Anatomy and Physiology C Key
Science Olympiad North Regional Tournament at the University of Florida
**Tie breaker questions are 11, 14, 35, 36, 41, 43**

**Part 1- Respiratory System**

1. An individual has arterial hypoxemia; PaO2 = 50 mmHg. Which possible cause of this hypoxemia would cause the largest elevation in arterial PCO2?
   a. High altitude  
   b. Diffusion impairment  
   c. Physiological shunt  
   d. Pulmonary embolism  
   e. Hypoventilation

2. Which of the following would not normally be treated by 100% oxygen therapy? Choose all that apply:
   a. Anoxia  
   b. Carbon monoxide poisoning  
   c. Respiratory crisis in an emphysema patient  
   d. Eupnea

3. Surfactant produced by cells lining the alveoli serves to
   a. increase surface tension.  
   b. increase stretching of the alveolar walls.  
   c. assist muscular movements of breathing.  
   d. reduce cohesion of water molecules  
   e. reduce ciliary movement

4. Under ordinary circumstances, the inflation reflex is initiated by:
   a. noxious chemicals  
   b. the ventral respiratory group  
   c. overinflation of the alveoli and bronchioles  
   d. pontine respiratory centers

5. A 59-year-old morbidly obese female patient is diagnosed with a restrictive lung disease that causes lung compliance to be half the normal value. If tidal volume and breathing rate are normal, then:
   a. Total work of breathing is twice normal  
   b. Airway resistance is twice normal  
   c. Pleural pressure at end-inspiration is more negative than normal  
   d. Alveolar pressure at end-inspiration is positive  
   e. The functional reserve capacity (FRC) is increased

6. When the inspiratory muscles contract,
   a. the size of the thoracic cavity increases in diameter  
   b. the size of the thoracic cavity increases in length  
   c. the volume of the thoracic cavity decreases  
   d. the size of the thoracic cavity increases in both length and diameter.
7. A baby holding its breath will:
   a. have brain cells damaged because of low blood oxygen levels
   b. automatically start to breathe again when the carbon dioxide levels in the blood reach a high enough value
   c. suffer heart damage because of increased pressure in the carotid sinus and aortic arch areas
   d. be called a “blue baby”

8. A patient has normal function of the diaphragm but has a spinal injury that completely prevents any activity of abdominal or intercostal muscles. In this patient you expect to find that:
   a. Residual volume is smaller than normal
   b. Vital capacity equals total lung capacity
   c. Intrapleural pressure is positive during expiration
   d. Transpulmonary pressure is negative during expiration
   e. Alveolar pressure is positive during expiration

9. The air pressure at the top of Mt. Everest is about 1/3 of the air pressure in Gainesville, FL. What is the partial pressure of O\(_2\) at the top of Mt. Everest?
   a. 0.21 atm
   b. 0.07 atm
   c. 21 atm
   d. 1 atm
   e. 0.7 atm

10. A sudden ascent to high altitude (e.g. atmospheric pressure half that at sea level) will, in the first several hours, cause:
    a. Hypoxic stimulation of central chemoreceptors
    b. A decrease in the pH of the fluid surrounding the central chemoreceptors
    c. An increase in alveolar to arterial PO\(_2\) difference
    d. Hypoxic stimulation of carotid body chemoreceptors
    e. A decrease in pulmonary arterial blood pressure

11. After exhalation, the lungs and airways…
    a. contain some residual air with a lower oxygen partial pressure than air
    b. contain some residual air with an oxygen partial pressure equal to air
    c. are completely empty with no air
    d. are filled with pure carbon dioxide

12. Damage to which of the following would most likely result in cessation of breathing?
    a. the pontine respiratory group
    b. the ventral respiratory group of the medulla
    c. the stretch receptors in the lungs
    d. the dorsal respiratory group of the medulla
13. Air flows into the lungs of mammals during inhalation at rest because…
   a. the diaphragm contracts and certain intercostal muscles contract, decreasing the volume of the lungs and increasing the pressure inside the lungs relative to the atmospheric pressure.
   b. the pressure in the lungs remains equal to the atmospheric pressure.
   c. the diaphragm contracts and certain intercostal muscles contract, increasing the volume of the lungs and lowering the pressure inside the lungs relative to the atmospheric pressure.
   d. the diaphragm relaxes and certain intercostal muscles contract, increasing the volume of the lungs and lowering the pressure inside the lungs relative to the atmospheric pressure.

