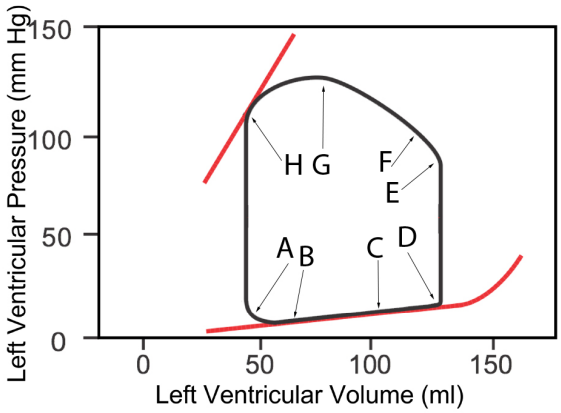
Exam Key

# NROSCI/BIOSC 1070 and MSNBIO 2070
# Exam # 1
# September 27, 2019




**1)** A standard left ventricle pressure-volume curve is illustrated to the left. Match the letters indicated in the diagram to the events below. Each letter can be matched to more than one event. ***(2 points each; 12 points total).***

**a)** Ventricular filling rate is most rapid: B

**b)** Ventricular pressure is near mean arterial pressure: H

**c)** Blood is ejected from the ventricle at highest velocity: F

**d)** The peak of the ECG T-wave occurs: G

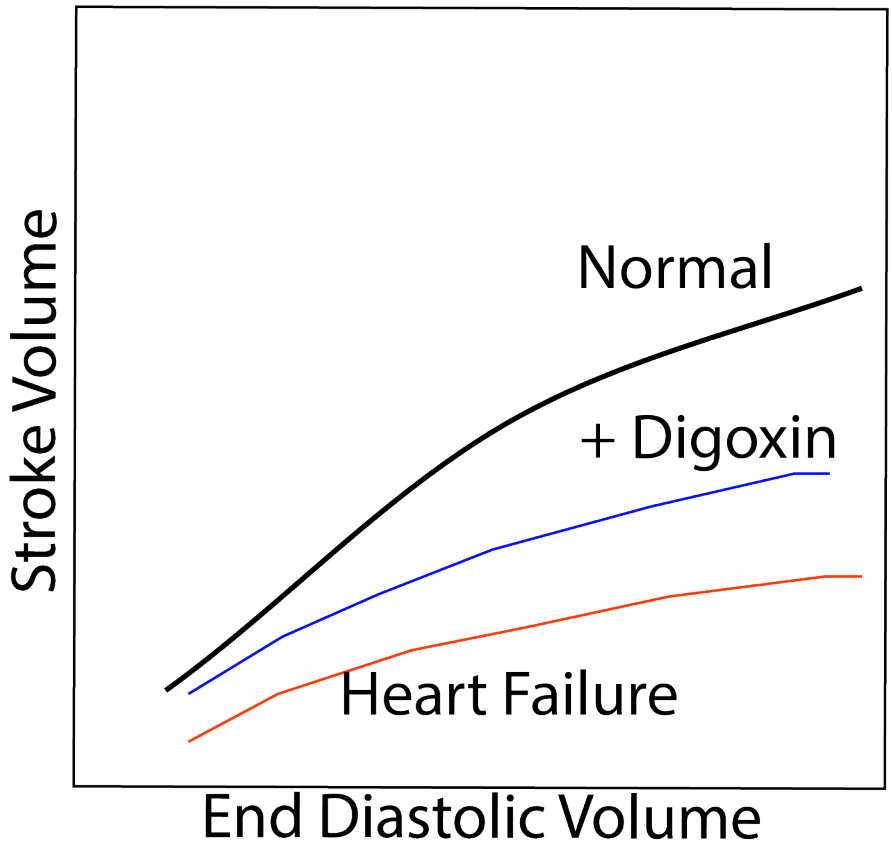
**e)** The third heart sound occurs: C (B also OK)

**f)** Ventricular blood volume constitutes preload: D (E also OK)

**2)** Following a heart attack, a patient is suffering from heart failure.

**a)** On the diagram below, indicate how the Starling curve changes from normal on the side of the heart that is damaged. ***(3 points)*.**

