



Anatomy and Physiology EXAM

2018 Golden Gate Science Olympiad Invitational Anatomy Test

Time limit: 55 minutes

Names:	
Team Number:	
School:	
Score:	/ 214

Rank:

**Tiebreakers are indicated by asterisks on the exam and answer sheet.

(Point values) are indicated on the exam.

Questions 176-189 relate to the microscope STATION. Each team will be called up to spend 5 minutes at this station.

Respiratory System

Questions 1 to 6. (1pt each) Use the diagram of the respiratory system shown below. For each question, write the number of the labeled structure which is best described by the statement.



- 1. This structure contains mucous membranes which have olfactory receptors.
- 2. This structure prevents food or drink from entering the airway when you swallow.
- 3. This structure contains a pair of membranes which vibrate when you move air over them to produce speech.
- 4. The inferior end of this structure is marked by a cartilage known as the carina.
- 5. When this structure contracts, the thoracic cavity expands in volume.
- 6. This structure contains the sites of gas exchange known as the alveoli.

- 7. (1) Which of the following is NOT a function of the respiratory system and its organs?
 - A. Allows exchange of carbon dioxide and oxygen between the blood and the air
 - B. Regulates blood pH by adjusting oxygen levels
 - C. Allows for speech generation
 - D. Protects the body from some microorganisms
- 8. (1) When air moves through the nasal cavity, it enters three narrow, curved passageways formed by the nasal conchal bones. Which of the following best describes the airflow through this area?
 - A. These narrow passageways create turbulence in the airflow, thus increasing the likelihood that air will come into contact with the epithelium.
 - B. These narrow passageways increase the speed of airflow, thus increasing the rate at which air is filtered through the nasal cavity.
 - C. These narrow passageways create a smoother airflow, thus increasing the efficiency of respiration.
 - D. These narrow passageways slow down airflow, thus allowing more time for gas exchange to occur.
 - E. These narrow passageways increase the speed of airflow, thus allowing us to detect smells more quickly.
- 9. (0.5) What is the name of these narrow, curved passageways described in the previous question?
- 10. (1) The posterior surface of the nasopharynx contains which tonsils?
 - A. Oral
 - B. Lingual
 - C. Palatine
 - D. Pharyngeal
- 11. (1) Which of the following is true of the pharynx?
 - A. When swallowing, the uvula helps close off the laryngopharynx.
 - B. The oropharynx and laryngopharynx are primarily made of pseudostratified columnar epithelium, while the nasopharynx is primarily made of stratified squamous epithelium.
 - C. The nasopharynx serves as a passageway for air, food, and drink, while the oropharynx and laryngopharynx serve only as a passageway for air.
 - D. The laryngopharynx becomes inflamed when a person has laryngitis.
 - E. When swallowing, the nasopharynx is closed off by the soft palate from the oropharynx and laryngopharynx.

- 12. (1) Barbara and Elena are of similar height, weight, and age. In a normal conversation, Barbara and Elena speak at the same decibel level; however, Barbara speaks at a higher pitch than Elena. Which of the following is a likely explanation for this difference?
 - A. Barbara is a smoker, while Elena is not.
 - B. Barbara's true vocal cords are longer than Elena's.
 - C. When speaking, air passes slower through Barbara's true vocal cords and passes faster through Elena's true vocal cords.
 - D. When speaking, Barbara forces more air over her true vocal cords than does Elena.
 - E. When speaking, Barbara only vibrates the anterior half of her true vocal cords, while Elena vibrates a greater length of her true vocal cords.

Questions 13 to 17. (1 pt each) Choose from the following structures. For each question, list which structure or structures are described in the statement.

- A. Cartilage surrounding the trachea
- B. Cricoid cartilage
- C. Thyroid cartilage
- D. Epiglottis
- E. Glottis
- 13. The two halves of this structure meet to form the Adam's apple
- 14. This structure completely encircles the larynx.
- 15. This structure is one of nine cartilages that make up the larynx framework.
- 16. This structure is made of hyaline cartilage.
- 17. Relative movement between these two structures changes the pitch of the voice (two structures).
- 18. (1) Which of the following structures is NOT surrounded by C-shaped cartilage?
 - A. Larynx
 - B. Trachea
 - C. Primary bronchi
 - D. Secondary bronchi
- 19. (1) In humans, two-thirds of the increase in thoracic cavity volume occurs by:
 - A. Contraction of the diaphragm
 - B. Relaxation of the diaphragm
 - C. Contraction of the external intercostals
 - D. Relaxation of the internal intercostals
 - E. Contraction of the internal intercostals

Questions 20 to 21. Refer to the following scenario.

