

## Biomathematics Seminar, Fall 2007, BIOL 380/MATH 383 Wednesdays, 10:30 – 11:20, Bailey 128

Gregg Hartvigsen    Office = ISC 344, Office Hours = 9:30 – 10:20 MWF or by appointment.  
 Chris Leary        Office = South 324d, Office Hours = MW 3:00-4:00, T 9:30-10:30, F 10:30-11:30 or by appointment.  
 Text:                Sole and Goodwin. 2002. Signs of Life: How Complexity Pervades Biology.  
 Papers:             See folder in Hartvigsen's outbox: "Biomath Seminar".

The primary goal of this seminar is to bring together students and faculty interested in learning more about topics that span the disciplines of biology, mathematics, and computation. Whenever folks get together, however, there is the possibility that collaborations will develop. Please keep your eyes out for possible research projects. If you develop a research project you should try to present it at the April campus-wide symposium.

This semester we will discuss readings over a broad range of biomathematics and hear, and possibly provide, short presentations on research. This seminar is offered each semester with a rotating schedule of topics (e.g., networks, molecular computation, epidemiology, and ecology).

**Expected Learning Outcomes.** After completing this course students should expect to be

- familiar with applications of mathematics and computational approaches to better understand biological phenomena,
- able to explain discuss the contribution of a scientific paper to the field of biomathematics,
- able to develop and lay the foundation to the solution of a problem in biomathematics.

In addition, seniors taking this course to fulfill the seminar requirement in the biology and mathematics degree programs should expect to be develop and write a grant proposal to do research in the area of biomathematics.

### Schedule

Date	Topic	Text	Paper	Due
8/29	Introductions			
9/5	Nonlinearity, chaos, & emergence	Chapt. 1.	1	
9/12	Order, complexity, disorder	Chapt. 2.	2	
9/19	Genetic networks etc.	Chapt. 3.	3	Research topic statement
9/26	Physiology on the edge of chaos	Chapt. 4.	4	
10/3	Brain dynamics	Chapt. 5.	5	
10/10	Ants, brains, and chaos	Chapt. 6.	6	Paper Presentation Abstract
10/17	The baroque of nature	Chapt. 7.	7	
10/24	Life on the edge of catastrophe	Chapt. 8.	8	
10/31	Evolution and extinction	Chapt. 9.	9	
11/7	Fractal cities and market crashes	Chapt. 10.	10	
11/14	Student research presentations			Grant proposal draft (opt)
11/21	Thanksgiving break -----			
11/28	Student research presentations			
12/5	Student research presentations			

**Papers.** We expect everyone to read the abstracts and glance through the figures of the following papers. You should know the main result(s) of the paper. Discussants should have read the paper with a more complete understanding of the findings (probably not able to reproduce the math). Papers are available in Hartvigsen's outbox.

1. Nicholas J. Savill and Paulien Hogeweg. 1997. Modelling morphogenesis: from single cells to crawling slugs. *J. theor. Biol.* 184: 229–235.
2. Bak, P., C. Tang, and K. Wiesenfeld. 1987. Self-organized criticality. *Physical Rev. Letters* 59(4): 381-384.
3. Stumpf, M.P.H., W.P. Kelly, T. Thorne, and C. Wiuf. 2007. Evolution at the system level: the natural history of protein interaction networks. *Trends Ecol. & Evolution* 22(7): 366-373.
4. Poon, C.-S., and C.K. Merrill. 1997. Decrease of cardiac chaos in congestive heart failure. *Nature* 389: 492-495.
5. Hopfield, J. 1982. Neural networks and physical systems with emergent collective computational abilities. *PNAS* 79: 2554-2558.
6. Bonabeau et al. 1997. Self-organization in social insects. *Trends Ecol. & Evol.* 12: 188-193.
7. Pascual, M., and F. Guichard. 2005. Criticality and disturbance in spatial ecological systems. *Trends Ecol. & Evol.* 20: 88-95.
8. Pearson, J.E. 1993. Complex patterns in a simple system. *Science* 261: 189-192.
9. Sneppen, Bak, et al. 1995. Evolution as a self-organized critical phenomenon. *PNAS* 92: 5209-5213.
10. Makse et al. 1998. Modeling urban growth patterns with correlated percolation. *Phys. Rev. E.* 58: 7054-7062.

