Boston University Department of Biomedical Engineering

NIH T32 Training Program in Quantitative Biology and Physiology (QBP)

Trainee Handbook

2026 Version

This handbook summarizes requirements, expectations, and resources for trainees in the Quantitative Biology and Physiology training program. It is intended to complement, not replace, requirements of the BU BME PhD program, Graduate School policies, NIH training grant requirements, and university policies. Course offerings, faculty participation, and administrative procedures may change; trainees should consult the Program Director or Administrative Director when questions arise.

Contents

1. Program Mission and Identity

The Quantitative Biology and Physiology (QBP) program trains PhD scientists who can use quantitative, computational, engineering, and measurement-based approaches to understand biological and physiological systems across length scales. QBP is a specialized path within the BU BME PhD program. Trainees satisfy all requirements of the parent BME PhD program while completing additional QBP requirements in multiscale biology, quantitative analysis, rotations, mentoring, reproducibility, fellowship writing, and professional development.

The core mission is to prepare PhD researchers who demonstrate:

- A quantitatively based understanding of molecular biology, cell biology, and physiology.
- The ability to develop and apply advanced techniques of computational modeling, quantitative measurement, machine learning, and instrumentation.
- The capacity to identify emergent properties of biological systems across spatial and temporal scales.
- The insight to apply research knowledge in academic, industrial, clinical, governmental, or other research-related settings to improve human health.

QBP emphasizes convergence: trainees learn to connect mechanisms across molecules, cells, tissues, organs, and whole-body physiology, while using rigorous computation, measurement, and data science to make those connections testable.

2. Program Structure and Support

2.1 Relationship to the BME PhD program

QBP is housed in the BU Department of Biomedical Engineering. Students are drawn from the BME PhD program and remain BME PhD students. QBP adds a distinct training structure built around multiscale quantitative biology and physiology.

The major QBP-specific additions are:

- A structured curriculum requiring machine learning or computational biology, advanced mathematics, quantitative biology or physiology at multiple scales, and scale-independent modeling or measurement.
- Three to four laboratory rotations over the first 12 months, selected to expose trainees to quantitative research at multiple biological length scales.
- Selection of dissertation mentors from a curated group of QBP training faculty.
- Structured replication packages beginning with first-year rotations and extending to the prospectus and dissertation.
- Mandatory mentor training for QBP faculty and structured mentee development for trainees.
- An external fellowship submission requirement, with structured writing support.
- Summer retreats after Years 1 and 4 focused on career development, regulatory issues, RCR refreshers, fellowship writing, and professional preparation.
- Participation in QBP community activities including journal club, annual symposium, dinners with academic and clinical leaders, alumni events, and town halls.

2.2 Appointments and support

QBP trainees are normally appointed for two years of support during Years 1 and 2, subject to continued good standing and availability of slots. The renewed program is designed to support first-year and second-year cohorts annually, including NIH-funded slots and additional department/college-supported parallel slots. Trainees remain members of the QBP community after their funded appointment ends and are expected to continue participating in program activities through graduation.

2.3 Leadership and administration

The Program Director is Prof. Darren Roblyer. Prof. Irving Bigio and Prof. Shannon Stott serve as Associate Directors. The program is administered through the BME Department, with day-to-day administration managed by the Administrative Director. The Steering Committee provides program oversight and includes program leadership, faculty representatives, career development leadership, administrative staff, and trainee representatives.

The Steering Committee reviews curriculum compliance, trainee progress, mentor effectiveness, trainee feedback, program outcomes, and policy changes. Trainee representatives provide direct input into program governance and are expected to bring cohort concerns, suggestions, and priorities to the committee.

3. Academic Requirements

QBP trainees complete a minimum of eight graduate courses. These requirements are designed to satisfy the BME PhD curriculum while adding QBP-specific depth in multiscale biology and quantitative analysis.

