

Summary of Topics for Bioengineering/Physiology 6000
System Physiology I
Mid Term #1, 2014 Edition, March 17

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Forward

The following is a list of topics that we covered in the first part of the semester in Bioengineering 6000 course. I expect students to be familiar with each of the concepts and ideas and will draw from this list for first midterm questions.

1 Basic Ideas in Animal Physiology

1. Adaptation, acclimatization, and acclimation
2. Homeostasis: what it is, different ways of responding to external change, examples, role of negative feedback
3. Structure function relationships: what we mean by structure/function relationships, with examples.

2 Electrophysiology

2.1 Cellular

1. Ion transport mechanisms of the membrane in heart cells: channels, pumps, exchangers.
2. Critical concepts:
 - Equilibrium potential
 - Resting potential
 - Driving force
3. Ion currents:
 - Channel structure and regulation (state transition model for channel opening),
 - Hodgkin-Huxley formalism (gate variables),
 - Important cardiac currents and their regulation (voltage and time dependence),

- Be sure to go over the cell membrane simulation homework and be familiar with the mechanisms and behavior you observed there, *eg.*, thresholds, all-or-nothing, response to varying ion concentrations.
4. Action potentials:
- Different types of cardiac action potentials, *i.e.*, those belong to different cell types in the heart,
 - Effects of autonomic nervous system neurotransmitters on pacemaker action potentials.

2.2 Myocardial Tissue

1. Structural characteristics of myocardial tissue: organization, fibers, gap junctions, syncytium,
2. Nature and role of anisotropy,
3. Propagation of excitation through myocardial tissue,
4. Cell to cell coupling, local circuit currents,
5. Measurement of electrical activity in cardiac tissue, *eg.*, bipolar and unipolar electrical recordings and optical methods,
6. Gap junction structure, function,
7. Mechanisms of reentry and ectopic focus in cardiac arrhythmias.

2.3 Whole heart

1. Electrophysiology of the whole heart:
 - Structure, role of conduction system,
 - Role of different pacemakers (“overdrive suppression”),
 - Effects of autonomic nervous system on the heart rate,
 - Activation sequence of the heart,
 - Cardiac arrhythmias.
2. Electrocardiography:
 - Basic physiology and biophysics of the ECG, components required for ECG to arise,
 - Heart dipole and the sequence of activation,
 - Lead systems,
 - Basic interpretation of ECGs.

3 Background materials from the text

The following pointers are to sections in the Eckert Animal Physiology text that are recommended or required reading:

- Chapter 1: pages 3–14
- Chapter 2: pages 26–29
- Chapter 3: pages 49–51 (should be review)
- Chapter 4: pages 79–104 (should be review)
- Chapter 5: pages 122–150 (selectively, some as review)
- Chapter 12: pages 476–481 and assume that you have to know everything that is even mentioned in these few pages.

For other resources should you need more explanation please see here

<http://www.sci.utah.edu/~macleod/bioen/be6000/background.html>