

**BIO 3302 Animal Physiology II
Midterm #1**

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80 min

NAME: _____

STUDENT #: _____

Part A: Answer the following questions in the space provided on the question sheet. (1 mark per answer unless otherwise stated; 30 marks in total + 1 bonus)

1. Complete the following table listing the structural features of the different functional types of blood vessels and the physiological significance of these structural features. Please note that only **one** structural feature per vessel type is needed. In addition, name the blood vessel associated with each functional type. (0.5 marks per answer)

Blood vessels by function	Blood vessel	Structural characteristic	Functional significance
Windkessel vessel			
Pre-capillary resistance vessel			
Capillary			
Capacitance vessels			

2. True OR false (select one): Vasomotor tone refers to the resting level of parasympathetic output to the heart.

3. Use the data below to calculate the contribution (as a percentage) of physically dissolved CO₂ to the total blood CO₂ concentration. Please show all calculations. (3 marks)

$$\alpha_{\text{plasma}}\text{CO}_2 \text{ (at } 15^\circ\text{C)} = 0.055 \text{ mmol L}^{-1} \text{ Torr}^{-1}$$

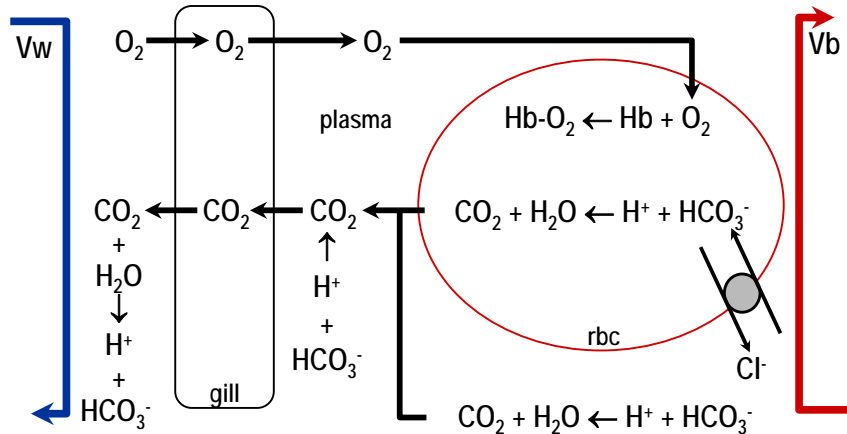
$$\beta_{\text{blood}}\text{CO}_2 \text{ (at } 15^\circ\text{C)} = 1.65 \text{ mmol L}^{-1} \text{ Torr}^{-1}$$

$$\text{PCO}_2 = 4 \text{ Torr}$$

4. One of the characteristics of animals adapted to a diving lifestyle is a blunted hypercapnic ventilatory response. Based on your knowledge of the control of ventilation, explain the significance of this trait. (2 marks)

5. Assuming that the pressure drop across a blood vessel remains constant, blood flow through the vessel will be increased OR decreased (**select one**) by a factor of _____ if the radius and length of the vessel are both halved.

6. The figure below presents a model of CO_2 excretion at the gills of an elasmobranch fish such as a dogfish. Currently, the model is missing carbonic anhydrase (CA), which will have a significant negative impact on the ability of the dogfish to excrete CO_2 ! Correct this problem by adding "CA" to indicate the locations in which carbonic anhydrase would be found in a dogfish. (2 marks)

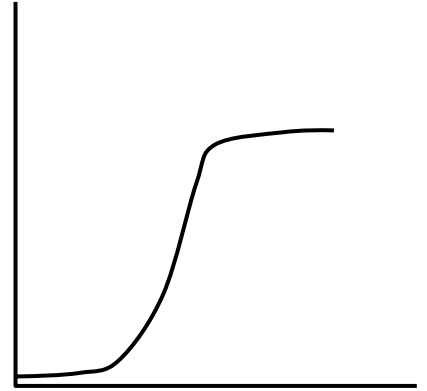


7. As Harry the herring schools with his buddies, he consumes O_2 at a rate of $1.8 \text{ mmol g}^{-1} \text{ h}^{-1}$ and ventilates his gills with $250 \text{ mL g}^{-1} \text{ min}^{-1}$ of water. Given that Harry lives in the upper layers of the ocean where the PO_2 of the water is about 160 Torr, at what PO_2 does water exit Harry's gills? You may assume that the capacitance coefficient of the water for O_2 (i.e. βwO_2) is $2 \text{ } \mu\text{mol L}^{-1} \text{ Torr}^{-1}$. (3 marks)

8. In honour of St. Valentine's Day... Whose heart am I?

- I have four chambers connected in series, the final chamber being the bulbus arteriosus. I am the heart of _____.
- My single ventricle is undivided. I am the heart of _____.
- My two halves are completely divided, allowing different input pressures to the systemic and respiratory circulations. I am the heart of _____.

9. Erythropoietin (EPO) is a peptide hormone that acts on the bone marrow to stimulate red blood cell production. Synthetic EPO has become a popular drug among high-performance endurance athletes (e.g. cross-country skiers, distance cyclers). On the axes below, sketch the O_2 equilibrium curve, relative to that provided, that might be expected in an athlete that has used EPO. Label the axes. Use your sketch to explain the benefit of EPO to endurance athletes. (3 marks)



EPO abuse is associated with increased risk of cardiovascular problems including elevated blood pressure and resultant cardiac failure. Use your knowledge of Poiseuille's equation to explain the risks of EPO to endurance athletes. (3 marks)

10. With reference to the Fick equation, explain (**briefly**) why fish gills do not function effectively in air. For a bonus mark, note the adaptations of the mudskipper that allow this limitation to be overcome. (2 marks + 1 bonus)

Part B: Of the following questions, answer 1 **OR** 2, **AND** 3 in the exam booklet.

1. During exercise, cardiac output may increase 7-fold and peripheral vasoconstriction occurs, yet blood pressure remains constant. Explain (**briefly**) why blood pressure remains constant, naming and explaining the underlying physiological mechanism(s) involved. (4 marks; 5 min)

OR

2. Data are presented in the table below for two different creatures, one of which is a vertebrate, while the other is an invertebrate. Which creature, A or B, is the vertebrate? Please explain your reasoning. (4 marks; 5 min)

Circulatory characteristic	Creature A	Creature B
Rate of O ₂ delivery to tissues (mL O ₂ kg ⁻¹ min ⁻¹)	0.65	0.60
Blood flow (mL blood kg ⁻¹ min ⁻¹)	25	85
Pressure difference between blood exiting the heart and blood returning to the heart (mmHg)	22	16
Systemic resistance (mmHg min kg mL ⁻¹)	0.9	0.2
Heart rate (min ⁻¹)	63	65
Blood-O ₂ carrying capacity (vol%)	4	1.6

AND

3. In 1968, Tucker reported that for sparrows, there was no visible change in the behaviour of birds at an altitude of 6100 m versus sea level. However, while mice were continuously active and exploring the experimental chamber at sea level, at 6100 m, mice “lay on their bellies and usually did not move although they could crawl slowly” (Tucker, 1968, JEB 48, 55-66). Discuss the structural and functional features of the avian respiratory system that contribute to this difference between birds and mammals. (8 marks; 10 min)

Bonus: For a bonus mark that, in the spirit of socialism will be applied to the entire class if even one person answers correctly, circle the names of the celebrities below who do **not** enjoy fishing:

Vince Gill

Kevin Costner

Tiger Woods

Robert Redford

Kim Alexis

Clint Eastwood

Liam Neeson

Paris Hilton

Bing Crosby

Sean Connery