**Exam 2 - Zoology 250**  
version B

Instructor: John Godwin, Fall 2003

Name (please print): _____KEY__________

**Sign your name** in the space provided below if you would like your grade to be posted by the last five digits of your social security number (sign here, do not put your ID# here): ______

This exam has 6 pages, Please check that your copy is complete.

**Terminology/short answer** - These questions require terms or brief answers. (13 questions, 1 pt. each except where noted, 30 pts total plus one bonus)

1. List one disadvantage to the very large surface area in mammalian lungs.  
   Different ones are possible: Heat loss, water loss, large area that can become infected.

2. What is the term for the volume of air that is the volume at full inhalation and complete exhalation (when the lungs are emptied as much as possible)?  
   **Vital Capacity**

3. What is the key muscle responsible for inhalation in mammals? How does it work to cause inhalation? (2 pts)  
   **Diaphragm**, Contracting produces negative pressure (expands cavity) in thoracic cavity that draws air in.

4. Briefly compare oxygen and carbon dioxide in terms of their solubility in water.  
   **Oxygen is much less soluble than CO$_2$ in water.**

5. How are insects able to rapidly get oxygen to their tissues and carbon dioxide away despite having a low pressure, open circulatory system? Name the type of system and briefly explain why it does not rely on the circulatory system (2 pts)  
   **Tracheal system**: Air is delivered directly to the tissues

6. Using a solid line for CO$_2$ concentrations in air passing through the lung of a bird and a dashed line for CO$_2$ concentrations in the blood passing through the lung, illustrate what these would be at air enters the back of the lung and moves forward.
7. What is the general term for the mechanism discussed in the question above that maximizes diffusion gradients in an exchange organ?
Counter current exchange (point for noting countercurrent whether ‘exchange’ is said or not)

8. CO₂ entering the blood lowers the blood pH. Briefly explain why this is. (2 pts)
   CO₂ rapidly combines with water to form carbonic acid, which dissociates to form bicarbonate ions and H⁺
   put another way: CO₂ + H₂O → H₂CO₃ to HCO₃⁻ and H⁺

9. List two events in the inflammation response (2 pts)
   Different ones are possible: release of histamines and prostaglandins, vasodilation, monocytes move into tissues, monocytes become macrophages

10. A risk faced by patients treated with antibiotics is opportunistic infections (e.g., candidiasis). What important defense mechanism does this example illustrate? (only 1-2 words necessary here)
    Competition

11. List the four ‘key features’ of the immune system that we discussed (2 pts) and briefly explain two of the four you list (2 pts, 4 pts total)
    Specificity – the system has the ability to respond to very specific molecular configurations
    Diversity – The system can generate responses to a vast number of different molecular configurations
    Memory – The system ‘remembers’ a previous antigen exposure and can mount a response more quickly on a second exposure (due to memory B cells – good here, but not necessary)
    Self/Non-self recognition – The system can distinguish between antigens that are part of the body and those that are foreign.

12. AIDS has proven a very difficult disease to treat and no cure has yet been developed. What are two major reasons that HIV is such a difficult disease for the body to combat? (2 pts)
    HIV is difficult be it a) targets the immune system itself, and b) mutates rapidly, presenting a ‘moving target’ for the immune system

13. The figure to the right shows a nephron in a mammalian kidney. Using this diagram and the letters marking various sections of it, answer the questions below here. (5 pts total)

   Where does filtration take place? (answer with a letter)
   A

   Does the permeability of the tubule differ between points B and D? If so, how? (2 pts)
   Yes, descending loop is permeable to water while ascending loop is permeable to sodium ions.

   At which two points is the osmolarity of the fluid surrounding this structure highest? (pick 2 letters, 2 pts possible here)
   C and F
On the axes to the right here, show the relationship between the osmotic concentration of the aquatic environment and that of two different kinds of aquatic animals – show an osmoconformer with a solid line and an osmoregulator with a dashed line. Label the line that would be characteristic of a marine fish with an ‘A’ and the line that would be characteristic of a marine invertebrate like a coral with a ‘B’. (2 pts, 4 pts total)

**Bonus Question:** Why do we get allergies? What is the evidence for your answer?

Allergies appear to be part of a defense mechanism that would ordinarily protect us from worms (and other things) at the skin. This defense seems to act against inappropriate targets in the absence of this natural threat. When islanders on Mauke atoll were treated for worm infections, the worms went away, but they developed allergies in many cases.

**Multiple Choice (1 pt each, 24 points total)**

1. I am writing version (mark B) of this exam

2. Breathing centers in the brainstem primarily respond to CO\(_2\) entering the blood. These brain areas are responding specifically to the concentration of which of the following?
   a) CO\(_2\) dissolved in the plasma
   b) H\(_2\)CO\(_3\)
   c) H\(^+\)
   d) HCO\(_3^-\)
   e) CO\(_2\) bound to hemoglobin

3. Respiratory turbinates are bony shelves in the nasal passages of some vertebrates. What problem(s) do these appear to be an adaptation to deal with?
   a) Heat loss
   b) Heat gain
   c) Water loss
   d) A and C are correct
   e) B and C are correct

4. Imagine a mutation to the fetal form of hemoglobin that increased the affinity of the molecule for oxygen. Such a mutation would be expected to __________ transfer of oxygen from the maternal circulation to the fetal circulation.
   a) Increase
   b) Decrease
   c) No alteration
   d) No way to answer the question
5. Now, imagine the same mutation discussed above, but consider the release of oxygen at the fetal tissues. This would be:
   a) Increased  
   b) **Decreased**  
   c) Unchanged

