

## Exam KEY

NROSCI / BIOSC 1070 -- MSNBIO2070

Exam # 3

November 16, 2018

<b>Total POINTS: 100</b>	<b>20% of grade in class</b>
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- 1) A patient with chronic emphysema has a 20% decrease in arterial plasma  $pO_2$ . How does arterial oxygen content compare in this patient to a healthy individual? Provide a brief explanation for your answer. **(6 points)**.

*It is near normal. Even with a 20% reduction in plasma  $pO_2$ , hemoglobin is nearly totally saturated with oxygen, and virtually all the blood oxygen is bound to hemoglobin. Polycythemia can also occur, increasing the oxygen carrying capacity of the blood.*

- 2) A diver who is swimming just beneath the water's surface is breathing through a snorkel with a volume of 150 ml. The diver's breathing rate is 12 breaths/min, and each breath takes in 600 ml of air. Calculate the diver's alveolar ventilation. **(6 points)**.

*Dead space = 150 ml (airways) + 150 (snorkel) = 300 ml  
Alveolar ventilation = (600-300 ml)\*12 breaths/min = 3.6 L/min*

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- 3) A drug is injected into a pregnant woman that shifts her oxygen-hemoglobin dissociation curve to the right. This drug does not cross the placenta, and thus does not affect the fetus. Provided that the mother's hemoglobin remains saturated, would this drug impair oxygen delivery to the fetus? Discuss the basis for your answer. **(6 points)**.

*Fetal oxygen delivery is not impaired. The mother's hemoglobin will be more likely to donate oxygen to the fetal hemoglobin.*

- 4) The chart below shows pH, pCO<sub>2</sub> and HCO<sub>3</sub><sup>-</sup> levels measured from an arterial blood sample. For each example, indicate whether 1) acidosis or alkalosis is present, 2) whether the cause is metabolic or respiratory and 3) whether the condition is compensated or uncompensated. **(18 points)**.

Blood Gases			Acidosis or Alkalosis	Metabolic or Respiratory	Compensated or Uncompensated
HCO <sub>3</sub> <sup>-</sup> (mM)	pCO <sub>2</sub> (mm Hg)	pH			
36	46	7.51	Alkalosis	Metabolic	Compensated
18.3	40	7.28	Acidosis	Metabolic	Uncompensated
33	60	7.35	Acidosis	Respiratory	Compensated

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- 5) A patient has Chronic Obstructive Pulmonary Disorder (COPD), but otherwise their lungs are healthy (no change in compliance or alveolar surface area). Assume that the patient is not being treated for the condition. Indicate whether the disorder causes an increase, decrease, or no change in the following: **(2 points each; 10 points total)**

<b>Residual Volume:</b>	<b>Increase</b>	Decrease	No Change
<b>Transpulmonary Pressure:</b>	Increase	Decrease	<b>No Change</b>
<b>Blood Viscosity:</b>	<b>Increase</b>	Decrease	No Change
<b>Vital Capacity:</b>	Increase	<b>Decrease</b>	No Change
<b>Activity of External Intercostal Muscles:</b>	<b>Increase</b>	Decrease	No Change

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- 6) A Pittsburgh native who has never before left Allegheny County is transported to La Rinconada, Peru (altitude 16,728 feet above sea level), to work in the gold mine located there. In the chart below, indicate how plasma levels of  $pO_2$ ,  $pCO_2$ , and  $HCO_3^-$  and blood pH change in this individual relative to the levels in Pittsburgh. Indicate the changes measured 10 minutes after arriving in La Rinconada, and those measured 15 days later. **(2 points each; 16 points total).**

<b>Values at 10 minutes after arriving at high altitude (relative to those before leaving Pittsburgh)</b>			
$pO_2$	Lower	Higher	Same
	Due to low barometric pressure		
$pCO_2$	Lower	Higher	Same
	Due to hyperventilation		
pH	Lower	Higher	Same
	Hyperventilation-related respiratory alkalosis		
$HCO_3^-$	Lower	Higher	Same
	Due to mass action (lower $CO_2$ resulting from hyperventilation)		
<b>Values at 15 days after arriving at high altitude (relative to those at 10 minutes after arriving at high altitude)</b>			
$pO_2$	Lower	Higher	Same
	Hyperventilation is greater due to renal correction of pH		
$pCO_2$	Lower	Higher	Same
	Hyperventilation is greater due to renal correction of pH		
pH	Lower	Higher	Same
	Returns to normal (lower than before acclimation)		
$HCO_3^-$	Lower	Higher	Same
	Renal mechanisms lower bicarbonate to normalize pH		

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- 7) After approving the pain killer Vioxx in 1999, the FDA withdrew the drug from the market in 2004 when it was discovered that it resulted in an increased incidence of stroke and heart attack. It was subsequently determined that Vioxx inhibits the synthesis of prostacyclin. Briefly explain how a prostacyclin inhibitor would increase the likelihood of suffering a stroke or heart attack. **(7 points)**.

*Prostacyclin inhibits the formation of blood clotting. Thus, a prostacyclin synthesis inhibitor increases the likelihood of formation of clots that can block arteries in the heart or brain.*

- 8) An arterial blood sample from a patient shows an oxygen content of 200 ml O<sub>2</sub>/L. The patient's venous blood content is determined to be 150 ml O<sub>2</sub>/L. The patient has a body surface area of 1.9 m<sup>2</sup>. What is the patient's cardiac output? You must show your calculations. **(7 points)**.

*Cardiac Output = (125 ml O<sub>2</sub>/minute x 1.9) / (200 ml O<sub>2</sub>/L - 150 ml O<sub>2</sub>/L) = 4.75 L/minute*

*Note: 125 ml O<sub>2</sub>/minute is a standard value for O<sub>2</sub> consumption at rest.*

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- 9) Dendritic cells participate in the inflammatory response that can lead to arterial hypertension. Briefly discuss the role of dendritic cells in this process. **(6 points)**.

*Main point: dendritic cells are antigen-presenting cells. Their main function is to process antigen material and present it on the cell surface.*

*Full credit for stating that dendritic cells activate T cells.*

- 10) During inflammatory responses, histamine is released by mast cells. Describe the actions of histamine that result in inflammation. **(6 points)**.

*The two main actions of histamine are to cause arteriolar dilation (3 points) and increased local capillary permeability (3 points).*

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- 11) Natural killer cells play a particular role in immune responses that is unique to this cell class. Briefly describe the role of natural killer cells in immune function. **(6 points)**.

*Natural killer cells are effectors of innate immunity, Natural killer cells rapidly target cells lacking markers of self, including virus-infected cells, and kill the cells.*

- 12) What is complement, and what role does it play in producing immune responses? **(6 points)**.

*Complement is a component of the innate immune system (3 points). Complement proteins are opsonins: they mark along with antibodies non-self cells thereby targeting them for destruction by the immune system. (3 points).*