

**Class sessions for Section 0001 (2 sh)** **12:30P – 2:20P**  **TUES 214 Blank Honor’s Center**

**Class sessions for Section 0B01 (4 sh)** **12:30P – 2:20P** **TUES &THURS BHC**

Instructors: Bin He (450 BB) Jan Fassler (202 BBE) David Cooper (201 BBE)

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Office Phone: (319) 467-0158 (319) 335-1542

Office Hours (zoom): T, Th 2:30-4:00 PM §  W, F 2:00-3:30 § M 9:00 AM-12:00 PM

Zoom Links:

<https://uiowa.zoom.us/my/jsfmeeting> (Jan Fassler)

<https://uiowa.zoom.us/j/9624226407> (Bin He)

<https://uiowa.zoom.us/my/dgcooper> (David Cooper)

§ Students unable to make the scheduled office hours are encouraged to arrange separate appointments with the

instructors.

Department Chair (DEO): Jodie Plumert, 143 Biology Building, (319) 335-1054

**CovID19 impact on our classroom**

From the University of Iowa Office of Executive President and Provost:

*“The University of Iowa* ***strongly encourages students, faculty, and staff to be vaccinated against COVID-19****. The university also encourages students, faculty, and staff to wear a face mask while on campus,* *and* ***strongly encourages the use of face masks in all classroom settings and during in-person office hours****. However, face mask usage is not required except on CAMBUS and in specified research and healthcare settings.”*

From the instructors:

*We too,* ***strongly encourage students to wear a face mask in the classroom****. As instructors we will be wearing a face mask not only because some of us live with small children who cannot yet be vaccinated but also because we know firsthand cases of breakthrough infections and the scientific evidence that fully vaccinated people can still get infected, spread the disease, and get sick themselves.*

**Course Description**

This is a one-semester overview of topics in Bioinformatics including gene annotation, protein sequence analysis (such as domain and tandem repeat prediction), pairwise and multiple sequence alignment, local alignment (blast), molecular phylogenetics, functional genomics (e.g., transcriptomics) and protein structure modeling. Emphasis is on understanding the theoretical or conceptual basis of the methods, choosing the correct tool and parameters for the question, and best practices for interpreting the results. The course is open to graduate students and advanced undergraduates.

**Course Goals**

In today’s post-genomic world of biological research, the scientist is awash in data as never before. This data is in the form of DNA and polypeptide sequences, data from genomic and transcriptomic applications, as well as protein structures and phenotypic variation, all of which must be integrated and analyzed together. Furthermore, high-throughput sequencing technology has brought us to the doorstep of the personal genomics revolution. This brings with it another big data explosion, which calls for robust and scalable bioinformatic (data science) tools. The broad goal of this course is to provide an introduction to many of the most important bioinformatics sub-disciplines as well as to provide the opportunity to learn and use basic skills to exploit and integrate the vast public data to advance their own research, curiosity and/or industrial needs.

**Recommended Background**

BIOL:2512 or BIOC:3120 or MICR:3170.

**TILE Format**

This course is taught in a TILE (Transform, Interact, Learn, Engage) format classroom. The TILE project facilitates lively interaction, enhanced learning, increased faculty/student engagement, and student-centered, active learning. TILE rooms are equipped with circular tables, laptops, flat screen monitors and whiteboards to support collaboration and active learning. This free-flowing learning environment is well suited to small group work and ideal for learning to use diverse bioinformatic applications to solve various analytical challenges.

The BHC TILE classroom computers have been preconfigured for our bioinformatics activities. Most of the software applications that will be introduced during the TILE sessions are either available online or easily installable on personal computers for use and practice outside of the TILE sessions and will be mentioned as we go along. **As a courtesy to your classmates and instructors, we ask you to refrain from using computers, phones, and other electronic devices for purposes unrelated to course activities.**

Teaching Approach

This course is offered in either a 2 sh or 4 sh format. Both formats require the students to attend the Tuesday session while only the 4 sh class will attend the Thursday session. The main difference between the two formats is that students enrolled in the 4 sh class will apply the techniques they learned to a semester-long project based on a recently sequenced genome.

**Tuesday sessions** will consist of a mixture of workshop, presentation and discussion. Each workshop will involve a short introduction, group work, and a presentation / discussion period. The workshops are designed to illustrate (i) how each bioinformatic technique of interest can be adapted to specific biological questions, and (ii) how to interpret output with attention to its potential significance.

