Joint Carnegie Mellon University-University of Pittsburgh

Ph.D. Program in Computational Biology

An HHMI-NIBIB Interfaces Initiative Program

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STUDENT AND FACULTY HANDBOOK

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Welcome and Introduction

Welcome to the Joint Carnegie Mellon University-University of Pittsburgh Ph.D. Program in Computational Biology (CPCB). Computational Biology is a field that encompasses a wide range of topics, ranging from molecular modeling and protein dynamics to large-scale analysis of genome/proteome data. This program brings together the considerable talents of researchers in both universities in implementing an excellent training program in this rapidly developing field.

This handbook provides useful information pertaining to CPCB and progress toward your degree. The material contained in this handbook is as current as possible; however, many areas change and material may become outdated or inaccurate. Please read any future memos and/or emails you might receive to remain abreast of such changes.

Please contact us with any questions or suggestions concerning your handbook. Again, welcome to the program.

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1. Program Overview

The Joint CMU-Pitt Ph.D. Program in Computational Biology (CPCB) offers a Ph.D. in computational biology. Students receive their doctoral degree from either the University of Pittsburgh (Pitt) or Carnegie Mellon University (CMU), depending on the university at which the student's thesis advisor holds his/her primary appointment. Within CMU, the administrative home for the program is the Lane Center for Computational Biology and degrees are awarded by the School of Computer Science. Within Pitt, the administrative home is the Department of Computational Biology, School of Medicine, and the degree-granting school is either the School of Medicine or the School of Arts and Sciences, depending on the primary affiliation of the student's thesis advisor.

The goal of CPCB is to provide intensive interdisciplinary education to enable outstanding students to become leaders in identifying and solving tomorrow's biological problems using computational and/or mathematical methods and fundamental principles of life and physical sciences. CPCB provides students with cross-disciplinary training in established as well as newly emerging fields of computational biology.

CPCB has instituted a curriculum that is designed to train students who will shape the next generation of discovery in computational biology in academia and industry. The curriculum offers a set of core courses, which provide the students with fundamental concepts and methods in computational biology, and elective courses from one of four areas of specialization; there are also journal clubs and scientific ethics and scientific integrity courses. The areas of specialization are:

- **Computational Genomics**
- **Computational Structural Biology**
- **Cellular and Systems Modeling**, and
- **Bioimage Informatics**.

A comprehensive examination is conducted at the completion of the core courses. This examination entails the preparation of a dissertation proposal and an oral defense of this proposal to a committee comprised of program faculty. As they approach the end of their doctoral studies, students are mentored toward finding top faculty or postdoctoral positions in academia, or positions in the biotechnology and pharmaceutical industries. The doctoral degree is awarded upon submission and oral defense of the dissertation.

The core courses aim at providing students a strong common background in computational biology before they specialize in particular research areas, consistent with the goal of the program stated above. There are five core courses, designed to offer an overview of the current state-of-the-art in computational biology (organized in three courses: Computational Genomics, Computational Structural Biology, and Cellular and Systems Modeling), basic methods of computer science (Machine Learning), and "wet" laboratory science (Laboratory Methods for Computational Biologists). Elective courses include options for training in fundamental concepts in life sciences or physical sciences (e.g., Molecular Biology, Biophysics, Cell Biology, or equivalent courses), quantitative methods (e.g., Algorithms, Statistical Methods, etc.), a specialization-specific course selected in accord with the student's specialization area to provide advanced interdisciplinary training in that specialization, and an open elective.

Terminal Masters Degree

The Program does not admit students whose goal is to attain a Master of Science (M.S.) degree. However, it might become necessary for a Ph.D. student to transfer to a M.S. track for a variety of reasons. These could include academic performance factors and factors beyond the student's control, e.g., medical circumstances or a change in family circumstances necessitating a long-distance move. The requirements and procedures for the transfer from the Ph.D. program to a Masters program are described below.

The student must petition to be transferred to a terminal Masters program. The petition must be addressed in writing to the Program Directors and must have the support of the thesis advisor. For students enrolled through Pitt, the M.S. degree in Computational Biology will be conferred by Pitt School of Medicine or School of Arts & Sciences, depending on the primary affiliation of the student's advisor. For students enrolled through CMU, transfer will be to the M.S. in Computational Biology program jointly administered by the Lane Center for Computational Biology in the School of Computer Science and the Department of Biological Sciences in the Mellon College of Science. Completion of the requirements described below will be accepted in lieu of the normal requirements for that program pending approval of the awarding program.

An M.S. degree awarded through the University of Pittsburgh requires the completion of coursework with a minimum of 30 credits or 90 units with a minimum GPA of 3.0. The degree also requires successful completion of all core courses in the PhD program. For a student to receive an M.S. degree through Carnegie Mellon University, the student must complete at least 99 units (33 credits) of coursework of which at least 36 units (12 credits) are graduate level courses. The student must receive a C or better in each individual class credited and must have received a cumulative B average over the 99 units. The student will also need to have approved substitutions for the core classes of the M.S. program, which will normally be accomplished through the Ph.D. program core classes.

The requirement for passing an M.S. comprehensive examination is met by an oral exam based on a brief (approximately two page) proposal for the Master's thesis research. A Thesis Committee, constituted as described below for the Ph.D. Dissertation Committee, will conduct this examination. The scope of the Master's research proposal should be appropriate for a Master's thesis and therefore less than for a Ph.D. dissertation. For students who transfer to the M.S. track after attempting the Ph.D. comprehensive examination, the examining committee has the option of deciding that performance in the Ph. D. comprehensive examination meets the standard required for an M.S. comprehensive examination. Masters students must submit and defend a thesis and comply with all other applicable requirements for the M.S. degree.

2. Program Administration

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3. Training Faculty

An outstanding group of over 80 CPCB training faculty from diverse backgrounds and schools at the two universities provide ample opportunities for cutting edge thesis projects in well funded research groups. The research interests of the faculty span a broad spectrum of computational biology fields, including computational genomics, computational structural biology, cell and systems biology and bioimage informatics. Research topics include mining of high-throughput genomic data in a systems biology framework, evolution of genomes, genetic variation analysis, protein-protein and protein-ligand interactions, protein folding, biomolecular machinery, computer-aided drug discovery, metabolic and regulatory cellular networks, protein localization from cell images, and many others. A current list of the training faculty and their interests can be found at http://www.compbio.pitt.edu/Faculty/ and http://www.compbio.cmu.edu/Faculty/.

