

NROSCI/BIOSC 1070 and MSNBIO 2070

Exam # 1

September 30, 2016

Total POINTS: 100	20% of grade in class
--------------------------	------------------------------

1) Patients with very low blood potassium levels are often given potassium chloride to take in pill form. However, the patients are counseled never to take an overdose of potassium chloride, as this can induce sudden death.

a) Discuss the mechanism through which a large dose of potassium leads to sudden death. **(6 points)**.

b) If a patient were to take an overdose of potassium chloride that was not fatal, what adverse effects would be apparent? **(4 points)**.

- 2) a) Which heart valves are open just *before* the second heart sound (S2) occurs? **(3 points)**.
- b) In a “normal” individual at rest, what is the approximate volume of blood in the left ventricle at the time the second heart sound occurs? **(3 points)**.
- c) Which wave of the ECG precedes the occurrence of the second heart sound? **(2 points)**.

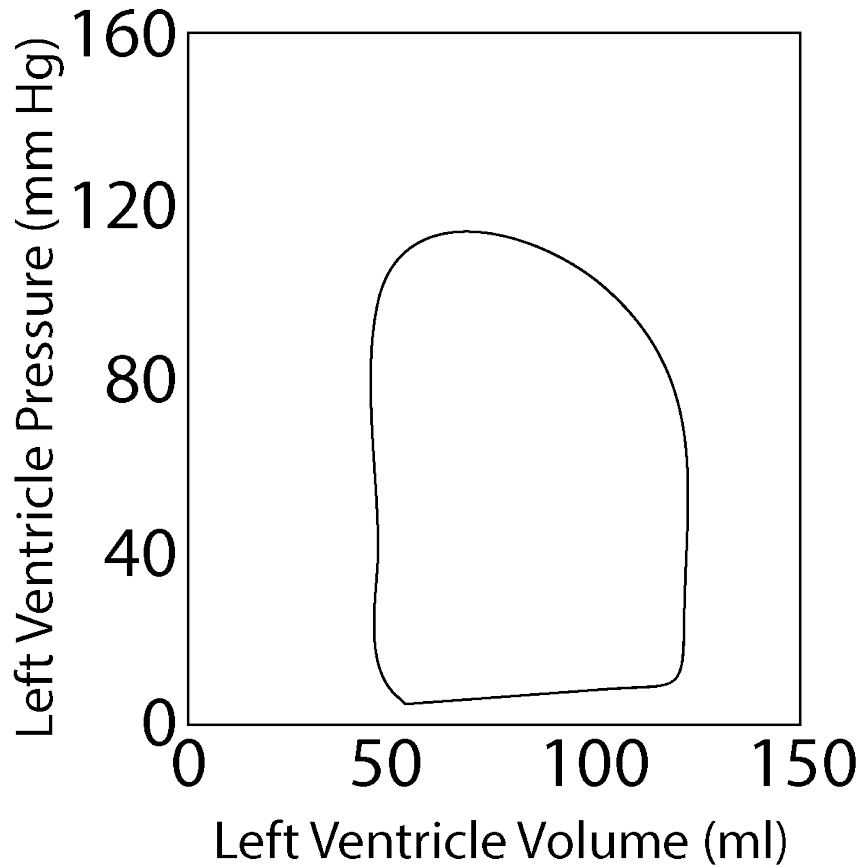
- 3) Patients with narrowed cardiac arteries due to atherosclerosis sometimes experience chest pain, called angina, when they exert themselves. This is because they cannot produce adequate ATP to meet the metabolic needs of the myocardial cells. Discuss three distinct, commonly-used drug treatments that act on the heart and serve to diminish angina (by reducing myocardial oxygen demand). Please provide the mechanism through which each drug exerts its effects. **(9 points)**.

Treatment 1:

Treatment 2:

Treatment 3:

- 4) A “standard” pressure-volume curve for an individual at rest is illustrated below. Show how the pressure-volume curve changes during exercise, and describe (*in words*) why these changes occur. **(12 points)**.



- 5) Systemic filling pressure (P_{sf}) is an important factor in determining cardiac output. Describe the two principal mechanisms/factors that control P_{sf} , and briefly discuss how each of these mechanisms/factors alters P_{sf} . **(6 points)**.

- 6) An individual has a mutation such that the isoform of myosin ATPase in their cardiac myocytes is replaced with an isoform similar to that in type FF skeletal muscle fibers. In the tables below, indicate how this mutation alters cardiac function in the individual, and briefly explain why. Assume that the mutation has no effect on ventricular size or stiffness. **(9 points)**.