**Thursday sessions** will allow the 4 sh students to apply the approaches we discuss on Tuesday to a semester-long genome-centered project. In this portion of the course, students will be assisted in the design and execution of a project on a biological question of their choosing. Through a series of self-guided workshops, they will identify a gene (family) relevant to their question, conduct and interpret the appropriate bioinformatic analyses and develop new hypotheses from those analyses that could ultimately be tested experimentally.

Assignments

**Both the 2 sh and 4 sh** students will attend the Tuesday classes. Each week except for week 1, a *Prelab* for the week’s material will be assigned the previous Friday and due before the Tuesday class. On the last week of each module, a *Module Quiz* will be assigned on Tuesday and due on the Sunday of the same week. Both types of assignments are designed to be completed outside of the class.

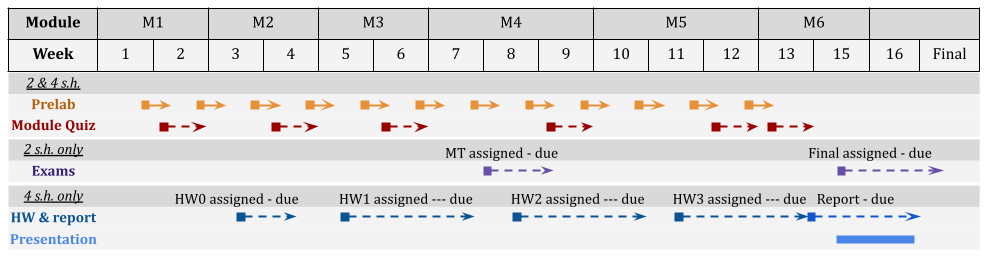
**For the 2 s.h. section only**

The 2 sh students will complete one midterm, assigned in Week 8 and due the next Tuesday, and one final exam, assigned in Week 15 and due in finals week.

**For the 4 sh section only**

The 4 sh students will complete 4 homeworks (the first one is ungraded) designed to help the students select their gene (family) and develop the bioinformatic analyses that will eventually be part of the final report. In addition to the final report, they will also present their main findings during the final two weeks.

Spread of the assignments throughout the semester:



Course Schedule and Reading List \*

\* Both courses are responsible for the Xiong (X) and Hall (H) readings and the Bioinformatics Reader (BR). See Textbooks and Readings section of the syllabus for the key to abbreviations in this table.

2 sh only assignments; 4 sh only assignments

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Wk | Dates | Topics | Textbook Readings\* | Agenda and Assignments  [T] = Tue; [R] = Thu |
| MODULE 1 | | | **Genes & Proteins** | |
| 1 | 8-24,  8-26 | Introductions; History and Overview of the Bioinformatics & Data Science fields |  |  |
| [R] Project preview (past examples) |
| 2 | 8-30  9-2 | Genes; Logic, structure, detection & annotation; Protein secondary structures; PFAM & other Databases | X ch. 8 (p97-106) &  X ch. 12 (p173–180)  BR (week 2) | [T] Prelab1 due, Quiz M1 assigned |
| [R] Student-led discussion of the Genome paper |
| MODULE 2 | | | **Sequence Alignment** | |
| 3 | 9-7  9-9 | Pairwise alignment; BLAST algorithm (theory) | X ch. 3 (p31–50)  BR (week 3) | [T] Prelab2 due |
| [R] Gene Family Selection –  HW0 Launch Page |
| 4 | 9-14,  9-16 | BLAST database searches (practical) | X ch. 4 (p51–62)  BR (week 4) | [T] Prelab3 due, Quiz M2 assigned |
| [R] HW0 Launch page due  BLAST identify homologs |
| MODULE 3 | | | **Multiple Sequence Alignment** | |
| 5 | 9-21, 9-23 | Multiple sequence alignment algorithms; Profiles & HMMs | X ch. 5 (p63–74) & ch. 6 (75-84)  BR (week 5) | [T] Prelab4 due |
| [R] HW1 assigned, MSA for project |
| 6 | 9-28, 9-30 | Motif & Domain Prediction; MSA editing and annotation | X ch. 7 (p85–94)  BR (week 6) | [T] Prelab5 due, Quiz M3 assigned |
| [R] MSA and annotation |
| MODULE 4 | | | **Phylogenetic Analysis** | |
| 7 | 10-5, 10-7 | Phylogenetics (example); Distance based method (neighbor-joining) | X ch. 10 (p127–131)  **H** ch. 1, 5, 6 (all very short) | [T] Prelab6 due |
| [R] Sharing progress for HW1 HW1 due on Saturday |
| 8 | 10-12, 10-14 | Maximum parsimony, maximum likelihood & bootstrapping | X ch. 11 (p163-165)  **H** ch. 8, 9 | [T] Prelab7 due, MT assigned |
| [R] MP and ML trees for project; HW2 assigned |
| 9 | 10-19,  10-21 | Gene tree vs Species tree | TBD | [T] Prelab8 due, Quiz M4 assigned  MT due |
| MODULE 5 | | | **Functional Genomics** | |
| 10 | 10-26,  10-28 | What questions could RNA-seq (or similar) data help answer? | X ch. 9 (p113-124) & ch. 18 (p261-280) | [T] Prelab9 |
| [R] Sharing progress for HW2  HW2 due on Saturday |
| 11 | 11-2  11-4 | GEO database, GEO2R, GalaxyTranscriptomics -2  (working with RNA-Seq data) | TBD | [T] Prelab10 due |
| [R] Explore transcriptomics dataset for project, HW3 assigned |
| 12 | 11-9,  11-11 | David’s RNA-seq lab | TBD | [T] Prelab11 due, Quiz M5 assigned |
| [R] Work on HW3 |
| MODULE 6 | | | **Protein Structure** | |
| 13 | 11-16  11-18 | Swiss Model Homology Modeling | X ch. 12 (p180-186) & ch.15 (p214-230)  BR (week 13) | [T] Prelab12 due, Quiz M6 assigned |
| [R] HW3 Due  Structural predictions for project |
| THANKSGIVING BREAK | | | | |
|  | | |  | |
| 15 | 11-30,  12-2 | Visualizing structures with PyMol | Video tutorial TBD | [T] Final assigned, due W17 Tue |
| [R] Project presentation 1 |
| 16 | 12-7  12-9 | Review and Help with Project Reports |  | [R] Project presentation 2  [R] Project report due on Sunday |