4. Committees

In order to better provide rigorous training to top quality students, CPCB has established six committees. Committee members can be found at http://www.compbio.cmu.edu/Committees.html and http://www.compbio.pitt.edu/Committees.html.

Executive Committee

Responsibilities: The Executive Committee oversees the program, and approves major changes to the program structure and policies. The Executive Committee ensures that the program is maintained within the general guidelines of the goals and objectives of both universities. The Executive Committee consists of the two Directors of the program, any Associate Directors, and up to eight Faculty members named by the senior administration of the two universities. It is composed of an equal number of Faculty members from Pitt and CMU, and within Pitt it includes members from the SOM and the School of Arts & Sciences. This committee is expected to meet three times per year, in approximately late October, the first week of March and the first week of July.

Admissions Committee

Responsibilities: The Admissions Committee is responsible for selecting applicants to be admitted to the program. The committee is also charged with coordinating the visits of applicants. It consists of a total of eight members named by the Directors (three from each university), including two chairs (one from each university.) Faculty will normally serve on the Admissions Committee for a three-year term, following which new faculty will be appointed; no more than one faculty member from a given university will be replaced per year. The committee will meet in August to discuss preparation of the admissions website and will meet the second or third week in December to do a first review of applicants and again in January for a final review.

Advising Committee

Responsibilities: The Advising Committee is responsible for reviewing academic progress, considering petitions for course substitutions, and advising students in course selection prior defending their dissertation proposals. After the defense of the proposal, academic advising is conducted by the student's Dissertation Committee. The Advising Committee consists of four training faculty members from the two universities (2 CMU and 2 Pitt) named by the Directors. This committee meets in the second week in August, the first week in November and the first week of April to review academic progress and to recommend course selections. These recommendations are made in consideration of suggestions from the student's advisor(s), if any.

Curriculum Committee

Responsibilities: The Curriculum Committee is responsible for maintaining and revising program elective courses and for making recommendations about curriculum modifications or additions to the program Directors and Associate Directors, who in turn seek the approval of the Executive Committee before implementation of the changes in the program's curriculum. The committee consists of ten training faculty members (five from each university), consisting of two chairs (one from each university) and one representative from each university for each of the

four program specialization areas. They will meet at least 4 times a year, approximately in the first week in September, the second or third week in October, the second or third week in January and the first week of April.

Seminar Series Committee

Responsibilities: The Seminar Series Committee is responsible for selecting and organizing the Seminar Series speakers. This committee will meet during the first week of August and the first week of April.

Journal Club Committee

Responsibilities: The Journal Club Committee is responsible for organizing the Journal Club for first and second year students.

5. Policy for Student Admissions

1. The Admissions Committee will complete the review of all applications within three weeks after the deadline (not later than January 5) for admission in the Fall of the same year).

2. The Admissions Committee will identify all students who are considered potentially acceptable to the program, and provide a ranking (perhaps in groups) of them, which they will recommend to the program Directors and Associate Directors, if any.

3. The Admissions Committee will create a list of students to be interviewed and will supervise the organization of the interview process (which will be implemented by the program coordinators), after approval of the original list of acceptable students by the program Directors and Associate Directors, if any.

4. The Admissions Committee Chairs (assisted by program coordinators) will send the list of these students to all Faculty members, along with information on their preferred research areas. The e-mail will also contain information on how to access on-line the application material of these students.

5. Those training faculty members who are interested in potentially accepting one or more students from that class will inform the program Directors about the number of students (perhaps fractional) that they expect to be able to support, and the names of students in whom they are interested. The support estimate is intended to be a serious, but probabilistic, commitment. That is, it can be based on existing funding as well as on estimates of the likelihood of success of pending proposals. No specific commitment of student to advisor (or *vice versa*) is made, although the expectation is that if a student is acceptable to an advisor (directly or after a rotation), the advisor will support that student if at all possible.

6. Based on the support estimates, the distribution of available support among the program research areas, and the list of students with whom faculty members are interested in working, the program Directors and any Associate Directors will decide which students should be offered acceptance. The offer letter will state that the student is being offered admission to the program through the university from which their advisor is more likely to come. However, the offer will not mention the name(s) of potential advisor(s). One or more follow-up letters may be sent by 'potential advisors' to welcome the student to the program and express their level of interest in accepting the student to their group either directly and/or (more frequently) as a rotation student. See the “Policy on matching of students and advisors” for important relevant procedures.

7. For any students who are being considered for acceptance as transfer students from another Ph.D. program, a Transfer Student Checklist must be completed and signed by the admissions committee chairs, the advising committee chairs, and the program Directors before an offer can be made.

6. Program Academic Plan of Study and Requirements

Students are required to complete 72 credits/216 units of academic work towards partial fulfillment of the requirements for completion of dissertation study. Of these, a minimum of 27 credits/81 units must be fulfilled by formal coursework. This includes five core courses, one specialization elective, one life sciences elective (specific to the specialization area), one quantitative elective and one open elective. Open electives may be chosen from any of the course menus program (quantitative or specialization; see the web site for a complete list). Any graduate course can also count as open elective, upon approval by the Advising Committee. In addition, all students should complete an approved *Ethics* course, and should attend the *CPCB Seminar Series* in the Fall and Spring. All 1st and 2nd year students should attend the *Journal Club* course in the Fall and Spring (see below). The remaining credits/units will be completed with full time research. Waivers or temporary deferral of specific requirements may be possible, given a sound educational justification, through petition to the program Directors.

I. Year One (Semester 1-3)

A. Coursework

We anticipate two types of course schedules for students in the program. Students will normally be expected take two or three core courses in the first semester and conduct limited research (either in a group, if an advisor has accepted them directly, or through rotations.) In the second semester they are normally expected to take three more courses (50-75% time), thus completing their core courses, and spend the remaining time on research. The subsequent semesters would be divided between taking electives and doing research.

In some cases, a student whose background is more limited in biology, computer science, or the physical sciences, may delay a core course in order to pursue basic course work in one or more of these areas. Such a student will take a mix of core courses and other courses that will help them bridge this knowledge gap. These students will complete the remaining core courses and electives in the third and fourth semesters (along with a minimum of 50% research).

