Special Topics:
RNAseq Gene Expression Analysis Using Galaxy
BIOLOGY 4590.003/5590.003/6590.003

Department of Life Sciences
Summer II 2015

A. COURSE INFORMATION

Course number/section: BIOLOGY 4590.003/5590.003/6590.003
Class meeting time: F2F: M 2:00-4:00, W, R 2:00-3:00; Plus eLearn
Class location: TBD
Course Website: See BlackBoard

B. INSTRUCTOR INFORMATION

Instructor: Kirk Cammarata
Office location: EN 319 B
Office hours: M, W, R 1:00-2:00; T 3:00-4:00
Telephone: 361-825-2468
e-mail: kirk.cammarata@tamucc.edu
Appointments: Email or call to check on my availability at other times or to make an appointment

C. COURSE DESCRIPTION

Catalog Course Description
An in-depth exploration of RNAseq and the Galaxy bioinformatics platform to characterize and measure changes in gene expression as part of a functional genomics approach to biological questions. Course will be 45% face-to-face and 55% on-line.

Extended Course Description
We will explore, in-depth, RNAseq, the use of Next Gen DNA sequencing technology to measure RNA on a genome-wide basis, as well as the Galaxy open-access bioinformatics platform to characterize and quantify changes in gene expression. This mostly on-line course will review the molecular biology of eukaryotic gene expression, the methodology of Next Gen DNA sequencing, and the theory behind sequence output as a measure of gene expression. Students will be guided through the use of Galaxy as an analytical bioinformatics platform to process data, assess sequence quality, assemble sequence data, map output to a reference genome, identify splice variants, quantify gene expression levels, and to visualize and comparatively analyze the output.
D. **PREREQUISITES AND COREQUISITES**

Prerequisites

*Three* of the following courses (or equivalents): Genetics, Cell Biology, Molecular Biology, Biochemistry, Genomics OR permission of instructor

Corequisites

None

E. **REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES**

Required Textbook(s)

None

Optional Textbook(s) or Other References

Readings will be assigned from appropriate journals or multimedia sources accessed via BlackBoard, and from materials placed on library reserve. However, a recent text from your Genetics or Molecular Biology course is recommended for reference purposes.

As this course is partially on-line, access and utilization of BlackBoard will be REQUIRED. Please see below for more details.

Some of the lecture materials and many of the hands-on tutorials can be found here: http://training.bioinformatics.ucdavis.edu/docs/2013/09/short-course-2013/

Supplies

Access to computer and internet

F. **STUDENT LEARNING OUTCOMES AND ASSESSMENT**

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.
By the end of this course, students should be able to:

1. describe the mechanisms of eukaryotic gene expression, including critical points and mechanisms for regulation
2. describe mechanisms that generate variants of expressed genes
3. provide examples of the biological relevance and application of gene expression measurements
4. describe a common Next Gen DNA sequencing technology, its data output format and primary error mode
5. identify different sample preparation methodologies for “RNAseq” experiments
6. access databases of public high throughput DNA/RNA sequencing data
7. navigate through the Galaxy bioinformatics analysis platform, including data upload, download, processing and workflow assembly
8. apply a core set of sequence analysis tools, including knowledge of the basis for adjusting variable analysis parameters
9. outline the RNAseq data analysis pipeline, including:
   - Quality control measures and sequence processing
   - Sequence assembly (de novo vs referenced)
   - Mapping to reference or assembled genomes
   - Quantify and normalize gene expression levels
   - Application of statistical analysis
   - Visualization of gene expression data
10. interpret, present and critique results of RNAseq experiments (Graduate)
11. describe how RNAseq could be applied to a research topic of interest (Graduate)

G. INSTRUCTIONAL METHODS AND ACTIVITIES

Course will be 45% face-to-face and 55% on-line. This course will utilize traditional lecture, in-class demonstrations, hands-on tutorials, and scientific literature reading/presentation/discussion to: 1) introduce students to the theoretical basis for the use of modern “Next Gen” DNA sequencing (NGS) technology as a tool to characterize and
measure gene expression; 2) learn about NGS methodology and application; and 3) provide guided hands-on learning experience in the use of a common open-source GUI-based bioinformatics analysis platform to process and analyze data.

