BIO 3302 Animal Physiology II
Final examination

April 19th, 2013 (3 h) **Name: _____**
Dr KM Gilmour
Closed book exam **Student number: _____**

Note: This exam consists of three sections and one bonus question. The questions in Section A should be answered **in the space provided on the question sheet.** The questions in Sections B and C should be answered **in the exam booklet**.

Part A: Answer on the question sheet. (1 mark per answer unless otherwise indicated; 33 marks in total)

1. The functional unit of gas exchange in a fish is the

   _____.

2. True OR false (**select one**): An increase in stroke volume at a constant venous filling pressure can be achieved via the Frank-Starling effect.

   Explain your answer using a labelled sketch of the Frank-Starling relationship. (3 marks)

3. Owing to low blood protein levels (a consequence of starvation), the colloid osmotic pressure difference at the renal corpuscle has decreased to 15 mmHg. To preserve the normal (net) glomerular filtration pressure of 10 mmHg, blood pressure would have to increase OR decrease (**select one**) from its normal value of 55 mmHg to _____, assuming a fluid pressure of 15 mmHg in Bowman's capsule. This change could be accomplished by dilation OR constriction (**select one**) of the afferent arteriole.

4. Which one of the following conditions will tend to promote release of atrial natriuretic peptide (ANP)?
   a. Mild dehydration owing to sitting in a sauna
   b. Consumption of several bags of salty potato chips
   c. An increase in blood pressure owing to infusion of 1 L of saline solution
   d. Consumption of 1 L of ice-cold fresh water
   e. An acid-base disturbance owing to prolonged vomiting

   Explain your answer. (1 mark)

5. Because the red (swimming) muscle temperature in bluefin tuna is maintained above the water temperature, these animals are considered to be _____.

6. Distinguish between an antifreeze protein and a cryoprotectant. (2 marks)

7. Sufferers of Raynaud's syndrome exhibit _____ when blood flow is re-established following a period of ischemia due to cold exposure.

8. Sketch the relationship between O_2 consumption and water O_2 tension (PO_2) for a mangrove rivulus exposed to progressive hypoxia. Indicate the critical O_2 tension. (3 marks)

9. Which of the following is **not** an AVT-induced response that would be observed in a frog?
   a. an increase in water uptake from the bladder
   b. an increase in water uptake from the environment via the pelvic patch
   c. an increase in water reabsorption at the distal tubule of the nephron
   d. an increase in glomerular filtration rate
   e. all of the above responses can be induced by AVT in frogs

10. For enzyme function, how does the strategy for acclimatization to seasonal changes in temperature differ from that for adaptation to differences in temperature owing to climate? (2 marks)

11. The extraction efficiency of a fish inhaling air-equilibrated water and exhaling water of PO_2 = 100 Torr is _____.

12. At a PO_2 of 100 Torr, the total blood O_2 content of an unknown species of fish is 200 mL O_2 L^{-1}. If $\alpha_{plasma}O_2$ = 0.03 mL O_2 L^{-1} $Torr^{-1}$, is this unknown species of fish likely to be a member of the icefish family? Explain your answer. (3 marks).

13. Both lobster and cod are (or at least used to be) found off the coast of Newfoundland, where winter water temperatures hover around -2°C. Which of these two species would be more likely to exhibit antifreeze compounds, and why? (2 marks)

