Applied Mathematics-Biology

Biology, the science of all life and living matter, is an incredibly diverse discipline offering students the opportunity to learn about topics ranging from the fundamental chemical reactions that fuel all living organisms to the population dynamics of entire ecosystems all the way to the question of how our brains give rise to the complexities of human cognition and experience. Applied mathematics is an increasingly important component of modern biological investigation. Modern technologies have enabled the creation of vast new biological data sets that often require sophisticated mathematical and statistical models for interpretation and analysis. Advances in computing have similarly enabled the simulation of biological phenomena at increasingly fine levels of detail. Entire subfields, such as bioinformatics and computational neuroscience, have developed around these new paradigms of biological investigation. The foundations of these new fields are inherently mathematical, with a focus on probability, statistical inference, and systems dynamics.

The Applied Mathematics – Biology concentration allows students to develop complementary expertise in biology and applied mathematics. Students will focus their advanced biological coursework in an area of particular interest to them. The applied math requirements emphasize those areas of mathematics that have found widespread use throughout all of the biological sciences. The program culminates in a senior capstone experience that enables students to participate in creative research collaborations with faculty.

Standard program for the Sc.B. degree

Prerequisites – the equivalent of two semesters of single-variable calculus

Single-variable calculus is not an enforced requirement for our concentration, but it is a required prerequisite for many of our courses. At Brown, single-variable calculus consists of MATH 0090 followed by one of MATH 0100, MATH 0170, or MATH 0190.

Requirements – 16 courses [1]		
Mathematical Requirements – 7 courses		
MATH 0180	Multivariable Calculus [2]	1
or MATH 0200	Multivariable Calculus (Physics/Engineering)	
or MATH 0350	Multivariable Calculus With Theory	
MATH 0520	Linear Algebra [2]	1
or MATH 0540	Linear Algebra With Theory	
APMA 0355	Applied Ordinary Differential Equations with Theory [3]	1
APMA 0365	Applied Partial Differential Equations I with Theory [4]	1
APMA 1655	Introduction to Probability and Statistics with Theory [5]	1
APMA 1070	Quantitative Models of Biological Systems	1
APMA 1080	Inference in Genomics and Molecular Biology	1
or NEUR 2110	Statistical Neuroscience	
Scientific Requirements – 7 courses		
One approved course (or course grouping) covering Newtonian mechanics. [6]		1
CHEM 0330	Equilibrium, Rate, and Structure	1
BIOL 0200	The Foundation of Living Systems [7]	1
Two BIOL or NEUR courses. [8]		2
Two 1000-level or higher BIOL or NEUR courses from the same Biology track. [8,9]		2
Additional Requirements – 2 courses		
One approved course in the mathematical, biological, or computational sciences. [10]		1
One approved capstone, senior seminar, or research-related course in the mathematical or biological sciences. [11]		1
Total Credits		**16**

1. A required course may be replaced by a more advanced course with concentration advisor approval. No course may be used to satisfy multiple concentration requirements. Transfer credits and courses receiving placement credit notation can satisfy concentration credit as long as they appear on the Brown internal transcript. Pursuing honors will require 17 courses – these 16 along with two semesters of independent study courses for the honors research project, one of which can be used to satisfy the capstone concentration requirement. For students with multiple concentrations: calculus, linear algebra, one intro CSCI course, and at most two additional courses can be used for concentration credit in the other concentration(s).
2. APMA 0260 can substitute for the multivariable calculus and/or the linear algebra requirements. If it is used as a substitute for both requirements, then students must take one additional approved 1000-level APMA or MATH course not used elsewhere for concentration credit that adheres to the restrictions in footnote 5 and 9 and these additional restrictions: APMA 1910, APMA 1920, MATH 1090, MATH 1910 and research/independent study courses cannot be used.
3. MATH 1110 may be used in place of APMA 0355. If MATH 1110 is used, then the concentration must include at least three 1000-level APMA courses that adhere to the restrictions in footnote 6. These can appear anywhere in the declaration. Students matriculating prior to Fall 2025 can use APMA 0330 or APMA 0350 as a substitute for APMA 0355. Students matriculating in Fall 2025 or later who wish to use APMA 0330 or APMA 0350 must also complete the APMA 0355 online bridgework course and pass the in-person bridgework exam that is offered once per semester.
4. MATH 1120 may be used in place of APMA 0365. If MATH 1120 is used, then the concentration must include at least three 1000-level APMA courses that adhere to the restrictions in footnote 6. These can appear anywhere in the declaration. Students matriculating prior to Fall 2025 can use APMA 0340 or APMA 0360 as a substitute for APMA 0365. Students matriculating in Fall 2025 or later who wish to use APMA 0340 or APMA 0360 must also complete the APMA 0365 online bridgework course and pass the in-person bridgework exam that is offered once per semester.
5. Students matriculating prior to Fall 2025 can use APMA 1650 as a substitute for APMA 1655. Students matriculating in Fall 2025 or later who wish to use APMA 1650 must also complete the APMA 1655 online bridgework course and pass the in-person bridgework exam that is offered once per semester.
6. PHYS 0050 or PHYS 0070 are recommended. The following course(s) are automatically approved: PHYS 0030, PHYS 0050, PHYS 0070, ENGN 0040 + (one of PHYS 0040, PHYS 0060, a score of 3 or higher on any AP Physics, a score of 4 or higher on IB-HL Physics). When considering alternative course(s) a key criterion is whether both statics and dynamics are covered.
7. A BIOL placement test score of 30 or higher may be used in place of BIOL 0200. The placement test score can be found in ASK, in the advising detail view, under the test scores section. This will reduce by 1 credit the number of credits needed to complete the concentration.
8. Mixing BIOL and NEUR courses is fine. Students are encouraged to take at least one laboratory or fieldwork course.
9. The tracks (tracks, not areas) are listed at this link to the Biology Bulletin page (https://bulletin.brown.edu/the-college/concentrations/biol/) at the end of the Biology ScB requirements. The physical sciences track is not allowed. If the biomedical informatics track is used, then one of the courses must be BIOL 1565. Substitutions or the use of 2000-level courses requires approval of the Director of Undergraduate Studies in Biology.
10. 1000-level courses in APMA, BIOL, CSCI, MATH, NEUR are automatically approved, including APMA 1910, APMA 1920. Research/independent study courses cannot be used. At most one of APMA 1910, MATH 1090, MATH 1910, at most one of APMA 1001, MATH 1000, MATH 1001, and at most one of APMA 1650, APMA 1655, CSCI 1450,

