Anatomy and Physiology B Test

Name(s): ____________________________________________

Team Name: __________________________

School Name: __________________________

Team Number: ______

Rank: ______

Score: ______
NORTHERN REGIONAL SCIENCE OLYMPIAD 2019

Anatomy and Physiology Division B TEST: Cardiovascular, Lymphatic, and Excretory Systems

Answer all questions with the best answer choice. NOTA means “None of the Above.”
STRUCTURAL ANATOMY

1. Label the following diagram with the parts of the nephron that each letter corresponds to. K is the space above the bold line and L represents the space below it.

![Diagram of the nephron](image)

2. Label the following diagram with the parts of the lymphatic system that each letter corresponds to.

![Diagram of the lymphatic system](image)
3. On figure A below, label each part of the ECG wave corresponding to the correct number. On figure B, label the part of the wave as represented on the heart corresponding to the correct number. On figure C, label the type of wave pattern shown corresponding to the correct number and note that one of the answers is a “normal wave pattern”. (See picture packet for this picture printed in color)
4. Which of the following presents the correct order of urine flow:
   a. Kidney, Bladder, Ureter, Urethra
   b. Ureter, Minor Bladder, Major Bladder, Urethra
   c. Ureter, Kidney, Loop of Henle, Bladder, Urethra
   d. Kidney, Ureter, Bladder, Vas Deferens, Urethra
   e. NOTA

5. Which of the following is not majorly involved in the processes necessary for carbon dioxide to be transported out of the body via hemoglobin?
   a. Chlorine
   b. Calcium
   c. Oxygen
   d. Iron
   e. A and B.

6. Which of the following is not a result of excessive water intake?
   a. Seizures
   b. Diarrhea
   c. Hyponatremia
   d. Increase in ADH/Vasopressin
   e. NOTA

7. Which of the following procedures will not change the concentration of solutes/composition of the blood?
   a. Kidney transplant to a patient with lupus nephritis, a disease that significantly worsens the capabilities of nephrons.
   b. Transplant of a healthy liver to a patient with cirrhosis, permanent and severe damage to the liver.
   c. Gastric bypass, a surgery that reduces the volume of the stomach and the area of the small intestine
   d. Tracheotomy, a procedure that opens the windpipes to air flow in patients with a sudden obstruction in the normal path for air intake.
   e. NOTA
8. Ammonia, NH₃, is the toxic product that needs to be removed from our blood stream. Ammonia is formed as the result of protein digestion and needs to either be converted into a less toxic form or diluted to a large extent in order to remain at concentrations that are relatively non-toxic. Which of the following species most likely won’t have to convert NH₃ into a less toxic form?
   a. Adult Alligator
   b. Adult Zebrafish
   c. Baby Humans
   d. Baby Birds
   e. NOTA

9. The function of aldosterone is the following:
   a. Upregulate aquaporins in the proximal convoluted tubule
   b. Alter the structure of the collecting duct such that it is more water permeable
   c. Increase the blood pressure
   d. Trigger the pituitary gland to release ADH.
   e. NOTA

10. Which of the following processes of osmoregulation by the kidney is the least selective?
    a. Secretion
    b. H⁺ pumping to control pH
    c. Reabsorption
    d. Salt pumping to control osmolarity
    e. Filtration

11. Which one of the following, if present in a urine sample, would likely be caused by trauma?
    a. Glucose
    b. Amino Acids
    c. Ammonia
    d. Erythrocytes
    e. NOTA

12. Who would have the most alkaline urine?
    a. A high school student that just ran a marathon
    b. An old person eating dinner
    c. A person that doesn’t eat meat
    d. A person that just woke up
    e. We are not able to tell / NOTA

13. Most of the ammonium found in the urine is secreted by which structure?
    a. Collecting Duct
    b. Thick ascending loop of Henle
    c. Renal Cortex
    d. Proximal Convoluted Tubule
    e. NOTA
14. Which of the following substances is most relevant in the calculation of Glomerular Filtration Rate?
   a. Creatinine  
   b. Testosterone  
   c. ADH  
   d. Sodium ions  
   e. NOTA

15. If the clearance of caffeine equals 3000 ul/min. Approximately how many hours will it take to clear caffeine from the plasma of a subject with a plasma volume equal to 3 L?
   a. 17  
   b. 10  
   c. 22  
   d. 9  
   e. NOTA

16. How does consumption of alcohol most impact the volume of urine produced?
   a. Inhibits relay of signals between osmoreceptors  
   b. Upregulates Angiotensin  
   c. Increases blood pressure  
   d. Decreases liver efficiency  
   e. NOTA

17. Where on the body has the highest density of eccrine glands?
   a. Axillae  
   b. Soles  
   c. Neck  
   d. Inner Cheeks

18. Which part of the lymphatic system begins to atrophy with the onset of puberty?
   a. The spleen  
   b. Adenoids  
   c. Thyroid gland  
   d. Adrenal glands  
   e. NOTA