A snake's ability to increase or decrease the size of its lung volume also depends on respiratory muscles. You treat a snake with a drug that prevents the ability of the snake's nervous system to cause these muscles to contract. You find that the snake's lungs are expanded and the snake is now unable to reduce its lung volume.

- 20. (2) What does this information suggest about the snake's respiratory system?
 - A. In snakes, expiration is an active process that occurs when respiratory muscles relax.
 - B. In snakes, expiration is an active process that requires the contraction of respiratory muscles.
 - C. In snakes, expiration is a passive process that requires the contraction of respiratory muscles.
 - D. In snakes, expiration is a passive process that occurs when respiratory muscles relax.

After treating the snake with this drug, you are still able to activate the respiratory muscles temporarily with an electric current.

21. (3**) How could you use this technique to deduce whether inspiration (in snakes) is an active or passive process? Explain your procedure (e.g. "After the snake is treated with the drug, I will..."), and how your results would support one conclusion or the other (e.g. "If inspiration is active/passive, I would expect...").

Questions 22-26. (1 pt each). Refer to the alveolar structures below. Select the letter best described in the statement.

- A. Type I alveolar cell
- B. Type II alveolar cell
- C. Dust cell
- D. Elastic fibers
- 22. (1) This structure is responsible for producing surfactant.
- 23. (1) Most diffusion of gases occurs across this structure.
- 24. (1) This structure is a type of macrophage.
- 25. (1) If this structure were removed from alveoli, the lungs would have difficulty returning to their original size during exhalation.
- 26. (1) If this structure were removed from alveoli, the lungs would be harder to inflate and more likely to collapse.

- 27. (1) Your vestibular and vocal cords close tightly, your abdominal muscles contract, and the muscles of expiration contract forcefully. You are about to:
 - A. Hiccup
 - B. Cough
 - C. Sneeze
 - D. Shout
 - E. Blow your nose

Question 28 to 29. Refer to the following chart of partial pressures of gases at sea level.

	Dry /	Air	Humidifi	ied Air	Alveola	r Air	Expire	d Air
Gases	mm Hg	%	mm Hg	%	mm Hg	%	mm Hg	%
Nitrogen	597.5	78.62	563.4	74.09	569.0	74.9	566.0	74.5
Oxygen	158.4	20.84	149.3	19.67	104.0	13.6	120.0	15.7
Carbon dioxide	0.3	0.04	0.3	0.04	40.0	5.3	27.0	3.6
Water vapor	0.0	0.0	47.0	6.20	47.0	6.2	47.0	6.2

- 28. (1) The partial pressure of water is 47 mm Hg in both alveolar air and expired air, despite the changing partial pressures of nitrogen, oxygen, and carbon dioxide. Which of the following best explains why?
 - A. Water is continually added to air in the respiratory tract to 100% humidity.
 - B. Water is removed from the air in the respiratory tract to prevent the entry of pathogens.
 - C. Water is neither added nor removed in the respiratory passages.
 - D. Carbon dioxide and oxygen are exchanged in the alveoli for water in equal ratios.
 - E. The air we breathe contains a constant water vapor partial pressure.
- 29. (1) Which of the following best explains why the partial pressure of nitrogen varies between alveolar air and expired air, despite the fact that nitrogen is not significantly exchanged in the respiratory tract?
 - A. Random diffusion of N2 across the alveolar membrane results in a net decrease of N2 pressure in expired air
 - B. Nitrogen gets added to air in the alveoli, and then reabsorbed in other areas of the respiratory tract.
 - C. The removal of oxygen and the addition of carbon dioxide, as well as water, causes the partial pressure of nitrogen to change.
 - D. As the most abundant gas in the atmosphere, nitrogen does not obey Dalton's Law.
 - E. It is not possible for the partial pressure of nitrogen to change without changing the absolute amount of nitrogen in the air.

Questions 30 to 35. (1 pt each) Refer to the below graph of lung capacities. For each question, give the letter which best matches the description.



- 30. This volume is typically around 500 mL in an average person.
- 31. This letter represents air that is left in the lungs after a forced expiration.
- 32. This letter represents the maximum amount of air that can be inhaled following exhalation of resting tidal volume.
- 33. This letter represents the total lung capacity (TLC).
- 34. This letter represents the expiratory reserve volume (ERV).
- 35. This letter represents the inspiratory capacity (IC).