B. Journal Club

Effective presentation of scientific data is an invaluable aspect of graduate training. Therefore, all students in their first and second years will participate in the CPCB Journal Club. Each semester, each student will present a scientific article on a topic that introduces students to the methodology and applications of computational biology. The talk will be made in a format that allows students to develop their presentation skills.

C. Training in Ethics

Ethical conduct and scientific integrity is an essential aspect of research. This is especially important given the competitive nature of funding processes and the high demand for productivity. Hence, the program aims to help students understand the significance and practice of ethical conduct. This will be accomplished as follows:

- Students will be given copies of the relevant academic integrity and research integrity policies of both universities (*i.e.*, the *Guidelines on Academic Integrity* and the *Research Integrity Policy*.)

- Students will be required to take an appropriate course in scientific ethics, which introduces ethical issues and ethical reasoning that arise when conducting or overseeing research. No specific course is specified, although *Scientific Ethics* (INTBP 2290) is commonly used for this purpose. Students may petition the advising committee to allow the use of any other class covering the essentials of scientific and research ethics for this purpose.
- Students will complete any university mandated education and certification program in research practice fundamentals.

D. Program Seminar Series

Students enrolled in the program will be expected to attend scientific seminars offered through the program seminar series during all years of training. This requirement may be waived at the discretion of the program Directors if there is a compelling research or educational justification, such as a conflicting class important to the student's research.

E. Directed Studies/Rotations

All students must engage in a minimum of 1 credit/3 units of research in each semester, beginning with the first. Research performed in rotations will meet this requirement for those students doing rotations.

F. Summary of first year course work

Below is an example of coursework for the first year.

Fall Semester	**Spring Semester**
Machine Learning (core; 3 credits/9 units)	Computational Genomics (core; 3 credits/9 units)
Comp Structural Biology (core; 3 credits/9 units)	Cellular and Systems Modeling (core; 3 credits/9 units)
Journal Club (1 credit/3 units)	Laboratory Methods for Computational Biologists (core; 2 credits/6 units)
Program Seminar Series (1 credits/3 units)	Journal Club (1 credits/3 units)
Ethics (1 credits/3 units)	Program Seminar Series (1 credits/3 units)
Directed studies and/or research rotations (3 credits/9 units)	Directed studies and/or research rotations (3 credits/9 units)
TOTAL: 12 credits/ 36 units	**Total: 13 credits/ 39 units**

II. Subsequent Years

A. Coursework

Students who have completed all core courses in the first year will complete their coursework in the subsequent years by taking a total of four elective courses drawn from lists approved by the Curriculum Committee: one Life Sciences elective, one Quantitative Elective, one Specialization Elective (depending on the research field of the student) and one Open Elective (which may be

drawn from any of the lists of electives.) Students who have not completed the core courses will do that in the second year (together with taking additional elective courses.)

B. Directed Studies/Dissertation Research
After the first two semesters and prior to the successful completion of the Dissertation proposal, students must be enrolled in a minimum of 4 credits/12 units of research in each semester. After successful completion of the Dissertation proposal, students must be enrolled in a minimum of 6 credits/18 units of research in each semester.

C. Journal Club
All students in their first and second years are expected to participate in the Journal Club unless prevented by a course conflict.

D. Program Seminar Series
All students are expected to attend the CPCB seminar series unless prevented by a course conflict.

III. Other Required Program Activities

A. Annual Program Retreat
An annual program retreat is held each year in the second half of August prior to the beginning of the Fall semester, and provides a forum for discussing research topics and socializing. New students have the opportunity to learn about research topics of faculty who are considering accepting students, helping them make more knowledgeable choices about rotations and potential advisors. All students are expected to attend each year.

B. Student Research Presentations
Student research presentations of held each week. Beginning in the second year, students must present their research progress to fellow students and the faculty on at least an annual basis. First year students are expected to attend the student research presentations but are not required to present.

IV. Procedures for Ph.D. Proposal Exam

Students are expected to defend their Dissertation proposals no later than the end of their seventh semester in the program (not counting summers), but they are encouraged to do so on the fifth semester or earlier to ensure the dissertation committee is formed and can properly advice and monitor the progress of the student. Also, Pitt-registered students should be aware that at least 40 dissertation credits are needed for the thesis defense. Requests for extensions of this date must be submitted in writing to the program Directors no later than eight weeks before the end of the semester in which the defense would normally occur. Prior to defending their thesis proposal students must have completed all core courses and be in good standing with the program. The completion of all core courses and the successful defense of the thesis proposal is the *Comprehensive Examination* for the CPCB students.

The student together with his or her advisor(s) should decide upon the members of the

Dissertation committee, which should consist of at least four faculty members. At least three members must be from the program's training faculty and there must be at least one from the Pitt training faculty and at least one from the CMU training faculty. One of the committee members should be external to the program and –preferably- from another University. The Dissertation advisor(s) is/are part of the Dissertation committee. For the students registered through Pitt an additional rule applies that the majority of the committee members should have Graduate Faculty status at Pitt. One of the committee members is selected to serve as the Chair. The student is responsible for obtaining the agreement of all committee members that they are willing to serve and for finding a date and time that is suitable for the whole committee. The list of committee members and the defense date should be communicated to the program Directors no later than eight weeks prior to the date on which the exam is to be taken.

The student should prepare a written Dissertation proposal and provide it to the thesis committee no later than seven (7) calendar days before the defense (students should ask the committee members whether they would like to receive this document electronically or on paper).

The thesis proposal should consist of no more than 12 single-spaced pages with 1 inch margins. This limit does not include references, which can consist of no more than 5 additional pages. Students may also append higher-resolution versions of figures as long as the original version is contained within the proposal. The proposal should describe:

1. -the background and significance of the proposed project,
2. -the overall goal and specific aims to be accomplished,
3. -the methods and approaches to be used,
4. -the preliminary results that have been obtained to support the feasibility of the project, and
5. -the way in which the results obtained will be evaluated.

Note that previous work by others (including by anyone within the advisor(s)'s group(s) other than the student defending) should be included in the background and significance section, not in the preliminary results section.

