

BENG 100b: Frontiers in Biomedical Engineering

Spring 2008

FINAL EXAMINATION

May 7, 2008

***INSTRUCTIONS: You have three hours to complete this exam. This is a closed book exam. You may use a calculator. Only work shown in the space provided will be graded. Partial credit will be given when warranted. The exam is worth a total of 100 points.***

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Open Yale courses

**Question 1.** *(20 points)* Cardiovascular physiology

As you know from our section meeting, blood pressure is measured using an inflatable cuff and a stethoscope. Describe how this blood pressure measurement works by answering the following questions:

a) What happens in your arm as the inflatable cuff is pressurized? Why is it usually inflated to ~200 mmHg?

b) Blood pressure is recorded as (systolic pressure)/(diastolic pressure), with a typical value of 120/80 (in mmHg). These pressures are determined by listening with a stethoscope as the pressure in the cuff is decreased. What physical process creates the sounds?

c) How are pressures measured in the arm related to pressures in the heart?

**Question 2.** (20 points) Renal Physiology

The nephron is the functional unit of the kidney.

a) Describe the structure of the nephron, using a diagram, if you like.

b) Describe an experimental approach for measuring the glomerular filtration rate using the tracer molecule inulin.

**Question 3.** (20 points) Tissue Engineering

Many people believe that tissue engineering may someday offer an alternative for patients who now can only be treated by whole-organ transplantation. List three **other** possible uses for tissue engineering and provide an example of each.

Tissue engineering strategies can generally be divided into 2 categories; cell-based and biomaterial-based. Discuss the strengths and weaknesses of each approach using examples from the lectures and address some of the challenges of integrating the two approaches.

**Question 4.** (20 points) Biomechanics

- a. A bird in flight (or an airplane in flight) experiences forces that move it in a forward direction and that keep it aloft. Draw a diagram showing the forces that are acting on a bird (or airplane) that is moving forward at a constant velocity and maintaining a constant altitude.
- b. Label the forces in the diagram.

- c. What physical mechanisms does a bird use to generate the forces necessary to move forward and stay aloft?

**Question 5.** (20 points) Imaging

- a) What is ionizing radiation?
- b) Ionizing radiation from a variety of sources is used for creating images in humans. Select any two sources of ionizing radiation and describe a method for imaging based on that type of radiation.
- c) Ultrasound imaging does not involve ionizing radiation. What physical principle does it use? How is an image created using this principle (i.e. what properties of tissues does it detect)?

**Bonus.** *(10 points)*

Describe one interesting biomedical engineering principle that you learned from reading the research papers prepared by your peers.