3.1 Required core courses

- BE 605 Molecular Bioengineering. A quantitative, engineering-based treatment of biomolecular structure, energetics, information transfer, protein function, molecular methods, and experimental biotechnology.
- BE 606 Quantitative Physiology for Engineers. A graduate-level treatment of human physiology with quantitative modeling and simulation of major organ systems.
- BE 604 Statistics and Numerical Methods. A required two-credit foundation for modeling, numerical analysis, statistics, and subsequent machine learning or computational coursework.
- One additional two-credit advanced mathematics course, normally BE 601 Advanced Linear Algebra, BE 602 Advanced Ordinary Differential Equations, or BE 603 Partial Differential Equations. Students with extensive prior advanced mathematics may petition to replace this requirement with a technical elective.
- Machine learning or computational biology requirement: BE 559 Foundations of Biomedical Data Science and Machine Learning or BE 562 Computational Biology.

3.2 Restricted electives

QBP trainees take three restricted electives. At least one course must come from two different biological-scale columns among Molecular & Genetic Engineering, Cellular-to-Tissue Level Engineering, and Tissue-to-Organ Level Engineering. A third restricted elective must come from Scale-Independent Analysis & Modeling. Many courses appear in more than one column because they connect multiple biological scales. Courses marked with an asterisk in Appendix A are taught by QBP faculty in the renewal proposal.

3.3 Unrestricted elective

Trainees also complete at least one unrestricted elective appropriate to their dissertation research and professional goals. With advisor approval, electives may be drawn from BME, other Engineering departments, Arts and Sciences, the School of Medicine, or other relevant BU units.

3.4 Additional required training activities

- BE 790 Biomedical Engineering Seminar in Fall of Year 1, which introduces faculty research programs and helps students identify rotation labs.
- BE 792 Critical Literature Review & Training in Rigor and Reproducibility in Spring of Year 1, which prepares students for the literature-based qualifier and introduces rigor and reproducibility concepts through critical paper analysis.
- Teaching practicum: two semesters of teaching fellowship service, typically in Years 2 and 3 after coursework, rotations, qualifying exam, and lab selection.

- University RCR training in Year 1, including online modules and ENG EK 800, followed by QBP/BME-specific supplemental RCR at retreats.
- Title IX and sexual misconduct prevention training required by the university.

4. Laboratory Rotations and Mentor Selection

QBP rotations are designed to expose trainees to quantitative approaches at multiple biological scales before they choose a dissertation laboratory. Trainees must complete a minimum of three rotations and are encouraged to complete four. Rotations should normally be distributed across at least three distinct laboratories and should expose the trainee to research at multiple length scales. Students may petition out of a summer rotation if they are ready to join a dissertation lab and have satisfied the programmatic intent of the rotation requirement.

Rotations should be selected in consultation with the first-year QBP academic advisor. A rotation in a laboratory listed under multiple scales should be justified by the work actually performed during that rotation. The student should be able to explain how the rotation addressed the relevant scale or scales.

4.1 Rotation expectations

- Discuss goals, time commitment, and expected deliverables with the rotation mentor before beginning.
- Engage substantively with the scientific question, quantitative method, dataset, instrument, model, or experimental system used by the lab.
- Participate in lab meetings and relevant group activities when possible.
- Complete a brief end-of-rotation summary and a structured replication package, described in Section 7.
- Use rotations to evaluate mentoring fit, scientific fit, lab culture, and feasibility of dissertation work.

4.2 Dissertation mentor selection

By the end of summer after Year 1, trainees are expected to join a dissertation laboratory. Dissertation mentors for QBP trainees must be QBP training faculty or otherwise approved by the Steering Committee. Mentor selection should reflect both scientific fit and the trainee's ability to pursue a dissertation that is quantitative, biologically or physiologically grounded, and connected to multiple scales or systems-level questions.