The student should give an oral presentation of the proposal lasting no more than 45 minutes (not counting time for questions.) This presentation is not public but is open only to students and faculty of the Program and members of their research groups. Following the presentation, the Dissertation committee will question the student on the proposed work and any related material in order to determine whether the proposed work is suitable for a Ph.D. Dissertation and whether the student is adequately prepared to engage in the proposed research.

At the conclusion of the exam, the committee shall determine whether the student has passed, failed, or conditionally passed and, if conditionally passed, what conditions the student must meet to pass. The committee shall communicate this result to the program Directors and communicate to them when the conditions on the pass, if any, have been met. This will be done using the appropriate form(s) for each university. It is the responsibility of the student, with the assistance of the program coordinators, to ensure that all necessary forms have been filled and signed by the committee members, and submitted on time to the program Directors and coordinators.

A student may retake the Ph.D. Dissertation proposal exam no more than once.

V. Dissertation Work

A. Requirements

Students who have been accepted to Ph.D. candidacy will conduct research on a full time basis, and are required to complete a minimum of 40 credits/120 units (9 credits/27 units per semester) of full-time dissertation study in order to meet the criteria for dissertation defense. Students starting their Dissertation studies in the Spring semester of Year 2 can potentially finish their doctoral studies in four years.

All students are required to attend the Program Seminars and Student Presentations, as well as any journal clubs, symposia, or program meetings designated by the Dissertation Committee.

B. Admission to Candidacy for the Doctor of Philosophy Degree

Admission to candidacy for the Doctor of Philosophy degree constitutes a promotion of the student to the most advanced stage of graduate study and provides formal approval to devote essentially exclusive attention to the research and the writing of the dissertation. To qualify for admission to candidacy, students must be in full graduate status, have completed core course work with a minimum GPA of 3.00, have passed the Ph.D. proposal examination, and completed the necessary paperwork documenting that they have passed the Ph.D. proposal exam.

C. Dissertation Committee

The Dissertation Committee shall consist of at least four members: the advisor(s), two faculty members from within the Program (at least one from each University), and one faculty member outside of the Program. Pitt-registered students should also be aware that the majority of their committee members should be Graduate Faculty at Pitt and one member of their committee should be a faculty that is not a member of CPCB. Members of the Dissertation Advisory Committee may also be members of the student's Comprehensive Examination Committee; however the student and mentor are given the option of selecting an entirely new committee. The composition of the Dissertation Committee may change over time for various reasons.

The Dissertation Committee shall provide mentorship and support for the student while critically evaluating the progress of the dissertation project. To accomplish this objective, a student will be required to meet regularly (minimally once each year) with his or her Dissertation Committee. The procedure for these meetings is described in the section on Advising and Evaluation.

Changes to the Dissertation Committee may be made at any time prior to the Dissertation defense with approval of the Dissertation advisor and the Directors.

D. Career Guidance

A goal of the program is to train students to become leaders in academic and biomedical research. In their third year, students will be expected to submit a career development plan to their Dissertation Committee, detailing their goals for obtaining a position after graduation. The Dissertation Committee will guide the students in identifying, applying for, and securing top postdoctoral positions. Students will also be given the opportunity to participate in career-development workshops.

E. Dissertation and Abstract

Each student must write a dissertation that presents the results of a research project carried out by the student. An appropriate research project involves a substantive piece of original and independent research grounded in an appropriate body of literature. It is relevant to an identifiable field as it is currently practiced. It provides a significant contribution or advancement in that field. It is the responsibility of the student's Dissertation Committee to evaluate the dissertation in these terms and to recommend the awarding of the doctoral degree only if the dissertation is judged to demonstrate these qualities. To ensure proper evaluation, the students are encouraged to submit their thesis write up to their committee at least 4 weeks prior to defense and certainly no later than two weeks prior the defense date.

Characteristics which a dissertation should demonstrate are:

- the establishment of a historical context for the presentation of an innovative and creative approach to the problem analysis and solution;
- a clear understanding of the problem area as revealed by analysis and synthesis of a broad literature base;
- a well defined research design;
- clarity in composition and careful documentation;
- results of sufficient merit to be published in refereed journals or to form the basis of a book or monograph;
- sufficient detail so that other scholars can build on it in subsequent work.

If the dissertation is the result of a collaborative research effort, the project should be structured in such a way that the student's dissertation results from at least one clearly identified piece of work in which the student has supplied the unquestionably major effort. The contributions of the student and the other collaborators must be clearly identified.

Published articles authored by the student and based on research conducted for the dissertation study may be included in the dissertation, if permitted by the policies of the student's school. In any case, the published work must be logically connected and integrated into the dissertation in a coherent manner, and sufficient detail must be presented to satisfy the characteristics of a dissertation. The student should be the sole or primary author of the published work. If the published articles were co-authored, the contribution of the student must be clearly delineated in the introduction so the committee can ascertain that the student's own work satisfies the requirements of a dissertation.

Candidates for the doctoral degree must provide a suitable number of copies of the dissertation, as determined by the doctoral committee and school policy, for review and use during the final oral examination. After the final oral examination is successfully completed, the candidate must deposit with the Directors at least two copies of the approved complete dissertation and abstract in final form, at least two additional copies of the dissertation abstract, a receipt for payment of the dissertation binding/microfilm fees, and meet any other related requirements of the university from which the degree will be awarded.

F. Final Oral Examination

The final oral examination in defense of the doctoral dissertation is conducted by the doctoral committee and need not be confined to materials in and related to the dissertation. The

candidate's oral presentation will normally be advertised and open to the general public. Although the committee may optionally elect for a closed defense, any member of the CPCB Training Faculty may attend and participate in the examination. The date, place, and time of the examination should be published well in advance. Other qualified individuals may be invited by the committee to participate in the examination. Only members of the doctoral committee may be present during the final deliberations and may vote on the passing of the candidate. A report of this examination, signed by all the members of the doctoral committee, must be sent to the Program Directors. If the decision of the committee is not unanimous, the case is referred to the Directors for resolution. The chair of the doctoral committee should ensure that the dissertation is in final form before requesting signatures of the members of the committee.

G. Completion of Degree

A goal of the Program is that students finish their degree within 4 years of beginning thesis research. However, it is recognized that achieving this goal is dependent on the specific type of research undertaken.

