Bioinformatics for Immunologists

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La Jolla Institute for Immunology

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BGGN 239 [A00] - Spring 2025

Biology/Grad/General » BGGN 239 - Bioinformatics/Immunologists (Kronenberg)

Course Resources

📖 Book List ⧉

🗓 Listing in Schedule of Classes ⧉

Course Schedule

LE	A00	T	2:00 PM - 3:50 PM	TATA 2501	📱	🗓
DI	A01	Th	2:00 PM - 3:50 PM	TATA 2501	📱	🗓

BGGN 239. Bioinformatics for Immunologists (4)
Technological advances brought an unprecedented increase in both the depth and breadth of data to study the immune system. This course will provide a conceptual understanding of and hands-on experience with computational methodologies to analyze such data for immunology research. Students will use their own technology/laptops. ***Prerequisites:*** BGGN 213. Enrollment restricted to the following major codes: BI77, BI78, BI80, BI81, BI82, BI83, BI85, BI86, BS75, and BS81.

Spring 2025	
Spring Quarter begins	Wednesday, March 26
César Chávez Holiday	Friday, March 28
Instruction begins	Monday, March 31
Fifteenth day of instruction	Friday, April 18
Memorial Day observance	Monday, May 26
Instruction ends	Friday, June 6
Final Exams	Saturday – Friday, June 7–13
Spring Quarter ends	Friday, June 13
Commencement programs	Saturday – Sunday, June 14–15
49 Days of Instruction - 58 Days in Quarter	

Line up of Instructors

- Week 1: Barry Grant   : Introduction, R basics
- Week 2: Ferhat Ay   : Gene expression analysis
- Week 3: Graham McVicker   : Human genetics
- Week 4: Miguel Reina-Campos   : Spatial Transcriptomics
- Week 5: Ferhat Ay   : Epigenomics in immune cells
- Week 6: Bjoern Peters   : Epitope discovery
- Week 7: Hannah Carter   : Neoantigens
- Week 8: Sam Myers   : Proteomics
- Week 9: Pieter Dorrestein   : Metabolomics
- Week 10: Z Mikulski, Sara McArdle   : Imaging analysis

Dr. Barry J. Grant, Lecturer, Molecular Biology

Teaching

- BGGN-213: Foundations of Bioinformatics
- BIMM-143: Introduction to Bioinformatics
- BIMM-194: Genomics, Big Data and Human Health
- BIMM-173: Clinical Applications of Genomic Technologies

Recap of Foundations of Bioinformatics (Week 1)

- Working with UNIX
- Sequence alignment
- Key online resources
- Data analysis and visualization with R and Bioconductor
- Annotation of gene lists (GO term and pathway enrichment)

Dr. Ferhat Ay, LJI, Pediatrics (Adjunct)

Research

- Computational biology
- Epigenetic gene regulation
- 3D chromatin structure
- Cancer, malaria and autoimmune diseases

Analysis of gene expression data in bulk (Week 2)

- RNA-seq concepts and basics
- Processing RNA-seq data
- Differential gene expression and relevant statistics
- Gene co-expression analysis
- Visualization of RNA-seq data
- Single-cell RNAseq analysis

Dr. Graham McVicker, Salk, CMM (Adjunct)

Research

- Human genetic variation
- Pathogenic variants in immune cells and cancer cells
- Variants that impact regulatory elements
- Profiling enhancers in immune cells

Genetics of immune traits (Week 3)

- Intro
- Genome-wide association studies with a focus on immune-related diseases
- Identification of expression quantitative trait loci (eQTLs)
- Identification of chromatin/histone quantitative trait loci (hQTLs)

Dr. Miguel Reina-Campos, LJI,

Research

– Spatial Transcriptomics
– Cancer Metabolism
– Tissue-resident memory CD8 T cells

Spatial Transcriptomics (Week 4)

– Intro to spatial transcriptomics (ST) technologies
– Probe-based and sequencing-based ST
– Data structures for spatial datasets
– Cell segmentation and cell typing
– Cellular networks and neighborhoods
– Spatial organization of immune networks in the mouse colon
– Current challenges and the future of spatial omics