19. What color is the human spleen?
   a. Blue  
   b. Gray  
   c. Green  
   d. Purple  
   e. Black
20. Where are antibodies synthesized?
   a. Red Pulp
   b. White Pulp
   c. Bone Marrow
   d. RBCs
   e. NOTA

21. Which organ **regulates** the production of Thymosin?
   a. Pituitary gland
   b. Parotid gland
   c. Thyroid Gland
   d. Prostate Gland
   e. NOTA

22. Non-Hodgkin Lymphoma originates in _____ whereas Hodgkin Lymphoma begins with cancerous __________
   a. B cells; Neurons
   b. Bone Marrow; Synovial cells
   c. B cells; Reed-Sterner Cells
   d. A and C
   e. NOTA

23. Which disease causes a certain gland to enlarge and then atrophy several years later?
   a. Hashimoto's Thyroiditis
   b. Myasthenia gravis
   c. Grave's Disease
   d. Stargardt’s Syndrome
   e. NOTA

24. Fluid pressure in the lymphatic system is ______, similar to that in _____.
   a. Low, arteries
   b. Low, veins
   c. High, arteries
   d. High, veins

25. Identify the correct order of lymphatic circulation.
   a. Lymph node → Affere nt lymph vessel → Efferent lymph vessel → Lymph trunk → Lymph duct
   b. Affere nt lymph vessel → Lymph node → Efferent lymph vessel → Lymph duct → Lymph trunk
   c. Affere nt lymph vessel → Lymph trunk → Efferent lymph vessel → Lymph duct → Lymph node
   d. Affere nt lymph vessel → Lymph node → Efferent lymph vessel → Lymph trunk → Lymph duct
26. Which of these is NOT a function of mucosa associated lymphatic tissue (MALT)?
   a. Store immune cells, such as T and B lymphocytes
   b. Destroy bacteria that breach the mucosal membrane
   c. Initiate immune responses to specific antigens
   d. Develop “memory” lymphocytes for long term immunity

27. How is appendicitis treated?
   a. Surgery (removal of the appendix)
   b. Antibiotics
   c. Both A and B
   d. NOTA

28. Elephantitis is a disorder of the lymphatic system caused by:
   a. A mosquito
   b. A roundworm
   c. The filarial worm
   d. All of the above

29. Pharyngeal tonsils are also known as _______.
   a. Pharyngi
   b. Vessels
   c. Adenoids
   d. Nodes

30. The thymus lacks _____ cells.
   a. B
   b. T
   c. Both A and B
   d. NOTA

31. In which of the following places are the submental & submaxillary lymph nodes NOT found?
   a. Mouth
   b. Nose
   c. Ears
   d. Teeth

32. Where are inguinal lymph nodes found?
   a. Legs
   b. Torso
   c. Genitals
   d. Both A and B
   e. Both A and C

33. T-cell activation requires a/an _______ cell.
   a. Activation
   b. Accessory
   c. Plasma
   d. Helper
34. Which of the following laboratory separation techniques prove useful in determining the hematocrit of a blood sample?
   a. Gel Electrophoresis
   b. Ion exchange chromatography
   c. Gel filtration chromatography
   d. Filtration
   e. Centrifugation

35. Albumin is manufactured by the ________
   a. Kidneys
   b. Liver
   c. Red bone marrow
   d. Yellow bone marrow
   e. Spleen

36. Recall the different types of plasma proteins found in blood. Which of these is found in the GREATEST abundance?
   a. Alpha globulins
   b. Beta globulins
   c. Gamma globulins
   d. Fibrinogen
   e. Albumin

37. What concept does the phrase “cooperative binding of oxygen” refer to?
   a. The greater ease with which future oxygen molecules can bind to hemoglobin after one molecule has already bound and caused a conformational change.
   b. The “coupling” of oxygen molecules that allows them to bind to sites on hemoglobin with greater ease than if they were to do so individually.
   c. The means by which oxygen molecules “take turns” binding to sites on hemoglobin to maintain a consistent ratio of bound to unbound oxygen molecules.
   d. The interactions observed between ferric and oxygen molecules as the ferric molecules make way for the oxygen to bind to hemoglobin sites with greater ease.
   e. Both C and D

38. The structure of an erythrocyte is unique from that of many other cells in order to allow for optimization of its function in the human body. Identify the correct shape of a healthy erythrocyte and how it contributes to its function:
   a. Concave disk with few internal organelles - allows for greater surface area over which gas exchange can occur and greater interior space to accommodate more hemoglobin molecules.
   b. Concave disk with all organelles and extra mitochondria - allows for greater surface area over which gas exchange can occur and fulfills the need for more
energy production to support the efficient processing of hemoglobin molecules inside.

c. Biconcave disk with few internal organelles - allows for greater surface area over which gas exchange can occur and greater interior space to accommodate more hemoglobin molecules.

d. Biconcave disk with all organelles and extra mitochondria - allows for greater surface area over which gas exchange can occur and fulfills the need for more energy production to support the efficient processing of hemoglobin molecules inside.

e. Healthy erythrocytes are shaped like plump spheres, not disks. This allows for a larger internal cell volume to counteract the effects of large amounts of pressure that can build up inside the cell and potentially cause it to burst if it were to be disk-shaped.