7. Academic Policies and Procedures

A. Course Grade and GPA Requirements
All required core courses must be completed with a grade of B or better, with the sole exception of Machine Learning. Students receiving a grade of B- in Machine Learning will be considered to have met the requirement upon completion of a remedial project under the supervision of the Dissertation Advisor in consultation with the course instructor. For the elective courses the minimum course grade requirement is B-. Students are required to repeat any core course that they have completed with a grade less than the required minimum, preferably at the next offering of the particular course. If a student fails an elective course she or he will need to repeat the same or take a substitute course (equivalent course approved/recommended by the Student Advising Committee).

Students who do not achieve the required minimum grade in a required course, who elect to take an incomplete in a required course, or whose cumulative grade point average is below 3.0, will be placed on academic probation. Students on probation are not eligible to defend their thesis proposal, or to graduate. Being on probation for two consecutive semesters constitute grounds for dismissal from the program.

All grades count towards the GPA, except for repeated courses, in which case the final grade replaces the previous grade.

B. Directed Studies/Rotations/Dissertation Research
All students must engage in a minimum of 1 credit/3 units of research in each semester, beginning with the first. Research performed in rotations will meet this requirement for those students doing rotations. After the first semester but prior to successful completion of the Dissertation proposal, students must be enrolled in a minimum of 4 credits/12 units of directed research in each semester. After successful completion of the Dissertation proposal, students must be enrolled in a minimum of 6 credits/18 units of dissertation research in each semester.

8. Curriculum

The core courses aim to provide a strong background in computational biology before students specialize in particular research areas, consistent with the goal of the program stated above. The core courses include

- An overview of the current state-of-the-art in **computational biology** (organized as three courses as Computational Genomics, Computational Structural Biology, and Cellular & Systems Modeling)
- **Theories and methods of computer science** (Machine Learning)
- **Laboratory Methods for Computational Biologists,** a course designed to convey a deep understanding of the types of experiments and instrumentation that generate data appropriate for computational analysis.

Students are expected to take the five core courses in the first year, unless they are advised by the Advising committee to take additional courses before taking one or more core courses.

The core courses are listed below:

1, *Machine Learning* (CMU 10-701)

2. *Computational Genomics* (CMU 02-710 / Pitt COMPBIO 2070)

3. *Introduction to Computational Structural Biology* (Pitt COMPBIO 2030)

4. *Cellular and Systems Modeling* (CMU 02-730 / Pitt COMPBIO 2040)

5. *Laboratory Methods for Computational Biologists* (CMU 02-760 / Pitt COMPBIO 2050)

In addition to the five core courses, each student will be required to take at least **four graduate elective courses (i.e., at at least 12 credit hours) drawn from a series of menus depending on the student's area of specialization.** At least 3 credits/9 units must be drawn from a program-wide menu of quantitative classes (**quantitative elective**), 3 credits/9 units from a specialization-specific menu of life sciences classes (**life sciences elective**), and 3 credits/9 units from a specialization-specific menu of advanced interdisciplinary classes (**specialization elective**) and 3 credits/9 units may be any graduate-level class in any of the other lists or approved by the Advising Committee (**general elective**). A list of elective courses approved for each menu can be found on the program website (http://www.compbio.cmu.edu or http://www.compbio.pitt.edu). In most cases, each menu will be satisfied by a single course. Some menu options may offer less than 3 credits/9 units and need to be combined with others from the same menu to yield the required number of credits or units. Students should note that elective menus will evolve over time and that student input is an important part of this evolution; students may propose changes to any elective menu by making a request to the Curriculum Committee.

Students may petition to substitute an unapproved course for one of the menu classes provided there is a valid educational reason and the chosen course fulfills the purpose of the elective slot for which it is used. Such a petition must be submitted in writing to the Directors prior to the start of the term in which the course is offered. In the event that a student is unable to make progress towards his or her degree because an insufficient number of approved courses are offered to fill the student's schedule, such a petition may be approved directly by the Advising Committee.

The first elective will be a quantitative course appropriate to the student's chosen area of specialization. Examples of approved courses are

Pitt CS 2150	Graduate Algorithms
CMU 15-750	Algorithms

The second elective should be a life science/physical science course, appropriate to the student's chosen area of specialization and selected from a menu of courses approved for that specialization. Below are a few relevant courses.

CMU 03-742	Molecular Biology of Eukaryotes
CMU 03-743	Biochemistry and Cell Biology
Pitt CHEM 2810	Biological Chemistry 1
Pitt MSMBPH 2001	Molecular Biophysics 1

One additional interdisciplinary elective course must be drawn from the student's area of specialization, to be selected in consultation with the dissertation advisor. The four areas of specialization are:

(a) Computational Genomics
(b) Computational Structural Biology
(c) Cellular and Systems Modeling, and
(d) Bioimage Informatics

These areas are fundamentally different in their theories and methodologies. Computational structural biology is usually based on physical sciences, computational genomics and sequence analysis on computer science, cellular and systems modeling and computational neuroscience on mathematics and engineering, and bioimage informatics on image analysis and processing. They all share, however, a common goal: *quantitative evaluation/prediction of biological data/processes*. The CPCB envisions an educational program that will allow for training the next generation of multidisciplinary researchers possessing an integrative knowledge of all four areas of computational biology.

Computational Genomics, *which includes phylogenetics and molecular population genetics,* entails efforts to digest the daunting quantity of now available genomic and proteomic data by systematic development and application of probability and statistics theories, information technologies and data mining techniques. All three sub-areas involve computationally-intensive approaches to the development and testing of hypotheses about the functional significance of sequence variation at levels of biological organization from subcelluar and molecular processes to the evolution of organismal diversity. Computational genomics aims at understanding the

gene/protein function, identifying and characterizing cellular regulatory networks and discerning the link between genes and diseases. Discovery and processing of this information is pivotal in the development of novel gene therapy strategies and tools. Molecular population genetics entails the development of robust null models and testing methods for detecting the signature of past selection and population dynamics on gene sequence or other phenotypic data. Computational phylogenetics uses discrete algorithms and statistical and machine learning inference methods to develop robust hypotheses about phylogenetic relationships, combining sequence diversity information with morphometrics, physiology and ecology. An accurate phylogenetic framework is a key factor to understanding the constraints on the evolution of form and function in the face of novel environmental conditions.