Dr. Ferhat Ay, LJI, Pediatrics (Adjunct)

Research

- Computational biology
- Epigenetic gene regulation
- 3D chromatin structure
- Cancer, malaria and autoimmune diseases

Analysis of epigenomics data from immune cells (Week 5)

- Analysis of ChIP-seq for histone modifications and transcription factor binding
- Analysis of chromatin accessibility using ATAC-seq data
- Analysis of 3D genome architecture and enhancer-promoter interactions using Hi-C and HiChIP data

Dr. Hannah Carter, UCSD Medicine

Research

- Interplay between cancer mutations and immune system
- Identification of cancer genes
- Immunoediting and infiltration in tumors
- Statistical modeling

Analyzing neoantigen presentation versus occurrence in tumors (Week 6)

- Brief review of HLA-antigen binding prediction
- HLA-typing from exome data
- Tumor neoantigens
- Analysis of immunoediting in tumors
- Tumor-immune infiltrates

Dr. Bjoern Peters, LJI, Medicine (Adjunct)

Research

- Computational immunology
- Epitope discovery
- Vaccine design
- Co-investigator of Immune Epitope Database (IEDB)
- Cancer, infectious diseases, autoimmune disorders

Prediction and analysis of epitopes (Week 7)

- Background: antibodies, T cell receptors, MHC molecules, epitopes
- The Immune Epitope Database (IEDB)
- Machine learning approaches for peptide:MHC binding

Dr. Samuel Myers, LJI, UCSD

Research
- Mass spectrometry
- Proteomics
- Genomics techniques

Proteomics (Week 8)
- Intro to liquid chromatography and mass spectrometry
- Intro to relevant data structures and spectral alignment
- Survey of bioinformatic tools for proteomic analyses.

Dr. Pieter Dorrestein, UCSD Skaggs School

Research

- Mass spectrometry for metabolomics
- Metabolic exchange
- Post-translational modifications
- Microbial communities

Metabolomics (Week 9)

- Metabolomics
- Hands-on example of metabolomic data analysis using GNPS database.

Drs. Mikulski and McArdle, Imaging Core, LJI

Dr. Zbigniew Mikulski
Director, Microscopy and Histology Core

Dr. Sara McArdle
Microscopy Specialist

Research

- Imaging of the immune system
- Immunostaining
- RNA imaging
- Machine learning for image processing
- Flow cytometry
- Intravital microscopy

Analysis of imaging data (Week 10)

- Introduction to 2D imaging of 4D objects and QuPath
- Cell classification with random forests
- Pixel classification with artificial neural networks
- Quantification of tumor-immune infiltrates
- Quantification of RNA molecules in cells with RNAscope
- Data export for FlowJo analysis and deep learning

Thank you

Course directors and contact information:

Ferhat Ay

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La Jolla Institute for Immunology

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Mitchell Kronenberg

Professor, President Emeritus

La Jolla Institute for Immunology

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Course TAs and contact information:

Daniela Salgado-Figueroa

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Dante Bolzan

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Similar courses outside UCSD

COURSE AT EMBL-EBI

Bioinformatics for immunologists

Course overview   Programme   How to apply   Additional information   Competencies

This course will provide participants with an introduction to a range of bioinformatics resources and approaches applicable to immunological research. Participants will gain experience in analysis pipelines for NGS experiments relevant to immunology including immune receptor sequencing, RNA sequencing, single-cell RNA sequencing, and flow cytometry data analysis.

Additionally, participants will be introduced to how data from several sources can be integrated to provide a wider view of their research, thereby enabling them to be more confident users of their own data and that from public sources.

Who is this course for?

The course is aimed at individuals working in immunology research who have minimal experience in bioinformatics. Applicants are expected to be at an early stage of using bioinformatics in their research with the need to develop their skills and knowledge further. Participants will need a basic knowledge of the Unix command line, and R programming language.