## **Grading**

For students not taking this course for seminar credit in biology your grade will be based on a 10-minute chalkboard (no visual aids) summary presentation of a recent (within two years) primary research paper on a biomath topic (25%), leadership of discussions (25%), and participation (the consistent addition of insightful comments that reflect reading comprehension) (50%).

For students taking this course to fulfill the seminar requirement in biology you will need to complete a research proposal on a topic consistent with the content of this course and approved by the faculty member(s). In conjunction with this paper you will provide a 10-minute chalkboard presentation (no visual aids) to the group on your research proposal. In this case your grade will be determined as follows:

Leadership of discussions	25%
Participation	25%
Paper (5-10 pages)	25%
Presentation (10 minutes)	25%

The proposal should adhere to the Grant Proposal Guidelines published by the National Science Foundation (the file “NSF GPG.pdf” is available in my outbox for this course – essentials are included below). You must include only what is described in those sections: II.C.2b, II.C.2d(i), and II.C.2e.

Grant proposals are due by 5:00 PM on December 10, 2007.

# Excerpts from National Science Foundation Grant Proposal Guidelines (July 2004)

## 2. Sections of the Proposal

### b. Project Summary

The proposal must contain a summary of the proposed activity suitable for publication, not more than one page in length. It should not be an abstract of the proposal, but rather a self-contained description of the activity that would result if the proposal were funded. The summary should be written in the third person and include a statement of objectives and methods to be employed. It must clearly address in separate statements (within the one-page summary): (1) the intellectual merit of the proposed activity; and (2) the broader impacts resulting from the proposed activity. (See Chapter III for further descriptive information on the NSF merit review criteria.) It should be informative to other persons working in the same or related fields and, insofar as possible, understandable to a scientifically or technically literate lay reader. **Proposals that do not separately address both merit review criteria within the one page Project Summary will be returned without review.**

### d. Project Description (including Results from Prior NSF Support)

#### (i) Content

All proposals to NSF will be reviewed utilizing the two merit review criteria described in greater length in Chapter III.

The Project Description should provide a clear statement of the work to be undertaken and must include: objectives for the period of the proposed work and expected significance; relation to longer-term goals of the PI's project; and relation to the present state of knowledge in the field, to work in progress by the PI under other support and to work in progress elsewhere.

The Project Description should outline the general plan of work, including the broad design of activities to be undertaken, and, where appropriate, provide a clear description of experimental methods and procedures and plans for preservation, documentation, and sharing of data, samples, physical collections, curriculum materials and other related research and education products. It must describe as an integral part of the narrative, the broader impacts resulting from the proposed activities, addressing one or more of the following as appropriate for the project: how the project will integrate research and education by advancing discovery and understanding while at the same time promoting teaching, training, and learning; ways in which the proposed activity will broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.); how the project will enhance the infrastructure for research and/or education, such as facilities, instrumentation, networks, and partnerships; how the results of the project will be disseminated broadly to enhance scientific and technological understanding; and potential benefits of the proposed activity to society at large. Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF Website<sup>18</sup>.

### e. References Cited

Reference information is required. Each reference must include the names of all authors (in the same sequence in which they appear in the publication), the article and journal title, book title, volume number, page numbers, and year of publication. If the document is available electronically, the Website address also should be identified.<sup>19</sup> Proposers must be especially careful to follow accepted scholarly practices in providing citations for source materials relied upon when preparing any section of the proposal. While there is no established page limitation for the references, this section must include bibliographic citations only and must not be used to provide parenthetical information outside of the 15-page project description.