5. Year-by-Year Milestones

Stage	Primary activities	QBP-specific expectations
Before/early Year 1	Select courses; meet QBP academic advisor; identify rotations; attend BE 790.	Map coursework and rotations to QBP requirements.
Year 1 Fall/Spring	Complete core coursework, rotations, RCR, BE 792, and preparation for qualifier.	Participate in journal club and cohort activities; complete rotation replication packages.
Early summer after Year 1	Take oral qualifying exam; attend QBP summer retreat.	Complete IDP; participate in career/fellowship/RCR programming; finalize lab choice if not already complete.
Year 2	Begin dissertation research; complete remaining coursework as needed; teaching practicum may begin.	Maintain QBP participation; plan fellowship submission strategy with mentor.
Year 3	Annual committee meetings begin; prospectus preparation and defense; teaching practicum if not complete.	External fellowship submission expected no later than end of Year 3 unless alternative approved; submit thesis-level replication plan at prospectus.
Year 4	Continue dissertation research, publications, presentations, and annual committee meetings; attend second QBP summer retreat.	Refresh IDP; complete career development, CV review/mock interview, regulatory/RCR, and alumni/career networking activities.
Years 5+	Complete dissertation research, publish, present, defend, and transition to next career stage.	Give required symposium talk before graduation; complete exit survey; maintain QBP alumni connection.

6. Qualifying Exam, Prospectus, and Dissertation Committees

6.1 Oral qualifying exam

The oral qualifying exam is taken in early summer after Year 1. The exam is literature-based and evaluates the student's ability to read, understand, critique, and discuss scientific papers in an oral format. It emphasizes core biomedical engineering knowledge, integration across disciplines and length scales, quantitative and mathematical reasoning, communication, and the ability to place publications in a broader research context.

Students select two topic areas in April. They receive assigned papers in early May and prepare individually and in groups. A demonstration qualifier with senior trainees and faculty is held to help first-year students understand expectations. The oral exam is typically 1.5 to 2 hours and is administered by three faculty. Outcomes are honors, pass, conditional pass, or fail. Students are allowed two attempts.

6.2 Prospectus

Within four semesters after completing the qualifying exam, each trainee must submit and defend a PhD prospectus in NIH-style proposal format. The prospectus should describe a dissertation project that addresses a biological or physiological question using quantitative, computational, measurement-based, and/or analytical approaches. It should articulate the larger systems perspective of the work and explain how the research connects mechanisms across relevant scales.

At the prospectus stage, QBP trainees also submit a thesis-level replication plan describing how data, code, analysis workflows, protocols, metadata, and documentation will be organized to support reproducibility and reuse.

6.3 Dissertation committee meetings

Beginning in Year 3, QBP trainees meet annually with their dissertation committee. The committee chair reports to the Program Director or Steering Committee on the trainee's progress, including quantitative skills, communication skills, and progress toward a multiscale biological or physiological dissertation. Each annual meeting includes a portion in which the student meets with the committee without the research advisor present. This provides a confidential opportunity to discuss mentoring, project, climate, or progress concerns.

7. Rigor, Reproducibility, and Replication Packages

A major new element of the renewed QBP program is experiential training in research rigor and transparency. Trainees create structured digital replication packages beginning with first-year rotations and continuing through the prospectus and dissertation. The purpose is to make reproducible practice routine rather than retrospective.

7.1 Rotation replication package

At the end of each rotation, trainees should submit a concise digital package appropriate to the project. The package is not expected to be a complete publication archive, but it should be sufficient for another trainee, the rotation mentor, or the student's future self to understand what was done.

- A short summary of the scientific question, hypothesis, or technical objective.
- Relevant protocols, experimental conditions, model assumptions, or analysis steps.
- Data or representative data when sharing is permitted; if not, a description of data location and access restrictions.
- Analysis scripts, notebooks, or workflow descriptions when applicable.
- Software versions, instrument settings, key reagents, file naming conventions, and metadata needed to interpret the work.
- A brief reproducibility note describing what worked, what failed, and what would be needed to reproduce or extend the result.

7.2 Prospectus replication plan

The prospectus replication plan should describe how the dissertation project will manage data, code, protocols, preregistered or pre-specified analyses when appropriate, version control, authorship expectations, sharing restrictions, and final archiving. It should also identify any constraints imposed by human subjects, clinical data, proprietary agreements, intellectual property, or sensitive information.

8. Responsible Conduct, Ethics, and Regulatory Training

QBP trainees complete the university's required RCR curriculum in Year 1, including online modules and ENG EK 800, a live 10-hour course. QBP supplements this required training with BME-specific discussion at the summer retreat, particularly for issues that arise in engineering, quantitative biology, clinical translation, data science, imaging, instrumentation, and industry-facing research.

