have completed their first year of study are also required to participate in the weekly journal club and attend the monthly BMB Colloquium series each academic year.

Also, all students are required to take (and receive a passing grade for) the following Cells-to-Society courses:

- Foundational Principles of Public Health (0.5 credits)
- The Role of Quantitative Methods in Public Health (0.5 credits)
- The Role of Qualitative Methods & Science in Describing & Assessing a Population's Health (0.5 credits)
- Causes and Trends in Morbidity & Mortality (0.5 credits) *NOTE: can be replaced by 260.600.81 Introduction to the Biomedical Sciences*
- The Science of Primary, Secondary & Tertiary Prevention in Population Health (0.5 credits)
- The Critical Importance of Evidence in Advancing Public Health Knowledge (0.5 credits)
- Essentials of Environmental Health (0.5 credits)
- Psychological & Behavioral Factors that Affect a Population's Health (0.5 credits)
- The Social Determinants of Health (0.5 credits)

- Globalization and Population Health (0.5 credits)
- Essentials of One Health (0.5 credits)

Many of the courses are offered more than once in an academic year. For the current schedule of the courses, please check the following link (<https://publichealth.jhu.edu/academics/course-directory/schedule-of-cells-to-society-course-offerings/>).

**Table 1. Course Requirements for BMB Ph.D. Students**

| Course             | Title   | Credits        |
|--------------------|---|----------------|
| <b>First Year</b>  |   |                |
| <b>Summer Term</b> |   |                |
| PH.120.829         | Summer Thesis Research  | 12             |
|                    |   | <b>Credits</b> |
|                    |   | <b>12</b>      |
| <b>First Term</b>  |   |                |
| ME.100.716         | Analysis of Macromolecules  | 2              |
| ME.330.709         | Organic Mechanisms in Biology   | 2              |
| PH.120.850         | Biochemical Techniques (laboratory rotations)   | 6              |
| PH.120.852         | Core Research Literature  | 2              |
| PH.550.860         | Academic & Research Ethics at JHSPH   | 0              |
| PH.120.872         | Special Studies-Current Topics in BMB   | 1              |
|                    |   | <b>Credits</b> |
|                    |   | <b>13</b>      |
| <b>Second Term</b> |   |                |
| ME.110.733         | Principles of Genetics  | 2              |
| ME.260.709         | Molecular Biology and Genomics (Molecular Biology and Genomics)                       | 3              |
| PH.120.840         | Special Studies and Research Biochemistry   | 2              |
| PH.120.850         | Biochemical Techniques (lab rotations)  | 6              |
| PH.120.852         | Core Research Literature  | 2              |
|                    |   | <b>Credits</b> |
|                    |   | <b>15</b>      |
| <b>Third Term</b>  |   |                |
| ME.110.728         | Cell Structure and Dynamics (Cell Structure and Dynamics)                             | 3              |
| ME.360.728         | Pathways and Regulation (Pathways and Regulation)                                     | 2              |
| PH.120.850         | Biochemical Techniques (laboratory rotations)   | 6              |
| PH.120.852         | Core Research Literature  | 2              |
| PH.140.615         | Statistics for Laboratory Scientists I  | 4              |
|                    |   | <b>Credits</b> |
|                    |   | <b>17</b>      |
| <b>Fourth Term</b> |   |                |
| PH.120.624         | Cancer Biology  | 3              |
| PH.120.630         | Fellowship Grant Writing for Students and Postdoctoral Fellows in Biomedical Research | 2              |
| PH.120.840         | Special Studies and Research Biochemistry   | 2              |
| PH.120.850         | Biochemical Techniques (laboratory rotations)   | 6              |
| PH.120.852         | Core Research Literature  | 2              |
|                    |   | <b>Credits</b> |
|                    |   | <b>15</b>      |
| <b>Second Year</b> |   |                |
| <b>First Term</b>  |   |                |
| PH.120.820         | Thesis Research Biochemistry  | 1 - 22         |

