



## Topics in Interdisciplinary Biology and Biological Sciences (TIBBS)

Biology 503 (also taught as: CS/591C, Stat/579.04, Math/579.02, & Anth 560)  
Wednesdays Castetter, Room 258

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Fall 2006

General Information

### Instructors:

Dr. James Brown	Email: <a href="mailto:jhbrown@unm.edu">jhbrown@unm.edu</a> ,	Office phone 277.9337
Dr. Ed Bedrick	Email: <a href="mailto:bedrick@math.unm.edu">bedrick@math.unm.edu</a> ,	Office phone 277.2911
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Dr. Felisa A. Smith	Email: <a href="mailto:fasmith@unm.edu">fasmith@unm.edu</a> ,	Office phone 277.6725
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Dr. Blair Wolf	Email: <a href="mailto:wolf@unm.edu">wolf@unm.edu</a> ,	Office phone 277.4122

Office Hours by arrangement

**Text.** There is no set text; readings will be assigned as necessary by the various instructors.

**Course Description.** This course presents and discusses recent work in biological science that bridges scientific disciplines, integrates different approaches, and demonstrates the effectiveness of collaborative research. The course is required of PIBBS fellows, but is also open to other interested graduate students from participating departments as space permits. The multiple units in this course are taught by faculty drawn from Biology, Math and Statistics, Computer Sciences and the Santa Fe Institute. A brief description of each module follows:

**Unit 1: *Examining process and dynamics in biological systems at multiple scales: tracer and modeling approaches* (B. Wolf).** This unit will focus on the dynamics and movements of energy and materials in the biosphere at multiple scales and how they are traced, recorded and modeled. We will introduce the use of elemental tracers (with a focus on natural abundance stable isotopes of carbon and nitrogen) to indicate, integrate, record, trace and model biological processes at scales that vary from cellular to global. We will also introduce the application of models to examining these same processes. The format will combine readings from the literature with discussions and lectures.

**Unit 2: *Life, mind, and the pursuit of good books: network modeling and inference across disciplines* (T. Lane).** Life, Mind, and the Pursuit of Good Books: Network Modeling and Inference Across Disciplines will examine network models of large, complex, multi-element systems. For systems, we'll examine some subset of genetic regulatory networks: the internet; and social graphs. The important commonality among these is the underlying, mathematical and computational formalisms that we'll use to abstract and represent their structures and behaviors. We will survey some of the different mathematical formalizations that have been applied to represent characterize, simulate, and predict such systems, Boolean models, or others, depending on the whims of the class and instructor.

**Unit 3: *Scaling: From physics to biology to human systems* (J. Brown and G. West).** This unit will provide an interdisciplinary exploration of scaling. We will start with a first segment designed to provide general background on scaling from the perspective of physics and mathematics: What is scaling? Why is it important? What is the history and current state of the subject? How are scaling relations described mathematically and interpreted scientifically? The second part will focus in depth on West, Brown, and Enquist's theory for the quarter-power allometric scaling of metabolic rate and other biological attributes. We will examine the fractal

model for scaling of resource distributing vascular networks, the more general model that incorporates both body size and temperature to explain the scaling of metabolic rate, and the extension of this framework to address biological scaling at levels from molecules and cells to ecology and evolution. The last part will be more speculative and free-form. It will address implications of scaling for human social, economic, and technological systems. Possible examples include scaling of and possible parallels between brains, computers, cities, businesses, economies, and the Internet.

**Unit 4: A biologically motivated statistical model for the fetal lifetime distribution in dairy cattle (E. Bedrick).** This unit will discuss the basic research and biological methods used in statistical modeling with a focus on the effect of spontaneous abortion on the dairy industry. In California alone this phenomena costs the industry on the order of \$200 million per year. We analyze data from a cohort study of nine dairy herds in Central California. A key feature of the analysis is the observation that only a relatively small proportion of cows will abort (around 10-15%), so that it is inappropriate to analyze the time-to-abortion (TTA) data as if it were standard censored survival data, with cows that fail to abort by the end of the study treated as censored observations. We thus broaden the scope to consider the analysis of fetal lifetime distribution (FLD) data for the cows, with the dual goals of characterizing the effects of various risk factors on (i) the likelihood of abortion and, conditional on abortion status, on (ii) the risk of early versus late abortion. A single model is developed to accomplish both goals with two sets of specific herd effects modeled as random effects. Because a multimodal fetal hazard function is expected for the TTA data, both a parametric mixture model and a nonparametric model are developed. Furthermore, the two sets of analyses are linked because of anticipated dependence between the random herd effects. All modeling and inferences are accomplished using modern Bayesian methods.

**Tentative Schedule:**

Week	Date	Topic
1	August 23	Organizational meeting
2	August 30	
3	September 6	Blair Wolf, Biology
4	September 13	Unit 1: <i>Examining process and dynamics in biological systems at multiple scales: tracer and modeling approaches</i>
5	September 20	
6	September 27	
7	October 4	Terran Lane, Computer Science
8	October 11	Unit 2: <i>Life, mind, and the pursuit of good books: network modeling and inference across disciplines</i>
9	October 18	
10	October 25	Break
11	November 1	James Brown, Biology & Geoffrey West, Santa Fe Institute
12	November 8	Unit 3: <i>Scaling: From physics to biology to human systems</i> (to be taught at the Santa Fe Institute, transportation to be arranged)
13	November 15	
14	November 22	Ed Bedrick, Mathematics & Statistics
15	November 29	Unit 4: <i>A biologically motivated statistical model for the fetal lifetime distribution in dairy cattle</i>
17	December 6	