Topics may include authorship and publication practices, peer review, data management, reproducibility, conflicts of interest, collaboration, mentor-mentee responsibilities, human subjects and animal research, intellectual property, regulatory pathways, responsible use of computational tools and machine learning, and responsible conduct in translational or industry-linked research.

All trainees, staff, and faculty must also complete university-required Title IX and sexual misconduct prevention training. Concerns about harassment, discrimination, safety, or misconduct should be reported through appropriate university channels. Trainees may also consult QBP leadership for guidance on where to seek help.

9. Fellowship Writing and Funding Expectations

All QBP trainees are required to submit at least one external fellowship application during PhD training. Eligible mechanisms include the NIH F31 Ruth L. Kirschstein Predoctoral Individual NRSA, NSF Graduate Research Fellowship Program when eligible, and relevant foundation or discipline-specific fellowships. Trainees are expected to submit no later than the end of Year 3, when many will have sufficient preliminary data for a competitive proposal.

The program provides structured support for this requirement, including fellowship writing panels, peer and faculty feedback, mentor guidance, and career-development programming. Trainees who receive independent funding are eligible for a $3,000 annual supplement from the department and advisor, consistent with departmental policy. In cases where citizenship status or research area makes standard fellowship mechanisms inappropriate, the Steering Committee may approve an alternative scholarly writing requirement, such as a first-author manuscript.

10. Mentoring, Advising, and Trainee Support

10.1 First-year advising

During Year 1, trainees are advised by QBP leadership. The first-year advisor helps trainees interpret QBP requirements, select courses, choose rotations, prepare for the qualifier, and plan for mentor selection. After a trainee joins a dissertation laboratory, the research advisor becomes the primary academic advisor, while QBP leadership and the Steering Committee remain available for programmatic and mentoring support.

10.2 Mentor expectations

QBP mentors are selected for alignment with the program mission, including quantitative and multiscale research, strong funding or startup support, commitment to graduate training, and ability to provide an appropriate dissertation environment. All QBP faculty mentors are required to complete evidence-based mentor training through the Entering Mentoring curriculum, coordinated by the Graduate and Postdoctoral Success office.

10.3 Mentee development

QBP trainees are expected to take an active role in mentoring relationships. The Graduate and Postdoctoral Success office offers Mentoring Conversations, a bimonthly series focused on aligning expectations, navigating difficult conversations, advocating for professional development, and developing future mentoring skills. These activities complement RCR training, annual committee meetings, IDPs, and iterative mentor feedback on manuscripts, talks, qualifiers, and fellowship applications.

10.4 Addressing concerns

Trainees may raise concerns with the Program Director, Associate Directors, Administrative Director, dissertation committee chair, trainee representatives, or appropriate university offices. Annual dissertation committee meetings include advisor-free time so that students can discuss concerns candidly. Structured trainee interviews, town halls, and exit surveys provide additional routes for feedback. Title IX or safety-related concerns must be handled through appropriate university reporting channels.

11. Career Development

QBP prepares trainees for research and research-related careers across academia, biopharma and biotech, startups, medical devices, technology and data science, consulting, intellectual property, government, and non-profit research. Career development is integrated throughout the program rather than reserved for the end of training.

- Individual Development Plans completed before the summer retreat and reviewed with mentors and program leadership.
- Career panels featuring representatives from academia, industry, government, startups, biotech, pharmaceutical, and medical device sectors.
- CV review and mock interviews with advisory board members and career professionals.
- Fellowship-writing panels featuring prior awardees and faculty mentors.
- Alumni events that expose trainees to a broad range of research careers.
- Encouragement to attend scientific conferences or visit collaborating organizations, especially after Year 2.
- Optional internships in industry, government, or non-profit settings when aligned with the trainee's goals and research stage.

Internships are not required. Trainees considering internships should discuss timing, funding, visa implications if applicable, intellectual property, publication constraints, and time-to-degree impact with their advisor and QBP leadership before committing.