Questions 36 – 37. Refer to the following formula: $F = (P_1 - P_2) / R$

Where F represents airflow, P_1 represents air pressure in the alveoli, P_2 represents atmospheric pressure and R represents resistance to airflow.

- 36. (2) During an asthma attack, what would you expect to happen to airflow (F), and how does this depend on P or R? (e.g. F will not change because P1, P2, and R will be the same). What physical processes cause these changes?
- 37. (2) Name two physical factors which contribute to resistance (R).
- 38. (2**) Which of the following does NOT correctly describe alveolar gas exchange?
 - A. When blood leaves the alveolus, the partial pressures of oxygen and carbon dioxide in the blood are equal to those in the alveolus.
 - B. A smaller membrane thickness and a larger surface area at the respiratory membrane both would help maximize the amount of gas exchange.
 - C. At the respiratory membrane, the partial pressure of oxygen in the blood entering the pulmonary capillary is around 40 mm Hg, while the partial pressure of carbon dioxide in the blood is around 45 mm Hg—the greater partial pressure of carbon dioxide relative to oxygen promotes the transfer of CO2 into the alveolus.
 - D. The amount of air that a portion of the lung receives is coupled to the amount of blood flow to that region (e.g. more airflow promotes more bloodflow), increasing the amount of gas exchange.
 - E. At the respiratory membrane, the diffusion gradient for CO2 is much smaller than that of O2, yet the concentrations of both gases quickly reach equilibrium in the short amount of time spent at the interface—this is possible because CO2 is much more soluble in water than is oxygen.
- 39. (2) Name three ways carbon dioxide is transported through the blood. Which method transports the majority of carbon dioxide?
- 40. (1) A SCUBA diver who suddenly ascends to the surface can develop decompression sickness, or "the bends", in which bubbles of nitrogen gas form and block blood flow through small vessels. Which of the following best explains this phenomenon?
 - A. Nitrogen has a low solubility coefficient, but will diffuse into alveolar capillaries at high pressures.
 - B. Nitrogen has a high solubility coefficient, but high pressure decreases its solubility coefficient.
 - C. Nitrogen has a higher partial pressure in the alveoli than does carbon dioxide, and some nitrogen displaces carbon dioxide under high pressure.
 - D. Nitrogen has a low solubility coefficient, but high pressure increases its solubility coefficient.
 - E. The low solubility coefficient of nitrogen prevents nitrogen from entering the alveolar capillaries.

Questions 41 to 43. Refer to the graph below, which plots the percent of oxygen saturation of hemoglobin as a function of the partial pressure of oxygen (mmHg).



Oxygen Saturation Curve

- 41. (1) On the black curve, a drop in PO2 from 40 mm Hg to 20 mm Hg will result in what % drop in oxygen saturation of hemoglobin?
- 42. (2) Name two factors which could cause the black curve to shift to the right, resulting in the blue curve.
- 43. (1) The partial pressure of oxygen in tissues is around 20 mmHg. How much more oxygen is released to the tissues, in terms of the difference in oxygen saturation, under the conditions of the blue curve as compared to the black curve?
- 44. (2) Fill in the blanks to appropriately describe the difference between the Bohr and the Haldane effects:

The Bohr effect describes the effect of the concentration of ______ (1) on the ability of hemoglobin to bind to ______ (2), while the Haldane effect describes the effect of the concentration of ______ (3) on the ability of Hemoglobin to bind to ______ (4).

45. (3**) Explain how hemoglobin's ability to bind to carbon dioxide changes, depending on the concentration of oxygen. How does this mechanism enhance gas exchange at body tissues and in the alveoli?

