

### **COURSE DESCRIPTION**

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Emergent systems are those whose large-scale behavior cannot simply be understood by breaking them down into their constituents, for the interactions of the parts produce phenomena not explicit in the rules that govern those interactions. Many systems, both biological and otherwise possess this characteristic; however, here we will focus mainly on biological systems and study emergence through both case study and simple computer simulations. As a theme, we will focus on the source of modern biodiversity (number and variety of species) through reading, discussion and simulation from the perspective of systems biology (which unifies many biological subdisciplines through the common thread of their emergent properties) and at multiple levels of organization (from genes to species to populations to communities).

### **LOCATION**

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Lecture: T-TH 11:30 – 1 Room: TBA

Programming Session: TBA Room: TBA

### **INSTRUCTOR**

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Emily Greenfest-Allen

Office: Park 246 (Computer Science Offices)

Ph: x6503

E-mail: [egallen@brynmawr.edu](mailto:egallen@brynmawr.edu)

Office Hours: TBA or by appointment

### **TEXTS**

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Throughout the course we will be reading excerpts from various texts, as well as journal articles. Readings will be available for download from the course website.

### **SCHEDULE AND TOPICS**

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Week 1: 1/22, 1/24

- Class Organization and Overview
- Systems Biology: Emergence, Robustness, Modularity, and Organization
- Chaos

Week 2: 1/29, 1/31

- Parts, Rules, and Interactions
- Chaos versus Complexity

Syllabus

Week 3: 2/5, 2/7

- The Origin of Life and Irreducible Complexity
- Conway's Game of Life

Week 4: 2/12, 2/14

- Cellular Automata
- Introduction to NetLogo

Week 5: 2/19, 2/21

- Hierarchy and Scale: Self-Organization
- Cellular Automata

Week 6: 2/26, 2/28

- Ecological Release and the Origin of Phyla
- Cellular Automata

Week 7: 3/4, 3/6

- Midterm Presentations

Week 8: 3/11, 3/13: Spring Break

Week 9: 3/18, 3/20

- The Source of Variation
- Genes and Genetic Algorithms

Week 10: 3/25, 3/27

- AVIDA Digital Life Simulations
- Project Proposals Due

Week 11: 4/1, 4/3

- Robustness, Redundancy, and Preadaptation
- Genetic Algorithms

Week 12: 4/8, 4/10

- Modularity versus Integration
- Gene and Protein Networks

Week 13: 4/15, 4/17

- Hox Genes and Heterochrony
- Projects

Week 14: 4/22, 4/24

- TBA
- Projects

Week 15: 4/29, 5/1

- Project Presentations

### ASSIGNMENTS

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***Journal and Weekly Readings:*** This class is for the most part a true seminar; much of our class time will not be dedicated to lecture, but to discussion. Each week you will be responsible for completing a reading assignment and submitting 1-2 paragraphs to a class blog summarizing your thoughts regarding the reading and an assigned discussion topic. ***The readings and journal should be completed by Monday evening at 7 pm***, so that comments can be reviewed before discussion on class on Tuesday.

***Weekly Exercises:*** To supplement our discussions, most weeks we will also explore a new simulation and/or type of model that can help us visualize the patterns and processes discussed in class. These will be supplemented with simple exercises involving the manipulation and study of pre-existing model systems. You will have one week to complete each exercise, ***which will be due the following Wednesday at 5 pm***. Exercises should be submitted via e-mail.

***Mid-Term Presentations:*** Each student will be responsible for exploring and researching a NetLogo simulation not discussed in class and then preparing a short presentation to introduce and explain the modeled system to the class. This exercise is in lieu of a mid-term exam.

***Project:*** The course will culminate in a term research project, which in many ways will be a variation of the mid-term exercise. Students will be responsible for researching and exploring a system discussed in class and then, depending on skill and comfort either 1) modify an existing model or 2) write their own models to simulate a novel aspect of the system behavior. The completed project will involve this coding exercise, a write-up, and an in-class presentation. Depending on numbers of enrolled students this may or may not be completed in pairs.

### GRADING

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Class Participation: 10%

Journal: 25%

Weekly Exercises: 25%

Mid-Term Presentation: 15%

Term Project: 25%

**POLICIES**

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**Grading.** Exercises and Journals are graded on a point scale, based upon the number and complexity of the exercise. Thus, some programming exercises may be worth more points, and contribute more overall to your grade than others. Journals are worth 10 points, 3 of which are awarded just for the completion of the writing task, while the other 7 are awarded based upon the thoughtfulness of the content. No points are awarded or refused for grammar in the journals as they are informal.

**Challenging a Grade.** If you are unhappy with an assigned grade, or would like the opportunity to redo an assignment, please speak to me **within one (1) week** of receiving that grade. I am very open to second chances and realize that I do make mistakes. However, please do not come to me at the end of the semester with a series of grading issues. I will assume you are fishing for points and won't take you seriously.

**Late Assignments.** Assignments will be docked an appropriate point value for the number of days late. The exact amount will depend on the assignment. Don't worry; I am very accommodating to extraneous circumstances.

**Extensions.** Requests for extensions should be made 48 hours (that's two days) before the assignment is due. I understand that emergencies happen, so feel free to request more time on shorter notice if absolutely necessary (no guarantees, though).

**Working in Groups.** You are welcome to work in groups on your weekly exercises. In fact, I highly recommend it, especially as the semester progresses. However, each completed assignment must be unique – i.e. do not simply copy each other's answers.

**Programming Exercises.** Copying someone else's program is a form of **plagiarism** and **a violation of the honor code**. Even if you work together, please take the time to prepare your own final answers.

**Extra Credit is always an option.** If you are feeling unchallenged or worried about your grade, come see me and I will find something for you to do with your free time!