|                      |   |           |
|----------------------|---|-----------|
| PH.120.840           | Special Studies and Research Biochemistry (variable credit) | 1 - 22    |
| PH.550.600           | Living Science Ethics - Responsible Conduct of Research     | 1         |
| <b>Credits</b>       |   | <b>1</b>  |
| <b>Second Term</b>   |   |           |
| PH.120.840           | Special Studies and Research Biochemistry (variable credit) | 1 - 22    |
| PH.120.820           | Thesis Research Biochemistry (variable credit)              | 1 - 22    |
| PH.550.865           | Public Health Perspectives on Research                      | 2         |
| <b>Credits</b>       |   | <b>2</b>  |
| <b>Third Term</b>    |   |           |
| PH.120.840           | Special Studies and Research Biochemistry (variable credit) | 1 - 22    |
| PH.120.820           | Thesis Research Biochemistry (variable credit)              | 1 - 22    |
| <b>Credits</b>       |   | <b>0</b>  |
| <b>Fourth Term</b>   |   |           |
| PH.120.840           | Special Studies and Research Biochemistry (variable credit) | 1 - 22    |
| PH.120.820           | Thesis Research Biochemistry (variable credit)              | 1 - 22    |
| <b>Credits</b>       |   | <b>0</b>  |
| <b>Total Credits</b> |   | <b>75</b> |

**Notes:**

- Courses designated ME are offered by the School of Medicine and those designated PH are offered by the Bloomberg School of Public Health.
- Special Studies and Research/BMB = Monday Departmental Seminar Series
- Current Research Literature 4th term = Thesis proposal writing workshop

**Additional Requirements**

- Three (3) credits of a course in Epidemiology (PH.340.618 Epidemiology: the Basics – offered in 4th term).
- Six (6) credits of coursework outside BMB but within BSPH. **Note: PH.500 series courses do not count toward this requirement.**

**Laboratory Rotations**

During their first year, students spend approximately one-half of their time conducting bench research during four laboratory rotations. Each rotation lasts eight weeks. The purpose of these rotations is to familiarize the student with research activities performed by faculty members in the program and to allow the student to make an informed decision in choosing a thesis adviser. Each rotation will be assigned by the Program Director, Dr. Michael Matunis, with input from the student, as follows:

- For the first rotation, students will receive a list of laboratories available for rotations during the summer. After receiving this list, students will provide the Program Academic Manager with the names of three labs for possible rotation assignment. Assignments will be made by the Program Director in consultation with the Program Steering Committee.
- For the second through fourth rotations, students are required to meet with available faculty and discuss possible rotations during

the two weeks prior to the end of their current rotation. Following these discussions, students will provide the Academic Office with the names of three labs for possible rotation assignment. This list must be submitted one week prior to the end of the current rotation. Rotation assignments will be determined by the Program Director in consultation with the Program Steering Committee.

Students are allowed to rotate only once in any given lab. Normally, the rotations will be distributed so there is only one rotation student per laboratory. This rule may be waived if there are unusual circumstances. To assist students in rotation choices, the department offers a one-credit course titled “Current Topics in BMB” held twice a week (12:00-1:00 PM) during the first term of the academic year where training faculty introduce students to their ongoing research.

Students will be given a specific research project at the beginning of each laboratory rotation. The student is expected to acquire the necessary background information to carry out the project through literature reviews and discussions with the faculty adviser and other lab members. In carrying out the project, the student can also expect hands-on assistance as required from the faculty heading the lab and their trainees.

At the end of each rotation, first year students present a report on their rotation project before the faculty and other interested parties. Each student will write a brief abstract which is to be submitted to the Academic Program Manager on the day before the rotation report. During the rotation report, students give an oral presentation lasting 10 minutes. A five-minute question period follows each oral presentation. Each student is also required to complete a rotation self-evaluation form at the end of each rotation (Appendix I). The completed form should be discussed in person with the faculty adviser who will provide their own assessment of the student’s understanding of the project, effort, interest, and technical abilities in carrying out the project. The faculty’s assessment, including an overall evaluation of the rotation, will be documented on the final page of the form. **The signed form together with the updated “Milestones Tracker” form must be returned to and briefly discussed with the student’s first year faculty adviser within one week of the end of each rotation.**

**Satisfactory Academic Progress and Laboratory Rotation Performance**

- Students must receive a grade of B or better in each of the eight core (ME) courses listed in Table 1 and in Cancer Biology. Accumulation of two or more grades of C or lower in these courses is grounds for dismissal from the program. If a student receives a C or lower grade in any of these nine courses, then the student must repeat the course and receive a B or better grade the second time.
- The School of Public Health requires Ph.D. candidates to achieve a final GPA of 3.0 or higher for graduation.
- Students must also receive satisfactory evaluations for each of the four laboratory rotations. Receiving two or more “poor” evaluations is grounds for dismissal from the program.
- Academic progress and laboratory rotation performances will be evaluated by the Program Steering Committee in early April, prior to the completion of the 4th rotation. Students who have met both academic and laboratory rotation standards will be notified and permitted to select a laboratory for thesis research. Students who have not met these standards may be dismissed from the program.

