Syllabus:

Development of New Applications for Next Generation Sequencing

Bulletin Description:
Development of New Applications for Next Generation Sequencing.
Prerequisites: Biol 201 & 202

This class is designed to shed new light on wide variety of tools available for developing new ideas for NGS applications.

General Course Info:
Term: Fall 2019
Department: Genetics
Course number: GNET747
Number of Students: between 3 and 10

Instructor Info:
Name: P.A. Mieczkowski, PhD
Office: 4256 Genome Sciences Building
Email: miecz001@med.unc.edu
Phone #: 919 6196832
Web:
Office hours: Tuesday at 11:30am

Textbooks and Resources:

Textbook: There is no required textbook for this class. Students will be provided with the list of reading assignments, which will include scientific, peer-reviewed publications.

Website: We use the Sakai course website, for access to handouts, papers, and presentations. You will need an Onyen to log into Sakai. / My website is open source, available without need to login.

Supplemental videos/materials: These will be provided as needed during the semester.

Disabilities: If you have a physical or learning disability, please let us know about your special requirements. Also, please see:
http://disabilityservices.unc.edu

Prerequisites: Biol 201 & 202

Course Objectives: In this class you will learn:
• Learn about current NGS applications
• Learn about chemistry behind NGS applications
• Design NGS application: design and problem solving

Course Requirements: This class is meant to be explorative in nature, which has several implications:

**Reading:** Students will be required to read preparatory literature before most of classes to enable their participation in discussion following lecture part of the class. There will be approximately 1-3 papers per class assigned. Supplemental reading will be also suggested.

**Seeking help:** Information in this class is linked. If you do not understand one element, you may trouble in understanding implications later. Do not hesitate to ask questions during the class, email your instructor, take advantage of office hours.

Key Dates: See Master Course Schedule for details.

Basic Structure:
• Class consists of lecture and discussion/student presentation and discussion;
• Midterm: Oral Exam
• Practical part - library preparation
• Final: Oral Exam

Grading Criteria: Your course grade is based on your cumulative performance on participation, presentation, midterm, and final.

<table>
<thead>
<tr>
<th>Grading Criteria</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Discussion/preparation/quizzes</td>
<td>25%</td>
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<tr>
<td>Library preparation</td>
<td>35%</td>
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<tr>
<td>Midterm</td>
<td>15%</td>
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<tr>
<td>Final</td>
<td>25%</td>
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Exams (Midterm 15%, Final 35%): There will be one midterm and one final exam. The dates for exams will be posted on Sakai/website. Each student will have a separate time slot for his/her oral exam. If the campus is closed for any reason during a scheduled exam, then the exam will be rescheduled to first available, mutually agreeable date.

Course Policies:

**Attendance:** Attendance is recommended in order to stay on top of the material. Lectures will start promptly at the beginning of each class. If you must be absent for an extended period of time, please contact the instructor.
to make arrangements to receive in-class handouts and directions. It is your responsibility to read assigned literature.

**Honor Code:**

**Academic Honesty:** Refer to UNC’s honor code at [http://instrument.unc.edu/](http://instrument.unc.edu/) for discussion on academic honesty. If you are in doubt about any of the honor code, please ask me.

**Plagiarism:** If you consult any outside sources when doing your work, you are expected to fully document those sources. Give credit where credit is due. Plagiarism will not be tolerated.

**Cheating:** Cheating in any form on assignments or exams will not be tolerated.

**Civility:** UNC places a priority on student learning. We value the inherent worth and dignity of every individual. We expect all to be civil to each other by:

- **Etiquette:** With the exception of laptops used to take notes or to run MATLAB, please keep all other electronic devices (i.e. cell phones) turned off or silenced in class.

- **Respecting Others:** Respect faculty, staff, students, guests, other peoples’ private property, university property, policies, rules and regulations.

- **Being Responsible:** Take responsibility for your choices and actions. Accept consequences for your inappropriate choices and actions.

- **Being Professional:** Communicate in a professional and courteous manner in all forms, and at all times, whether verbal, non-verbal or written.

**Course Schedule:** A preliminary course schedule is posted on Sakai/website. While we will make every attempt to follow this schedule, we reserve the right to adjust the schedule as the course progresses; however, you will be given advance notification of any changes.

**Master Course Schedule:**

(DRAFT)

Class 1: Introduction. How to choose Sequencing System right for your project?
Course overview and structure
Overview of current and upcoming DNA Sequencing systems
Types of available chemistry for Illumina Sequencing Systems
Students select topics of their presentations

Class 2: Whole Genome DNA sequencing: Strategies
Types of repetitive elements in the genomes: Student presentation (10 mins)
Short reads sequencing strategies
Long reads sequencing strategies
Supporting technologies: Genome optical mapping, 10x customization of chemistry

Class 3: Whole Genome DNA sequencing: Library preparation using KAPA DNA HyperPrep.

Class 4: Target Enrichment systems
Types of DNA Polymerases: Student presentation (10 mins)
DNA target capture for NGS
MIPS technology
Modifications of DNA capture strategies (NuGen and Archer)
Customization of chemistry for low frequency DNA variants detection

Class 5: Amplicon and Metagenomics 16S/ITS studies
Detection of low frequency DNA variants: Student presentation (10 mins)
Development of the amplicon system for Illumina systems
Examples of high throughput amplicon studies on PacBio

Week of Class 6: **Mid-term oral Exam**

Class 7: Epigenetics
Buffers content: Student presentation (10 mins)
Practical information about protein/protein modification mapping - ChIPseq
DNA methylation mapping strategies
ATACseq

Class 8: Analysis of transcription profiles (part 1)
Strategies for transcripts depletion: Student presentation (10 mins)
mRNAseq systems – low and high input
Total RNAseq systems – low and high input
Class 9: mRNaseq Library preparation – practice

Class 10: Single cell applications
Libraries from damaged RNA or DNA from FFPE samples:
Student presentation (10 mins)
Single cell transcription analysis technologies
Whole genome sequencing from single cell

Class 11: Total RNAseq library preparation – practice

Class 12: Library preparation by tagmentation - practice

Class 13: Clinical versus Research DNA sequencing
Types of genetic variations: Student presentation (10 mins)
Difference between clinical and research sequencing
Hot subjects in research and clinical diagnostics
Examples of clinical tests

Class 14: Amplicon Library preparation

Class 15: Discussion: NGS application selected by students
Example: Cell barcoding
Example: Mapping genetic elements/lesions in the genome
Example: Enrichment and sequencing of a virus genome

Class 16: Discussion: NGS application selected by students
Example: Unique Molecular Barcodes and Duplex barcodes
Example: proposed by students
Example: proposed by students

Class 17: Makeup day
Catch –up

**Reading Assignments:**