12. Program Community and Trainee Leadership

QBP trainees are members of the program throughout their PhD training, even after the period of T32 or department-supported appointment. Senior trainees are expected to help sustain the community, mentor junior trainees informally, contribute to program activities, and serve as scientific role models.

12.1 Journal club

The QBP journal club meets several times per year, often in connection with distinguished speakers. Trainees discuss recent papers that advance quantitative and systems approaches in biology and physiology. First-year students attend but are not expected to lead. All trainees should lead a journal club discussion by the end of Year 2.

12.2 Annual symposium

The annual symposium is co-sponsored with related BU training programs and includes trainee talks, posters, and an external keynote speaker. Each QBP trainee beyond the third year must give a symposium talk before graduating. The symposium is an important venue for trainee leadership, scientific communication, cross-program interaction, and community building.

12.3 Dinners, alumni events, and guest interactions

QBP hosts dinners with external academic, clinical, industry, or alumni guests. These events are intended to be substantive, informal opportunities for trainees to discuss scientific trends, clinical and societal needs, career paths, and leadership in modern biomedical engineering. Guests are often suggested or invited by student leaders.

12.4 Town halls and trainee representatives

QBP holds a town hall each year, often during the summer retreat or on campus. The town hall gives trainees, faculty, and staff an opportunity to discuss program strengths, concerns, and proposed changes. Trainee representatives serve on the Steering Committee and are expected to communicate with the trainee community before and after committee meetings.

13. Program Evaluation and Trainee Feedback

The program tracks outcomes and uses trainee feedback to improve training. Evaluation includes annual trainee reports, PD or Associate Director meetings in Years 1 and 2, annual dissertation committee reports beginning in Year 3, town halls, second-year structured interviews conducted by an external evaluator, exit surveys, and longer-term alumni outcomes. Data are maintained securely and used in aggregate for program improvement, public reporting, and renewal planning.

Program-level objectives include curriculum completion, time to degree, scholarly productivity, fellowship funding, retention, career placement, presentations, belonging, and the quality of the research training climate. The Steering Committee reviews these data and may change program practices in response.

14. Quick Reference Checklist for Trainees

Year 1 checklist

- Meet with QBP academic advisor and map courses/rotations.
- Complete required core coursework as scheduled.
- Complete at least three rotations unless an approved exception applies.
- Complete RCR and Title IX requirements.
- Participate in QBP journal club and community events.
- Prepare for and take the oral qualifying exam.
- Complete rotation summaries and replication packages.
- Attend Year 1 summer retreat and complete IDP.
- Join dissertation laboratory by the end of summer.

Years 2-3 checklist

- Complete remaining coursework and teaching practicum requirements.
- Begin annual dissertation committee meetings in Year 3.
- Prepare and defend prospectus within required timeframe.
- Submit thesis-level replication plan at prospectus.

- Submit at least one external fellowship application or obtain approved alternative.
- Present research at meetings and participate in QBP events.

Years 4+ checklist

- Attend Year 4 summer retreat and update IDP.
- Continue annual committee meetings with advisor-free discussion.
- Publish and present dissertation research.
- Give required QBP symposium talk before graduation.
- Complete dissertation defense and program exit survey.
- Stay connected as a QBP alum.

Appendix A. Restricted Elective Course List

Courses listed here are based on the 2026 renewal proposal. Offerings and instructors may change. Courses marked with an asterisk were listed as taught by QBP faculty in the renewal proposal.