**Selecting a Thesis Adviser**

As a general policy, only one student may enter a given laboratory in any one year. Exceptions to this policy are made when circumstances

warrant. Students are expected to meet with potential thesis lab advisers during the two weeks prior to the end of the fourth rotation and discuss the possibility of joining that lab for their thesis studies. Following these meetings, students will provide the Academic Program Manager with the names of possible thesis advisers. Names must be submitted one week prior to the end of the fourth rotation. Students are required to meet and discuss thesis lab choices with the Program Director, Dr. Matunis, during the last week of the final rotation. Thesis lab placements will then be formalized between the student and adviser following this discussion. Every effort will be made to give students their first choice of thesis research lab.

## Thesis Proposal/Oral Exam

Students must successfully pass one program examination (step 1, by October 15) and one oral practice examination (step 2, by November 15) before they are permitted to take the university Preliminary Oral Exam (step 3, by April 30) (see Table 2 (p. 4) for a summary of completion dates). The first of these steps, the program examination, is a two-part written/oral exam that must be based on the student's doctoral thesis project. Students are asked to write a six-page research proposal that follows the format of an NIH F31 fellowship. This proposal shall be written with close guidance from the thesis adviser during the summer/early fall of the second year. The completed proposal will be submitted by the first week of October of the second year to a committee consisting of the student's thesis adviser and two other JHU faculty members that may be within or outside of BMB. The student must present the research proposal and defend the rationale and experimental plan during an oral exam that must take place before October 15th of the second year. The committee will provide instructive feedback and recommended changes for a revised written proposal that the student submits by November 15th. Once the revised proposal is approved by the committee, the student has passed the departmental written and oral exam requirements. Full details of the examination process are provided in Appendix II (p. 5). Additionally, detailed instructions on how to develop and write the research proposal shall be disseminated as part of the Current Research Literature class taken in the 4th quarter.

## Preparation for Preliminary Oral Exam

Students are required to successfully pass a university-administered Preliminary Oral Exam (described below) to be officially accepted as candidates for the Ph.D. degree. In preparation for this exam, students are required to schedule an oral examination practice session within 4 months of completing their Thesis Proposal/ Oral exam (by March 31). This practice session should be held no later than 1 month prior to the Preliminary Oral Examination. The purpose of the practice session is to help assess exam readiness. The student will select a committee consisting of their Ph.D. thesis adviser and five peers. These five peers should be pre-doctoral students who have already taken and passed their oral exam and/or postdoctoral students. No more than two of the peers can be from the student's own laboratory. Scientific diversity is highly encouraged. The role of the adviser is to ensure that the practice session emulates the official Preliminary Oral Examination mandated by the university and to provide feedback and guidance to the student for the final stages of their preparation. A form (available from the BMB academic office) attesting that the practice session has taken place must be signed and dated by the members of the committee, including the student's adviser, and filed with the Academic Office. The student is allowed to finalize the faculty panel and schedule the Preliminary Oral Examination prior to the oral examination practice session. However, the practice session must be completed before the official examination.

## Preliminary Oral Examination

The Preliminary Oral Examination is a university-administered examination that is designed to test the student's breadth and depth of knowledge in their area of study. Students must pass this examination to officially become candidates for the Ph.D. degree. The examining committee must:

1. consist of at least five voting members, no more than three of whom may be from the department sponsoring the candidate; **the student's thesis adviser will not be a member of the examining committee;**
2. be comprised of duly appointed faculty members of Johns Hopkins University departments and must hold, at the time of selection, an appointment at the rank of Assistant Professor, Assistant Research Professor, or Assistant Public Health Professor or higher;
3. be comprised of three departments of Johns Hopkins University, two being from the Bloomberg School of Public Health; and
4. include a faculty member outside of BMB who has the rank of Associate or Full Professor, Research Professor, or Public Health Professor; there must be at least one member who has neither a primary nor joint appointment in BMB.

