Medical School Hotline

Bioinformatics Research at University of Hawai'i: an Overview and Undergraduate Student Perspective

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The Medical School Hotline of the University of Hawai'i John A. Burns School of Medicine was founded in 1993, by Satoru Izutsu PhD (former vice-dean UH JABSOM). It is a monthly column and is edited by Kathleen Kihmm Connolly PhD; HJH&SW Contributing Editor.

Introduction

Bioinformatics uses computers, databases, math, and statistics to analyze large amounts of biological information. It is a rapidly expanding field due to the availability and growing quantity of biological data. For example, the GenBank, a public database, contains all known DNA sequences: trillions of base pairs from billions of nucleotide sequences.[1] Additionally, the cost of sequencing a human genome has also fallen dramatically, from $1 million in 2007 to less than $1000 in 2023,[2] which allows much more data to be produced and analyzed.

As a result, applying bioinformatics methods to investigate the molecular mechanisms of diseases is a burgeoning field of research. For example, bioinformatics can be used to identify specific genetic biomarkers, generate mutation data, determine microbiota composition (if applicable), or identify cellular pathways implicated in specific types of cancers. These can, in turn, be used to create diagnostic or prognostic models, which can be translated to provide better screening or better management of cancer symptoms. Nearly 150 000 cancer bioinformatics-related articles have been published and are available on PubMed in 2025, with more than 15 000 published in 2024 alone.

Despite the importance of bioinformatics, education at the undergraduate level remains relatively limited nationally, with most universities exclusively offering graduate degrees. Significant barriers in implementing bioinformatics undergraduate education have also been reported in the literature, with the most common being lack of faculty training, lack of undergraduate interest, or insufficient mathematics background from undergraduate students.[3] Within the University of Hawai'i (UH) System, one of the only consistently offered undergraduate-level bioinformatics course is Biology 483,[4] which is an introduction to bioinformatics offered at the Mānoa campus. Information and Computer Sciences courses 475 and 476 focus on the algorithmic components of bioinformatics[5,6]; however, these classes were last offered in 2013. UH also does not offer an undergraduate bioinformatics degree.

Bioinformatics at the John A. Burns School of Medicine (JABSOM)

Despite challenges in bioinformatics education at the undergraduate level, undergraduates can get exposure to bioinformatics through mentored research. JABSOM has a few opportunities for undergraduates looking for research in bioinformatics. For example, the Bioinformatics Core Facility, led by Dr. Youping Deng, is looking to develop precision medicine for cancer using both bioinformatics and experimental approaches.[7] Ongoing projects focus on cancer disparities affecting Native Hawaiian/Pacific Islanders (NHPI) in Hawai'i, such as investigating gut microbiome and function in NHPI colorectal cancer patients, or identifying genetic function in NHPI with triple-negative breast cancer.[8] Other projects include creating a diagnostic model for non-small cell lung cancer[9] and identification of protein biomarkers for pancreatic cancer.[10] These types of research can pave the way for clinical trials, better screening, earlier detection, and better symptom management of these cancers. Undergraduates may experience such research through many programs offered at the University of Hawai'i at Mānoa (UHM), such as the Maximizing Access to Research Careers (MARC)[11] and Minority Health Research Training (MHRT)[12] programs. In addition, Dr. Deng recently taught a graduate level bioinformatics course that focused on bioinformatics approaches for functional genomics[13] that is open to students outside the department and has no prerequisites.

JABSOM also runs the IDeA Networks for Biomedical Research Excellence (INBRE) program,[14] which is designed to expose undergraduates to mentored biomedical research. Undergraduates choose a mentor from one of INBRE's partnering institutions (including those from JABSOM's Bioinformatics Core Facility) to participate in a research project over the fall semester and present their findings at the INBRE undergraduate symposium in the following spring. In the most recent symposium in 2025, a handful of posters had topics on cancer bioinformatics, mentored by both JABSOM and UH Cancer Center faculty. INBRE is open to any undergraduate major in the biomedical sciences, who has a GPA above 2.75 and has completed 1 semester at university. This makes it an ideal program for undergraduates looking for early research experience. In addition, students may elect to participate in INBRE over consecutive semesters, which makes it possible for longer, more complicated projects in bioinformatics.