6. Which of the following is FALSE concerning the hemoglobin molecule?
   a) It binds oxygen in a cooperative manner  
   b) It contains iron  
   c) It is composed of four protein subunits  
   d) It can bind four O_2 molecules  
   e) **It is found only in humans**

7. All of the following are reasons why gas exchange is more difficult for aquatic animals than it is for terrestrial animals **EXCEPT:**
   a) Water is denser than air  
   b) Water contains much less O_2 than air  
   c) **Gills have very limited surface area relative to lungs**  
   d) Diffusion is slower in water than air

8. Macrophages travel through the blood primarily as macrophages.
   a) This is true  
   b) **This is false**

9. Which of the following cell types is **NOT** part of our non-specific defenses?
   a) Plasma B cell  
   b) Neutrophil  
   c) Eosinophil  
   d) Natural killer cell  
   e) Macrophage

10. In clonal selection, the response of the immune system cells to a new antigen is best described as:
    a) Cells with various antigen specificities adapt this specificity to recognize a new antigen  
    b) **Cells with various antigen specificities are all being exposed, but only a small number can respond to this new antigen and proliferate**  
    c) Each immune system cell carries clones within it that are specific for different antigens and it is selection among these clones intracellularly that underlies the immune response.  
    d) This refers to the tendency for some individuals in clonal organisms to be resistant to a given antigen, while others are not with selection eliminating the non-resistant forms.

11. Imagine you were culturing immune system stem cells with the hope of producing T cells for immune-deficient patients. You would need to incubate them in a tissue environment like that they would see in the body. Which of the following would you choose to induce T cell development?
    a) Liver  
    b) Kidney  
    c) **Thymus**  
    d) Bone Marrow
12. Assuming no differentiation had yet taken place in your immune stem cells, could the same immune system stem cells differentiate into B cells given the appropriate environment?
   a) Yes, b) No

13. Two proteins that play key roles in allowing HIV access to helper T cells are ____ and ____.
   a) CCR5 and CD4  
   b) CD8 and perforin  
   c) IgG and CD4  
   d) MHC and CD8  
   e) MHC and calmodulin

14. HIV is what is referred to as a ‘retrovirus’. This means that:
   a) The virus uses RNA as its genetic material and incorporates a copy of itself into the host DNA  
   b) The virus uses DNA as its genetic material and incorporates a copy of itself into the host RNA  
   c) The virus uses DNA as its genetic material and immediately takes over transcription machinery upon entering a cell.  
   d) HIV infects bacteria and it is actually bacterial infection that induces the symptoms characteristic of AIDS  
   e) None of the above

15. __________ play a key role in stimulating the immune system to respond to novel antigens through the release of______:
   a) B cells, perforins  
   b) Macrophages, antibodies  
   c) Cytotoxic T cells, perforins  
   d) Helper T cells, cytokines  
   e) Neutrophils, cytokines

16. Comparing ammonia with urea as a nitrogenous waste, urea requires ____ water to excrete and is____ toxic.
   a) Less, less  
   b) Less, more  
   c) More, less  
   d) More, more

17. Which of the following statements about the transfer of fluid from the bloodstream into the lumen of the nephron is correct?
   a) It results from active transport  
   b) It transfers large molecules as easily as small ones  
   c) It is very selective as to which small molecules are transferred  
   d) It is mainly a consequence of blood pressure force filtering the fluid  
   e) It usually includes the transfer of red blood cells to the nephron tubule.

18. Which of these vertebrates are usually endotherms?
   a) Cartilaginous fishes like sharks  
   b) Bony fishes  
   c) Amphibians  
   d) Reptiles  
   e) Birds
19. Which of the following thermoregulatory mechanisms would you not find in an ectotherm?
   a) Evaporative cooling
   b) Posture
   c) Vasoconstriction/vasodilation
   d) Countercurrent heat exchangers

20. Acid rain decreases environmental pH, interfering with the function of specialized ‘chloride cells’ crucial to osmoregulation in fishes. Given what you know about the problems facing a freshwater fish, you would expect plasma ion concentrations of a fish under low pH conditions to be _______.
   a) Unchanged
   b) Increased
   c) Decreased

21. Malpighian tubules are the excretory organs found in:
   a) Earthworms
   b) Insects
   c) Jellyfish
   d) Reptiles
   e) Mammals

22. The main nitrogenous waste excreted by birds is:
   a) Ammonia
   b) Nitrate
   c) Nitrite
   d) Urea
   e) Uric acid

23. A biologist discovers a new species of organism adapted to living in a deep underground cavern that has no source of free water. The organism is eyeless and covered by fur, and it has a four-chambered heart with a closed circulatory system. What excretory system modifications might the biologist expect to find in this challenging environment?
   a) Very long Malpighian tubules
   b) Very short Malpighian tubules
   c) Metanephridia with a large number of nephridiopores
   d) Kidneys whose juxtamedullary nephrons had very long loops of Henle
   e) Kidneys whose juxtamedullary nephrons had very short loops of Henle

24. If you were to block active transport of sodium ions in the mammalian kidney, the result would be:
   a) A smaller volume of concentrated urine
   b) A smaller volume of dilute urine
   c) A larger volume of concentrated urine
   d) A larger volume of dilute urine
   e) The same volume of concentrated urine