DOCTOR OF PHILOSOPHY (PHD) DEGREE IN THE FIELD OF SYSTEMS, SYNTHETIC AND PHYSICAL BIOLOGY

Program Learning Outcomes for MS and PhD Degrees in the field of Systems, Synthetic and Physical Biology

Upon completing the MS and PhD degrees in the field of Systems, Synthetic and Physical Biology, students will be able to:

1. Develop knowledge of the breadth of topics within Science, Technology, Engineering and Mathematics (STEM) disciplines that underlie the foundations of Systems, Synthetic and Physical Biology.
2. Demonstrate the critical thinking skills and ability to integrate knowledge from diverse STEM fields to solve biological problems.
3. Demonstrate the written communication skills required for a thesis describing independent research, published research, and external research proposals.
4. Demonstrate the effective oral and visual communication skills necessary for articulating scientific findings and significance to diverse audiences.

Requirements for the MS and PhD Degrees in the field of Systems, Synthetic and Physical Biology

MS Degree Program

The MS degree is a thesis master’s degree. For general university requirements, please see Thesis Master's Degrees (https://ga.rice.edu/graduate-students/academic-policies-procedures/regulations-procedures-thesis-masters-degrees/). For additional requirements, regulations, and procedures for all graduate programs, please see All Graduate Students (https://ga.rice.edu/graduate-students/academic-policies-procedures/regulations-procedures-all-degrees/). The Graduate Program in SSPB offers Master’s and Doctoral degrees. Students will be directly admitted only to the Doctoral program. For each degree, the student must fulfill the university requirements set forth in the General Announcements under which he or she entered. The semester credit hour requirements may be fulfilled both by classroom hours and research hours. Students are required to accumulate at least 25 semester hours of graduate approved courses while maintaining a GPA of 3.00 or higher. Students must be enrolled for at least 12 credits each semester.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
<td>Total Credit Hours Required for the PhD Degree in the field of Systems, Synthetic and Physical Biology</td>
<td>90</td>
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Degree Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>SSPB 501 / BIOE 502</td>
<td>PHYSICAL BIOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>SSPB 502 / BIOE 552</td>
<td>INTRO COMPUTATIONAL SYSTEMS BIOLOGY: MODELING &amp; DESIGN PRINCIPLES OF BIOCHEM NETWORKS</td>
<td>3</td>
</tr>
<tr>
<td>SSPB 503 / BIOE 508</td>
<td>SYNTHETIC BIOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>UNIV 594</td>
<td>RESPONSIBLE CONDUCT OF RESEARCH ¹</td>
<td>1</td>
</tr>
<tr>
<td>SSPB 599</td>
<td>GRADUATE TEACHING IN SSPB</td>
<td>1</td>
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</table>

Advanced Topics

Select at least 3 courses from approved Advanced Topics in the SSPB field

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>SSPB 550</td>
<td>GRADUATE SEMINAR (4 semesters required, 1st semester)³</td>
<td>1</td>
</tr>
<tr>
<td>SSPB 550</td>
<td>GRADUATE SEMINAR (4 semesters required, 2nd semester)³</td>
<td>1</td>
</tr>
<tr>
<td>SSPB 550</td>
<td>GRADUATE SEMINAR (4 semesters required, 3rd semester)³</td>
<td>1</td>
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<tr>
<td>SSPB 550</td>
<td>GRADUATE SEMINAR (4 semesters required, 4th semester)³</td>
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Elective Requirements

Select 2 open elective courses ²

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
<td>Additional Coursework as Approved by the Department</td>
<td>61</td>
</tr>
</tbody>
</table>

Footnotes and Additional Information

¹ All students are required to complete UNIV 594 during their first semester, and credit earned for UNIV 594 does not apply toward the minimum of 24 credit hours in coursework requirement for the degree.

² Select 2 open elective courses.
2 Courses are subject to approval by the Graduate Advising Committee (GAC). It is recommended that at least one of the courses in advanced topics apply quantitative concepts from computer science, physics, and mathematics or statistics to biological problems, and at least one of the courses focus on biology within the sub-area where students pursue their thesis research.