Find similar courses

This course has ended

Access materials

📅 **01 - 05 July 2024**

📍 **European Bioinformatics Institute**
United Kingdom

🏷 **£850.00 inclusive of four nights accommodation and catering, including dinner**

✉ **Contact**
Juanita Riveros

Organisers

https://www.ebi.ac.uk/training/events/bioinformatics-immunologists-0/

Similar courses outside UCSD

Stanford MEDICINE | Immunology

IMMUNOL 207: Essential Methods in Computational and Systems Immunology
Introduction to the major underpinnings of systems immunology: first principles of development of computational approaches to immunological questions and research; details of the algorithms and statistical principles underlying commonly used tools; aspects of study design and analysis of data sets. Prerequisites: CS106a and CS161 strongly recommended.

Terms: Spr | Units: 3

IMMUNOL 312: Emerging Topics in Computational Immunology
This course will take an emerging topic of area of interest in computational immunology and give the class some time to discuss and take a hands-on approach with the material . The course will be a mix of talks and hands-on work/projects with a curriculum shaped by recent activities in the field.

Terms: Sum | Units: 1

https://med.stanford.edu/immunol/phd-program/curriculum.html

Similar courses outside UCSD

Welcome to DIY Transcriptomics

A semester-long course covering best practices for the analysis of high-throughput sequencing data from gene expression (RNA-seq) studies, with a primary focus on empowering students to be independent in the use of lightweight and open-source software using the R programming language and the Bioconductor suite of packages. This course follows a hybrid format in which online lectures are paired with in-person labs where students participate in hands-on, live coding exercises using real 'omic datasets. The course is focused on datasets and topics central to infectious disease research, immunology, and One-Health, but the concepts and approaches covered are applicable to any genomic study.

https://diytranscriptomics.com/ by Daniel Beiting at U Penn

Bioinformatics

- Bioinformatics is conceptualizing biology in terms of macromolecules and then applying "informatics" techniques derived from disciplines such as applied mathematics, computer science, and statistics to understand and organize the information associated with these molecules, on a large-scale.

Image courtesy of www.genome.gov
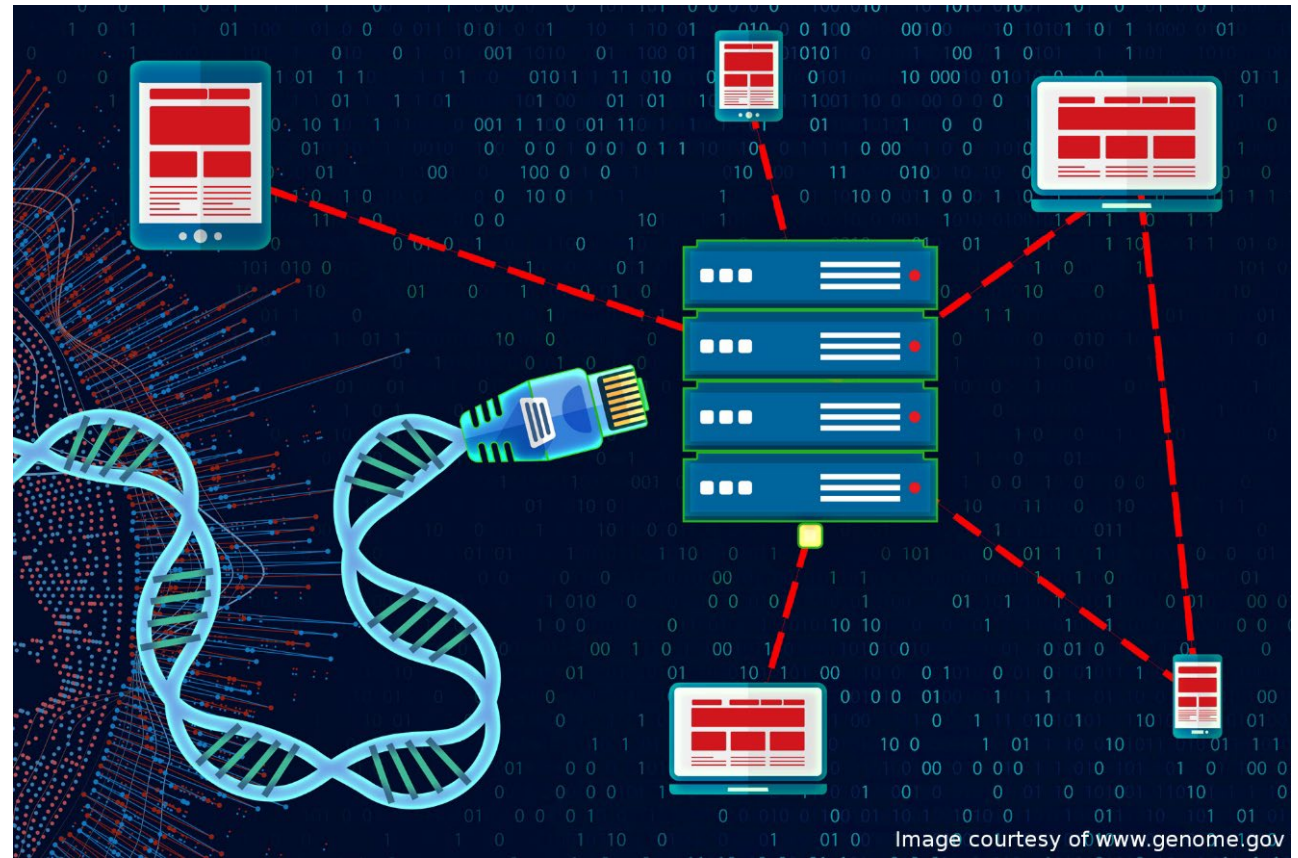
Bioinformatics in Immunology