Molecular & Genetic Engineering	Cellular-to-Tissue Level Engineering	Tissue-to-Organ Level Engineering	Scale-Independent Analysis & Modeling
BE 500: Systems Immunology (Immunology-Engineering)	BE 500: Systems Immunology (Immunology-Engineering)	BE 508: Quantitative Studies of Respiratory & Cardiovascular Systems*	BE 500: Introduction to Biological Feedback Control*
BE 500: Introduction to Biological Feedback Control*	BE 500: Introduction to Biological Feedback Control*	BE 524: Skeletal Tissue Mechanics	BE 500: Programming for BME Data Analysis (Python)*
BE 556: Optical Spectroscopic Imaging*	BE 504: Polymers and Soft Materials	BE 567: Nonlinear Systems in BME*	BE 504: Polymers and Soft Materials
BE 560: Biomolecular Architecture	BE 517: Optical Microscopy of Biological Materials*	BE 570: Introduction to Computational Vision	BE 511: Biomedical Instrumentation
BE 562: Computational Biology*	BE 521: Continuum Mechanics for BMEs	BE 710: Neural Plasticity & Perceptual Learning	BE 515: Introduction to Medical Imaging*
BE 564: Biophysics of Large Molecules	BE 533: Biorheology	BE 726: Fundamentals of Biomaterials*	BE 519: Speech Signal Processing*
BE 566: DNA Structure and Function	BE 549: Structure & Function of the Extracellular Matrix*	BE 727: Principles & Applications of Tissue Engineering*	BE 521: Continuum Mechanics for BMEs
BE 567: Nonlinear Systems in BME*	BE 555: Introduction to Biomedical Optics*	BE 771: Introduction to Neuroengineering*	BE 533: Biorheology
BE 568: Systems Biology of Human Disease	BE 556: Optical Spectroscopic Imaging*	BE 772: Neuroengineering Devices*	BE 559: Foundations of BME Data Science & ML*
BE 700: Chemical & Physical Methods for Molecular Cell Organization	BE 567: Nonlinear Systems in BME*	BE 788: Soft Tissue Biomechanics	BE 562: Computational Biology*
BE 704: Cancer Biology & Oncology for Engineers*	BE 700: Methods & Logic in Quantitative Biology*		BE 567: Nonlinear Systems in BME*
BE 745: Nanomedicine*	BE 704: Cancer Biology & Oncology for Engineers*		BE 703: Numerical Methods & Modeling in BME
BF 768: Biological Data Base Design	BE 707: Quantitative Studies of Excitable Cells*		BE 747: Advanced Signals & Systems for BME
BI 645: Cellular & Molecular Neurophysiology	BE 709: From Cells to Tissue: Engineering Structure & Function*		MA 565: Math Models in the Life Sciences
	BE 726: Fundamentals of Biomaterials*		
	BE 727: Principles & Applications of Tissue Engineering*		
	BE 771: Introduction to Neuroengineering*		
	BE 772: Neuroengineering Devices*		
	BE 773: Advanced Optical Microscopy*		
	BI 645: Cellular & Molecular Neurophysiology		

Appendix B. QBP Training Faculty and Rotation Planning

The training faculty list changes as faculty join, leave, or change program participation. Trainees should consult the current QBP website or program leadership before finalizing rotations or dissertation mentor plans.

Faculty 1	Faculty 2	Faculty 3	Faculty 4
Michael Albro	Samoyav Banskota	Irving Bigio	David Boas
Chris Chen	Jerry Chen	Ji-Xin Cheng	Brian DePasquale
Brianne Connizzo	Douglas Densmore	Anna Devor	Mary Dunlop
Michael Economo	James Galagan	Alex Green	Mark Grinstaff
Xue Han	Liangliang Hao	Miguel Jimenez	Mo Khalil
Catherine Klapperich	Jerome Mertz	Elise Morgan	Hadi Nia
Tim O'Shea	Erica Pratt	Darren Roblyer	Kamal Sen
Michael Smith	Cara Stepp	Matthias Stangl	Bela Suki
Michelle Teplensky	Adriana Tomic	John White	Joyce Wong
Wilson Wong	Muhammad Zaman		

Appendix C. Suggested Rotation Replication Package Template

- Rotation student, mentor, dates, and project title.
- Research question or technical objective.
- Experimental system, data source, model, or instrument used.
- Short description of methods and analysis workflow.
- Data location, access constraints, and metadata.
- Code or notebook location and software versions.
- Key results, negative results, and unresolved issues.
- What would be needed for another person to reproduce or extend the work.

Appendix D. Suggested IDP Components

- Near-term research goals and milestones.
- Skills assessment: strengths, weaknesses, and training needs.
- Career interests and candidate career paths.
- Professional development goals for the next year.
- Planned fellowship, manuscript, conference, teaching, outreach, or internship activities.
- Mentor and Steering Committee feedback.