

MATHEMATICS AND BIOLOGY
MATH-UA 255 and BIOL-UA 255
Syllabus

Professors Daniel Tranchina

Fall 2018

Required Textbook

Hoppensteadt, F. and Peskin, C.S. (2002), Modeling and Simulation in the Life Sciences, 2nd ed., Springer. Available online (pdf) through NYU Library Springer Link

Prerequisites

Calculus I and Introductory Biology

Week 1

The Heart and Circulation

- 1.1 Plan of the Circulation 5
- 1.2 Volume, Flow, and Pressure 7
- 1.3 Resistance and Compliance Vessels 8
- 1.4 The Heart as a Pair of Pumps 10
- 1.5 Mathematical Model of the Uncontrolled Circulation 14

Week 2

The Heart and Circulation

- 1.5 Mathematical Model of the Uncontrolled Circulation 14
- 1.6 Balancing the Two Sides of the Heart and the Two Circulations 18
- 1.7 The Need for External Circulatory Control Mechanisms 20
- 1.8 Neural Control: The Baroreceptor Loop. 21

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Gas Exchange in the Lungs

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3.3 The Movement of Ions Across Cell Membranes . . 115

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Control of Cell Volume and Electrical Properties of Cell Membranes

- 3.4 The Interaction of Electrical and Osmotic Effects . . . 118
- 3.5 The Hodgkin-Huxley Equations for the Nerve Action Potential 124

Week 8

Control of Cell Volume and Electrical Properties of Cell Membranes

- 3.5 The Hodgkin-Huxley Equations for the Nerve Action Potential 124

MIDTERM, Tuesday, October 25.

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The Renal Countercurrent Mechanism

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- 4.2 Dynamics of Na⁺ and H₂O: Transport along the Renal Tubules 150
- 4.3 The Loop of Henle 152

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The Renal Countercurrent Mechanism

- 4.3 The Loop of Henle 152
- 4.4 The Juxtaglomerular Apparatus and the Renin-Angiotensin System 155
- 4.5 The Distal Tubule and Collecting Duct: Concentrating and Diluting Modes . . . 157

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The Renal Countercurrent Mechanism

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Muscle Mechanics

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Thanksgiving

Week 13

Muscle Mechanics

- 5.2 Crossbridge Dynamics 173

Week 14

Epidemiology

Epidemics (Lecture notes to be distributed)

Endemics (Lecture notes to be distributed)

Week 15

Epidemiology

Endemics (continued)

Discussion of final exam questions

Closing remarks

Course Grades

Course grades are based on graded homework assignments, midterm and final examinations.

Each accounts for one-third of the overall grade.

Office Hours

Tuesdays 10:30 am – 12:30 pm, room 918 Courant Warren Weaver Hall

Appointments outside formally scheduled office hour are welcome.