- Among many other discoveries, bioinformatics approaches coupled with sequencing of RNA and DNA molecules have enabled the discovery of new immune cell types and previously uncharacterized functions for known immune cells in the context of different diseases.
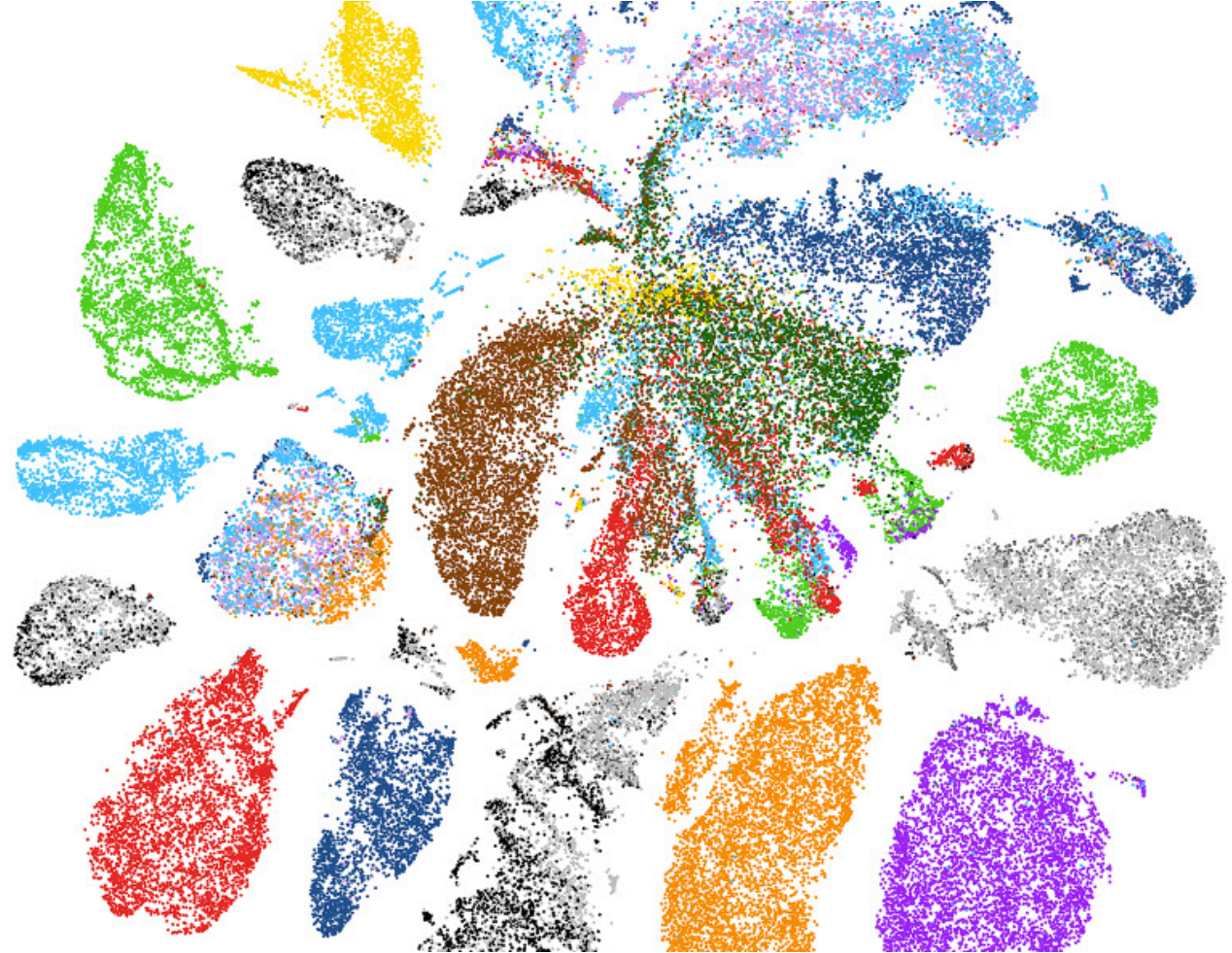
Immunology at UCSD and LJI