39. A doctor is examining the sounds of a patient’s heart. He can hear the “dub” sound but not the normal “lub” sound. What is a reasonable explanation for the doctor’s observations?
   a. The tricuspid and mitral valves are not closing properly
   b. The tricuspid and mitral valves are not opening properly
   c. The aortic and pulmonary valves are not closing properly
   d. The aortic and pulmonary valves are not closing properly
   e. NOTA

40. What is hemophilia?
   a. A rare genetic disorder most common amongst females that occurs when there is a deficiency or absence of a particular protein needed for blood to clot.
   b. A rare genetic disorder most common amongst males that occurs when there is a deficiency or absence of a particular protein needed for blood to clot.
   c. A rare genetic disorder most common amongst females that occurs when there is an excess of a particular protein needed for blood to clot, increasing risk of thrombosis.
   d. A rare genetic disorder most common amongst males that occurs when there is an excess of a particular protein needed for blood to clot, increasing risk of thrombosis.
   e. NOTA

41. On a typical blood pressure monitor, the top reading is known as the _________ and represents ___________.
   a. Systole; contraction of the heart muscle.
   b. Diastole; relaxation of the heart muscle.
   c. Systole; relaxation of the heart muscle.
   d. Diastole; contraction of the heart muscle.
Use the following figure to answer questions 42-45 (See picture packet for this picture printed in color):

42. Identify the blood vessels represented by numbers 1 and 2:
   a. 1: Lymph node; 2: artery
   b. 1: Artery; 2: vein
   c. 1: Vein; 2: lymph node
   d. 1: Vein; 2: artery

43. Briefly explain how you determined your answer to number #42 (2 pts):

44. Based on your identification of the blood vessels in the histological image above, what type(s) of muscle is the arrow pointing to?
   a. Cardiac muscle
   b. Skeletal muscle
   c. Smooth muscle
   d. Both A and C
   e. NOTA
45. From a physiological point of view, what purpose does the specific type of muscle identified in the previous question serve in relation to the structure of blood vessel 1?  
   a. To allow for expansion and reduction of vessel size and withstand pressure changes  
   b. To allow for widening of vessel size in order to collect lymph fluid  
   c. The striations allow for repeated contraction and relaxation necessary for basic movement of the muscle  
   d. The specific type of muscle in this vessel regenerates at a faster rate to account for the common wear and tear that can occur within it due to the purpose it serves in the body  

46. What is the blood type of the sample that was tested in the following image (See picture packet for this picture printed in color)?  

   a. A-negative  
   b. B-negative  
   c. A-positive  
   d. B-positive  
   e. None of the above  

47. On a typical ECG grid, 5 small squares, or 1 large square, represent 0.30 seconds of time.  
   a. True  
   b. False  

48. What is Atherosclerosis?  
   a. The hardening of the arteries  
   b. The hardening of the veins  
   c. The widening of the arteries  
   d. The widening of the veins  
   e. NOTA
49. What are the functions of Renin and Aldosterone and what changes to the body can induce the release of these molecules? (5 points)

50. After a horrible accident, Charlie had to have some of his nephrons’ ascending limb of the loop of henle taken out. Because of this, the ______ had to be connected to the ____________. Name the parts of Charlie that had to be fused together and talk about the effect this will have on the the kidney and charlie’s urine and why. (4-6 sentences). (6 points)

51. Explain how lymphedema occurs and give two potential causes of lymphedema. (4 points)

52. A child complains of having an infection and then begins breathing through their mouth, experiencing frequent ear infections that don’t respond well to antibiotics, and a sore throat, and difficulty swallowing. As their primary care physician, tell them what they are experiencing and a way to fix their problem. (2 points)

53. Jenna shows up to the emergency room with her father, Dave, who she suspects suffered from a stroke just a few minutes before their arrival. The nurses on call for the night decide to measure and record some crucial indicators of cardiovascular health to determine Dave’s current physical condition. Help the nurses with some calculations by following through parts a-c below. (10 points)
   a. Dave’s end systolic volume is measured to be 50 ml and his end diastolic volume is measured to be 100 ml. Write down the equation for stroke volume and then calculate Dave’s stroke volume based on these measurements (show your work and remember to report answer with units). (3 points)
   b. If Dave’s heart rate is 75 BPM and his stroke volume rate is 70 ____ (same units as in the answer for part a), then what is his cardiac output (show your work and remember to report answer with units)? (3 points)
   c. Using your answers to parts a and b, determine whether Dave’s cardiac output and stroke volume measurements are within normal ranges or not and if not, then state whether they are too high or too low. (4 points)