Over the summer, INBRE also offers a free, no-credit, 8-week course in bioinformatics. Students get access to

Table 1. List of Bioinformatics Opportunities for Undergraduates at University of Hawaiʻi at Mānoa (UHM)

Bioinformatics opportunity/ course	Description	Prerequisites
Course: BIOL/MBBE 483 (Bioinformatics)	3-credit course – Teaches the computational tools necessary to analyze large amounts of biological data.	• BIOL 171 (1 semester of General Biology)
Course: QHS 610/611	Both 3-credit courses – the course sequence focuses on hands-on bioinformatics training with an emphasis on human disease.	• None for QHS 610, • QHS 610 is a prerequisite for QHS 611
Research: U54 summer genomics	A hands-on program to train the next generation of genomic scientists.	N/A
Research: IDeA Networks of Biomedical Research Excellence (INBRE)	Promotes undergraduate research and education in biomedical sciences at the University of Hawaiʻi and partner institutions.	• 1 semester of undergraduate at UHM or partnering institutions • 2.75 GPA • Biomedical sciences major
Course: INBRE Bioinformatics Course	A no-credit course that provides technical training for undergraduates in bioinformatics, using the R programming language.	• Recommended to be an INBRE student
Research: Minority Health Research Training (MHRT)	Provides research training for undergraduates in tropical medicine, infectious diseases, and social and behavioral health sciences.	• 2 years of undergraduate, any major • Underrepresented backgrounds encouraged
Research: Maximizing Access to Research Careers (MARC)	Trains underrepresented students at UHM in biological research.	• Full-time student at UHM • Science, technology, engineering or mathematics (STEM) major • 2-3 years of undergrad left • Underrepresented backgrounds encouraged

web-based DataCamp modules that go over the R programming language by combining video tutorials and hands-on, interactive programming. Basic skills for bioinformatics research such as statistics and data visualization are taught. The course is supplemented by guest speakers from the bioinformatics core at JABSOM, offering undergraduates valuable insight into bioinformatics research.

INBRE also links students with other bioinformatics research opportunities. The U54 genomics training program was advertised at the 2024 INBRE undergraduate symposium, and INBRE students with a background in bioinformatics were encouraged to apply. U54 is an intensive summer program that trains next generation of genomic. At U54, every undergraduate is paired with a faculty mentor from JABSOM or UH Cancer Center to conduct cancer research, which can include bioinformatics. Undergraduates also shadow genomics professionals in a wet lab setting, which gives them an insight into how and where the data they are analyzing in their bioinformatics projects come from. The 2024 cohort had 2 undergraduates, but has expanded to 4 undergraduates (with the 2 original undergraduates continuing) in 2025. See **Table 1** for list of bioinformatics opportunities for undergraduates at UHM.

Personal Experience in Bioinformatics as an Undergraduate at JABSOM

As an undergraduate student, I personally have participated in both INBRE and U54 programs. Bioinformatics was the perfect fit for me as I am a computer science major, and I am interested in how computers can be applied towards medical research. The U54 program initially paired me with Dr. Yuanyuan Fu from JABSOM's bioinformatics core, and I continued working with her through the fall and spring semesters as part of INBRE. I was assigned to her project of investigating disparities in Native Hawaiian colorectal cancer patients. Native Hawaiians have higher mortality rates and earlier onset of colorectal cancer compared to other populations, so our aim was to use bioinformatics to analyze their genomic/microbiome data to explain these disparities. Both programs, combined with Dr. Fu's mentorship, provided hands-on experience in bioinformatics research and development of specific research skills.

At the start of the mentorship, I was unfamiliar with bioinformatics; thus it was suggested to break the project down to bite-size pieces to complete every week. For example, I learned how to filter data on week 1, and the next week I learned a bioinformatics tool to analyze the filtered data. The INBRE bioinformatics course was also very helpful during these beginning stages, as I drew parallels be-

tween the course content and the research project. When errors occurred, Dr. Fu would spend time helping me to debug or send me similar code she wrote, which was very helpful and allowed me to avoid similar errors in the future.

This type of mentorship allowed the project to be digestible while also taking a full-time course load at UHM. This excited me to learn the "next" step that was coming up the following week. After more than a year of being mentored, I went from having no knowledge about bioinformatics to being able to utilize common bioinformatics tools to analyze genomics and metagenomics data. I have also started to appreciate the practical application of computer science to bioinformatics research. Participation in both INBRE and U54 programs motivated me to keep learning about bioinformatics, and evolved into Dr. Fu serving as the mentor for my undergraduate senior honors project. I will continue working with her on the bioinformatics project on colorectal cancer.

Conclusion

JABSOM has a strong Bioinformatics Core Facility that investigates and conducts research on many types of cancers, including those that disproportionately affect NHPI. Participating in research at JABSOM is a way undergraduates can learn bioinformatics. While there is no formal undergraduate bioinformatics major offered at UH, JABSOM-affiliated programs—such as INBRE and U54—show that through mentored research and accessible training, undergraduates can thrive in this field and contribute meaningfully to bioinformatics research.

As the availability and quantity of biological data continue to increase, opportunities will also increase for bioinformatics researchers who can analyze the data to increase medical knowledge and ultimately improve health outcomes. To promote undergraduate interest in bioinformatics, advertising research opportunities to other undergraduate departments at UHM, such as computer science and mathematics, may be a first step. The future of bioinformatics at JABSOM is promising, and getting more students engaged in this field is a good way to train the next generation of bioinformatics researchers to serve the state of Hawai'i.

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