The Chair of the committee is appointed by the Senior Associate Dean for Graduate Affairs. The senior faculty member outside of the student's department will normally serve as Chair and must hold the rank of Associate or Full Professor. One adjunct faculty member or Scientist track faculty member may serve on the Committee but may not serve as Chair. Once a Ph.D. candidate's Examination Committee has been approved by the Office of Academic Affairs, the substitution of Committee members may not be made without prior approval of that office. Students are encouraged to select their committee members and two alternates in consultation with their thesis adviser. Forms must be completed at least one month prior to the exam and submitted to the office of Academic Affairs.

Students then meet with their committee to take the oral exam. During the oral examination, each faculty member of the committee is given an opportunity to ask questions designed to probe the student's understanding of the basic principles of biochemistry, molecular and cellular biology, and the ability to conduct hypothesis-driven research. The examination has three possible outcomes: unconditional pass, conditional pass, or failure. In cases of conditional pass, students may be required to take additional coursework or write an essay to remove the condition. If the student fails the Preliminary Oral Examination and is permitted a reexamination, the student must be reexamined within one year. **The Preliminary Oral Examination should be completed by April 30th of the second academic year.**

## Thesis Advisory Committee

Upon successfully completing the Preliminary Oral Examination, a Thesis Advisory Committee is formed to monitor the student's progress on their thesis research. The committee consists of at least three faculty members (typically four) including the student's thesis adviser. Members of the committee may have primary appointments in BMB or in other departments of the university. Students are encouraged to select members of their committee in consultation with their thesis adviser. In addition to regularly scheduled meetings with their Thesis Advisory Committees, students are also encouraged to consult regularly with their committee members for advice as necessary.

**Students are required to meet with their Thesis Advisory Committees at least once each year, beginning from the time that they select a thesis lab**

in April. Thesis committee meetings will be conducted using the following format:

1. Students will designate one committee member as the chair – this should be the most senior BMB faculty member on the committee, excluding the thesis adviser. If the thesis adviser is the only BMB faculty member on the committee, the chair should be the most senior faculty member from outside of the department.
2. The student “Annual Thesis Committee Meeting Form” (Appendix III) will be completed and mailed to all committee members at least one day in advance of the meeting.
3. The meeting begins with the student stepping out of the room, allowing for a private discussion between committee members.
4. The meeting proceeds with the student presenting research progress and any other relevant information related to meeting individual development plans and progress toward graduation.
5. Following completion of the student presentation, the committee chair will lead a discussion that summarizes the committee’s views on student progress and recommendations for continued success and timely completion. Specific points in the committee’s “Annual Thesis Committee Meeting Form” (Appendix IV) will also be discussed, and the form will be completed by the chair and signed by all committee members before the end of the meeting. The student will retain a copy of the form and return a copy to the Program Academic Manager.
6. The meeting concludes with the thesis adviser stepping out of the room, allowing for a private discussion between the student and all other committee members.

## Individual Development Plans

After joining a thesis research laboratory, all pre-doctoral trainees and their preceptors are required to participate in an Individual Development Plan (IDP) process on an annual basis. The form being used for this purpose is provided in Appendix V. As part of this process, trainees and their mentor discuss the following elements during a confidential, face-to-face meeting set up specifically for the IDP purpose:

1. career goals;
2. assessment of relevant skills, ranging from proficiency at the lab bench to knowledge of the literature, oral presentation, writing, leadership, collegiality, etc., as they relate to these goals;
3. list the achievements of the last year;
4. set specific goals relating to productivity, training, and professional development for the upcoming year; and
5. discuss time to graduation and preparation for post-graduation professional life. Completed IDP forms are to be sent to the IDP Program Director, Dr. Valeria Culotta.

## Thesis Preparation

Once a target date for completion of the thesis project has been set by the Thesis Advisory Committee, the student should begin preparing to write their thesis. The thesis must consist of novel and publishable research findings and may contain material that has already been published by the student during the course of the thesis project.