- 46. (2) In which of the following structures would you find chemoreceptors that respond to the pH or CO2 content of the surrounding fluid? Select all that apply.
 - A. Carotid artery
 - B. Aortic artery
 - C. Medulla oblongata
 - D. Vena cava
 - E. Lymph nodes
- 47. (1) Which of the following is true of people living at higher altitudes?
 - A. The lower ambient temperatures help promote oxygen unloading at the tissues.
 - B. People living at higher altitudes have a lower blood pH to promote oxygen unloading at tissues.
 - C. People living at higher altitudes have higher BPG levels in their red blood cells, which promotes oxygen unloading at tissues.
 - D. The Bohr effect is larger for people living at higher altitudes, which increases the amount of oxygen available to tissues.
 - E. The Bohr effect shifts the oxygen saturation curve to the left for people living at higher altitudes, which increases the amount of oxygen available to tissues.
- 48. (2) Which of the following is TRUE concerning small cell and non-small-cell lung carcinomas?
 - A. Small cell carcinoma has a longer doubling time than non-small-cell carcinoma, and has a later development of metastasis.
 - B. Non-small-cell lung carcinoma is also known as "oat cell carcinoma" because the cancerous cells look plump with excess cytoplasm.
 - C. Small cell carcinomas are more sensitive to chemotherapy than are non-small-cell carcinomas.
 - D. Lung cancer in non-smokers is most often small cell carcinoma.
 - E. Small cell carcinomas are often thought to originate from neuroendocrine cells, and thus can ectopically produce hormones such as antidiuretic hormone (ADH).
- 49. (1) Which of the following best explains why your breathing rate increases during exercise?
 - A. Your muscles have used up ATP and creatine phosphate reserves.
 - B. Your muscles require more oxygen to generate more ATP.
 - C. The reduced oxygen levels in the blood signal to the respiratory center to increase the breathing rate.
 - D. Exercise increases the CO2 and H+ concentration in the blood, and lowers the pH of cerebrospinal fluid.
 - E. Your breathing rate increases to match the increased heart rate, in order to supply more blood to your body.

Questions 50 to 54. (0.5 pt each) Indicate whether the statement is TRUE or FALSE. The diagram below may help you answer the questions, but is not necessary to do so.



- 50. With surfactant, a smaller alveolus has the same surface tension as a larger alveolus.
- 51. Without surfactant, the air in a smaller alveolus is subject to higher pressure than the air in the larger alveolus
- 52. Without surfactant, a smaller alveolus is more likely to collapse than a larger alveolus.
- 53. With surfactant, a smaller alveolus has less surface tension than a larger alveolus.
- 54. With surfactant, the alveoli in the lungs are more likely to expand at the same rate.

Digestive System

Questions 55-60. Refer to the diagram below. For questions 55-57, give the letter which best matches the statement.



- 55. (1) These teeth are used for biting and cutting food.
- 56. (1) These teeth are known as wisdom teeth.
- 57. (1) These teeth are called the premolars.
- 58. (1) How many teeth does an adult human have?
- 59. (1) What structure is label G pointing to?
- 60. (2) List two functions of structure F.

Question 61. You are walking in the forest when you come across the lower jaw of an unidentified animal, shown below.



- 61. (2) Based on the teeth, what do you suspect the diet of this animal is like? Explain why (1-2 sentences).
- 62. (1) Which of the following is NOT part of the alimentary tract?
 - A. Oral cavity
 - B. Pharynx
 - C. Larynx
 - D. Small Intestine
 - E. Large Intestine
 - F. Rectum
- 63. (1) Which of the following will occur following activation of the sympathetic nervous system?
 - A. Peristalsis will increase by increased contraction of skeletal muscles.
 - B. Peristalsis will increase by decreased contraction of skeletal muscles.
 - C. Peristalsis will increase by increased contraction of smooth muscles.
 - D. Peristalsis will decrease by decreased contraction of skeletal muscles.
 - E. Peristalsis will decrease by increased contraction of smooth muscles.
 - F. Peristalsis will decrease by decreased contraction of smooth muscles.

Questions 64 to 70. (1 pt each) Refer to the diagram of the digestive tract below. Give the number which best corresponds to the statement.



- 64. This structure stores and concentrates bile.
- 65. One proposed function for this structure is as a "safe house" for beneficial intestinal bacteria which can repopulate the gut following diarrhea.
- 66. This structure contains both an involuntary internal and a voluntary external sphincter.
- 67. This structure is made of the duodenum, jejunum, and ileum.
- 68. This structure is both an exocrine and an endocrine gland.
- 69. This structure is where most chemical digestion of food takes place.
- 70. This structure produces bile.

Questions 71 through 82. (0.5 pt each) For each digestive enzyme, indicate

- 1) the organ which produced the enzyme
 - A. Salivary gland
 - B. Stomach
 - C. Gallbladder
 - D. Liver
 - E. Pancreas
 - F. Small intestine
 - G. Large intestine

2) the site of the enzyme's action

- H. Mouth
- I. Stomach
- J. Small intestine lumen
- K. Small intestine brush border

Enzyme	Source (A-G)	Site of action (H-J)
Salivary amylase	71.	72.
Trypsin	73.	74.
Nucleosidases	75.	76.
Pepsin	77.	78.
Lipase	79.	80.
Maltase	81.	82.

