

**School of Systems Biology**

**BIOL 502 Adaptation in Biosystems.**

***From molecular dynamics to ecology and evolution.***

**Instructors**

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**BIOL 502 001 is a hybrid section with online coursework and in-class meetings**

**Room:** SciTech (PW): Colgan Hall 302 / online

**Time:** Monday 4:30 PM – 7:10 PM

**Principles of the course.**

Biological communication networks adapt and maintain robust function in the face of external stress, challenges or assaults. In order to survive, the cell, and the organism, must create meaning from a complex array of external and internal signals, and make decisions as to how it should respond. A central question in biologic networks, ranging from individual molecule interactions, to cells, organisms, and extending to large ecosystems is how do these complex networks evolve, adapt and heal without becoming fragile and crashing when subjected to external stress, change, or assault? Mathematical models provide a new paradigm for understanding how biological networks of any size or complexity adapt to changes over a wide dynamic range of inputs. A few classes of network modules embedded within the topology fabric of the network are strictly required for any network to achieve robust adaptation, thereby returning the network to baseline state. Based on this comprehensive theoretical discovery, the research theme of the present application is to gather experimental data to identify and model simple and scalable modular design principles that promote robust performance in biological systems of different scales, from biomolecule interactions, to evolutionary processes, including cell behavior and survival, and ecosystems. The theme of the proposed training program encompasses a novel integrative life science perspective, namely adaptation, or maladaptation, in the face of constant change. Adaptation to external sources of stress takes place at the level of the molecule, the cell signaling network, communication between cells, networks and populations of organisms, and entire ecosystems. Students will learn how biological systems react to stress and how maladaptation leads to disease, addiction, global climate change, or ecosystem collapse. Viewing living systems from this viewpoint provides a fresh and career-relevant framework for graduate science education. Our philosophy is exactly the opposite of conventional programs of instruction using a reductionist approach. Main training elements of the course encompass systems biology, principles of control theory, a choice of different levels of biological system investigation: structural biology, cell signaling and cellular networks, environmental network systems. Integration of the research and training will foster development of cognitive synergy, sense of self, and professional capacity. Short modular lecture series will be offered by different instructors, covering the following topics:

1. Principles of resiliency and robustness in biological systems. How organisms adapt and survive in the face of disease related or environmental stresses. (Lance Liotta)
2. Principles of robustness and adaptation at the molecular level. How 3-dimensional conformation and energetic landscapes of molecules stabilize systems. (Amanda Haymond)
3. From molecules to signaling networks in the cell: Signaling pathways, cytokines, growth factors, autocrine and paracrine signaling, electrical signaling and how they follow principles of robustness and adaptation in face of stimuli. (Lance Liotta)
4. Overview of human and animal physiology in health, and what may go wrong in disease. Healing processes and embryologic resilience in developmental systems: embryology and morphogenesis, wound healing. (Alessandra Luchini, Lance Liotta)
5. Principles of cancer somatic evolution. Cancer as an example of a maladapting system: oncogenes, tumor suppressor genes, chromosomal rearrangement, clonal cooperation, drug resistance. Principles of host adaptation to invading pathogens and microbiome. Role of microbiome in physiological homeostasis. (Virginia Espina)
6. Maladaption in addiction and chronic pain: adaptation of sensory systems in the brain to addictive substances and neurological pain signaling. (Lance Liotta)
7. Ecological adaptation to various environments, variation, and bottle necks. Why some human diseases are ethnic specific. (Alessandra Luchini)

**Course Grading**

Grades will be based on 1) mid-term take home exam, 2) final presentation (Power Point presentation and project description in a Word file) and 3) class participation (35%, 35%, 30%, respectively).

*Mid-term take home exam*: Students will be given three essay questions. Students will have one week to answer to the questions. This assignment will be open book and carried out individually.

*Final presentation*: each student individually will propose a solution to a given challenge using the principles of the class. Students will prepare a power point presentation and deliver it to the class during the final three classes of the semester.

The presentation should include:

1. Description of the problem.
2. Explanation of why past solutions have failed.
3. Description of different radical ways of solving the problem. Choice of one solution and explanation of why it is the best idea.
4. Description of how to implement your idea.
5. Description of commercial potential and societal potential.