Fill in the blank:

14. **Gases always diffuse from high to low ________.**
   a. Partial pressure

15. _____ ________ is air that never contributes to gas exchange in the alveoli.
   a. Dead Space

16. A patient’s respiratory volumes are measured below, what is their functional residual capacity?
   
   Tidal volume = 500ml Expiratory Reserve Volume = 1200ml
   Inspiratory Reserve Volume = 3100ml Residual Volume = 1200ml
   a. 2400ml

17. **Which three laws describe the properties of gas exchange in the lungs?**
   a. Dalton’s law
   b. Henry’s Law
   c. Boyle’s Law
Part 2- Digestive System

19. Obstruction of the hepatopancreatic sphincter impairs digestion by reducing the availability of
   a. bile and HCl
   b. HCl and intestinal juice
   c. pancreatic juice and intestinal juice
   d. pancreatic juice and bile.

20. The parasympathetic nervous system influences digestion by
   a. relaxing smooth muscle
   b. stimulating peristalsis and secretory activity
   c. constricting sphincters
   d. none of these
21. The peritoneal cavity
   a. is the same thing as the abdominopelvic cavity
   b. is filled with air
   c. like the pleural and pericardial cavities is a potential space containing serous fluid
   d. contains the pancreas and all of the duodenum.
22. The gallbladder
   a. produces bile
   b. is attached to the pancreas
   c. stores and concentrates bile
   d. produces secretin.
23. Which sphincter is located between the stomach and duodenum?
   a. Pyloric
   b. Gastroesophageal
   c. Hepatopancreatic
   d. Ileocecal
24. The site of production of cholecystokinin is
   a. the stomach
   b. the small intestine
   c. the pancreas
   d. the large intestine
25. Carbohydrates are acted on by
   a. peptidases, trypsin, and chymotrypsin
   b. amylase, maltase, and sucrase
   c. lipases
   d. peptidases, lipases, and galactase
26. The products of protein digestion enter the bloodstream largely through cells lining
   a. the stomach
   b. the small intestine
   c. the large intestine
   d. the bile duct
27. Someone has eaten a meal of buttered toast, cream, and eggs. Which of the following would you
    expect to happen?
    a. Compared to the period shortly after the meal, gastric motility and secretion of HCl 
       decrease when the food reaches the duodenum
    b. gastric motility increases even as the person is chewing the food (before swallowing)
    c. fat will be emulsified in the duodenum by the action of bile
    d. all of these.
28. Which of the following is not characteristic of the colon?
    a. It is divided into ascending, transverse, and descending portions;
    b. It contains abundant bacteria, some of which synthesize certain vitamins
    c. It is the main absorptive site
    d. It absorbs much of the water and salts remaining in the wastes
34. Lymphatic vessels
   a. serve as sites for immune surveillance,
   b. filter lymph
   c. transport leaked plasma proteins and fluids to the cardiovascular system
   d. are represented by vessels that resemble arteries, capillaries, and veins.
35. The germinal centers in lymph nodes are largely sites of
   a. Macrophages
   b. proliferating B lymphocytes
   c. T lymphocytes
   d. all of these.
36. The lymphoid organ that functions primarily during youth and then begins to atrophy is the
   a. Spleen
   b. Thymus
   c. palatine tonsils
   d. Bone marrow
37. All of the following are considered innate body defenses except
   a. Complement
   b. Phagocytosis
   c. Antibodies
   d. lysozyme
   e. inflammation
38. **Which of the following antibodies can fix complement?**
   a. IgA
   b. IgD
   c. IgE
   d. IgG
   e. IgM
39. **Which antibody class is abundant in body secretions?**
   a. IgA
   b. IgD
   c. IgE
   d. IgG
   e. IgM
40. The process by which neutrophils squeeze through capillary walls in response to inflammatory
    signals is called
    a. Diapedesis
    b. Chemotaxis
    c. Margination
    d. Opsonization
41. The cell type most often invaded by HIV is a(n)
    a. Eosinophil
    b. cytotoxic T cell
    c. natural killer cell
    d. helper T cell
    e. B cell
42. Which of the following is not involved in the activation of a B cell?
    a. Antigen
    b. helper T cell
    c. cytokine
    d. cytotoxic T cell
43. Cells that can directly attack target cells include all of the following except
   a. macrophages,
   b. cytotoxic T cells
   c. helper T cells
   d. natural killer cells

44. In patients with lymphomas, the cancer cells invade the bone marrow and destroy the
environment required for normal hematopoiesis. This leads to bone marrow failure, which
disrupts the production of hematopoietic cell lineages. All of the following cell types would be
affected by this EXCEPT:
   a. Red blood cells
   b. Macrophages
   c. Lymphocytes
   d. Endothelial cells
   e. Granulocytes

