BIO 3302 Animal Physiology II
Final examination

December 13th, 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; 38 marks in total)

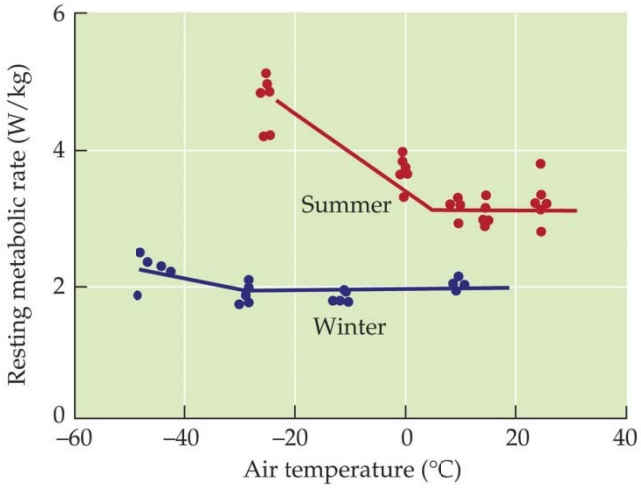
1. Use a labelled sketch to illustrate the salt-secreting mechanism of the marine teleost chloride cell. (4 marks)

2. During aestivation, the African lungfish accumulates _____ to prevent ammonia toxicity.

3. The figure at right presents data on the metabolic rate of reindeer as a function of air temperature in summer and in winter.
   a. What is the lower limit of the thermoneutral zone for a summer reindeer?

      _____

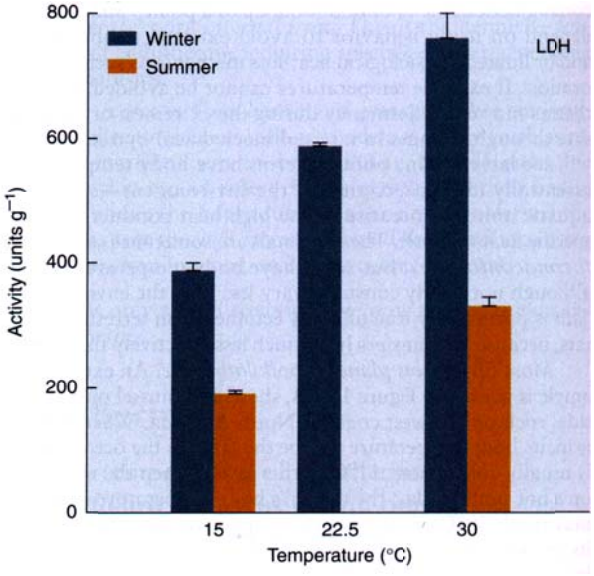
   b. Provide an example of a mechanism the reindeer might use to regulate body temperature below this lower limit.



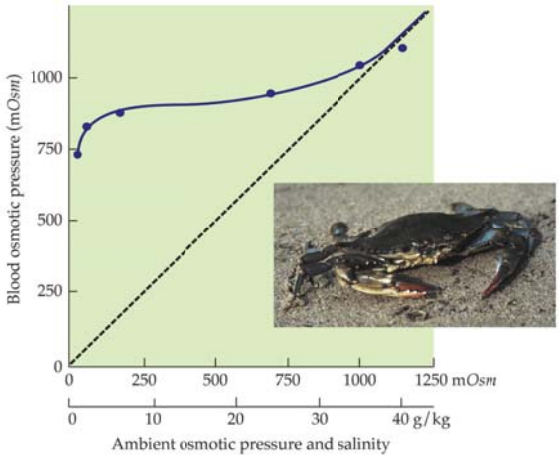
   c. Provide an explanation for the somewhat surprising observation that resting metabolic rate is higher in summer than in winter.

4. The _____ capillaries of the glomerulus and the _____ that form the inner wall of Bowman's capsule constitute the permeability barrier of the _____, which is the site of filtration in the vertebrate kidney.

5. The figure at right illustrates lactate dehydrogenase (LDH) activity in the leg muscles of alligators. Based on this figure…
   a. Animals acclimated to the same temperature experience essentially equal LDH activities.
   b. LDH activity does not exhibit a Q_{10} effect.
   c. Acclimatization acts essentially to equalize LDH activity for animals tested at the temperature to which they were acclimatized.
   d. The Q_{10} for LDH activity appears to be higher in alligators sampled in the summer than in alligators sampled in the winter.
   e. None of the above is true.



