BIOL 5140, GENOME BIOLOGY  
Spring 2020

Time: Tuesdays & Thursdays, 9:10 AM – 10:30 AM, Spring 2020

Location: Life Sciences 111 (LS 111)

Instructor: Dr. Richard Clark, Professor, School of Biological Sciences  
Office: Biology Building Room 341  
Phone: 801-585-9722  
Email: richard.m.clark@utah.edu

Teaching Assistant: Alexander Bradshaw (Email: Alexander.bradshaw@utah.edu).

(Please put “BIOL 5140” in subject lines of emails so that we can recognize class emails and respond ASAP; we will only respond to emails sent to the addresses above).

Office Hours: By appointment.

Department Offering Course: School of Biological Sciences (SBS).

Pre-requisites: BIOL 2020/2021 (Principles of Cell Biology) & BIOL 2030 (Genetics).

Units: 3 units.

Course Catalog Description: The sequence of the human genome, and that of other animals and plants, highlights the rapid progress in genomics, the study of the DNA sequence and genes of an organism. This course will examine recent findings in the field, with an emphasis on how advances in genomics are revolutionizing the ways by which we assign functions to sequences and genes. While human genomics will feature prominently, examples will be selected from diverse organisms to illustrate basic principles.

Content Overview: For the first time, knowing the complete DNA sequence (the genome) of individuals is within reach, even for species with large genomes like human. At the same time, genome-wide studies of gene expression help us to understand how DNA sequences act to affect phenotypic outcomes (for example, disease susceptibility in humans). In this course, we will examine how recent findings are shaping our understanding of genome structure, the causes and consequences of DNA sequence variation, and the role of transcription and epigenetic DNA modifications (for example, DNA methylation) in mediating diverse aspects of genome biology.

Expected learning outcomes: Students successfully completing BIOL 5140 (Genome Biology) will understand:

- The basic structure and evolution of eukaryotic genomes
- Genome sequencing technologies, and how genome sequencing enables genome-wide association studies to identify disease causing variation
- What constitutes an epigenetic process, and the molecular-genetic bases of such processes (for example, histone modifications and DNA methylation)
• The role of small RNAs in endogenous gene regulation, as well as applications of small RNAs to experimentally manipulate gene function
• The role of transposable elements in shaping the content of eukaryotic genomes
• The evolution of gene expression, and the consequence of variation in gene expression on disease and other organismal phenotypes
• The latest in genome editing technologies and the potential to impact human welfare
• How to locate, critically read, and evaluate the primary scientific literature

**Teaching & Learning Methods:** Lectures presented by the instructor will be followed by in-class student presentations and discussions of articles from the primary literature (hereafter called “literature discussions”). For in-class exercises, students will work in groups to discuss and evaluate assigned research articles. In general, a given group will present some aspect of an article to the larger class (for instance, a table/figure). In-class discussions, as well as quizzes and problem sets, will be focused on developing critical thinking skills. Review materials will be distributed by the instructor prior to exams.

**Evaluation Methods:** Class participation will feature prominently. The grading component to the “in-class participation” aspect of the course will include participating in discussions during class periods, especially in the designated discussions of the primary literature. Two problem sets will be assigned, and will consist of questions of similar scope to those that will be asked on two midterm exams and on the final exam. Literature discussion handouts will be due at the beginning of class periods the day of the discussions, and will be handed out on the first day of class.

**Grade Scale:**
- Exams (two midterms & final exam): 50%
- In-class participation: 20%
- Problem sets: 20%
- Literature discussion handouts: 10%

All exams will be given equal weight. However, the LOWER of the two midterm scores will be dropped. *That is, your exam component to the final grade will be based on your best midterm exam score and on the final exam (the final exam will be cumulative, but will be weighted somewhat toward the last one-third of the semester).* Thus, you can do well on one of the midterm exams and on the final exam and still do well in the course. There will not be make up exams for the two midterms unless under exceptional circumstances (again, the lowest midterm exam score will be dropped). While you are allowed (even encouraged) to work together to understand reading materials, answers to problem sets and quizzes must, of course, be your own (see also Student and Faculty Responsibilities section, page 6). Literature discussion handouts and problem sets are due at the beginning of class periods except under exceptional circumstances and by prior arrangement with the instructor (there will be no exceptions). Answer keys for problem sets will be posted after the class periods in which they are due. *Letter grading will be based on the following: A grades (90-100%), B grades (80-90%), C grades (70-80%), D grades (60-70%), and E (< 60%).*

**Reading List:** No textbook is required. Reading assignments will be from review or primary literature articles, and can be download (at no cost as you are a University of Utah student) as PDFs from journal websites (details for downloading articles will be covered in the first class period).

(continued on the next page)
### Weekly Schedule of Topics and Due Dates:

