

What is Biomath?

Summary

Biomathematics covers a wide range of activities at the interface between the mathematical and biological sciences. Depending on who you talk to, it might have a different name, including mathematical biology, systems biology, quantitative biology or theoretical biology.

The focus of our biomathematics program is **on building and using mathematical models to describe and analyze biological systems**. Often this involves the **analysis of biological data**, which typically means using **statistical approaches** together with the models. In many cases, our models are mechanistic, meaning that their components represent biological processes, although many of us also use models that are more statistical in nature.

More In-Depth

Biomathematics is the use of mathematical models to help understand phenomena in biology.

Modern experimental biology is very good at taking biological systems apart (at all levels of organization, from genome to global nutrient cycling), into components simple enough that their structure and function can be studied in isolation. Dynamic models are a way to put the pieces back together, with equations that represent the system's components, processes, and the structure of their interactions.

Mathematical models are important tools in basic scientific research in many areas of biology, including physiology, cellular biology, developmental biology, ecology, evolution, toxicology, epidemiology, immunology, natural resource management, and conservation biology. The results obtained from analysis and simulation of system-level models are used to test and extend biological theory, and to suggest new hypotheses or experiments. Models are also widely used to synthesize available information and provide quantitative answers to practical questions. What measures can be used to reverse the decline in sea turtle populations, and how soon can we tell if they are working? How can laboratory experiments on chemical carcinogenicity be scaled up to set safe exposure limits on humans? How effective would various control measures be against the spread of the coronavirus that causes COVID-19? For questions like these, where it is desirable to predict the outcome accurately before action is taken, quantitative modeling is essential.

Thus, while mathematical biology may sound like a narrow discipline, in fact it encompasses all of biology and virtually all of the mathematical sciences, including statistics, operations research, and scientific computing.

Within the biomathematics program at N. C. State, faculty and student research areas include biomechanics, developmental biology, population genetics and ecology, epidemiology and immunology, environmental toxicology, and pharmacokinetics. Research on specific

applications is complemented by fundamental work on mathematical, statistical, and computational methods for fitting models to data and deriving their properties. See our website (<http://bma.math.ncsu.edu>) for more information on our faculty and their research areas.

Suggested Reading

A good place to get an idea of what mathematical modeling is all about is an article by Jackson et al. (2000) which appeared in the journal *BioScience*, volume 50, issue number 8, pages 694-706. Another good place to look is the February 6th 2004 edition of the journal *Science* (volume 303) which contains a series of articles on various areas of mathematical biology.

Related Fields

There are a number of other types of program in the area of quantitative biology. **Biostatistics** focuses on the statistical analysis of biological data. Many (but not all) biostatisticians exclusively use statistical models, and many work in the areas of medicine and public health. **Bioinformatics** focuses on the analysis of “-omics” data (e.g. genomic or proteomic data). Some of our biomathematics faculty would primarily describe themselves as biostatisticians or bioinformaticians, and the nature of some of our students’ specific research programs means that they will primarily work in the area of biostatistics or bioinformatics. Our program is broad enough to include such work, although other programs are more squarely focused on these topics.