Questions 83 to 86. (1 pt each) For each of the following enzymes, indicate whether the enzyme is involved in digestion of:

- A. Proteins
- B. Carbohydrates
- C. Nucleic acids
- D. Lipids
- 83. Amylase
- 84. Lactase
- 85. Chymotrypsin
- 86. Ribonuclease

- 87. (2) Put the following events in fat digestion in order:
 - I. Lipases digest fats into monoglycerides
 - II. Chylomicrons are formed
 - III. Fats enter lacteals
 - IV. Bile emulsifies fats entering the small intestine
 - V. Fats diffuse across the membrane of cells lining the small intestine
 - VI. Fats assemble into triglycerides

Questions 88 to 92. (1 pt each) Indicate which of the following sublayers of the GI tract is best described by each statement.

- A. Serosa
- B. Muscularis
- C. Submucosa
- D. Mucosa
- 88. This is the outermost layer of the GI tract
- 89. This layer contains goblet cells in the stomach
- 90. This layer has villi and microvilli in the small intestine
- 91. Absorbed nutrients enter the circulatory system through blood vessels in this layer.
- 92. This layer is thickest in the large intestine and contains tiniae coli.
- 93. **(2) Which of the following statements is TRUE concerning the muscularis?
 - A. Peristaltic activity is governed by Auerbach's plexus, which lies between the two muscle layers in the muscularis.
 - B. The longitudinal muscle layer prevents food from traveling backward, while the circular muscle layer shortens the tract in front of the food.
 - C. Unlike the majority of the GI tract which has two layers in the muscularis, the small intestine has a third oblique layer to aid in mechanical digestion.
 - D. Meissner's plexus in the muscularis contains many parasympathetic synapses that regulate the rate of peristalsis.
 - E. Peristaltic activity occurs unconsciously, and is independent of nervous system control.
- 94. (1) Which of the following describes chemical digestion?
 - A. Chewing in the mouth breaks down food into smaller pieces, allowing greater surface area for amylase to break down starch.
 - B. The inner oblique layer of the stomach churns chyme in the stomach.
 - C. Peristalsis moves food through the esophagus and stomach.
 - D. The molecular formula of food molecules changes as they pass through the stomach.

- 95. (2) What is a zymogen? Why is it especially important that zymogens are used in the digestive system?
- 96. (2) Give two examples of zymogens secreted by the stomach or the pancreas.

Questions 97-104. (1 pt each unless indicated) For each of the following, indicate the hormone or hormones which match(es) the statement.

- A. Gastrin
- B. Cholecystokinin
- C. Secretin
- D. Somatostatin
- E. Insulin
- 97. (2) This hormone is secreted by the stomach
- 98. (2) This hormone is secreted by the pancreas
- 99. (2) This hormone is secreted by the small intestine
- 100. This hormone stimulates parietal cells to secrete HCl
- 101. This hormone is released in response to chyme that is high in fats, and primarily stimulates the release of pancreatic juices rich in digestive enzymes.
- 102. This hormone suppresses the release of many other gastrointestinal and pancreatic hormones, decreases the rate gastric emptying, and reduces smooth muscle contractions.
- 103. This hormone is released in response to low pH in the duodenum, and primarily functions to neutralize the pH by stimulating bicarbonate release from the pancreas.
- 104. These two hormones work together to stimulate bile release from the gallbladder and reduce gastric motility, in addition to their roles in stimulating pancreatic secretions.

Immune system

Questions 105 to 109. (1 pt each) Use the diagram below. Indicate which letter corresponds to the immune organ.



- 105. T lymphocytes mature in this organ.
- 106. This letter points to Peyer's patches.
- 107. This organ contains red pulp and white pulp, and also functions as a blood reservoir.
- 108. This letter points to the tonsils.
- 109. This organ is larger in children and disappears with old age
- 110. (1) The composition of lymph is most similar to
 - A. Blood
 - B. Chyme
 - C. Cytosol
 - D. Interstitial fluid
 - E. Serum
- 111. Which of the following is a function of cells in the thymus?
 - A. Produce and secrete thymic hormones
 - B. Produce and secrete antibodies
 - C. Act as antigen-presenting cells in the humoral response
 - D. Produce and secrete interleukin-1
 - E. Generate B lymphocytes

Questions 112 to 117. (0.5 pts each) For each of the following statements, indicate whether it is a:

- A. Nonspecific immune response
- B. Specific immune response
- 112. Memory cells multiply rapidly in response to an antigen
- 113. Nasal hairs trap dirt and dust
- 114. Gastric juice kills many pathogens in the stomach
- 115. Local redness and swelling in response to a puncture wound
- 116. Natural killer cells destroy tumor cells that do not display an MHC on their surface
- 117. Cytotoxic T cells recognize a peptide bound to an MHC class I molecule

Questions 118 to 123. (1 pt each) For each of the following statements, indicate which cell type best matches the statement.