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Topic</th>
<th>Due Date</th>
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<tbody>
<tr>
<td>Jan 7</td>
<td>T</td>
<td>Genome features &amp; genes</td>
<td></td>
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<tr>
<td>9</td>
<td>H</td>
<td>Eukaryotic origins, experimental models</td>
<td></td>
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<tr>
<td>14</td>
<td>T</td>
<td>DNA sequencing I: Genome sequencing</td>
<td></td>
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<tr>
<td>16</td>
<td>H</td>
<td>DNA sequencing II: Re-sequencing &amp; transcriptome sequencing</td>
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<tr>
<td>21</td>
<td>T</td>
<td>LITERATURE DISCUSSION</td>
<td>1st Problem set assigned</td>
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<tr>
<td>23</td>
<td>H</td>
<td>Genome-wide association mapping (GWA)</td>
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<tr>
<td>28</td>
<td>T</td>
<td>GWA continued &amp; selective sweeps</td>
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<tr>
<td>30</td>
<td>H</td>
<td>LITERATURE DISCUSSION</td>
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<td>Feb 4</td>
<td>T</td>
<td>Histones: functions &amp; modifications</td>
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<td>6</td>
<td>H</td>
<td>The “5th base”: DNA methylation</td>
<td>1st Problem set due</td>
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<td>11</td>
<td>T</td>
<td>LITERATURE DISCUSSION</td>
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<tr>
<td>13</td>
<td>H</td>
<td>MIDTERM</td>
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<tr>
<td>18</td>
<td>T</td>
<td>Introduction to small RNAs (sRNAs)</td>
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<td>20</td>
<td>H</td>
<td>sRNAs continued</td>
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<td>25</td>
<td>T</td>
<td>LITERATURE DISCUSSION</td>
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<td>27</td>
<td>H</td>
<td>Centromeres, telomeres &amp; replication origins (2nd Problem set assigned)</td>
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<td>Mar 3</td>
<td>T</td>
<td>Recombination &amp; gene conversion</td>
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<td>5</td>
<td>H</td>
<td>LITERATURE DISCUSSION</td>
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<td>8 – 15</td>
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<td>Spring break (no classes)</td>
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<td>17</td>
<td>T</td>
<td>Transposable elements I: Types &amp; movement</td>
<td>2nd Problem set due</td>
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<td>19</td>
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<td>Transposable elements II: Effects on genes</td>
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<td>24</td>
<td>T</td>
<td>Genome editing: TALENs and CRISPR/Cas9 (not covered on 2nd midterm)</td>
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<td>26</td>
<td>H</td>
<td>MIDTERM</td>
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<tr>
<td>31</td>
<td>T</td>
<td>Gene expression &amp; evolution</td>
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<td>Apr 2</td>
<td>H</td>
<td>LITERATURE DISCUSSION</td>
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<td>7</td>
<td>T</td>
<td>Gene splicing</td>
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<td>LITERATURE DISCUSSION</td>
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<td>T</td>
<td>Sex specification &amp; sex chromosomes</td>
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<td>16</td>
<td>H</td>
<td>Gene drive: Can we halt malaria?</td>
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<tr>
<td>21</td>
<td>T</td>
<td>LITERATURE DISCUSSION</td>
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**FINAL EXAM**: Tuesday, April 28, 8:00-10:00 AM (in the regularly scheduled classroom). You must take the final exam (the final accounts for 25% of your grade).

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Reading Material for Lectures (by week):

Instructions for downloading reading materials:

2. Type in the Pubmed ID (PMID; this is a unique identifier for an article)
3. In the upper right-hand corner of the resulting webpage you will see a link to the journal website
4. Click on the link to the journal website, and you should see the paper abstract appear along with other information about the article
5. Search for, and click on, the “PDF” button to download the article (the link to download is typically in different places depending on the publisher, but is easy to find, use the search function in your browser window if needed).

Note: You must be connected to the U of U system to have access to the articles (for example, on the UConnect WiFi or by VPN if off campus). Information about connecting by VPN to the U of U system can be found here:

www.lib.utah.edu/help/off-campus.php

Class reading materials by date (to be read before classes):

Jan 9:

Jan 14:

Jan 16:

Jan 23:

Jan 28:

Feb 4:

Feb 6:
Feb 18:

Feb 20:

Feb 27:

March 3:

March 17 & 19:

March 24:

March 31:

April 7:
None.

April 14:

April 16:

Reading Material for in-class Literature Discussions (by day of discussion):

Jan 21:

Jan 30:

Feb 11:

Feb 25:

March 5:

April 2:

April 9:

April 21:

**University Policies**

**Faculty and Student Responsibilities**

All students are expected to maintain professional behavior in the classroom setting, according to the Student Code ([http://regulations.utah.edu/academics/6-400.php](http://regulations.utah.edu/academics/6-400.php)). Students have specific rights in the classroom as detailed in Section II of the Code ([http://regulations.utah.edu/academics/6-400.php#section_2](http://regulations.utah.edu/academics/6-400.php#section_2)). The Code also specifies expectations of student behavior (Section III, [http://regulations.utah.edu/academics/6-400.php#section_3](http://regulations.utah.edu/academics/6-400.php#section_3)). Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.

**Special Accommodations**

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice
needs to be given to the Center for Disability and Access (https://disability.utah.edu/). CDA will work with you and the instructor to make arrangements for accommodations.

**Academic Conduct**

In order to ensure that the highest standards of academic conduct are promoted and supported at the University, students must adhere to generally accepted standards of academic honesty. Acts of academic misconduct include cheating, plagiarizing, research misconduct, misrepresenting one's work, and inappropriately collaborating. Suspected cases of academic misconduct will be dealt with according to the rules found in the Student Code, University Policy 6-400 (http://regulations.utah.edu/academics/6-400.php). Instances of academic misconduct will be recorded in a database that may be made available to other University of Utah Departments and Colleges.

**Title IX: Addressing Sexual Misconduct**

Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veterans status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action (http://oeo.utah.edu/, 135 Park Building, 801-581-8365), or the Office of the Dean of Students (http://deanofstudents.utah.edu, 270 Union Building, 801-581 7066). For support and confidential consultation, contact the Center for Student Wellness (http://wellness.utah.edu, 426 SSB, 801-581-7776). To report to the police, contact the Department of Public Safety [http://dps.utah.edu, 801-585-2677(COPS)].

**University Safety Statement**

The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit http://safeu.utah.edu.

**Final Note**

This syllabus is not a binding contract. It may be modified by the instructor when students are given reasonable notice of changes.