Computational Structural Biology aims at establishing biomolecular sequence-structure-function relations using fundamental principles of physical sciences in theoretical models and simulations of structure and dynamics. After the advances in complete genome sequencing, it became evident that structural information is needed for understanding the origin and mechanisms of biological interactions, and to design/control function. Computational Structural Biology emerged as a tool for efficient identification of structure and dynamics in many applications. Major research topics include protein folding; protein dynamics, with emphasis on large complexes and assemblies; protein-protein, protein-ligand and protein-DNA interactions; and their functional implications. Drug design and protein engineering represent applications of note.

Cellular and Systems Modeling undertakes the ambitious task of studying the dynamics of biological and biomedical processes from a whole-system point of view. The observed systems range over orders of magnitude, from tissue to cells to molecular assemblies. Engineering tools are used along with genome-scale information in mathematical and/or computational models. Modeling diseases, entire 'virtual' cells, or subcellular networks of interactions are among typical tasks. Major research topics include the modeling of complex signaling and regulatory networks, transport mechanisms, spatio-temporal evolution of microphysiological events, as well as establishing the links between the development of complex phenotypes and the seemingly unrelated molecular events.

Bioimage Informatics draws upon advances in signal processing, optics, probe chemistry, molecular biology and machine learning to provide answers to biological questions from the growing numbers of biological images acquired in digital form. Microscopy is one of the oldest biological methods, and for centuries it has been paired with visual interpretation to learn about biological phenomena. With the advent of sensitive digital cameras and the dramatic increase in computer processing speeds over the past two decades, it has become increasing common to collect large volumes of biological image data that create a need for sophisticated image processing and analysis. In addition, dramatic advances in machine learning during the same period set the stage for converting imaging from an observational to a computational discipline and allowing the direct generation of biological knowledge from images.

9. Advising and Evaluation

A. Policy on matching of students and advisors
Prior to admission, applicants may express their interest in being advised by any member of the training faculty and faculty members may express a desire to advise a given applicant or allow him/her to rotate in their group should the applicant matriculate. Faculty members, however, may not provide opinions to applicants on likelihood of admission.

There are many opportunities for the students to learn about the faculty and their research before joining a group. For example, CMU organizes an *Immigration Course* in the beginning of each Fall, where CMU faculty and members of their groups present their work to incoming students. Pitt allows students to do three short rotations (4-6 weeks) in the Fall before they choose an advisor. First year students registered through the University of Pittsburgh are required to find an advisor within the first semester of their studies. First year students registered through Carnegie Mellon University are required to find an advisor by October 1, at the end of the CMU *Immigration Course* and the advisor matching process. Failure to secure an advisor through either of these processes by the deadline may be grounds of dismissal from the program.

Students admitted into the program may express interest in being advised by any member of the training faculty, and faculty may express their interest in advising any accepted student at any time before the start of the Fall semester. Accepted students may therefore receive one or more letters from potential advisors to welcome them into the program and to possibly invite them to join their research group or to offer them the opportunity to do a rotation in the advisor's group. Such welcome letters are strongly encouraged any time after the admission decision and before the start of the program rotations. Faculty members must acknowledge their acceptance of program policies (including financial responsibility) and obtain written approval from the Directors prior to extending an invitation to a student to join their research group. Invitations to do rotations do not require prior approval. Students who have accepted admission may choose to accept an invitation to join a specific research group directly any time prior to the beginning of the Fall term. A student accepting such an invitation will not be required to do rotations or go through the *Immigration Course*.

More details about rotations and the *Immigration Course* or the rotations can be obtained from the program's administrators.

It is recognized that there may be circumstances in which it is appropriate for a student to change primary advisor. The process for advisor changing is detailed in Section 10 of this handbook.

It is also possible for a student to have two advisors. These may be co-advisors, when the student will be working on a project jointly conducted and supported by two faculty members. Alternatively, one faculty member who will assume scientific and financial responsibility may serve as the primary advisor, and a second as the secondary advisor. The student will be enrolled in the university of his/her primary advisor.

B. Advisor Responsibilities
The primary research advisor(s) of a student will serve as the student's academic advisor and will guide the student through the execution of his/her dissertation project. In addition to

monitoring the student's progress, the academic advisor will also serve as faculty contact for the student if significant problems arise. Where appropriate, a co-advisor from a complementary discipline (e.g., a primary mentor in computational work and secondary in wet lab experimental work) may be selected to promote interdisciplinary collaboration and training or two advisors may jointly advise a student.

C. Policy on Monitoring of Student Progress and Termination of Advising Relationship
The progress of each student towards completion of the program requirements will be recorded in a student progress-tracking database.

Each student will be evaluated by the entire program faculty during a faculty meeting at the end of the Fall and Spring semesters, and the results of this evaluation will be communicated to each student in the form of a letter from the Directors on behalf of the entire faculty.

Each advisor will submit a written evaluation of the student's progress and an overall recommendation (*satisfactory*, *unsatisfactory*), listing any significant accomplishments and/or deficits, in advance of the evaluation meeting. This evaluation is independent of the student's academic performance. Prior to the meeting, the program coordinators, in consultation with the Directors and the Advising Committee, should evaluate student academic progress and determine whether the student should be placed on academic probation (see Academic Policies and Procedures.) Students who are found by the program faculty to have made Unsatisfactory Progress shall receive written notice of this finding, including a list of measures that need to be taken in the next semester to be considered to have made Satisfactory Progress upon the next evaluation. A student found to have made Unsatisfactory Progress for two or more consecutive semesters can be terminated from the program. Thus, the earliest time that a faculty advising relationship may be terminated (other than by withdrawal of the student from the program or change of advisor), is at the end of the second consecutive semester in which the student has made Unsatisfactory Progress.

Advisors may not terminate their advising relationship, nor communicate to the advisee their desire to terminate their advising relationship, until the procedures described above have been followed.

While complying with the above procedures, advisors are encouraged to communicate to the students their personal progress evaluations, suggestions for future directions, and measures to be taken to remedy any deficits. At the discretion of the advisor, copies of such communications may be provided to the program Directors for placement in the student file.