- 70+ faculty members
  - 50+ at UCSD
  - 20+ at LJI

- Program in Immunology

Why "Bioinformatics for Immunologists"?

- A dedicated course to teach bioinformatics with a specific focus on its applications to important problems in immunology

- A strong lineup of faculty and instructors who are **renowned experts** in their respective fields

- Practical and **hands-on training likely to impact students' overall success** in their research

- Bioinformatics expertise and scientist with cross-disciplinary training is in **high demand in academia and industry**

- Up-to-date information about finding and utilizing the latest tools, sources and databases related to immunology research

Learning goals

- Understand main computational concepts underlying commonly used bioinformatics tools

- Be familiar with online databases and resources (e.g., GWAS catalog, IEDB, DICE, ImmGen, ENCODE, IHEC) and efficient ways to query them

- Be able to utilize existing tools to perform data analysis for several different sequencing and imaging techniques (RNA-seq, ChIP-seq, ATAC-seq, RNA imaging)

- Learn and actively utilize best practices for reproducible research and collaboration related to bioinformatics (project organization, version control, online lab notebooks)

Envisioned to become a core course for The Program in Immunology

	Fall Quarter	Winter Quarter	Spring Quarter
Year 1	BGGN 299 (4) Rotation (6-8 week) BGGN 200 (2) Grad School Fund BIOM 200A (6) Molecules to Organisms: Concepts	BGGN 299 (4) Rotation BIOM 200B (2) Molecules to Organisms: Concepts BGGN 225A/BIOM 253A (4) – Grad Immunology	BGGN 299 (4) Rotation BGGN 225B/BIOM 253B (4) Graduate Immunology
Year 2	BGGN 213 (4), Foundations of Bioinformatics BIOM 219 (1) Ethics in Scientific Research BGGN 299 - Thesis Research in Biology	Bioinformatics for immunologists *(new)* (4) BGGN 299 Thesis Research in Biology	BGGN 216 (4)– Graduate Biostatistics BGGN 299 (4) Thesis Research in Biology
Year 3	BGGN 299 (12)	BGGN 299 (12)	BGGN 299 (12)
Year 4	BGGN 299 (12)	BGGN 299 (12)	BGGN 299 (12)