3 All students are required to enroll in SSPB 550 each semester in the first two years.

Other Program Requirements (Phd students)
All students involved in research must complete the Collaborative Institutional Training Initiative (CITI) Responsible Conduct of Research online course. Candidates for the PhD degree also must:

• Choose an advisor (PI) by the end of the first semester or equivalent
• Fulfill a teaching requirement
• Submit a thesis proposal that provides evidence of their ability to carry out original research in a specialized area of Systems, Synthetic and Physical Biology before the beginning of their fifth semester in residence
• Complete 90 semester hours of advanced study (including thesis research hours)
• Pass their qualifying exam which includes thesis proposal defense
• Defend the PhD thesis in a public oral examination.

Qualifying Exam (PhD students)
Students are expected to pass their qualifying exam before the beginning of their fifth semester in residence unless an extension has been granted by the Program Director. Students may retake the exam up to two times if granted permission to do so by the Program Director. Students who do not pass the Qualifying Exam may exit the program with a MS degree if the appropriate requirements have been met.

Thesis Proposal Defense
Students are required to submit their written proposal to their Research Progress Committee no later than two weeks before the scheduled exam. The proposal is expected to be in NIH NRSA-like format - limited to 10 pages (not including References) and include the following sections: Abstract, Background, Problem Statement, Research Plan, Preliminary Results, References, and Proposed Timeline. Students whose research area may not be suitable for this format may seek approval of an alternative format by their Research Progress Committee. On the day of the defense, students are expected to give an oral presentation of their proposal and answer technical questions. The student should expect to give a presentation, which if uninterrupted would last about 45 minutes, and be prepared for substantial questioning by the Research Progress Committee.

Admission
Applicants for graduate study in Systems, Synthetic and Physical Biology must have:

• BA or BS degree in natural sciences, engineering, or related field (or some equivalent)
• Strong ability and motivation for research as indicated by academic record, Graduate Record Examination (GRE) scores, and recommendations

Although the program offers an MS degree, only students who intend to pursue the PhD degree are admitted into the program. In rare instances, students who fulfilled the MS degree requirements and who do not wish to continue their studies toward their PhD degree may choose to graduate with MS degree. Information on admission to the program is available on the SSPB website (http://sspb.rice.edu/admissions/).

Prerequisite Requirements
Students are required to have training in the following 5 foundation areas:

1. Molecular Biology (Introductory Biology class, and at least 1 upper-level biology class such as Cell Biology, Genetics, or Biophysics)
2. Biochemical Reaction Kinetics (Biochemistry, Bioreaction Engineering, or equivalent)
3. Physical Chemistry or Thermodynamics or Statistical Mechanics
4. Ordinary Differential Equations
5. Statistics

If students are missing formal training in these subjects, they are required to take the equivalent background courses during their first year at Rice (no more than 1 of these classes can be taken as Pass/Fail). The corresponding courses at Rice include the following:

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<tr>
<td></td>
<td>Required Prerequisites</td>
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<tr>
<td>BIOC 341</td>
<td>CELL BIOLOGY</td>
<td>3</td>
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Select 1 from the following:

- BIOC 301 BIOCHEMISTRY I
- BIOE 330 BIOREACTION ENGINEERING

Select 1 from the following:

- BIOC 352 PHYSICAL CHEMISTRY FOR THE BIOSCIENCES
- BIOE 332 BIOENGINEERING THERMODYNAMICS
- CHEM 301 PHYSICAL CHEMISTRY I
- PHYS 425 STATISTICAL & THERMAL PHYSICS

Select 1 from the following:

- MATH 211 ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA
- CAAM 336 DIFFERENTIAL EQUATIONS IN SCIENCE AND ENGINEERING

Select 1 from the following:

- BIOE 439 APPLIED STATISTICS FOR BIOENGINEERING AND BIOTECHNOLOGY
- STAT 305 INTRODUCTION TO STATISTICS FOR BIOSCIENCES
- STAT 310 PROBABILITY AND STATISTICS

Policies for the PhD Degree in the field of Systems, Synthetic and Physical Biology

Systems, Synthetic and Physical Biology Graduate Program Handbook
The General Announcements (GA) is the official Rice curriculum. As an additional resource for students, Systems, Synthetic and Physical Biology publishes a graduate program handbook, which can be found here: https://gradhandbooks.rice.edu/2019_20/Systems_Synthetic_Physical_Biology_Graduate_Handbook.pdf
Additional Information
For additional information, please see the Systems, Synthetic and Physical Biology website: https://sspb.rice.edu/

Opportunities for the PhD Degree in the field of Systems, Synthetic and Physical Biology

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