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# Types and Applications of Computational Biology

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Commentary

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## DESCRIPTION

In order to comprehend biological systems and relationships, computational biology uses data analysis, mathematical modelling, and computer simulations. The area has roots in applied mathematics, chemistry, and genetics and is a nexus of computer science, biology, and big data. Biological computing, a branch of computer engineering that applies bioengineering to the construction of computers, is distinct from it.

The study of informatics processes in biological systems, or bioinformatics, first emerged in the early 1970s. In order to create new algorithms, artificial intelligence research at the time used network models of the human brain. Due to the utilisation of biological data, biological researchers are now evaluating and comparing massive data sets within their own field using computers.

By 1982, researchers were exchanging data using punch cards. By the end of the 1980s, the volume of data had increased dramatically, necessitating new computational techniques for quickly evaluating pertinent data.

The Human Genome Project, arguably the best-known illustration of computational biology, was underway in 1990. The project had achieved its primary objectives by 2003, having mapped approximately 85% of the human genome. Nevertheless, work persisted, and by 2021, level "full genome".

### Types of computational biology

**Network biology:** The purpose of systems biology is to identify emergent features by computing the interactions between various biological systems, from the cellular level to large populations. Cell signalling and metabolic pathway networking typically takes place during this process. Systems biology frequently applies computational methods from biological modeling and graph theory to examine these intricate cellular relationships.

**Darwinian biology:** Evolutionary biology has benefited from computational biology by:

1. Using computational phylogenetics to recreate the tree of life using DNA data.
2. Using DNA data and population genetics models to estimate demographic or selection history (either in the forward or backward time directions.
3. Constructing population genetics models of evolutionary systems from the ground up to forecast what is likely to change.

**Neuroscience:** The study of brain function in terms of the nervous system's information processing capabilities is known as computational neuroscience. It is a branch of neuroscience that focuses on modelling the brain to look at particular features of the nervous system. Examples of brain models are:

1. Realistic brain models these models aim to capture every feature of the brain, down to the molecular level, in great detail. The most accurate models offer the most knowledge about the brain, but they also have the greatest room for error.
2. A brain model with more variables can potentially make more mistakes. These models do not take into account the unknown components of cellular structure.

## Applications

**Anatomy:** The study of anatomical form and shape at the visible or large anatomical scale (displaystyle 50-100 mu) of morphology is known as computational anatomy. For modeling and simulating biological structures, it entails the development of computer, mathematical, and data-analytical techniques. Instead than concentrating on the medical imaging equipment, it emphasizes the anatomical structures being examined. In order to extract anatomical coordinate systems at the morphome scale in 3D, computational anatomy has arisen as a subfield of medical imaging and bioengineering due to the availability of dense 3D observations through technologies like magnetic resonance imaging.

Computational anatomy was first conceptualized as a generative model of shape and form from exemplars that were then transformed.

**Models and data:** The study of the processes that control the structure, development, and behavior of biological systems is known as mathematical biology. Mathematical models of live organisms are used in this field. In contrast to experimental biology, which is more emphatically minded, this requires a more theoretical approach to problems. Discrete mathematics, topology (which is helpful for computational modeling), Bayesian statistics, linear algebra, and Boolean algebra are all used in mathematical biology.

## Associated fields

The interdisciplinary fields of computational biology, bioinformatics, and mathematical biology all use quantitative fields like information science and mathematics to the study of life. Computational and mathematical approaches are used in computational and mathematical biology to answer theoretical and experimental problems about biology. In contrast, bioinformatics is the use of information science to comprehend complicated data from the life sciences.

The National Institutes of Health (NIH) defines computational biology as, the production and use of data-analytical and theoretical approaches, mathematical modeling, and computational simulation techniques to research biological, behavioral, and social systems. Research, development, or use of computational tools and methods for extending the use of biological, medical, behavioral, or health data, including those to collect, save, organize, archive, process, or display such data, is known as bioinformatics.