Contractility	<i>Less with mutation</i>	<i>Same with mutation</i>	<i>More with mutation</i>
WHY?			

MVO₂	<i>Less with mutation</i>	<i>Same with mutation</i>	<i>More with mutation</i>
WHY?			

End Systolic Volume	<i>Less with mutation</i>	<i>Same with mutation</i>	<i>More with mutation</i>
WHY?			

- 7) Another individual has a mutation such that the isoform of titin in their ventricular myocytes is replaced by one that is much stiffer. Assume that no compensatory changes in ventricular radius or contractility occur following the mutation. What effect would this mutation have on stroke volume, and why does this effect occur? **(5 points)**.
- 8) You are treating a patient with a mutation resulting in the enzyme phenylethanolamine N-methyltransferase (PNMT) being dysfunctional. What effects would this mutation have on the patient's capacity to exercise? Briefly explain why the changes in exercise capacity occur. **(6 points)**.

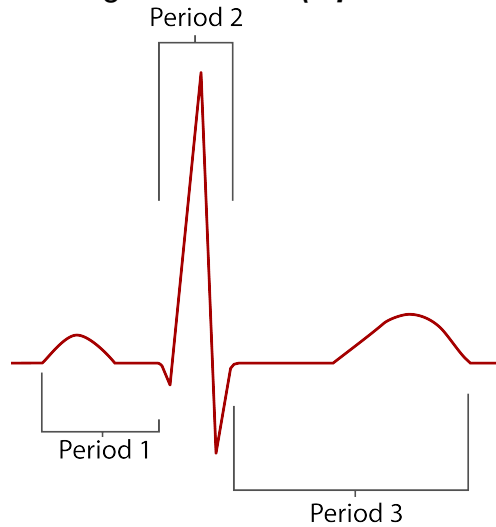
- 9) The following physiological parameters are determined for two individuals. Which has the highest myocardial oxygen demand? Provide a brief justification for your answer. **(5 points)**.

Individual 1	Individual 2
<i>Systolic Pressure</i> → 120 mmHg	<i>Systolic Pressure</i> → 100 mmHg
<i>Diastolic Pressure</i> → 80 mmHg	<i>Diastolic Pressure</i> → 75 mmHg
Heart Rate → 60 beats per minute	Heart Rate → 50 beats per minute
Cardiac output → 6 L/min	Cardiac output → 5.75 L/min

Answer:

Justification:

- 10) A standard ECG waveform is provided below, with several “periods” demarked. Circle or underline the period in which an abnormal heart sound would occur during each of the following conditions: **(1 point each; 4 points total)**.



Mitral Valve Stenosis	Period 1	Period 2	Period 3
Mitral Valve Regurgitation	Period 1	Period 2	Period 3
Aortic Valve Stenosis	Period 1	Period 2	Period 3
Aortic Valve Regurgitation	Period 1	Period 2	Period 3

11) The drug hexamethonium completely suppresses both sympathetic and parasympathetic nervous system activity.

a) Describe how this drug must work to suppress the firing rate of both sympathetic and parasympathetic postganglionic neurons. **(3 points)**.

b) Would administration of hexamethonium alter heart rate? If so, describe the changes in heart rate that would occur. **(3 points)**.

12) Which blood vessel type (*aorta, large artery, small artery, arteriole, capillary, venule, vein, vena cava*) contributes the most to producing total peripheral resistance in the cardiovascular system? Briefly describe the main property of these vessels that generates resistance to blood flow. **(5 points)**.

13) In which blood vessel type (*aorta, large artery, small artery, arteriole, capillary, venule, vein, vena cava*) does systolic pressure appear to be highest? Why is systolic pressure highest in this vessel type? **(5 points)**.

14) A patient has extremely high levels of both thyroid hormones (thyroxine) and thyroid-stimulating hormone (TSH) in their bloodstream.

a) What is the most likely explanation for this imbalance in hormones? Provide a brief explanation for your answer. **(4 points).**

b) Would it be feasible to measure blood levels of thyrotropin-releasing hormone to determine if overproduction of this hormone leads to high levels of thyroxine and TSH? Provide a brief explanation for your answer. **(3 points).**

c) Could an alternate test be done to determine if thyrotropin-releasing hormone levels are normal? What would you look for in such tests? **(3 points).**