H. MAJOR COURSE REQUIREMENTS AND GRADING

Undergraduate:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
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<tbody>
<tr>
<td>Quizzes</td>
<td>30</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20</td>
</tr>
<tr>
<td>Homework</td>
<td>40</td>
</tr>
<tr>
<td>Participation</td>
<td>10</td>
</tr>
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Graduate:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
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</thead>
<tbody>
<tr>
<td>Quizzes</td>
<td>33</td>
</tr>
<tr>
<td>Final Exam</td>
<td>19</td>
</tr>
<tr>
<td>Homework</td>
<td>27</td>
</tr>
<tr>
<td>Paper Presentation/Discussion Leadership</td>
<td>14</td>
</tr>
<tr>
<td>Participation</td>
<td>7</td>
</tr>
</tbody>
</table>

I. COURSE CONTENT/SCHEDULE

Important Dates:

- Classes Begin: July 6
- Last day to register: July 7
- Last Day to Drop without record: July 24
- Last Day to withdrawal: August 4
- Last Class Day: August 6
- FINAL EXAM: Thurs August 6 (2:00 – 4:00)
<table>
<thead>
<tr>
<th>DATE (BY DAY OR WEEK)</th>
<th>TOPIC</th>
<th>ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 6 – 9</td>
<td>Intro; Course setup; What is RNAseq &amp; Why? Review gene expression Review RNAseq application paper Intro to Galaxy – Accessing/Navigating Galaxy Galaxy workflows Overview of sequence file structures &amp; quality score encoding Load, view &amp; QC filtering NGS seq files</td>
<td>Navigate Galaxy Load, view &amp; QC filtering NGS seq files</td>
</tr>
<tr>
<td>July 13 - 16</td>
<td>NGS technologies Discussion of adv/disadv &amp; error modes Regulation of gene expression I Databases &amp; public seq repositories Sequence assembly &amp; assessment</td>
<td>Quiz 1 Sequence assembly</td>
</tr>
<tr>
<td>July 20 - 23</td>
<td>Sequence assembly &amp; assessment (Cont’d) Regulation of gene expression II UCSC Genome Browser</td>
<td>Quiz 2 Visualize assemblies</td>
</tr>
<tr>
<td>Aug 3 - 6</td>
<td>Statistical analyses, False Discovery Rate Pathway analysis: DAVID ChIPseq applications Metatranscriptomics Paper presentations and class discussions Cloud computing; Command line</td>
<td>Quiz 4 Final Exam (8-6)</td>
</tr>
</tbody>
</table>

The time and point schedule may require adjustment. Additional assignments may or may not be provided at the Instructor’s discretion. Such assignments might include homeworks, group
projects, reading assignments, quizzes, etc. Every attempt will be made to follow the time and evaluation schedules shown here. **It is the student’s duty to attend each class session and be aware of all assignments, deadlines, etc.**

**Other Course Requirements:**

1. All Exams are the property of the Instructor as they will be saved for course records.

2. All students must access BlackBoard on a regular basis to watch for class announcements and to complete course assignments, readings, etc.

For help with access to BlackBoard, email or internet, please contact the IT Helpdesk by phone (825-2692) or electronically (computer.helpline@tamucc.edu; http://it.tamucc.edu/selfservice/index.html)

3. Attendance at lecture, preparedness and participation in all online and hands-on learning activities is required and counts towards your participation points. Assignments cannot be made up later if absent without a recognized excuse (see below).

**Explanation of Assignments:**

Quizzes may comprise scantron-type questions, matching, data analysis or short answer/essay-type questions. Some questions typically require analysis and interpretation of data or experimental design to assess critical thinking skills. The **Final Exam will be held on Thursday August 6 from 2:00 – 4:00 PM.** Graduate students will take the same quizzes and final exam as the undergraduates, but will also have additional graduate-specific questions added to both the quizzes and final exam.

Readings, media viewing, tutorials and internet-based data analysis will be assigned and accessed via BlackBoard, internet URL, or via reserve at the library. You are encouraged to get together and work on problem-solving as a group. However, any assignments must be turned in individually and be written in your own words, NOT COPIED from someone else (unless specified as a group assignment).