The thesis will be evaluated by a Thesis Committee composed of four readers that include the student’s thesis adviser. Two committee members must have a primary faculty appointment in a department other than BMB. The readers should have the rank of Assistant Professor or higher. A minimum of three departments of Johns Hopkins University, two from the School of Public Health, must be represented. Two readers must

be primarily affiliated with BMB. At least one member must have neither a primary nor joint appointment in BMB. The committee may be increased to five members, provided that the above conditions are satisfied for four readers.

The committee and the required Final Oral Examination Form must be submitted to the BMB Academic Office at least one month prior to the date of the thesis defense. The thesis, accompanied by a letter from the student’s adviser signifying that the thesis is ready for distribution to the committee, should be submitted to the Thesis Committee at least two weeks prior to the thesis defense.

## Thesis Defense

The thesis defense consists of a seminar in which the student presents some or all of the findings of their thesis project. This seminar, which is sponsored by BMB, is open to the public. Immediately after the seminar, the student will meet privately with the Thesis Committee. The Committee will ask questions about the thesis and will inform the student if the thesis is satisfactory. Following any necessary revisions, the student will submit the final thesis to the School of Public Health Registrar. Thesis fees are the responsibility of the student unless their mentor agrees to pay them.

**Table 2. Summary of Program Milestones and Completion Dates**

| PhD Program Milestones   | Completion Dates                                   |
|--|--|
| Laboratory rotations (year one)                                | (Specific dates vary)                              |
|  | 1st: September/October                             |
|  | 2nd: November/December                             |
|  | 3rd: January/February                              |
|  | 4th: March/April                                   |
| Thesis lab selection (year one)                                | April 15   |
| Thesis proposal / oral exam (year two)                         | Oral defense: October 15                           |
|  | Revised proposal: November 15                      |
| Departmental practice POE (year two)                           | Before March 31                                    |
| University POE (year two)                                      | Before April 30 (within one month of practice POE) |
| Thesis Advisory Committee Meetings (years three to completion) | Annual   |
| Individual Development Plans (year two to completion)          | Annual   |
| Thesis defense   | To be determined / Maximum of 7 years              |

## Laboratory Notebooks

While different laboratories may use different kinds of physical (or online) notebooks, all share certain fundamentals. A proper laboratory notebook is an accurate, contemporaneous, permanent, and legible record of the student’s deeds and thoughts regarding their research project. This notebook is the property of the laboratory and should not leave the laboratory, though students are free to make and take copies. The student’s notebook will be consulted by others to establish what the student did, and to find out how they did it, often long after the student has gone. So, if a student has not developed good record-keeping habits, this is an excellent time to begin. Consult the faculty preceptors for guidance and please refer to the Bloomberg School of Public Health

Student Handbook ([publichealth.jhu.edu/offices-and-services/office-of-student-affairs](http://publichealth.jhu.edu/offices-and-services/office-of-student-affairs)) for Policy and Procedures on the subject of Academic Ethics.

## Appendix II

### Thesis Research Proposal / Oral Exam

Completion of the departmental written and oral exam requirements

All students that matriculated as of fall 2014 must prepare a research proposal that meets the requirements of the “Research Training Plan” section of an NIH F31 grant application. Specific guidelines for preparing this proposal, as detailed in the F31 grant application guide, are attached below. Other specifics and a timeline for completing the proposal and oral exam are as follows:

**May – September, Year 1:** Student works full-time in their chosen thesis lab to generate the preliminary data and ideas for developing a research proposal. The mentor must work closely with the student in defining the research project to pursue. The student and mentor choose a committee of two additional faculty that will act as additional consultants for the student, reviewers of the written proposal, and serve as members of an oral examination committee. These faculty members may come from within the BMB department or from outside the department should they provide special expertise in the research area and in writing fellowships. Over the summer, the student should schedule the oral exam component of the proposal which should occur within the first two weeks of October (see below).

**September – October, Year 2:** The student writes the first draft of the proposal. The mentor is expected to play an active role in proposal development and coaching the student to write in a clear, concise, study section-friendly manner. The adviser should not write the proposal but provide guidance and feedback through several drafts. Consultation with other committee members is also encouraged.

**October 1st-15th, Year 2:** The student submits their proposal to the committee at least one week in advance of the oral exam which must be scheduled no later than October 15th. For this oral exam, the student presents in a chalk talk format, the rationale and experimental sections of the research plan. The committee will test the student’s ability to defend the proposed experiments – is the rationale sufficiently compelling to support the experiments proposed? The committee will also provide guidance as to how to re-structure the proposal as needed and improve the research plan.

