IB 364: 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. Finally, students become an expert on a chosen genomic disease/disorder and successfully relay this information to the general public.

Prerequisite: IB 204 or consent of instructor.

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 and interpret 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;
- Become proficient at searching primary literature for answers to questions about genomic diseases/disorders;
- 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 relates to the chosen disease/disorder to members of the general public in an engaging and clear manner.

Instructor 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.

Course Structure

This is a **3–credit hour** course. The course is **8 weeks** long and consists of 7 content modules and a final project week. 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 **10-15 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.**

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. Most assignments are due by 11:55 PM of their respective due dates as listed on the course calendar.

Readings should be read and activities submitted during the module for which they are assigned in order to get the most benefit from the course and to stay on schedule for their final project. 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.

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.

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

- **The Gene: An Intimate History** by Pulitzer Prize winner Siddhartha Mukherjee 2016
- **Herding Hemingway's Cats: Understanding How Our Genes Work** by Kat Arney 2016
- **The Patient Will See You Now** by Eric Topol 2015
- **Neanderthal Man: In Search of Lost Genomes** by Svante Paabo 2014
- **Drawing the Map of Life: Inside the Human Genome Project** by Victor McElheney 2012
- H**ere Is a Human Being** by Misha Angrist 2011
- **My Beautiful Genome** by Lone Frank 2011
- **The $1,000 Genome** by Kevin Davies 2010
- **The Language of Life: DNA and the Revolution in Personalized Medicine** by Francis Collins 2011
- **The Human Genome: Book of Essential Knowledge** by John Quackenbush 2011
- **A Life Decoded: My Genome: My Life** by J. Craig Venter 2008

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

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**.

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 unfold 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

Grade	Points	Percent

Grade	Points	Percent
A+	527–555	95.00–100.00
A	499–526	90.00–94.99
B+	472–498	85.00–89.99
B	444–471	80.00–84.99
C+	416–443	75.00–79.99
C	389–415	70.00–74.99
D+	361–388	65.00–69.99
D	276–360	50.00–64.99
F	0–275	0.00–49.99

View the Graduate College Handbook for Students, Faculty and Staff Chapter III: Academic Record **Grading System** page for more information.

Assignments, Weights, and Deliverables

You can access your scores by clicking the **Grades** link from the left column of the course home page.

All interim and final deliverables have due dates. Failure to meet deadlines results in a reduction of the assignment points. For the due dates of each assignment, please see the course calendar.

Point Distributions

Assignments	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Total points per assignment
Orientation (quiz introduction)	10	-	-	-	-	-	-		10

Point Distributions

Assignments	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Total points per assignment
Bioinformatics Site Visit	15	15	15	15	15	15	15		105
Book Questions	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
Total points	65	55	55	55	55	55	55	160	545

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.

Bioinformatics Site Visits

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.

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, consult the **Final Project Overview**.