**Course Learning Outcomes:**

 Demonstrate applications of acquired information

 Formulate an original research topic

 Demonstrate proficiency and excellence in the core concepts

**Definition of Grades for Graduate Courses**

|  |  |  |
| --- | --- | --- |
| Grade | Quality Points | Graduate Courses |
| A+ | 4.00 | Satisfactory/Passing |
| A | 4.00 | Satisfactory/Passing |
| A- | 3.67 | Satisfactory/Passing |
| B+ | 3.33 | Satisfactory/Passing |
| B | 3.00 | Satisfactory/Passing |
| B- | 2.67 | Satisfactory\*/Passing |
| C | 2.00 | Unsatisfactory/Passing |
| F | 0.00 | Unsatisfactory/Failing |

\* Although a B- is a satisfactory grade for a course, students must maintain a 3.00 average in their degree program and present a 3.00 GPA for the courses listed on the graduation application.

Information about additional grade notations that apply to graduate students including “IN” Incomplete and “IP” In Progress as well as grading for undergraduate students may be found in the Academic Policies section of the catalog under [Grading System](http://catalog.gmu.edu/content.php?catoid=19&navoid=4065#grading). Graduate students are not required to take midterm exams.

**Weekly schedule**

|  |  |
| --- | --- |
| **Date** | **Topic** |
| Aug 23 | Principles of resiliency and robustness in biological systems part 1. |
| Aug 30 | Principles of resiliency and robustness in biological systems part 2. |
| Sept 13 | Principles of robustness and adaptation at the molecular level. |
| Sept 20 | Overview of human and animal physiology in health and disease part 1. |
| Sept 27 | Overview of human and animal physiology in health and disease part 2. |
| Oct 4 | Principles of cancer somatic evolution part 1. (Lecture will be held on line) |
| Oct 12 | Principles of cancer somatic evolution part 2. (Lecture will be held on line) |
| Oct 18 | Principles of robustness and adaptation in signaling networks in the cell. |
| Oct 25 | How do we adapt to a looming apocalypse (pandemics, climate change, etc.). |
| Nov 1 | Maladaption in addiction and chronic pain |
| Nov 8 | Ecological populations: adaptation to various environments |
| Nov 15 | Students’ presentations |
| Nov 22 | Students’ presentations |
| Nov 29 | Students’ presentations |
| Dec 13 | Final Exam due |

**Safe Return to Campus Statement**

* All students taking courses with a face-to-face component are required to follow the university’s public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage ([*https://www2.gmu.edu/safe-return-campus*](https://www2.gmu.edu/safe-return-campus)). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. Only students who receive a “green” notification are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class.
* Students are required to follow Mason's current policy about facemask-wearing. As of August 11, 2021, all community members are required to wear a facemask in all indoor settings, including classrooms. An [*appropriate facemask*](https://www2.gmu.edu/safe-return-campus/personal-and-public-health/face-coverings) must cover your nose and mouth at all times in our classroom. If this policy changes, you will be informed; however, students who prefer to wear masks either temporarily or consistently will always be welcome in the classroom.

**Campus Closure or Emergency Class Cancelation/Adjustment Policy**

* *If the campus closes, or if a class meeting needs to be canceled or adjusted due to weather or other concern, students should check Blackboard for updates on how to continue learning and for information about any changes to events or assignments.*

**Participation/visibility policy**

For online classes, students should turn on their video to be considered present. However, non-video participation is allowed for students whose workspaces are not private or whose technology or family situations make live video streaming difficult. Students will be counted “present” without sharing a video of themselves if:

* Students will add comments to a chat or poll, perhaps at the beginning and ending of a class, or
* Students who submit brief class notes without sharing video (e.g., “Three major points and one question”), or
* Students who complete a “minute paper” to submit at the end of class (e.g., “The clearest point and the muddiest point for me from today’s class were \_\_\_”)

**Late-work policy**

Due to disruptions caused by the COVID-19 pandemics, the following late-work policy is observed:

* “Life Happens Pass” Policy: a student will have an automatic 72-hour extension on a major assignment once per semester, no questions asked, as long as the student informs the instructors in writing.
* “Standard Deduction” Policy: any late assignment will earn a flat 10% grade deduction as long as they are completed within 7 days of the deadline.
* “One Extension” Policy: a student can propose a reasonable deadline extension, subject to instructor approval, once during the semester. Students should provide a plan for how they will complete the work.

**Make-up or revision work.**

The following make-up or revision work policy addresses a case when student access to or performance in the course is negatively affected by outside circumstances:

* “Discussion Forum Make-Up”: students who have to miss a class meeting when their participation was expected can provide a summary, analysis, and/or additional contribution based on the day’s questions/materials, and post asynchronously by one week to earn equivalent credit
* “One Revision” Policy: any student can revise one major assignment within two weeks after it is graded, either for a new grade or for up to a 15% increase on their prior grade provided that the revisions are significant (not just error corrections).