**October 15th – November 15th, Year 2:** The student prepares a revised version of the proposal that addresses concerns and incorporates suggestions by the committee. The adviser should work closely with the student in assembling this revised application. The revised application must be submitted to the committee no later than November 15th for review. Following approval of this revised application, and satisfactorily completing the oral exam component, the student has officially passed the departmental written and oral exam requirements.

**Additional comments:** This exercise is designed to help students prepare quality research proposals that can be submitted as fellowship applications for funding considerations. It is expected that a majority (but not all) students will choose to submit their proposals to the NIH and the exam requirement will be completed in time for the December 8th F31 deadline. Other students may choose alternative funding sources, but regardless, the exam requirements remain the same: A minimum 6-page research plan with a separate Specific Aims page as outlined below.

Students seeking non-NIH funding sources should be able to reformat the proposal as needed to meet the specific agency requirements.

The reviewing committee should be considered as a continual resource for the student. Prior to submitting the fellowship for funding considerations, the student is recommended to solicit feedback from their committee on all aspects of the fellowship application including pages that address the selection of sponsor and institution, description of research experience, etc.

## Appendix VI

### Timeline Summary

| Time                         | Description   |
|------------------------------|---|
| May – September, yr 1        | Define specific aims of the proposal, identify two committee members, generate preliminary data |
| September – October, yr 2    | Prepare first written draft of the proposal   |
| October 1st-15th, yr 2       | Submit the proposal to examining committee, schedule and complete oral exam                     |
| October 15th – November 15th | Submit revised proposal for review by the committee   |

### Guidelines for Preparing the Proposal (Verbiage Taken Directly from NIH Guidelines)

The Research Training Plan should include sufficient information needed for evaluation of the project, independent of any other document (e.g., previous application). Be specific and informative, and avoid redundancies. This section should be well-formulated and presented in sufficient detail that it can be evaluated for both its research training potential and scientific merit. It is important that it be developed in collaboration with your sponsor, but it should be written by you, the fellowship applicant.

**The following page limits apply** (All page limits include all tables, graphs, figures, diagrams and charts).

- Specific Aims – limited to one page.
- Research Strategy – limited to six pages (does **not** include the Bibliography and References Cited section).

Be succinct and remember that there is no requirement to use all six pages allotted to the Research Strategy. Note that the Research Training Plan may include graphic images of gels, micrographs, photographs, etc.; however these images may not be included in an Appendix.

**Note: Begin each text section of the Research Training Plan with a section header (e.g., Specific Aims, Research Strategy).**

#### **Specific Aims are limited to one page.**

State concisely the goals of the proposed research and summarize the expected outcome(s), including the impact that the results of the proposed research will exert on the research field(s) involved. List succinctly the specific objectives of the research proposed, e.g., to test a stated hypothesis, create a novel design, solve a specific problem, challenge an existing paradigm or clinical practice, address a critical barrier to progress in the field, or develop new technology.

**Research Strategy is limited to six pages.**

Organize the Research Strategy in the specified order using the instructions provided below. Start each section with the appropriate section heading — Significance, Innovation, Approach. Cite published experimental details in the Research Strategy section and provide the full reference in the Bibliography and References Cited section (there is not page limit to the Bibliography and References Cited section).

**Significance**

- Explain the importance of the problem or critical barrier to progress in the field that the proposed project addresses.
- Explain how the proposed project will improve scientific knowledge, technical capability, and/or clinical practice in one or more broad fields.
- Describe how the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field will be changed if the proposed aims are achieved.

**Innovation**

Fellowship applications should not include an Innovation section unless specified in the FOA.

**Approach**

- Describe the overall strategy, methodology, and analyses to be used to accomplish the specific aims of the project. Unless addressed separately in Item 14 (Resource Sharing Plan), include how the data will be collected, analyzed, and interpreted as well as any resource sharing plans as appropriate.
- Discuss potential problems, alternative strategies, and benchmarks for success anticipated to achieve the aims.
- If the project is in the early stages of development, describe any strategy to establish feasibility, and address the management of any high risk aspects of the proposed work.
- Point out any procedures, situations, or materials that may be hazardous to personnel and precautions to be exercised. A full discussion on the use of select agents should appear in Item 15, below.
- If research on Human Embryonic Stem Cells (hESCs) is proposed but an approved cell line from the NIH hESC Registry cannot be identified, provide a strong justification for why an appropriate cell line cannot be chosen from the Registry at this time.