**b)** The drug digoxin is sometimes prescribed to treat heart failure. The primary mechanism of action involves inhibition of Na+/K+ ATPase, mainly in the myocardium. On the diagram below, indicate how digoxin alters the Starling curve for the damaged ventricle. ***(3 points).***




**c)** Briefly describe the physiologic mechanism through which digoxin causes the change in the Starling curve you indicated above. ***(6 points).***

- Decreased activity of the Na+/K+ results in an increase in intracellular Na+ ( 1 pt).
- As a result, the driving force for the Ca2+/Na+ exchanger decreases. (2 pts)
- Thus, intracellular Ca2+ increases (2 pts)
- As a result, the critical Ca2+ threshold for causing contraction is reached earlier in the cardiac cycle, resulting in more shortening (contractility) (1 pt)

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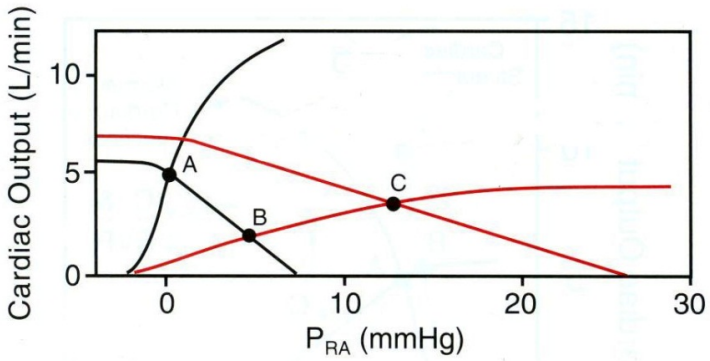
**3)** An individual is administered phenylephrine, an $\alpha$-1 receptor agonist. Assume that there are no compensatory or reflex-elicited changes that alter the direct effects of the drug on the cardiovascular system.

**a)** Would the $\alpha$-1 receptor agonist result in a change in blood pressure? If so, would blood pressure increase or decrease? What physiological actions of phenylephrine cause this change in blood pressure? ***(4 points).***

- It would produce a change in blood pressure (1 pt)
- Blood pressure will increase (1 pt)
- This results from arteriole vasoconstriction and an increase in TPR (2 pts)

**b)** Normal vascular and cardiac function curves are illustrated below. Indicate how the administration of an $\alpha$-1 receptor agonist would alter the curves. You may also add a description to clarify your response. ***(6 points).***




For vascular function curve: Psf increases (3 pts) and the slope decreases (RVR higher). (3 pts).

Cardiac function curve should not change much, but no points off for indicating that it shifts down (hypoeffective),

**4)** Does the sympathetic nervous system have any effect on skeletal muscle? If so, describe the receptors on skeletal muscle through which the sympathetic nervous system elicits actions, and the physiologic effects of the sympathetic nervous system on skeletal muscle. ***(5 points).***

Yes it does (1 pt)

Epinephrine released from the adrenal medulla binds to β-2 receptors on the skeletal muscle cells (2 pts)

As a result, contractility of skeletal muscle increases (2 pts)

**5)** It is not uncommon for cranial nerve III (the oculomotor nerve) to be damaged by an aneurysm from a large artery in the head, the posterior communicating artery. Often, the parasympathetic fibers in the nerve are damaged early. What are the consequences of damage to the parasympathetic nerve fibers in the third cranial nerve? ***(6 points).***

Dilated pupil

**6)** Binding of an agonist to either GABAa or glycine receptors increases the conductance of the same ion through the membrane.

**a)** Which ion is transported more readily through the membrane following the binding of agonists to these receptors? ***(3 points).***

Cl-

**b)** What is the physiologic effect of an agonist binding to either GABAa or glycine recptors? (What is the effect on membrane potential?) ***(3 points).***

IPSP (or membrane hyperpolarization)

**c)** Are GABAa and glycine receptors characterized as metabotropic or ionotropic receptors (circle the answer below)? ***(2 points).***

Metabotropic Ionotropic

**d)** Are the synaptic effects of GABA and glycine terminated by breaking down the transmitters or reuptaking them into nerve terminal? ***(2 points).***

Reuptake Breakdown

**7)** The following questions relate to muscle unit types. Circle which muscle unit type best meets the stated criterion. ***(1 point each; 6 points total).***