After successful completion of the Dissertation proposal defense, the primary responsibility for monitoring of student progress falls upon the Dissertation committee. As described above, the committee shall meet with the student at least once per year, and more often if desired or needed. Prior to the meeting, the student shall prepare a written report briefly outlining the goals of the project, summarizing cumulative progress to date, and detailing progress since the last committee meeting. The committee shall prepare a written report evaluating progress and/or fill in and sign the appropriate forms, copies of which shall be sent to the student, the thesis advisor(s), the Directors and the program coordinators. The report shall clearly indicate whether progress is Satisfactory or Unsatisfactory, and if Unsatisfactory, shall describe those measures that need to be taken in the next semester to be considered to have made Satisfactory Progress upon the next

evaluation. While a student is considered to be making Unsatisfactory Progress, committee meetings must take place at least once per semester. It is the program policy to have a penultimate Dissertation committee meeting with the student, where the Committee determines whether a thesis is ready for defense.

For students who have successfully completed their Dissertation proposal defense, the most recent Dissertation committee meeting report may be substituted for the written evaluation by the advisor. The progress of these students will be discussed by the faculty and an evaluation letter will be provided from the whole faculty.

10. Policy and Procedures for Changing Advisors

Students may request a change of advisor at any time, but all changes must be approved by the new advisor(s) and the program Directors. The responsibility for the entire process of managing a potential advisor change (including all of the steps described below) lies solely with the student. While students may seek advice from any member of the faculty, neither individual faculty members nor any program committees are responsible for assisting in this process. Students who are considering an advisor change should:

1. Inform their current advisor and the Directors that they are considering an advisor change.

2. Identify possible new advisors and contact them to determine if they are potentially willing and able to advise the student.

3. Meet with potential new advisors.

4.a. Request approval by the Directors of an advisor change if they obtain an advising offer from a new advisor and wish to accept it.
--or--
4.b. Inform their current advisor and the Directors if they decide to remain with the current advisor.

While students are considering or exploring an advisor change, they are expected to continue with their class and research work as usual. Advisors are not permitted to terminate their advising relationship with a student based on the student's considering an advisor change or to otherwise penalize a student for considering such a change.

The entire procedure above should ordinarily be completed within two to three weeks, and it is the student's responsibility to identify and obtain the agreement of new advisors, if they are interested in changing advisors. The Directors will respond to any request for approval of advisor change within one week of its receipt.

When a student changes from an advisor at one university to an advisor at the other university, she or he will be granted a transfer to the university of the new advisor. This will take place at the earliest opportunity, but typically not until the beginning of the next semester.

11. Conduct, Honor and Integrity Policies and Procedures

Guidelines on Academic Integrity
These guidelines contain a set of principles that shall be applicable to each of the academic units throughout the Universities. A student desiring information about the program's specific procedures and makeup of its academic integrity hearing board may obtain a copy of the procedures and other necessary information from the program Directors. Additional information or guidance may be obtained from the Offices of the Provosts. It is also available at the following web addresses:
http://www.pitt.edu/~provost/ai1.html
or
http://www.cmu.edu/student-affairs/theword/acad_standards/integrity.html

Guidelines for Ethical Practice in Research
Guidelines for Ethical Practice in Research can be found at the following web addresses:
http://www.cmu.edu/osp/research-handbook.html
http://www.pitt.edu/~provost/ethresearch.html

Research Integrity Policy
These guidelines cover policies for reporting research findings and data collection, to name a few. Policies for Research Integrity can be found at the following web addresses:
http://www.bc.pitt.edu/policies/policy/11/11-01-01.html
http://www.cmu.edu/osp/research-handbook.html

12. Outside Employment/Internships

Standards and expectations for internship work vary considerably from discipline to discipline, even within computational biology. Program requirements are intended to accommodate the expectations of each student's discipline. Students therefore may, with the approval of the thesis advisor and program Directors, pursue summer internships after the first year. It is the responsibility of the student and the advisor to ensure in such cases that the internship is consistent with the student's educational goals and does not compromise any intellectual property of the advisor or of the student's dissertation work. Students are expected to maintain full-time student status during the academic year and paid outside work is therefore normally prohibited during the academic year. Students believing there is a legitimate educational need for an exception should petition the Directors. International students should consult with their Program Coordinator 60-90 days in advance of the start of the internship to ensure that they have the proper immigration status during their internship.

13. TA Requirement

All students in the program are required to act as a teaching assistant (TA) for at least one semester during the program, typically during the second year of their studies. Note that Lane Center rules require that students registered through CMU TA for at least two semesters during their studies. TA's will work closely with the faculty member teaching the course they will be assisting in. This requirement is not graded but is marked as complete or incomplete. Students, advisors, and instructors may make requests for students to be assigned to particular courses, but final TA assignments will be made by the Directors and Associate Directors. TA assignments are normally served with program core classes, but may be fulfilled with any course given approval of the Directors.

14. Financial Awards

When a student applies for the program, his or her application is considered to be an application for financial aid as well. All enrolled students receive full financial support, consisting of full tuition and stipend. The stipend is set to provide a competitive level of support for our students.

Continued receipt of financial support is conditional on making satisfactory progress towards the Ph.D. The process of evaluation of progress is described elsewhere in this handbook.

15. Health Insurance

All Program students are offered health insurance through the university in which they are enrolled. Specific information regarding health insurance is provided at the following websites:

http://www.cmu.edu/health-services/student-insurance/index.html

http://www.upmchealthplan.com/plan/commercial/pitt.html

16. Leave of Absence

Under special conditions, graduate students may be granted one leave of absence for a maximum of two years. The rationale for the leave of absence and anticipated length must be stated in advance, and the procedures for requesting a leave of absence specified by the student's university shall be followed. If approved, the time of the leave shall not count against the total time allowed for the degree being sought by the student. Readmission following an approved leave of absence is generally a formality, but does require paperwork. Students returning from a leave of absence must contact the program coordinators at least two weeks prior to their anticipated return date.

