

## An integrated, quantitative introduction to the natural sciences

An integrated, mathematically and computationally sophisticated introduction to physics and chemistry, drawing on examples from biological systems. This year-long, four course sequence is a collaborative effort of four departments and provides an alternative to the combination of PHY 105/6, CHM 201/2 and COS 126. Students enroll in 231 and 232 in Fall, 233 and 234 in Spring. 5 hours of lecture, one 3 hour laboratory, one 3 hour computational laboratory, one optional evening problem session. Prerequisites: Familiarity with the calculus at the level of MAT 103/4 or Advanced Placement Calculus BC, solid high school physics and chemistry courses.

Note: All handouts, assignments, announcements will be posted on *Blackboard*. All questions about administrative matters in the course should be emailed to [class231@genomics.princeton.edu](mailto:class231@genomics.princeton.edu)

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### Brief outline

Rather than following the history of the individual disciplines, the lectures in the course will be organized around the different kinds of mathematical models that are used in describing the natural world. We hope to convey the universality of this mathematical language, cutting across traditional disciplinary boundaries. Central to the presentation is the interplay between mathematical abstraction and experimental observations on the real world, often with computation as an essential intermediary.

After an introduction (10 – 16 Sep), we will turn to dynamical models (17 Sep – 22 Oct) and probabilistic models (1 Nov – 10 Dec) in the Fall. In the Spring we take up models in which the fundamental objects are fields and then put these various ideas together in exploring the quantum world. Parallel to the lectures are the wet lab modules for the Fall: (1) Theory and measurements: moving through fluids (13 Sep – 1 Oct), (2) Exponential behavior: measuring bacterial growth (3 – 22 Oct), (3) Stochastic phenomena I: mutation rates in yeast (1 – 19 Nov), and (4) Stochastic phenomena II: Brown, Boltzmann & Avagadro (22 Nov – 10 Dec). Detailed descriptions and exact lecture schedules will be distributed as they become fixed.

### Weekly schedule (For the first six weeks ...)

|                  | Monday             | Tuesday                       | Wednesday          | Thursday              | Friday             |
|------------------|--------------------|-------------------------------|--------------------|-----------------------|--------------------|
| 10:00 – 10:50 AM | lecture<br>CIL 101 | COS 126<br>Frist 302          | lecture<br>CIL 101 | COS 126<br>Frist 302  | lecture<br>CIL 101 |
| 1:30 – 4:20 PM   |                    | wet lab A<br>CIL 003          |                    | wet lab B<br>CIL 003  |                    |
| 1:30 – 4:20 PM   |                    | comp lab B<br>CIL 280         |                    | comp lab A<br>CIL 280 |                    |
| 7:00 – 10:00 PM  |                    | problem session<br>CIL atrium |                    |                       |                    |

Stay tuned for updates later in the semester.

## Problem sets, exams and grading

In the fall we will give three exams in addition to the three hour final: the usual midterm (two hours, in the sixth week of classes) and two (one hour) in class exams scheduled tentatively for M 4 Oct and M 22 Nov. Our interest is not to torture you, but rather to provide as much feedback as possible and to be sure that not too much rests on one day's performance. The midterm and final exams will be in sections, each approximately one hour in length, and all exam grades will be summed with equal weight for each hour, dropping the lowest grade. This sum will contribute 60% of the course grade, with 20% coming from the problem sets and 20% from the lab writeups.

Problem sets are an essential part of the course. We encourage you to work with your fellow students in solving the problems, but of course the work that you submit must be your own: working together does not mean that four friends each do one quarter of the problems. Tentatively, the problem sets will be distributed and due on the following dates:

|     | distributed | due      |     | distributed | due      |
|-----|-------------|----------|-----|-------------|----------|
| PS1 | F 10 Sep    | F 17 Sep | PS6 | F 5 Nov     | F 12 Nov |
| PS2 | F 17 Sep    | F 24 Sep | PS7 | F 12 Nov    | F 19 Nov |
| PS3 | F 24 Sep    | F 1 Oct  | PS8 | W 24 Nov    | F 3 Dec  |
| PS4 | F 8 Oct     | F 15 Oct | PS9 | F 3 Dec     | F 10 Dec |
| PS5 | F 22 Oct    | F 5 Nov  |     |             |          |

Note that roughly there is one problem set per week, with adjustments for breaks and exams. If you anticipate problems with these due dates (athletic competitions, religious holidays, ...) please let us know as soon as possible and we will do our best to work with your constraints. For the first six weeks of the course you also are responsible for problem sets as assigned in COS 126.

### Faculty:

William Bialek (Physics & Lewis–Sigler Institute)  
David Botstein (Molecular Biology & Lewis–Sigler Institute)  
Bernard Chazelle (Computer Science)  
Maitreya Dunham (Lewis–Sigler Institute)  
John Groves (Chemistry)  
Michael Hecht (Chemistry)  
Linda Hodges (McGraw Center & Chemistry)  
Daniel Marlow (Physics)  
Will Ryu (Lewis–Sigler Institute)  
Olga Troyanskaya (Computer Science & Lewis–Sigler Institute)  
Eric Wieschaus (Molecular Biology)

### Assistants in instruction:

Course assistants:

Denis V Chigirev (fall) [chigirev@princeton.edu](mailto:chigirev@princeton.edu)  
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