

# IB 533: Human Genome and Bioinformatics

## Course Description

Highlights advances in understanding the human genome, utilizing the latest techniques in bioinformatics; i.e., acquiring, analyzing, storing, and displaying the information from the entire genome and protein sequences. Explores the latest laboratory techniques, as well as the use of extensive online databases and software. Students explore the significance of sequencing the human genome, applying bioinformatics to the genome, and realizing its potential to understand human health, disease, and the place of humans in the large ecosystem. In this course, students also produce teaching materials for their classrooms.

This course is 4 credit hours and does not have any prerequisites. It counts towards one of 5 required biology courses in the Online Master of Science Teaching Biology Program with the School of Integrative Biology.

## Course Goals and Objectives

Upon completing this course, students will be able to:

- Be fluent in terms related to genomics, DNA sequencing and annotation, and bioinformatics sites;
- Explain the different technologies used to sequence DNA and proteins;
- Navigate common bioinformatics databases and find information within;
- Understand what information bioinformaticians and researchers are looking for once a sequence of DNA or protein is obtained;
- Compare multiple sequences and explain why this information is useful for researchers;
- Evaluate the methods used for studying your chosen disease/disorder;
- Apply the gained knowledge to explain the complicated science of genomics and how it relates to the chosen disease/disorder to members of the general public in a clear and engaging manner;
- Consider ways to incorporate the new knowledge from this course into their teaching classroom.

## Instructor Information

**Joanne Manaster**

University of Illinois at Urbana-Champaign

## Contact Information

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## About Me

I've been teaching at the University of Illinois for over 27 years. My specialties are cell and molecular biology with histology being one of my favorite topics. I am especially interested in the medical applications of biology. Prior to online teaching, I coordinated and taught upper level labs for nearly 20 years in the School of Molecular and Cellular Biology and the Department of Bioengineering.

For this program I teach IB 531: Emerging Infectious Diseases, IB 533: Human Genome and Bioinformatics and IB 534: Evolution and Medicine.

## Course Structure

This is a **4-credit hour** course. The course is **8 weeks** long and consists of 8 content modules. Please be aware that this course is accelerated in nature; 16 weeks' worth of content will be covered in a 8-week time span. You should dedicate approximately **12–16 hours** per week to working on the course itself, but actual time commitments will vary depending on your input, needs, and personal study habits. You are required to log on to the course website a minimum of **4 days per week** but as discussions develop, you will probably need to do so more frequently.

This course is designed with the principles of collaborative learning, constructivism, and active participation in mind. You are encouraged to share your thoughts and engage in problem-solving. The course has a consistent and predictable structure, organized around the weekly modules, with a course website that is straightforward and easy to navigate. Instructions and due dates for activities and assignments are clearly articulated so that you know what is expected of you and will be able to easily stay on track.

We realize that you have a life beyond the scope of this course. However, if you are unable to complete an assignment because of professional obligations, you should notify the instructor or, better yet, prepare the assignment ahead of time and post it early. This will give your classmates a head start in reading and responding to your work. Most assignments are due by 11:55 PM of their respective due dates as listed on the course calendar, giving you and your classmates time to read and comment on each other's work before the next module begins.

**All late assignments will be penalized 20% if submitted in the first 24 hours after the due date/time. Past 24 hours, assignments will not be accepted.**

Readings and responses to discussion questions should be read and submitted during the module for which they are assigned in order to get the most benefit from the discussions. At the end of each content module, participants will have an opportunity to make sure that they have completed all the required activities and assignments.

# Textbooks

There is one book required for the course: [Genome: An Autobiography of a Species in 23 Chapters](#) by Matt Ridley. In addition, please refer to the optional books of interest, websites, and e-Reserve information listed below and in the overview of each weekly module.

## Optional Books of Interest

- [Here Is a Human Being](#) by Misha Angrist
- [Drawing the Map of Life: Inside the Human Genome Project](#) by Victor McElheney
- [The \\$1,000 Genome](#) by Kevin Davies
- [The Patient Will See You Now](#) by Eric Topol
- [Neanderthal Man: In Search of Lost Genomes](#) by Svante Paabo
- [A Life Decoded: My Genome: My Life](#) by J. Craig Venter
- [The Language of Life: DNA and the Revolution in Personalized Medicine](#) by Francis Collins
- [The Human Genome: Book of Essential Knowledge](#) by John Quackenbush

## Websites and Other References of Interest

- [Scitable: Learn Science at Nature](#)—We will have many readings from this site. It is a useful tool for teachers in general.
- [Genome.gov](#)—Home page for the National Human Genome Research Institute. Has a great talking glossary (look under Education tab)
- [SimGene.com](#)—Hosts a wide selection of bioinformatics tools. A very useful resource for teachers and researchers.

## Articles and e-Reserves

Other reading materials and e-reserves will be listed in the weekly Module Overview pages within the course website.

## Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students should contact both the instructor and the Disability Resources and Educational Services (DRES) as soon as possible. You can contact DRES at 1207 S. Oak Street, Champaign, (217) 333-1970, or via email at [disability@illinois.edu](mailto:disability@illinois.edu).

## Academic Integrity

All students are assumed to have read and understood the “Code of Policies and Regulations Applying to All Students,” University of Illinois, and will be expected to act accordingly.

The Code is available online at <http://www.admin.uiuc.edu/policy/code/index.html>

## **Course Outline**

### **Week 1: Basic Molecular Biology Review, Introduction to Genomics and Bioinformatics, Introduction to Common Bioinformatics**

#### **Databases**

In this module, students will review and refresh their knowledge of the basic tenets of molecular biology and be introduced to the fields of genomics and bioinformatics. This will also be an introduction to the major bioinformatics databases. Students will take a tour of the sites and get a feel for navigating them.