**Basic Course Technology Requirements (Two options)**

* Activities and assignments in this course will regularly use the Blackboard learning system, available at [*https://mymason.gmu.edu*](https://mymason.gmu.edu). Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher. You can check your speed settings using the speed test on this website.)
* Activities and assignments in this course will regularly use web-conferencing software (Blackboard Collaborate / Zoom). In addition to the requirements above, students are required to have a device with a functional camera and microphone. In an emergency, students can connect through a telephone call, but video connection is the expected norm.

**Course Materials and Student Privacy**

*All course materials posted to Blackboard or other course site are private to this class; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class.*

* *Videorecordings -- whether made by instructors or students -- of class meetings that include audio, visual, or textual information from other students are private and must not be shared outside the class*
* *Live video conference meetings (e.g. Collaborate or Zoom) that include audio, textual, or visual information from other students must be viewed privately and not shared with others in your household or recorded and shared outside the class*

**Plagiarism:**

Plagiarism is the presentation of someone else’s ideas or work as one’s own. Students must give credit for any information that is not either the result of original research or common knowledge. If a student borrows ideas or information from another author, he/she must acknowledge the author in the body of the text and on the reference page. Students found plagiarizing are subject to the penalties outlined in the Policies and Procedures section of the University Catalog, which include a hearing by the Honor Code Committee and may include a failing grade for the work in question or for the entire course. The following website provides helpful information concerning plagiarism for both students and faculty: <http://oai.gmu.edu/the-mason-honor-code-2/plagiarism/>

**Honor Code:**

* George Mason University has an Honor Code, which requires all members of this community to maintain the highest standards of academic honesty and integrity. Cheating, plagiarism, lying, and stealing are all prohibited
* All violations of the Honor Code will be reported to the Honor Committee.
* See <http://oai.gmu.edu/the-mason-honor-code-2/> for more detailed information.

**Enrollment:**

* Students are responsible for verifying their enrollment in this class.
* Schedule adjustments should be made by the deadline published on the Registrar’s website.
* Note the add/drop dates in the Academic Calendar published on the Registrar’s website.
* After the last day to drop a class, withdrawing from this class requires the approval of the dean and is only allowed for nonacademic reasons.
* Undergraduate students may choose to exercise a selective withdrawal.
* See <http://registrar.gmu.edu> for selective withdrawal procedures.

**Ethics:**  
Ethical behavior in the classroom is required of every student. The course will identify ethical policies and practices relevant to course topics.

**Technology:**

Students are expected to be competent in using current technology appropriate for this discipline. Such technology may include presentation software. Students are required to become familiar with Mason’s Responsible Use of Computing Policy #1301 <http://copyright.gmu.edu/?page_id=301>

**Diversity:**

Learning to work with and value diversity is essential in every class. Students are expected to exhibit an appreciation for multinational and gender diversity in the classroom. Diversity is one of George Mason University’s core values. The instructors of this course and the University are committed to this value. The following resources are available to students and faculty: the Center for Culture, Equity, and Empowerment (https://stearnscenter.gmu.edu/wp-content/uploads/Diversity-Syllabus-Language-CCEE.pdf), [LBGTQ+](https://lgbtq.gmu.edu/), [Mason Non-Discrimination Policy](https://universitypolicy.gmu.edu/policies/non-discrimination-policy/), and [Mason Diversity Statement](https://stearnscenter.gmu.edu/knowledge-center/general-teaching-resources/mason-diversity-statement/).

**Civility:**

As a diverse community of learners, students must strive to work together in a setting of civility, tolerance, and respect for each other and for the instructor. Rules of classroom behavior (which apply to online as well as onsite courses) include but are not limited to the following:

* Conflicting opinions among members of a class are to be respected and responded to in a professional manner.
* Side conversations or other distracting behaviors including cell phone use or non-class online access are not to be engaged in during lectures, class discussions or presentations
* There are to be no offensive comments, language or gestures

Students not complying will be asked to cease immediately or leave the class session.

**Students with Disabilities:**

If you are a student with a disability and you need academic accommodations, please contact the Office of Disability Services at 703.993.2474 and see the instructors on the first day of class.  All academic accommodations must be arranged through that office. Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking accommodations, please visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email:ods@gmu.edu | Phone: (703) 993-2474