- A. Plasma B cells
- B. Eosinophils
- C. Helper T cells
- D. Basophils
- E. Neutrophils
- F. Dendritic cells
- G. Memory T cells
- 118. When these cells are activated in response to the first exposure to an antigen, they will differentiate into large numbers of effector T cells.
- 119. These cells are phagocytes that in tissues in contact with the external environment, including the skin, lungs, and intestines.
- 120. These cells are weakly phagocytic and attack parasitic worms.
- 121. These cells of the innate immune response are derived from myeloblasts, circulate in the blood, and produce histamine and heparin.
- 122. These cells produce secreted antibodies.
- 123. These cells recognize antigens bound to MHC II molecules through CD4 receptors.

- 124. (1) Until recently, which of the following organs was thought not to contain lymphatic vessels?
 - A. Lungs
 - B. Small Intestine
 - C. Brain and central nervous system
 - D. Appendix
 - E. Skin

Questions 125 to 130. (1 pt each) For each of the following descriptions, write the letter of the antibody class (which Ig class) best fits the description.

- 125. This Ig class is the most common, making up about 75% of all human antibodies
- 126. This Ig class is found in mucus membranes, tears, and breast milk.
- 127. This Ig class triggers mast cells and basophils during an allergic response.
- 128. This Ig class is the only type of antibody capable of crossing the placenta.
- 129. This Ig class helps mediate the earlier stages of a humoral immune response, and is later joined by IgGs to clear foreign antigens
- 130. This Ig class exists as a monomer and is co-expressed on the surface of B lymphocytes with IgM.
- 131. (1) Which of the following cell types does NOT express MHC class I molecules?
 - A. Platelets
 - B. Cytotoxic T cells
 - C. Red blood cells
 - D. Neurons
 - E. Muscle cells
- 132. (1) Which of the following cell types does NOT express MHC class II molecules?
 - A. Dendritic cells
 - B. Helper T cells
 - C. B plasma cells
 - D. Macrophages
- 133. (2) What is the major difference between the origin of antigens presented using MHC class I vs. the origin of antigens presented using MHC class II molecules?

Questions 134 to 138. (1 pt each) Refer to the diagram below of the specific immune response. Indicate which letter best matches the statement.



- 134. This letter indicates a plasma B cell.
- 135. This letter indicates a helper T cell.
- 136. This letter indicates a memory helper T cell.
- 137. This letter indicates a memory B cell.
- 138. This letter indicates a cell that will bind to and lyse infected or cancerous cells.

- 139. (2) Which of the following is true about MHC molecules?
 - A. Cytotoxic T cells cannot recognize antigens presented on MHC class II molecules because they express CD4 receptors.
 - B. Helper T cells recognize cells expressing MHC class I molecules, and then secrete cytokines to induce T cell proliferation.
 - C. MHC class II molecules on the surface of B cells recognize free antigens.
 - D. Helper T cells recognize antigens presented on MHC class II molecules, and can then secrete molecules including interleukins to induce B cell proliferation.
 - E. MHC molecules are specific regions of an antigen that activate lymphocytes expressing the appropriate receptors.
- 140. **(2) Which of the following is a mechanism that prevents T cells from targeting cells in the same body?
 - A. All T cells express CD8 receptors which prevent them from destroying healthy cells.
 - B. T cell survival and proliferation requires a co-stimulation signal such as CD80 or CD86, in addition to recognition of an antigen presented on an MHC molecule.
 - C. Like B cells, developing T cells undergo VDJ recombination to create an extremely diverse set of T cell receptors.
 - D. The antibodies expressed by developing T cells rarely react with "self" peptides
 - E. T cell receptors must be unable to bind to any "self peptide" before exiting the thymus.
- 141. (1) The immunoglobulin class of an antibody is determined by:
 - A. Function of the molecule
 - B. Structure of the constant region of the H chain
 - C. Structure of the constant region of the L chain
 - D. Structure of the variable region
 - E. Ability of the antibody to bind to a particular antigen
- 142. (2) Arrange the following events of helper T cell activation in order:
 - I. Macrophage releases interleukin-1 as a costimulation signal
 - II. Macrophage phagocytoses an antigen
 - III. Helper T cell binds to macrophage
 - IV. Helper T cell releases interleukin-2 and divides
 - V. Antigen is displayed on an MHC molecule

Questions 143 to 147. (1 pt each) For each statement, indicate which antibody mechanism or mechanisms fit the description.