6. The figure at right illustrates the responses of a blue crab (*Callinectes sapidus*) to variations in salinity in an estuary. This animal is best described as a <u>stenohaline OR euryhaline</u> (**select one**), <u>hyperosmotic OR iso-osmotic OR hypo-osmotic</u> (**select one**) <u>osmoregulator OR osmoconformer</u> (**select one**).

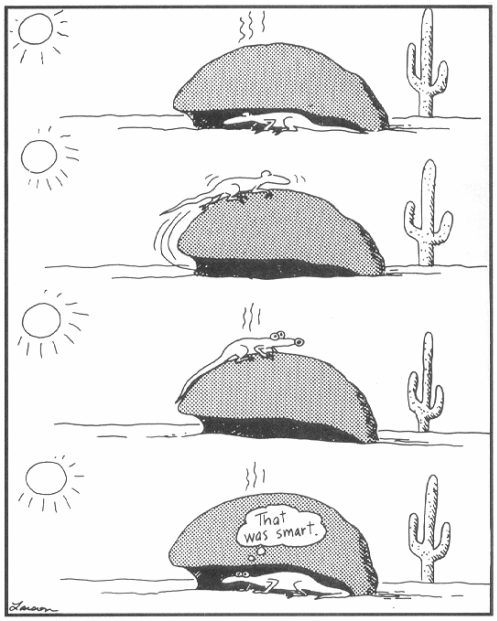


7. Because the temperature of the flight muscle in the thorax of a bumblebee is maintained above the air temperature, these animals are considered to be _____.

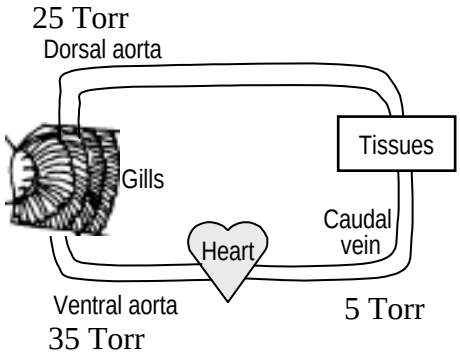
8. Label the peaks in the ECG trace below (1.5 marks). Use an arrow to indicate the peak that reflects atrial depolarization (0.5 marks). Below this trace, sketch a second trace illustrating the effect on the ECG of sympathetic stimulation of the heart (1 mark).

9. Which of the following statements about the transition from freshwater to seawater in a euryhaline teleost (such as a rainbow trout, eel or killifish) is **not** correct?
   a. AVT secretion increases.
   b. AVT increases water reabsorption from the bladder.
   c. AVT promotes water uptake from the environment via the pelvic patch.
   d. AVT initiates water reabsorption at the distal tubule.
   e. AVT reduces glomerular filtration rate.

10. What thermal strategy is illustrated in the figure at right? Explain the functional significance of this strategy for ectothermic versus endothermic animals. (3 marks)



11. Using the schematic diagram of the circulation of a fish at right, calculate the branchial resistance (i.e. the resistance across the gills) assuming cardiac output is 25 mL min^{-1}; please show your calculations. (2 marks)

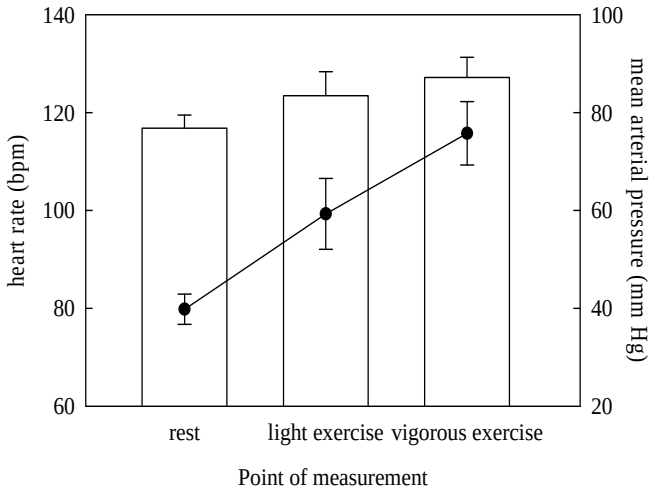


12. Explain why it is easier to overheat while sitting in a hot tub of water at 40°C than while sitting in a sauna of 40°C. (2 marks)

13. The functional unit of gas exchange in a bird is the _____.

14. Wood frogs can freeze and thaw successfully by synthesizing _____ that encourage ice crystal formation in the intracellular OR extracellular (**select one**) fluids.