### **Week 2: Genome Sequencing Techniques and Annotation**

This week's module will be an overview of the tools and techniques commonly used to sequence genomes and will look at information most commonly looked for once a researcher has a sequence of DNA.

### **Week 3: The Human Genome**

This module will allow students to explore the significance of genome sequencing and the vast potential of the information obtained by sequencing the human genome. The history of the human genome project is an important look at how science unfolded through advances in technologies and interpersonal drama.

### **Week 4: Genomes of Model Organisms; Genomic Variation; Genomic Medicine**

This week's module will consider the nature and distribution of variation of the genome within a species; students will be introduced to the role of Direct-to-Consumer sequencing services in personal genomics.

### **Week 5: Comparative Genomics in Evolution; The Microbiome**

In Week 5, students will consider the nature and distribution of variation of the genome between species and will receive an introduction to analyzing multiple sequence alignments. Using multiple online bioinformatics tools, students will analyze sequence alignments and understand the theory behind best alignments and will be introduced to creating phylogenetic trees using bioinformatics databases. Information will be provided on the role of genomics in the discovery and elucidation of information about the microbiome.

## **Week 6: Gene Expression, the Transcriptome, and Epigenetics**

In this module, students will be introduced to the importance of documenting gene expression on a genome-wide scale and the technologies developed for parallel analysis of the expression of thousands of genes.

## **Week 7: Proteomics; Gene Editing with CRISPR/Cas9**

Students will explore protein sequences, function, structure and the acquisition of information related to proteins. Additionally, students will learn about the new powerful molecular tool CRISPR/Cas9 for gene editing.

## **Week 8: Final Project**

This week, students will present or post their final project early in the week. Fellow students will be assigned a peer's project to evaluate before the end of the week. Students will earn points from evaluating the project but the projects will be graded solely by the instructors.

## **Course Activities**

### **Grading Scale**

<b>Grade</b>	<b>Points</b>	<b>Percent</b>
<b>A+</b>	703-740	95.00–100.00
<b>A</b>	666-702	90.00–94.99
<b>B+</b>	629-665	85.00–89.99



Assignments	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Total points per assignment
Book Questions	10	10	10	10	10	10	10		70
Discussion Post	15	15	15	15	15	15	15		105
Discussion Replies	10	10	10	10	10	10	10		70
Self-Assessment Quiz	10	10	10	10	10	10	10		70
Milestone for final project	20	20	20	20	20	20	20		140
Final Project								100	100
Evaluation of Peer's Final Project								50	50
<b>Total points</b>	90	80	80	80	80	80	80	150	720

**Note about synchronous session participation:** Though there will be a weekly synchronous session and while you are encouraged to attend every session, there is no credit since it is optional, though students usually find the session valuable.

## Module Overview

Each module will begin with the module overview, explain what the module is about, what learning goals you are expected to achieve, how long the module will take, and in what activities you will participate. Each module is designed with the same structure and activities unless otherwise specified. The module activities are explained in greater detail below. You can find the due dates of specific assignments in the course calendar.

## Synchronous Sessions

Each week there will be a synchronous session in which all students will join together online at the same time to talk. These sessions will use *Blackboard Collaborate* (formerly known as *Illuminate Live!*) to join all participants together in a session where you can text chat, voice chat, and see the computer desktop of the instructor.

### **Muddiest Point**

Weekly: After viewing the lecture, reading the assigned readings, watching associated videos and podcasts, students will briefly reflect upon what was most confusing or "muddy" aspects of the readings and turn that in by noon on Tuesday before the synchronous session where the instructor and other students will attempt to make the topic clearer. **This is OPTIONAL.**

### **Bioinformatics Site Visits**

Weekly: Students will follow guided instructions to visit multiple sites nearly weekly in order to familiarize themselves with common bioinformatics databases and explore what tools are available to researchers and the general public to assist in the analysis of DNA and protein sequences.

### **Discussion**

Weekly: Students will have the opportunity to discuss questions about each module topic. Some of these may be in depth and controversial and some will ask the students to reflect on how this information may be used in their teaching classrooms. Students will write a few paragraphs and reply to the postings of fellow students.

### **Guided Book Questions**

Weekly: Students will have the opportunity to learn more about their chosen genomic disease/disorder by finding answers to questions based on the book chapters they are reading in *Genome: An Autobiography of a Species in 23 Chapters*.

### **Milestone for Final Project**

Weekly: This course will guide you step by step toward the completion of your final project.

Each week you will have milestones and book questions to complete related to the information learned during the week and turn this in to "impress your professors". Any information you provide must be backed up by a primary literature source (or sources) and you will cite these in the format suggested by [Nature](#). All of these milestones will work together to help finish your final project for this class.

### **Self-Assessment Quiz**

Weekly: At the end of each module, students will take a self-paced 10-question quiz to evaluate new knowledge obtained. This will be a mixture of multiple choice, true/false, matching, and short answer questions.

### **Final Project**

One time: By the end of this course, you will become an expert on one disease/disorder that has been genomically elucidated. You may begin with a disease that has a long genetic history, but it must be one that has been further studied using the new techniques involved in genomics.

Your final project will be describing the disease to the general public (think your mom or cousin, for instance). You will have a lot of flexibility in HOW you present the disease for the final project. You may want to write a book chapter, a newspaper or magazine article, start a blog, or make a video or a podcast, or even write a comic book. Whatever method you choose is fine, but the information about the disease must be accessible to the general public.

For more information, please consult the [Final Project Overview](#).