17. International Students

A. Offices for International Students
International students make up a large percentage of graduate students at both universities. Each university has an office whose purpose is to assist international students. They are:

University of Pittsburgh's Office of International Services
http://www.ois.pitt.edu/
and
Carnegie Mellon University's Office of International Education
http://www.studentaffairs.cmu.edu/oie/

B. ITA Requirement
Before serving as a TA, all non-native English speaking (NNES) students must satisfactorily pass the ITA test to ensure that their command of English is adequate for serving as an instructor. Details about the ITA test requirement can be found here:

http://www.cmu.edu/icc/testing/ITA/who_needs.shtml

http://www.linguistics.pitt.edu/centers/ect.htm

The Program Coordinators will oversee the process of ensuring that all NNES students are ITA-certified by the end of their first year. Depending on the outcome of the test, a student may be required to take additional training in English, be required to retake the ITA test, and/or be restricted with regard to his or her allowed TA assignments. The specific requirements or restrictions will be provided with the results of the test.

18. Grievance policy

Students may at times encounter situations where they believe they have been treated unfairly or out of accordance with the program rules. We encourage students to raise such concerns with their advisors, the advising committee or the program Directors when possible. When an issue cannot be resolved informally, students have the right to pursue a formal grievance process. This process will be carried out in accordance with the rules of the university at which the student is registered. Students can access the current grievance policies of the two universities in the corresponding University's web pages.

University of Pittsburgh:
http://www.hr.pitt.edu/sites/default/files/uploads/ADA%20Grievance%206-2012.pdf

Carnegie Mellon University:
http://www.cmu.edu/graduate/policies/appeal-grievance-procedures.html

19. Transitional period rules

Over time, new program rules may be introduced or old rules modified. Unless stated otherwise, the students already enrolled at the time of a rule change are allowed to choose to follow the new guidelines or the guidelines that were in effect at the time of their enrollment. Below is a list of major changes that post-date the enrollment of at least some current students.

1. Minimum passing grade

In August 2008 the CPCB adopted B- as the minimum passing grade for all elective graduate courses. Students that do not score B- or better in a course need to retake it or take another course in the same category and pass it with B- or better. For the core courses, the minimum passing grade is B, with the exception of *Machine Learning* (ML). For ML the passing grade is B- as long as the student performs additional remedial work to the satisfaction of his or her advisor. *For the courses that students passed before August 2008, there is no minimum grade requirement.*

2. Number of elective courses

In November 2008 the Executive Committee decided to reduce the number of the open elective courses from two (2) to one (1) to accommodate the introduction of the rotation/research course in the first and second semesters. This rule can apply to the students that entered the program before November 2008.

3. Number of elective courses *vs.* number of course credits/units.

The elective course requirements of the CPCB initially stated a specific number of elective courses for each of the categories (specialization elective, quantitative elective, life sciences elective, and open elective). Since the elective courses differ in terms of hours taught and subsequently in the credits/units they are assigned, on November 2007 the Executive Committee replaced the number of elective courses per category with a number of credits/units per category. Currently, this is set to 3 credits/9 units, which usually corresponds to one course per category.

Appendices

I. **Transfer Student Checklist**

II. **Application for Approval of Computational Biology Internship (02-801)**

III. **Petition to transfer to terminal M.S. program**

IV. **Acknowledgment and Acceptance of CPCB Handbook Policies and Procedures**

Joint CMU-Pitt Ph.D. Program in Computational Biology Transfer Student Checklist

Student Name (Last, First) _____

Student ID number _____

Internal Transfer From ___ CMU ____ Pitt External Transfer From _____
To ___ CMU ____ Pitt

Transferring from Degree Program in _____

Official Transfer Request Letter received from student _____ Date

Transcripts received

University	Unofficial/Official	Date
_____	_____	_____
_____	_____	_____

Starting Semester of Transfer _____ Advisor _____

Selected Specialization Area _____

Course Requirements	Requirement Waived?	Name/number of course accepted towards requirement
Machine Learning	_____	_____
Computational Structural Biology	_____	_____
Cell and Systems Modeling	_____	_____
Computational Genomics	_____	_____
Lab course	_____	_____
Required Life Science Elective	_____	_____
Required Quantitative Elective	_____	_____
Required Specialization Elective	_____	_____
Open Elective	_____	_____

Additional Comments/Stipulations:

Approvals

Advisor _____

Admissions Committee Chairs _____

_____

Advising Committee Chairs _____

_____

Program Directors _____

_____

Application for Approval of Computational Biology Internship (02-801)

INTERNSHIP INFORMATION (*Please type or print)*

Student Name _____

Internship Organization _____

Internship Location _____

Internship Supervisor _____
(name and title)
Supervisor Email Address _____

Start Date _____ End Date _____

Project Summary
briefly describe the scope of the work and its relevance to the student's educational goals

REQUIRED SIGNATURES

Student _____
signature *date*

Thesis advisor _____
signature *date*

Program Directors _____
signature *date*

_____
signature *date*

Joint CMU-Pitt Ph.D. Program in Computational Biology
Petition to transfer to terminal M.S. program

I. Student request

Student Name (Last, First) _____

I hereby request transfer from the Joint Carnegie Mellon University-University of Pittsburgh Ph.D. Program in Computational Biology to a terminal M.S. program.

Student Signature _____ Date _____

Submit this form to the Program Directors.

II. Advisor Recommendation

I recommend ___ do not recommend ___ approval of this transfer.

Advisor Signature _____ Date _____

Advisor Name _____

III. Program Action

This transfer request is ___ is not ___ approved.

If approved, the requirements listed below must be completed to receive the terminal M.S. in Computational Biology.

__ Completion of an additional __ credits/__ units with a minimum GPA of 3.0

__ Completion of program core courses

- **__ Machine Learning**
- **__ Cell & Systems Modeling**
- **__ Laboratory Methods for Computational Biologists**
- **__ Computational Genomics**
- **__ Computational Structural Biology**

__ Completion of qualifying exam (waived if student has already completed Ph.D. qualifier)

__ Submission of written M.S. thesis

__ Successful oral defense of M.S. thesis

Program Directors Signatures

_____ Date _____

_____ Date _____

Joint CMU-Pitt Ph.D. Program in Computational Biology

Acknowledgment and Acceptance of Handbook Policies and Procedures

__ I acknowledge receipt of a copy of the 2013-2014 Student and Faculty Handbook for the Joint CMU-Pitt Ph.D. Program in Computational Biology and agree to be bound by the policies and procedures described therein.

__ This acceptance supersedes my previous acceptance of an earlier version of this Handbook.

Student

Date