15. The figure at right illustrates the effects of light and vigorous exercise on heart rate (black symbols) and blood pressure (bars) in a group of twelve students from BIO 3137 Experiments in Animal Physiology. Heart rate increases by ~46% during vigorous exercise, whereas blood pressure increases by only ~14%. Explain the effects of exercise on heart rate and blood pressure. Why does blood pressure not increase to the extent that might be expected by the observed increase in heart rate? (4 marks)



16. The gulf toadfish is unusual because it…
    a. Retains urea as an osmolyte
    b. Excretes uric acid
    c. Excretes urea in a pulsatile fashion across the gills
    d. Retains ammonia as the end-product of nitrogen metabolism even when it emerges from water
    e. Switches from ammonia to urea production when it emerges from water

17. Active hyperemia is…
    f. The higher than normal blood flow that occurs following a brief period of ischemia.
    g. Induced by local metabolic effects such as increased CO_2, O_2, or heat.
    h. Particularly pronounced in the blood vessels of the heart and brain.
    i. The result of an automatic vasodilation that relies on neither nerves nor hormones.
    j. All of a, b, c and d are true of active hyperemia

18. A deep-sea fish is best described as a poikilothermic OR homeothermic (**select one)** ectotherm OR endotherm (**select one**) because its body temperature of ~4°C varies by less than a degree over the course of a year.

Part B: Answer **FOUR** of the following five questions in the exam booklet. (8 marks each; 32 marks in total)

1. Discuss the structural and functional adaptations underlying the evolution of endothermy in vertebrates.

2. Contrast and compare the structure and function of the nephron in a freshwater teleost fish such as the goldfish, a freshwater bird such as the loon, and a freshwater mammal such as the beaver.

3. The waters of the Amazon are often very hypoxic and many fish of this region are capable of breathing air to maintain O_2 uptake in O_2-poor waters. During a trip to the Amazon, your instructor collected the data below for a fish that was breathing water. Was this fish breathing hypoxic water? Please show your calculations and explain your reasoning.

   $Vb = 50$ mL min^{-1}
   $CaO_2 = 5$ mmol L^{-1}
   $CvO_2 = 2.5$ mmol L^{-1}
   $Vw = 0.625$ L min^{-1}
   $ßwO_2 = 2$ μmol L^{-1} $Torr^{-1}$
   Extraction efficiency, E = 60%

4. Discuss the structural and functional adaptations underlying the "high performance" lifestyle of bluefin tuna.

5. Some human athletes use erythropoietin (EPO), a peptide hormone that acts on the bone marrow to stimulate red blood cell production, to try to improve athletic endurance. Draw a labelled sketch of the O_2 equilibrium curves that would be expected in a "normal" human athlete versus an athlete that has used EPO. Discuss the potential benefits and risks of EPO use to endurance athletes.

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

1. You find yourself lost in the desert with a kangaroo rat and a gila monster, and no drinking water. Which of these animals (you, the kangaroo rat or the gila monster) will be able to tolerate these conditions most easily? Please explain your rationale, making specific reference to the physiological challenges faced by each animal, and the strategies used by each animal to overcome these challenges.

2. You find yourself breath-hold diving in the ocean off the Galapagos Islands with a Galapagos marine iguana and a Weddel seal. Which of these animals (you, the marine iguana or the seal) will be able to make the longest dives? Please explain your rationale, making specific reference to the physiological challenges of diving, and the strategies used by each animal to overcome these challenges.

3. You find yourself climbing Mount Everest with a deermouse and a bar-headed goose. Which of these animals (you, the deermouse or the bar-headed goose) will be able to tolerate these conditions most easily? Please explain your rationale, making specific reference to the physiological challenges faced by each animal, and the strategies used by each animal to overcome these challenges.

Bonus: A final attempt at fish films! 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, name the piscine stars voiced by the following famous humans…

Angelina Jolie was the voice behind _____ in the movie _____.

Ellen DeGeneres was the voice behind _____ in the movie _____.

Noah Lindsey Cyrus was the voice behind _____ in the movie _____ (Disney version).

Mary Jo Catlett is the voice behind _____ in the television show _____.