Grading

Letter grades (A, A−, B+, …) will be based on the total points (out of 400 or 600) earned in the course and assigned according to the final distribution of points within the relevant student cohort (*i.e*., undergraduates or graduate students). The final grade will be based on the following course elements:

**SECTION 0001 (2 sh) 500 points**

12 Prelabs 20 % 100 points (variable)

6 Module quizzes 30 % 150 points (25 pts /quiz)

1 Midterm (Take home: Wk 6 - due in Wk 7) \* 20 % 100 points

1 Final exam (Take home: Wk15 - due Finals Weeks) 30 % 150 points

**SECTION 0B01 (4 sh) 600 points**

12 Prelabs 17 % 100 points (variable)

6 Module quizzes 25 % 150 points (25 pts / quiz)

3 Homeworks (HW) 25 % 150 points (50 pts / HW)

1 Project report 25 % 150 points

1 Project presentation 8 % 50 points

\* Exams are due electronically in the ICON dropbox before 12:30 pm of the indicated date. Exams submitted up to one week after due date will be subjected to a 25% penalty. Exams will not be accepted after that time.

Textbooks & Readings

**1. REQUIRED TEXTBOOK (X): *Essential Bioinformatics.* Author: Jin Xiong**

Publication Date: March 13, 2006 | ISBN-10: 0521600820 | ISBN-13: 978-0521600828 |

Available online (link from the course webpage)

From the publisher’s description: “Essential Bioinformatics is a concise yet comprehensive textbook of bioinformatics, which provides a broad introduction to the entire field. Written specifically for a life science audience, the basics of bioinformatics are explained, followed by discussions of the state-of-the-art computational tools available to solve biological research problems. All key areas of bioinformatics are covered including biological databases, sequence alignment, genes and promoter prediction, molecular phylogenetics, structural bioinformatics, genomics and proteomics. The book emphasizes how computational methods work and compares the strengths and weaknesses of different methods. This balanced yet easily accessible text will be invaluable to students who do not have sophisticated computational backgrounds. Technical details of computational algorithms are explained with a minimum use of mathematical formulae; graphical illustrations are used in their place to aid understanding. The effective synthesis of existing literature as well as in-depth and up-to-date coverage of all key topics in bioinformatics make this an ideal textbook for all bioinformatics courses taken by life science students and for researchers wishing to develop their knowledge of bioinformatics to facilitate their own research.”