If an applicant has multiple Specific Aims, then the applicant may address Significance, Innovation and Approach for each Specific Aim individually, or may address Significance, Innovation and Approach for all of the Specific Aims collectively.

As applicable, also include the following information as part of the Research Strategy, keeping within the three sections listed above: Significance, Innovation, and Approach.

**Preliminary Studies for New Applications**

For new applications, include information on preliminary studies, if any. Discuss the applicant's preliminary studies, data, and/or experience pertinent to this application. When applicable, provide a succinct account of published and unpublished results, indicating progress toward their achievement.

**Course Requirement Specific to the NCI-funded Training Grant**

Cancer Training Grant: Training in Areas Fundamental to Cancer Research

- Fundamentals of Cancer (ME.510.706 Fundamentals of Cancer: Cause to Cure – 1st and 2nd terms)

See Program Academic Coordinator regarding course availability or alternatives.

**RESPONSIBLE CONDUCT OF RESEARCH**

All research students must complete courses in the responsible conduct of research before graduation. Currently, the online course PH.550.860 Academic & Research Ethics at JHSPH must be completed by all students during the first term of matriculation. Students must also take the course PH.550.600 Living Science Ethics - Responsible Conduct of Research, in the 1st term of their second year. Students should refer to the Bloomberg School of Public Health Student Handbook ([publichealth.jhu.edu/offices-and-services/office-of-student-affairs](http://publichealth.jhu.edu/offices-and-services/office-of-student-affairs)) (<https://publichealth.jhu.edu/offices-and-services/office-of-student-affairs/>) for Policy and Procedures on the subject of Academic Ethics.

**Program Policies**

For a full list of program policies, please visit the Department of Biochemistry and Molecular Biology's For Current Students (<https://publichealth.jhu.edu/departments/biochemistry-and-molecular-biology/info-for-current-students/>) page where students can find the link to the most recent PhD in Biochemistry and Molecular Biology Student Handbook.

Upon successful completion of the PhD in Biochemistry and Molecular Biology, students will have mastered the following competencies:

- Evaluate current and future issues in public health related to one of the leading causes of death, cancer
- Assemble a research proposal appropriate for an NIH style fellowship application
- Defend and support a scientific argument in relevance to scientific literature and presentations
- Design hypothesis-driven research questions
- Read and critically evaluate primary research literature in biochemistry, molecular and cellular biology

According to the Council on Education for Public Health (CEPH) requirements, all BSPH degree students must be grounded in foundational public health knowledge. Please view the list of specific CEPH requirements by degree type (<https://e-catalogue.jhu.edu/public-health/ceph-requirements/>).

**Professional Development**

In addition to the commitment to enhancing their scientific knowledge base, critical thinking, and research skills, BMB is equally dedicated to students' development as science professionals. Experience teaches that students who start the process of formulating and refining a career plan early in their academic career have a better chance of achieving their goals. In this spirit, BMB requires that starting in their first year each student participate in the structured career and professional development OPTIONS program offered by the Johns Hopkins Professional Development and Career Office (PDCO). This multi-year program is designed to help students identify career objectives and systematically

devise and implement a strategic plan to achieve their goals. This plan includes a series of programs - **Career Exploration, Career Development, and Career Readiness** – that provide opportunities to explore career options, train in and develop valuable professional skill sets, and even gain hands-on experience as an intern in their field of interest. In addition, PDCO holds **Career Clinics** to aid students in preparing winning resumes, CVs, and web pages to prepare them to enter the marketplace. See the PDCO website for details of the program: <https://pdco.med.jhmi.edu/>. The progress and direction developed through the PDCO program will be monitored at each Thesis Advisory Committee meeting and documented in each student's customized Individual Development Plan (IDP).

In addition to the program offered by the PDCO, BMB has academic offerings designed to assist students with professional development such as the required course Fellowship Grant Writing for Students and Postdoctoral Fellows (120.630).