**a)** Most ATP usage per unit time

FF S

**b)** Most actin and myosin content per muscle cell

FF S

**c)** Most similar to cardiac muscle cells

FF S

**d)** Most able to undergo substantial hypertrophy (increase in diameter by adding actin and myosin)

FF S

**e)** Produce the most tension during contraction

FF S

**f)** Can contract for a sustained period without fatigue

FF S

**8)** A critically ill patient is given dobutamine at a dose that mainly serves as a β-1 receptor agonist. What effects would the drug have on the following? (circle the correct answer) ***(2 points each; 10 points total).***

**a)** End systolic volume

Unchanged Higher Lower

**b)** End diastolic volume

Unchanged Higher Lower

**c)** Ventricular filling time

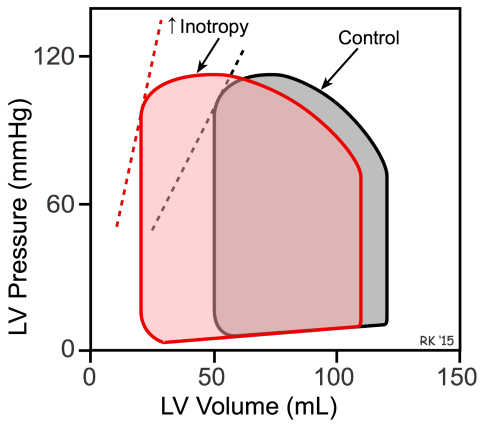
Unchanged Higher Lower

**d)** Blood pressure

Unchanged Higher Lower

**e)** Workload of the heart

Unchanged Higher Lower



**9)** Patient A is given a selective β-1 receptor agonist while Patient B is given a drug that activates both β-1 and β-2 receptors. If both drugs have equivalent effects on β-1 receptors, which will produce the greatest change in afterload? Discuss the physiologic mechanism accounting for your answer. ***(7 points).***

β-1 receptors (3 pts)

β-2 agonists also cause dilation of muscle arterioles, reducing TPR and afterload (4 Pts)

**10)** During a spinal surgery, the rostral portion of the sympathetic chain on one side is destroyed. As a result, the patient loses all sympathetic innervation of the head on that side. List three distinct physiologic changes that would result from removal of sympathetic innervation from half of the face. ***(7 points).***

Pupillary constriction (3 pts)
Face redness (due to dilation of face arterioles; 2 pts)
Lack of sweating on affected side (2 pts)

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**11)** The following physiologic parameters are determined for an individual:

Systolic aortic Pressure = 150 mm Hg
Diastolic aortic pressure= 90 mm Hg
Systolic pulmonary artery pressure = 12 mm Hg
Diastolic pulmonary artery pressure = 6 mm Hg
Heart rate = 50 beats/min
Left atrial pressure = 5 mm Hg
Right atrial pressure = 2 mm Hg
End systolic volume (both ventricles) = 50 ml
End diastolic volume (both ventricles) = 150 ml

For this individual, determine the resistance in the pulmonary circulation relative to the systemic circulation (i.e., Pulmonary resistance/Systemic resistance). You MUST show your calculations to receive credit. ***(10 points).***

Systemic circulation:
MAP = 0.66(90) + 0.33(150) = 109 mm Hg
$\Delta$P = 109-2 = 107 mm Hg
CO=(EDV-ESV)* HR = (150-50)*50 = 5000 ml/min
R= $\Delta$P/CO = 107 mm Hg / 5000 ml/min
R= 0.02 mm Hg / ml / min

Pulmonary circulation:
MAP = 0.66(6) + 0.33(12) = 8 mm Hg
$\Delta$P = 8-5 = 3 mm Hg
CO=(EDV-ESV)* HR = (150-50)*50 = 5000 ml/min
R= $\Delta$P/CO = 3 mm Hg / 5000 ml/min
R= 0.0006 mm Hg / ml / min

Pulmonary/Systemic R = 0006/0.02 = 300 times more in systemic circulation

**12)** A patient has highly elevated plasma levels of ACTH, β-LPH, and β-endorphin. What is the most likely cause of these abnormal plasma hormonal levels? ***(5 points).***

The most likely cause is a CRH-releasing tumor.