MCB 480/580 **Introduction to Systems Biology 2021**

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The proteins in a cell are organized into networks and circuits that act to process information and control cell activity. In this course we will explore the structure and function of these circuits through discussion of the relevant literature and by building and testing mathematical models of simple/toy circuits. Emphasis will be placed on key concepts such as hysteresis, ultrasensitivity, adaptation, robustness and noise propagation.

Prerequisites. MCB 181, Math 129 and one upper division biology/ biochem course or consent of instructor

GRADING: Regular grades will be awarded for this course (A, B, C, D, E). Students will be graded on four written assignments, several presentations, and their class participation (see below for details). Each assignment will require that the student understands the material covered in class and push them to apply it a new way. Assignments will be graded numerically for both clarity and content. Grades will be assigned as follows: A=90-100%; B=80-89%, C=65-79%; D=50-64%, E<50%.

Challenges and Reports
Students are expected to work in assigned groups on each of the three challenges. Each member of the group must also write a 5-10 page paper (including figures) describing the findings of the group and explaining why they designed the circuit the way they did and how the circuit(s) works (100 points). Although circuit modeling and detailed discussion can (and should) take place in the groups, **EACH STUDENT MUST WRITE THEIR OWN REPORT**. Failure to follow this policy will result in a 0 on the report.

The final report is to be written on a topic in genomics/proteomics that is of interest to the student (not in groups). This report must cover an area or system not discussed in class, 5-10 pages (including figures). Topics must be approved by the instructor by Nov 26th. (100 points)

Presentations
Groups will be assigned days where they have to present the days paper in class (50 points per presentation). This will occur approximately 2-times per group. Groups will sign up for these presentations during class.

- **Classroom attendance:**

- If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructor(s) if you will be missing a course meeting or an assignment deadline.
- Non-attendance for any reason does **not** guarantee an automatic extension of due date or rescheduling of examinations/assessments.
    - Please communicate and coordinate any request directly with your instructor.
- If you must miss the equivalent of more than one week of class, you should contact the Dean of Students Office DOS-deanofstudents@email.arizona.edu to share documentation about the challenges you are facing.
- Voluntary, free, and convenient COVID-19 testing is available for students on Main Campus.
- If you test positive for COVID-19 and you are participating in on-campus activities, you must report your results to Campus Health. To learn more about the process for reporting a positive test, visit the Case Notification Protocol.
- COVID-19 vaccine is available for all students at Campus Health.
- Visit the UArizona COVID-19 page for regular updates.

- **Academic advising:** If you have questions about your academic progress this semester, please reach out to your academic advisor (https://advising.arizona.edu/advisors/major). Contact the Advising Resource Center (https://advising.arizona.edu/) for all general advising questions and referral assistance. Call 520-626-8667 or email to advising@.arizona.edu

- **Life challenges:** If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at (520) 621-2057 or DOS-deanofstudents@email.arizona.edu.

- **Physical and mental-health challenges**: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520) 621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

- **Statement on compliance with COVID-19 mitigation guidelines:** As we enter the Fall semester, your and my health and safety remain the university's highest priority. To protect the health of everyone in this class, students are required to follow the university guidelines on COVID-19 mitigation. Please visit www.covid19.arizona.edu.

GRADUATE STUDENTS: Students enrolled in the 500 level section of the course must give a presentation on one their challenge/final report. The grade for this portion of the course will be based on the presentation and the report together. Graduate students will sign up for this presentation towards the end of the class.

POLICY ON REPORTS AND PRESENTATION: Students not appearing for presentations without an official excuse will receive a 0 for their presentation. Written assignments are due in class on the day stated on the syllabus or they are late. Assignments handed in <24hr late are marked down by 10%, 24-48 hrs late are marked down by 20%, and greater than 48 hours late get a zero.

ABSENCE POLICY: All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion. Absences pre-approved by the UA Dean of Students (or Dean's designee) will be honored.

ACADEMIC CONDUCT: Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: http://deanofstudents.arizona.edu/codeofacademicintegrity

http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://www.library.arizona.edu/help/tutorials/plagiarism/index.html.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

DISABILITIES: Students registered with the Disability Resource Center must submit the appropriate documentation to the instructor at the beginning of the course and reasonable accommodation will be arranged.