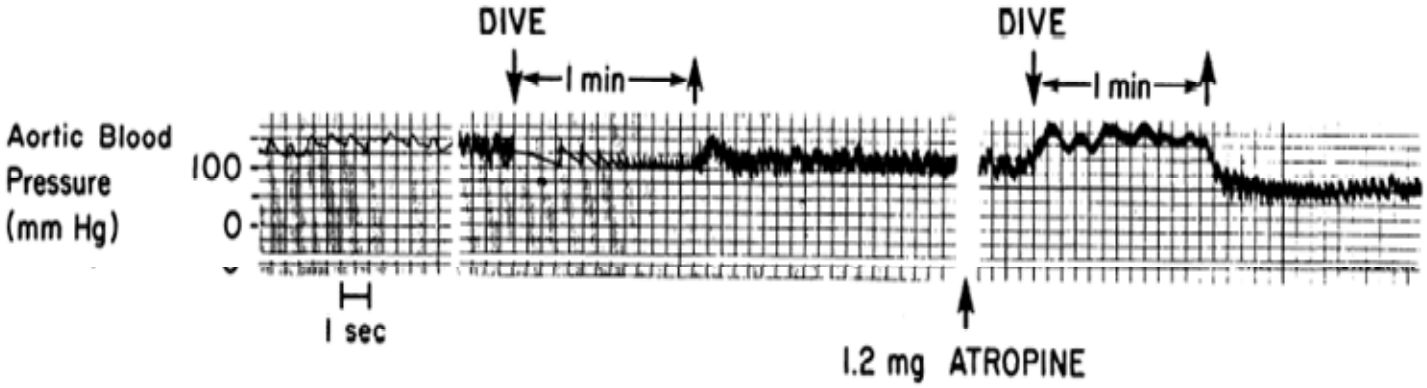
14. Fluid and _____ that are lost from the capillaries are returned to the circulatory system by means of the _____ system.

15. Body temperature in a tadpole generally is <u>less than OR equals OR is greater than</u> (**select one**) that of the surrounding water because of _____ heat exchange. For a frog sitting on a lily pad, _____ heat exchange may permit body temperature to be <u>less than OR equal to OR greater than</u> (**select one**) air temperature.

16. The pacemaker potential…
    a. Is slower following sympathetic stimulation of the heart, owing to increased K^+ efflux achieved by the action of noradrenaline on $ß_2$-adrenoreceptors.
    b. Reflects the presence of a Na^+ leak channel (sometimes called the Na^+ "funny" channel) that results in spontaneous depolarization.
    c. Is the unstable resting membrane potential that occurs in the contractile cells of the vertebrate heart.
    d. Is faster following vagal stimulation of the heart, resulting in an increase in heart rate that is termed a positive inotropic effect.
    e. Accounts for the prolonged plateau phase of the contractile cells of the vertebrate heart

Part B: Answer **FOUR** of the following five questions in the exam booklet. (6 marks each; 24 marks in total)

1. The figures below are taken from an experiment carried out by Elsner *et al.* (1985, *Am. J. Physiol.* 249, H1119-H1126) on seals. Aortic blood pressure was recorded in a seal during rest followed by a 1 minute dive. Note that the pulsatility of the aortic blood pressure trace corresponds to the heart beating. An injection of 1.2 mg of the muscarinic cholinergic receptor antagonist atropine was then administered to the seal (indicated by the arrow), and a second 1 minute dive was carried out. Explain the blood pressure responses during a normal dive and during a dive following atropine treatment.



2. Explain how blood O_2 transport and blood CO_2 transport are linked, illustrating your answer with labelled sketches of O_2 and CO_2 equilibrium curves.

3. Contrast and compare the iono- and osmoregulatory challenges and strategies of a marine elasmobranch such as the dogfish, and the hagfish. Illustrate your answer with a labelled sketch of their osmoregulatory strategies (on a plot of body fluid versus environmental osmotic concentration).

4. The circulatory system plays a critical role in a variety of thermoregulatory strategies. Discuss this statement, providing specific examples.

5. Explain with the aid of a (labelled) sketch why CO_2 excretion, NH_3 excretion and acid excretion are tightly linked in a freshwater teleost fish.

Part C: Answer **TWO** of the following three questions in the exam booklet. (12 marks each; 24 marks in total)

1. Discuss the acute and chronic mechanisms involved in returning blood pressure in a human to normal following an acute fall in blood pressure resulting from severe haemorrhage.

2. Discuss the physiological challenges faced by small mammals that inhabit hot, arid environments, and the strategies used to overcome these problems.

3. Discuss the physiological challenges faced by birds that fly at high altitudes, and the strategies used to overcome these problems.

Bonus: For a bonus mark that in the spirit of socialism will be applied to the entire class if even one student answers the question correctly…

What do you call a fish with a bad nicotine habit?

What do you call a fish that has lost its job?

What do you call a fish that got the worst of it in a fight?

What do you call a fish that is drunk?