45. The skin and bodily secretions provide the first line of defense against infection. One response in
this category that is common during upper respiratory virus infections is:
   a. Production of antibodies
   b. Infiltration by white blood cells
   c. Mucus production
   d. Increased saliva production
   e. Fever

46. Some Pattern Recognition Receptors (PRRs) recognize nucleic acids, like RNA or DNA. Since
our own cells contain human RNA and DNA, the activation of innate immune pathways by these
PRRs must rely on additional criteria to discriminate self from non-self. Additional criteria
include everything EXCEPT:
   a. The subcellular location of the RNA
   b. The presence of adenosine residues in viral RNA
   c. The methylation state of the DNA
   d. Unique structures found on viral RNA
   e. The subcellular location of the DNA

47. Given the enormous heterogeneity of antigen receptors expressed on the populations of naive B
and T lymphocytes, the adaptive immune response relies on a process whereby the rare
lymphocyte that binds to the antigen is first induced to proliferate, before it can perform its
effector function. For B cells, there is a clever mechanism that ensures that the specificity of the
antibody secreted by the plasma cell will recognize the same pathogen that initially stimulated the
B cell antigen receptor and induced B cell proliferation. This mechanism is:
   a. The naive B cell expresses an array of different B cell antigen receptors, and randomly
      chooses which specificity of antibody to secrete as a plasma cell.
   b. The naive B cell expresses a single specificity of B cell antigen receptor, and then up-
      regulates the expression of this receptor so it can bind tightly to the pathogen.
   c. The plasma cell proliferates after it has finished secreting antibody to generate more
      plasma cells with specificity for the pathogen.
   d. The plasma cell traps secreted antibody molecules in its extracellular matrix and uses
      these antibodies to bind to the pathogen.
   e. The naive B cell expresses a membrane-bound form of the antibody as a receptor, and
      secretes that same antibody when it differentiates into a plasma cell.
48. Unlike B lymphocytes, T lymphocytes do not generate a secreted form of their antigen receptor after they are activated and proliferate. This is because the effector functions of T cells are restricted to:
   a. Responses important in protozoan infections, but not other types of infections
   b. Interactions with large helminthic parasites, which cannot be phagocytosed
   c. Interactions with other cells, such as virus-infected cells or other immune cells
   d. Responses important in mucosal surfaces (e.g., the lung), where antibodies cannot go
   e. Stimulating B cells and not any other types of cells

49. The antigen receptor on a T cell recognizes a degraded fragment of a protein (i.e., a peptide) bound to a specialized cell surface peptide-binding receptor called an MHC molecule. One key aspect of this system is that the peptides displayed on MHC molecules can be derived from intracellular proteins. This mode of antigen recognition is particularly important in allowing the adaptive immune response to detect infections by:
   a. Large helminthic parasites in the gastrointestinal tract
   b. Intracellular pathogens, such as viruses and some protozoa
   c. Extracellular bacteria that colonize the lungs
   d. Fungi that form hyphae in the bronchial airways
   e. Fungal infections in the skin epithelium

50. Vaccination against many infectious diseases has provided enormous benefit in developed countries, leading to the virtual eradication of diseases such as polio, measles, smallpox, and others. However, efforts to create long-lasting vaccines against some viral infections, like Influenza and HIV, have not been successful to date because:
   a. Viruses like HIV and Influenza undergo antigenic variation to evade previous immune responses.
   b. Viruses like HIV and Influenza spread too rapidly in the population for a vaccine to be effective.
   c. Viruses like HIV and Influenza have RNA, rather than DNA genomes, and are resistant to current vaccine strategies.
   d. Viruses like HIV and Influenza infect via mucosal surfaces, a route that is not well protected by current vaccine strategies.
   e. Viruses like HIV and Influenza are transmitted vertically (from mother to child) during fetal development, so babies are infected before they can be vaccinated.

51. **What are the cell surface proteins that identify a cell as self?**
   a. (MHC) Major Histocompatibility Complex Proteins

52. What is the name of a category of cells that engulf antigens and show these fragments on their cell surface?
   a. Antigen Presenting Cells

53. **Name three major types of cells that fall in the category named in Question 42**
   a. Dendritic Cells, Macrophages, B lymphocytes

54. What are the two cell differentiation glycoproteins in T cell populations?
   a. CD4 and CD8

55. Which immune system is described as humoral?
   a. Adaptive Immune System