- A. Opsonization
- B. Neutralization
- C. Agglutination
- D. Precipitation
- E. Complement system
- 143. This mechanism promotes phagocytosis of the antigen by macrophages.
- 144. This mechanism leads to formation of a membrane attack complex
- 145. This mechanism leads to cell lysis of a target cell
- 146. This mechanism is shown below:



- 147. This mechanism requires an optimal antibody to antigen ratio to make soluble antigens easier to destroy.
- 148. (1) B cells proliferate and differentiate into plasma cells in the
 - A. Liver
 - B. Blood stream
 - C. Red pulp of the spleen
 - D. Lymph nodes
 - E. Adrenal cortex

- 149. (1) A vaccine produces its effects by:
 - A. Stimulating a primary immune response
 - B. Inducing opsonization
 - C. Directly attacking the antigens and neutralizing them
 - D. Inducing cell lysis
 - E. The activation of pre-existing memory B cells

Question 150. Refer to the diagram below.



- 150. (1) Which of the following statements is best supported by the figure?
 - A. The immune system of the patient was stronger at 7 weeks than at 1 week, creating a strong response to antigen A at week 7.
 - B. The introduction of antigen B at week 7 induced the rapid proliferation of memory T cells into helper T cells, cytotoxic T cells, and more memory T cells.
 - C. The first introduction of antigen A at week 1 induced a natural, acquired immunity in the patient.
 - D. Antigen B is more potent than antigen A, and induced a stronger immune response at week 7.
 - E. A vaccine was given at week 1.
- 151. (1) Complement and antibodies are similar in that:
 - A. Both are produced by mast cells
 - B. Both may make bacteria more attractive to phagocytes
 - C. Both have two identical antibody binding sites
 - D. Both are activated during an inflammatory cascade
 - E. Both are part of the nonspecific immune response

- 152. (2) Name two mechanisms that lead to the redness and swelling present during an inflammatory response.
- 153. (1) What phagocytic cell type is the most numerous cell to exhibit chemotaxis toward an inflammatory site?
- 154. (2) Place the following events in the inflammatory process in order:
 - I. Marginalization of leukocytes to capillary walls
 - II. Leukocytosis increases the number of white blood cells in the blood
 - III. Release of leukocytosis-inducing factor
 - IV. Diapedesis (leukocytes pass through capillary walls)
 - V. Leukocytes migrate through bloodstream to site of injury
 - VI. Phagocytosis of pathogens and dead tissue cells
- 155. (1) The passage of antibodies from the mother to a child gives the child:
 - A. Natural active immunity
 - B. Natural passive immunity
 - C. Artificial active immunity
 - D. Artificial passive immunity
- 156. (1) Which antigens are present on the red blood cells of a person with type AB blood?
 - A. A antigens
 - B. B antigens
 - C. AB antigens
 - D. O antigens
 - E. A and B antigens
 - F. A, B, and O antigens
 - G. AB and O antigens
- 157. Which antibodies are present in the blood of a person with type O blood?
 - A. Anti-A antibodies
 - B. Anti-B antibodies
 - C. Anti-AB antibodies
 - D. Anti-O antibodies
 - E. Anti-A and Anti-B antibodies
- 158. (2**) The innate and adaptive immune responses do not operate independently of each other. Give one example of how the innate immune response can direct an adaptive immune response, or vice versa.

Diseases and Disorders of the Respiratory, Digestive, and Immune Systems

- 159. (2) Which of the following are autoimmune disorders?
 - A. Emphysema
 - B. Cystic fibrosis
 - C. Multiple sclerosis
 - D. Grave's disease
 - E. Rheumatoid arthritis
- 160. (2) Patients with emphysema may be "barrel-chested". What does this say about their expiratory volume, and what mediates this change?
- 161. (1) Which of the following best describes why patients with untreated HIV lose cellmediated immunity?
 - A. HIV infection leads to a decrease in CD4+ T cell numbers, which are needed to promote cell-mediated immunity.
 - B. HIV only infects helper T cells, which activate the cells needed in cell-mediated immunity
 - C. HIV infection preferentially infects and kills cytotoxic T cells.
 - D. The glycoproteins on HIV's viral envelope recognize CD8 receptors in order to target cytotoxic T cells.
 - E. HIV is a retrovirus which uses reverse transcriptase to create DNA from RNA.
- 162. (1) The most common cause of hepatitis is through viral infection. Which types of viral hepatitis (A, B, C, D, or E) are preventable with immunization?
- 163. (3**) Explain in 1-2 sentences how vaccinations, if available, stimulate the immune system to prevent hepatitis.
- 164. (1) Other than viral infection, name two causes of hepatitis.