**2. REQUIRED TEXTBOOK (H): Phylogenetic Trees Made Easy, a How-To Manual. Author: Barry Hall**

Publication Date 2018 | ISBN-13: 978-1605357102 | ISBN-10: 1605357103

From the publisher’s description: “Fifth Edition helps the reader get started in creating phylogenetic trees from protein or nucleic acid sequence data. Although aimed at molecular and cell biologists, who may not be familiar with phylogenetic or evolutionary theory, it also serves students who have a theoretical understanding of phylogenetics but need guidance in transitioning to a practical application of the methodology. The reader is led, step by step, through identifying and acquiring the sequences to be included in a tree, aligning the sequences, estimating the tree by one of several methods, and drawing the tree for presentation to an intended audience. "Learn More" boxes present background on the various concepts and methods.”

**3. OPTIONAL TEXTBOOK: *Understanding Bioinformatics*. Authors: Marketa Zvelebil and Jeremy O. Baum**

Publication Date: 2008 | ISBN-13: 978-0815340249 | ISBN-10: 0815340249

On reserve at the Sciences Library

From the publisher’s description: “Suitable for advanced undergraduates and postgraduates, Understanding Bioinformatics provides a definitive guide to this vibrant and evolving discipline. The book takes a conceptual approach. It guides the reader from first principles through to an understanding of the computational techniques and the key algorithms. Understanding Bioinformatics is an invaluable companion for students from their first encounter with the subject through to more advanced studies.”

**4. REQUIRED BIOINFORMATICS READER (BR):** A compilation of relevant primary literature and program guides, available online (ICON)

Theme Project Genome

Each year, students in the course learn to apply bioinformatics methods to a gene or gene family from a newly sequenced genome of an organism or class of organisms. One classroom session each week will be devoted to this project. A project presentation or report will be presented at the end of the term. Additional information will be available at the beginning of the semester.

**2021:** To be announced at project launch!

**2020:** Genome of the beetle,*Tribolium castaneum* (red flour beetle) and others

**2019:** Genome of *Candida auris*

**2018**: Genome of the cockroach, *Periplaneta Americana*

**2017:** Genome of the tiger tail seahorse, *Hippocampus comes*

**2016:** Genome of the California spotted octopus, *Octopus bimaculoides*

**2015:** Genomes of the Amoebozoa (social slime molds such as *Dictyostelium discoideum* to parasitic ones such as *Entamoeba histolytica*)

**2014:** Genomes of the Giant Viruses (nucleo-cytoplasmic large DNA viruses, or NCLDV)

**2013:** Genome of the enigmatic placazoan *Trichoplax adhaerens*

**Attendance and Classroom Expectations**

Students are responsible for attending class and for knowing an instructor’s attendance policies, which vary by course and content area. All students are expected to attend class and to contribute to its learning environment. Students are also expected to comply with University policies and directives regarding appropriate classroom behavior or other matters. Students also have the right to be evaluated solely on their academic achievement and the fulfillment of related requirements.

**Absences**

Students are responsible for communicating with instructors as soon they know that an absence might occur or as soon as possible in the case of an illness. Students may use the CLAS absence form to aid in communication with instructors who will decide if the absence is excused or unexcused; the form is located on ICON within the top banner under "Student Tools.” Delays in communication could result in a forfeit of what otherwise might be an excused absence.

**Absences: Illness, Unavoidable Circumstances, and University Sponsored Activities**

Students who are ill, in an unavoidable circumstance affecting academic work, or who miss class because of a University sponsored activity are allowed by UI policy to make up a missed exam. Documentation is required by the instructor except in the case of a brief illness. Students are responsible for communicating with instructors as soon as the absence is known.

**Absences: Holy Days**

Reasonable accommodations are allowed for students whose religious holy days coincide with their classroom assignments, tests, and attendance if the student notifies the instructor in writing of any such religious Holy Day conflicts within the first days of the semester and no later than the third week. (See the University Operations Manual:

<https://opsmanual.uiowa.edu/students/absences-class#8.2>).

**Absences: Military Service Obligations**

Students absent from class due to U.S. veteran or U.S. military service obligations (including military service-related medical appointments, military orders, and National Guard Service obligations) must be excused without penalty. Instructors must make reasonable accommodations to allow students to make-up exams or other work. Students must communicate with their instructors about the expected possibility of missing class as soon as possible. (For more information, see <https://opsmanual.uiowa.edu/iv-8-absences-class%C2%A0-0>).

**Academic Misconduct**

All undergraduates enrolled in courses offered by CLAS have in essence agreed to the College's [Code of Academic Honesty](https://clas.uiowa.edu/students/handbook/academic-fraud-honor-code). Academic misconduct affects a student's grade and is reported to the College which applies an additional sanction, such as suspension. Outcomes about misconduct are communicated through UI email (<https://clas.uiowa.edu/students/handbook/academic-fraud-honor-code>).