MATH 1210, MATH 1610 can be used for concentration credit. Concentrators are strongly encouraged to use this requirement to develop their computer programming skills and to do so before the end of sophomore semester. Many upper-level APMA courses, including APMA 1080, require exposure to programming as a prerequisite. The following courses are automatically approved for this purpose: APMA 0160, APMA 0200, CSCI 0111, CSCI 0150, CSCI 0170, CSCI 0190, CSCI 0200, CLPS 0950, EEPS 0250.

[11] The following options can be used to satisfy this requirement
(a) A pre-approved course that satisfies the APMA Sc.B. capstone requirement: currently APMA 1360, APMA 193*/194* (where * is any combination of numbers and letters; these are the APMA senior seminars).
(b) A pre-approved course that satisfies the Biology A.B. capstone requirement: currently BIOL 1100, BIOL 1140, BIOL 1150, BIOL 1250, BIOL 1330, BIOL 1515, BIOL 1525, BIOL 1555, BIOL 1565, BIOL 1575, BIOL 1600, BIOL 1820, BIOL 1970. Courses over the 2000 level may be used with approval of the Director of Undergraduate Studies in Biology.
(c) A directed research/independent study course from the APMA 1970/APMA 1971, BIOL 1950/BIOL 1960, or NEUR 1970 series that is used for undergraduate research. For students pursuing honors in APMA-Bio, one of the two required semesters of independent study courses can be used.
(d) A directed research/independent study course in a related discipline (i.e. STEM disciplines, ENVS, PHP, etc.) that is used for undergraduate research if the project is relevant to the student's learning goals in the concentration and with approval from the concentration advisor.
(e) An upper-level course related to the concentration (usually a 1000-level or higher APMA or BIOL course) in addition to a research experience equivalent in scope and scale to work the student would pursue in an Applied Math or Biology research-related independent study course. Examples include UTRAs, LINK awards, REUs, research programs at other institutions, the APMA Directed Reading Program, etc. This requires approval from the concentration advisor and appropriate documentation that should be uploaded to ASK.
(f) Other equivalent opportunities not listed, with approval from the concentration advisor. Documentation should be uploaded to ASK.

Professional Tracks

The requirements for the professional tracks include all those of each of the standard tracks, as well as the following:

Students must complete full-time professional experiences doing work that is related to their concentration programs, totaling 2-6 months, whereby each internship must be at least one month in duration in cases where students choose to do more than one internship experience. Such work is normally done at a company, but may also be at a university under the supervision of a faculty member. Internships that take place between the end of the fall and the start of the spring semesters cannot be used to fulfill this requirement.

On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience, to be approved by the student's concentration advisor, addressing these questions:

- Which courses were put to use in your summer's work? Which topics, in particular, were important?
- In retrospect, which courses should you have taken before embarking on your summer experience? What are the topics from these courses that would have helped you over the summer if you had been more familiar with them?
- Are there topics you should have been familiar with in preparation for your summer experience, but are not taught at Brown? What are these topics?
- What did you learn from the experience that probably could not have been picked up from course work?
- Is the sort of work you did over the summer something you would like to continue doing once you graduate? Explain.
- Would you recommend your summer experience to other Brown students? Explain.

Honors

Concentrators that demonstrate excellence in grades and in undergraduate research can be awarded departmental honors. Honors students with primary advisors in Applied Math should follow the guidelines, requirements, and deadlines for honors as described in the bulletin for Applied Math concentrators (https://bulletin.brown.edu/the-college/concentrations/apma/) and as published on the APMA departmental website (https://appliedmath.brown.edu/academics/undergraduate-program/honors/). Honors students with primary advisors in Biomed should follow the guidelines, requirements, and deadlines for honors as described in the bulletin for Biology concentrators (https://bulletin.brown.edu/the-college/concentrations/biol/) and as published on the Biology departmental website (https://bue.brown.edu/academics/honors/). Students wishing to do honors research with a non-APMA or Biomed advisor should contact the Directors of Undergraduate Studies in APMA and Biology to discuss options.