Questions 165 to 175. (1 pt each) For each of the following statements, indicate which disease or disorder corresponds best.

- A. COPD
- B. Asthma
- C. Pneumonia
- D. Cystic fibrosis
- E. Sleep apnea
- F. Stomach and duodenal ulcers
- G. Diarrhea
- H. Lactose intolerance
- I. Hepatitis
- J. Appendicitis
- K. HIV/AIDS
- L. Contact Dermatitis
- M. Multiple Sclerosis
- N. Rheumatoid arthritis
- O. Grave's disease
- 165. This autosomal recessive disorder is commonly caused by a mutation in a chloride ion channel
- 166. This disease/disorder refers to inflammation of the liver
- 167. This disorder leads to warm, swollen, and painful joints.
- 168. Emphysema is an example of this type of disease which results from damaged alveoli and narrowing of air passageways.
- 169. The most common cause of this is *Helicobacter pylori*
- 170. This inflammatory condition is most commonly caused by viruses or bacteria, and can lead to the accumulation of fluid in alveoli.
- 171. This condition results in the erosion of the mucosa and reaches the submucosa or deeper
- 172. Common causes of this condition include exposure to poison ivy, poison oak, or poison sumac.
- 173. This disease leads to the destruction of oligodendrocytes.
- 174. This condition occurs when smooth muscles in the bronchioles contract.
- 175. This disease mimics the effect of having excess thyroid stimulating hormone (TSH).

Microscope Station #1

Questions 176 to 182. Human Blood Smear

(1 pt each) For each of the following types of white blood cells, indicate how many are visible in the field of view:

176.	Neutrophils
177.	Eosinophils
178.	Basophils
179.	Lymphocytes
180.	Monocytes

- 181. (2) Neutrophils, eosinophils, and basophils are called granulocytes due to the appearance of red or blue granules when stained. Name two types of proteins would you expect to be found in these granular secretory vesicles.
- 182. (2) Neutrophils and lymphocytes have dark-staining, highly condensed chromatin. What does this tell you about the level of protein production in these cells? Explain why.

Microscope Station #2

Questions 183 to 186. Slide A

- 183. (1) This slide shows a cross section of which type of human tissue?
 - A. Lung
 - B. Colon
 - C. Blood
 - D. Trachea
 - E. Skin
- 184. (1) This slide is stained with Mallory's trichome stain, which does the following: Nuclei stain red, muscle red to orange, nervous tissue lilac, collagen dark blue, and mucus and connective tissue become blue. What is the name of the abundant round, blue cells found in this slide?
- 185. (2) What are two reasons the function of these cells is important in the gastrointestinal tract?
- 186. (1) Name two other types of tissue in which you might find these blue cells.
- 187. (2) The chloride shift is a phenomenon that occurs both in the digestive system in parietal cells, as well as to aid in gas exchange in red blood cells. Which two ions are exchanged during chloride shift? Then, use 1-2 sentences to explain the function of chloride shift in either the digestive system or the respiratory system.
- 188. (1) Which of the following is released by chief cells in the stomach?
 - A. Pepsin
 - B. Pepsinogen
 - C. Mucus
 - D. Hydrochloric acid
 - E. Gastrin
- 189. (1) From which acid is the hydrogen ion (H+) that makes up gastric hydrochloric acid derived from?
 - A. Sulfuric acid
 - B. Phosphatidic acid
 - C. Carbonic acid
 - D. Oxalic acid
 - E. Citric acid





Anatomy and Physiology ANSWER SHEET

2018 Golden Gate Science Olympiad Invitational Anatomy Test

Time limit: 55 minutes

Names:	
Team Number:	
School:	
Score:	/ 214
Rank:	

**Tiebreakers are indicated by asterisks on the exam and answer sheet.

(Point values) are indicated on the exam.

Questions 176-189 relate to the microscope STATION. Each team will be called up to spend 5 minutes at this station.

Respiratory System

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Diseases and Disorders

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Microscope station

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