**Academic Accommodations for Students with Disabilities**

UI is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (such as a mental health, attention, learning, vision, and a physical or health-related condition) through the Student Disability Services (SDS) office. The student is responsible for discussing specific accommodations with the instructor. Note that accommodations are not granted retroactively but from the time of the student’s request to the instructor onward; additionally, accommodations must be requested at least two weeks in advance of the related assignment or exam (<https://sds.studentlife.uiowa.edu/>).

**Class Recordings: Privacy and Sharing**

Course lectures and discussions are sometimes recorded or live-streamed. These are only available to students registered for the course and the intellectual property of the faculty member. These materials may not be shared or reproduced without the explicit written consent of the instructors. Students may not share these recordings with those who are not enrolled in the course; likewise, students may not upload recordings to any other online environment. Doing so is a breach of the Code of Student Conduct and could be a violation of the Federal Education Rights and Privacy Act (FERPA); also see <https://dos.uiowa.edu/policies/code-of-student-life/>.

**Communication: UI Email**

Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and must use this address for any communication with instructors or staff in the UI community ([Operations Manual, III.15.2](https://opsmanual.uiowa.edu/human-resources/professional-ethics-and-academic-responsibility/responsibilities-students)). Emails should be respectful and brief, with complex matters addressed during the instructor’s drop-in hours, for example. Faculty are not expected to answer email after business hours or during the weekends.

**Communication: Free Expression**

The University of Iowa supports and upholds the First Amendment protection of freedom of speech and the principle of academic freedom to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech if student expression in a class context is germane to the subject matter of the class and is conveyed in an appropriate manner. To learn more, visit <https://freespeech.uiowa.edu/>.  
**Complaints about Academic Matters**

Students with a complaint about a grade or a related academic matter should first visit with the instructor and then with the course supervisor if one is assigned, and finally with the Chair of the department or program offering the course. Students may next bring the issue if not resolved to the College of Liberal Arts and Sciences. See <https://clas.uiowa.edu/students/handbook/student-rights-responsibilities>.  
**Final Examination Policies**

The final exam schedule is published during the fifth week of the fall and spring semesters or on the first day of summer classes; students are responsible for knowing the date, time, and place of their final exams. Students should not make travel plans until knowing this information. A student with exams scheduled on the same day and time or who have more than two final exams on the same day should visit this page for how to resolve these problems by the given deadline: <https://registrar.uiowa.edu/makeup-final-examination-policies>. No exams are allowed the week before finals, but with some exceptions made for labs, language courses, and off-cycle courses [(https://registrar.uiowa.edu/final-examination-scheduling-policies](https://registrar.uiowa.edu/final-examination-scheduling-policies)).  
**Home of the Course**

The College of Liberal Arts and Sciences (CLAS) is the home of this course, and CLAS governs the courses add and drop deadlines, the “second-grade only” option (SG0), and other undergraduate policies and procedures. Different UI colleges may have other policies or deadlines. See <https://clas.uiowa.edu/students/handbook>. Questions? Contact CLAS at [clasps@uiowa.edu](mailto:clasps@uiowa.edu) or 319-335-2633.

**Mental Health**

Students are encouraged to seek help as a preventive measure or if feeling stressed or overwhelmed. Students should talk to their instructors for guidance with specific class-related concerns and are encouraged to contact University Counseling Service (UCS) at 319-335-7294 during regular business hours to schedule an appointment. USC offers group and individual therapy as well as counseling for couples about relationships while making referrals to other resources (<https://counseling.uiowa.edu/>). Student Health can also address related concerns (<https://studenthealth.uiowa.edu/>). These visits are free to students. After hours, students are encouraged to call the Johnson County Community Crisis Line at (319) 351-0140 or dial 911 in an emergency.

**Nondiscrimination in the Classroom**

The University of Iowa is committed to making the classroom a respectful and inclusive space for people of all gender, sexual, racial, religious, and other identities. Toward this goal, students are invited in MyUI to optionally share the names and pronouns they would like their instructors and advisors to use to address them. The University of Iowa prohibits discrimination and harassment against individuals based on race, class, gender, sexual orientation, national origin, and other identity categories indicated by the University’s Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity at <https://diversity.uiowa.edu/division/office-equal-opportunity-and-diversity-eod>

**Sexual Harassment**Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff; all members of the UI community are expected to conduct themselves in a manner that maintains an environment free from sexual harassment and sexual misconduct. Those experiencing sexual harassment are strongly encouraged to report the incidents and to seek help (<https://osmrc.uiowa.edu/>).

**Last modified:** August 18, 2021