UA NONDISCRIMINATION AND ANTI-HARASMENT POLICY

The University is committed to creating and maintaining an environment free of discrimination; see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

CHANGES: Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Introduction to Systems Biology (480/580) Syllabus

Module I- Transcriptional Circuits and Kinetic Modeling

1	Aug 24 (T)	**Introduction to the class and systems biology** Brief overview of the class and systems biology. **(Homework, download Berkeley Madonna simulator (demo version: http://www.berkeleymadonna.com/)**
2	Aug 26 (Th)	**Network Structure** Scale free networks and network motifs
#3	Aug 31 (T)	**Introduction to Chemical kinetics and Berkeley Madonna**, Rate constants and differential equations **(Exercise: model turning a gene on)**
4	Sept 2 (Th)	**Introduction to binding constants and promoter activation** Adding transcription factors to our models **(Exercise: Equilibrium binding equations)**
#5	Sept 7 (T)	**Coupled differential Equations** Model feedback loops **(Exercises, model positive and negative feedback loops)**
6	Sept 9 (Th)	**Promoters as signal integrators**. Expand description of promoters to include multiple TFs and gating logic. **(Introduce Challenge I: model a coherent feed forward loop)**
#7	Sept 14 (T)	**Group work-time on Challenge I**. Use this time to make sure you understand what we have learnt so far, build models of the coherent FFL, and explore its properties.
*8	Sept 16 (Th)	**Wrapping it up** Discuss solutions to Challenge I. Introduction to complex circuitry made up of network motifs. ****Challenge I reports due BEFORE class****

Module II- Noise in Biology

9	Sept 21 (T)	**Stochastic Noise in gene expression**. Read paper assigned to your group before class (posted on D2L). Come prepared with your questions.
10	Sept 23 (Th)	**Overcoming noise I** Read posted paper and answer short questions before class
11	Sept 28 (T)	**Robustness, Overcoming noise II**. Read posted paper and answer short questions before class
12	Sept 30 (Th)	**Using noise to your advantage** Read posted paper and answer short questions before class
13	Oct 5 (T)	**Noise in Cancer I** Read posted paper and answer short questions before class (Introduce Challenge II, build a robust perfectly adapting circuit)
14	Oct 7 (Th)	**Noise in Cancer II** Read posted paper and answer short questions before class
15	Oct 12 (T)	**Noise in Genotype to Phenotype mapping** Read posted paper and answer short questions before class
*16	Oct 14 (Th)	**Group work-time on Challenge II** Bring computer ****Reports due by 10pm on Sun Oct 17****

Module III –Signaling Circuits

17	Oct 19 (T)	**Cooperativity** **Hill Equation, Adair equation, KNF model, MWC model** (Groups will present one of the above)
18	Oct 21 (Th)	**Zero order ultrasensitivity and MAPK cascades** Read posted paper and answer short questions before class.
19	Oct 26 (T)	**Bistability and hysteresis** as above
20	Oct 28 (Th)	**Interlocked feedback loops and Complex Circuits** as above. I will introduce Challenge III
21	Nov 2 (T)	**Genomics I (Dr. Plank, Instructor)** Read posted paper and answer short questions before class. (Start thinking about your final report for this module, you need to pick one or two papers using an omics approach, explain the methods, analysis and findings. Use Pubmed. I must approve by Nov 18th)
*22	Nov 4 (Th)	**Group work time Challenge III and presentations** ****Challenge III reports due Sun Nov 7th at 10pm****

Module IV –Genomics and Proteomics

*23	Nov 9 (T)	**Proteomics I (Dr. Plank, Instructor)** Read posted paper and answer short questions before class.
24	Nov 11 (Th)	No class, veterans day
25	Nov 16 (T)	**Functional Genomics (Dr. Plank, Instructor)** Read posted paper before class.
26	Nov 18 (Th)	**Omics in cancer research** Read posted paper and answer short questions before class. (Topics for final report must be approved by today)
27	Nov 23 (T)	**Grad student Presentations on omics papers**
28	Nov 30 (T)	**Grad student Presentations on omics papers**
29	Dec 2 (Th)	**Grad student Presentations on omics papers**
30	Dec 7 (T)	**Grad student Presentations on omics papers** 15 min each, 5 min questions **Reports due by 5pm**