A cornerstone of the course is to analyze a reduced-size RNAseq dataset using the Galaxy bioinformatics platform. This will be achieved in a guided, stepwise fashion, with review of relevant concepts along the way. **Data output and question assignments** will be weekly portfolios comprised of analytical outputs of the Galaxy-based data analyses as well as response to questions related to data interpretation and application.

**Graduate students will additionally do a Paper presentation and class discussion leadership assignment to acquire skills in the application and interpretation of RNAseq to a biological problem.**

All assignments and examination answers must be legible to the Instructor. Illegible answers will receive a “0”.
J. COURSE POLICIES

Attendance/Tardiness
Attendance is the student’s responsibility. You are responsible for the material covered in every lecture or online activity, regardless of your (lack of) attendance or participation. Nothing missed during an unexcused absence can be made up. An excused absence allows us to make alternative arrangements to complete an assignment. Only unavoidable absences are excused. Routine events (non-emergency medical visits, parent-teacher conferences, household or auto repairs) should be scheduled to avoid conflicts with class. Plane tickets booked to conflict with class do NOT constitute an excusable absence. An acceptable excuse must be:

• from an appropriate source (doctor, dentist, funeral director) who states the nature and dates of the event
• In writing, on official letterhead, and signed (it will not be returned)
• presented prior to, or within 3 days of, the absence

Late Work and Make-up Exams
Nothing missed during an unexcused absence can be made up. An excused absence allows us to make alternative arrangements to complete an assignment. Only unavoidable absences are excused. Routine events (non-emergency medical visits, parent-teacher conferences, household or auto repairs) should be scheduled to avoid conflicts with class. Plane tickets booked to conflict with class do NOT constitute an excusable absence. An acceptable excuse must be:

• from an appropriate source (doctor, dentist, funeral director) who states the nature and dates of the event
• In writing, on official letterhead, and signed (it will not be returned)
• presented prior to, or within 3 days of, the absence

There are No make-up examinations: For some scheduled events, you may arrange to take a lecture exam before, but not after, its scheduled time.

Cell Phone Use
As adult university students, you are expected to act with courtesy and common sense. Disruptive, disrespectful, or abusive language/behavior towards anyone in class (student, staff, faculty) will not be tolerated and could result in permanent removal from class. This includes tardiness to class, talking in class, insubordination, and electronic disturbances (cell phones, ipods, etc). Turn it off unless specifically being used for class.

Missed Exam
See Above.
Participation
All students are expected to attend the full class periods, complete all e-learning assignments and tutorials, complete reading assignments fully and carefully, and to participate in class discussions. A portion of your grade is earned by participation.

Expectations:
You are responsible for your own education. Take notes in class, during discussions, and when reading journal articles or completing assignments. Ask questions when you have them and seek help when you need it. The instructor is here to help you. Be aware of university-imposed deadlines (ie drop dates).

K. COLLEGE AND UNIVERSITY POLICIES
• Academic Integrity (University)
University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

• Classroom/Professional Behavior
Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

• Statement of Civility
Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex,
ethic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

- **Deadline for Dropping a Course with a Grade of W (University)**
  The grade of W will be assigned to any student officially dropping a course. Please consult with the instructor before you decide to drop to be sure it is the best thing to do. Just stopping attendance and participation **WILL NOT** automatically result in your being dropped from the class. Should dropping the course be the best course of action, visit the Office of the University Registrar for the Course Drop Form that must submitted. No student is eligible to receive a W without completing the official drop process by this deadline. Please consult the Academic Calendar ([http://www.tamucc.edu/academics/calendar/](http://www.tamucc.edu/academics/calendar/)) for the last day to drop a course.

- **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage at [http://sci.tamucc.edu/students/GradeAppeal.html](http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.

  If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.
http://disabilityservices.tamucc.edu/

- **Statement of Academic Continuity**
  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

L. **OTHER INFORMATION**

- **Academic Advising**
  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College’s Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.

**GENERAL DISCLAIMER**
I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes during regularly scheduled lecture periods.