

CAPTAINS TRYOUTS 2018

ANATOMY & PHYSIOLOGY ANSWER KEY

Section 1: Respiratory System (65 points)

- 1) It provides CO₂ and O₂ exchange, enables vocalization, provides the sense of smell, helps control the pH of blood, regulates blood pressure, promotes the flow of lymph and venous blood, and helps to remove abdominal contents. (7 points)
- 2) Angiotensin II
- 3) B (1 bonus point for simple epithelium is single-layered and stratified epithelium is multilayered)
- 4) Inferior concha (1 bonus point for 1-2 times)
- 5) Thyrohyoid, cricotracheal (½ point for each)
- 6) Three, two (½ point for each)
- 7) They repair alveolar epithelium (1 point) when squamous alveolar cells are damaged (1 point) and secrete pulmonary surfactant (1 point), which prevents alveoli and small bronchioles from collapsing during exhalation (1 point).
- 8) During inhalation, the rib cage expands and the parietal pleura follows it outward (1 point). The visceral pleura sticks to the parietal pleura and thus also moves outward (1 point), and because the visceral pleura is the lung surface (1 point), the lungs expand outward as well (1 point). Because there is greater volume, the pressure inside the lungs drops lower than atmospheric pressure, and air rushes into the space (1 point).
- 9) A
- 10) Air enters through the nose and passes through the nasal cavity, pharynx, and then larynx (4 points). It then enters the trachea and bronchi, travelling into bronchioles and finally alveoli, where gas exchange occurs (4 points). It then leaves through the bronchioles going to the bronchi, trachea, larynx, pharynx, nasal cavity, and out through the nose (1 point).
- 11) D
- 12) 7, chloride ion channel, phosphorylation, cAMP-dependent protein kinase (1 point for each)
- 13) False
- 14) B
- 15) D
- 16) The tidal volume is the amount of air inhaled or exhaled with a normal breath (1 point), and it is about 500 ml in the image (1 point). The inspiratory reserve volume is the extra amount of air that can be inspired if a person inspires with full force (1 point), and it is

about 3000 ml in the image (1 point). The expiratory reserve volume is the maximum amount of air that can be exhaled with full force (1 point) and it is about 1100 ml in the image (1 point). The residual volume is the amount of air that stays in the lungs even after a forceful expiration (1 point), and it is about 1200 ml in the image (1 point). The inspiratory capacity is tidal volume plus inspiratory reserve volume (1 point), and it is about 3500 ml in the image (1 point). The functional residual capacity is expiratory reserve volume plus residual volume (1 point), and it is about 2300 ml in the image (1 point). The vital capacity is the inspiratory reserve volume plus tidal volume plus expiratory reserve volume (1 point) and it is about 4600 ml in the image (1 point). The total lung capacity is vital capacity plus residual volume (1 point), and it is about 5800 ml in the image (1 point).

17) At the ocean bottom, the partial pressure of oxygen is much higher (1 point), but hemoglobin saturation can still only be 100% maximum (1 point), which is only 3% higher than normal (1 point). Thus, only a small amount of additional oxygen is dissolved in the blood (1 point) and when the blood passes through the capillaries, most of the oxygen is removed (1 point), leaving the P_{O_2} of the capillary blood only slightly higher than normal (1 point). However, alveolar P_{O_2} varies greatly (1 point).

18) True

19) A

20) D

Section 2: Digestive System (33 points)

21) B

22) Parietal

23) B

24) Tight junctions

25) False

26) Lipids are packaged into chylomicrons (1 point) after passing through intestinal absorptive cells (1 point), but chylomicrons are too large to pass through capillary walls (1 point), so the lymphatic system instead absorbs them and later delivers them to the bloodstream (1 point). (1 bonus point for mentioning that Golgi body packages lipids into chylomicrons)

27) The liver secretes bile (1 point), which contains a pigment called bilirubin (1 point). Bacteria metabolize this pigment to urobilinogen (1 point), which lends feces its brown color (1 point). In a malfunctioning liver, bile secretion may not be working properly, so feces can appear white and gray (1 point).

28) D, B

- 29) D
- 30) D
- 31) A
- 32) Hunger, highest, lowest (1 point each)
- 33) Thiocyanate
- 34) Hydrochloric acid, pepsinogen, intrinsic factor, and mucus (1 point for each)
- 35) In the acidic environment created by HCl (1 point) pepsinogen splits apart to form the active form pepsin (1 point).
- 36) C
- 37) Carboxypolypeptidase
- 38) Cellulose
- 39) Enterokinase
- 40) Ultrasound, CT scan ($\frac{1}{2}$ point for each)

Section 3: Immune System (41 points)

- 41) Fluid recovery, immunity, lipid absorption ($\frac{1}{3}$ point for each)
- 42) Memory
- 43) The thymus is conical, red, and much larger in children (3 points). As an individual ages, however, it starts to shrink and loses lymphatic tissue (2 points), becoming gray and then yellow in color as more fat is stored (2 points).
- 44) Macrophages and helper T cells ($\frac{1}{2}$ point for each)
- 45) Negative selection
- 46) B
- 47) A
- 48) Oxidizing
- 49) C
- 50) In humoral immunity, macrophages phagocytize antigens to present them to nearby B cells and T cells (1 point). The B cells bind to specific antigens and process them (1 point), presenting them on their surface with MHC II molecules (1 point). Helper T cells then bind to the complex and release cytokines to make the B cell divide rapidly (1 point). The daughter cells either become plasma cells, which produce many antibodies that circle through the blood (humor) (1 point), or memory cells (1 point). In cell-mediated immunity, an antigen-presenting cell loads antigens onto the MHC molecule of a T cell (1 point). Cytotoxic T cells then trigger apoptosis in targeted cells (1 point), TH1 cells activate macrophages (1 point) and TH2 cells activate B cells to produce antibodies (1 point).
- 51) MHC I
- 52) B

- 53) Cytotoxic T cells have receptors on their surface that bind to specific antigens on foreign substances (1 point). They then release perforins (1 point), which make holes in the foreign cell's membrane and release toxic substances into the cell (1 point). The attacked cell swells and dissolves quickly, and the cytotoxic T cell moves on to other foreign cells (1 point).
- 54) Myasthenia gravis
- 55) When an allergen with many IgE binding sites encounters a basophil with many IgE antibodies bound to it (1 point), and antibodies bind with the allergen (1 point), altering the surface of the basophil (1 point). The basophil ruptures, releasing histamine into surrounding tissues (1 point).
- 56) D
- 57) B
- 58) A
- 59) E
- 60) C

Section 4: Diagrams (33 points)

- 61) Sphenoidal sinus
- 62) Nasal cavity
- 63) Pharynx
- 64) Alveoli
- 65) Right lung
- 66) Diaphragm
- 67) Frontal sinus
- 68) Nasal conchae
- 69) Nose
- 70) Larynx
- 71) Trachea
- 72) Bronchus
- 73) Bronchioles
- 74) Left lung
- 75) Gallbladder
- 76) Duodenum
- 77) Minor duodenal papilla
- 78) Hepatopancreatic sphincter
- 79) Major duodenal papilla
- 80) Circular folds
- 81) Hepatic ducts

- 82) Common hepatic duct
- 83) Cystic duct
- 84) Bile duct
- 85) Accessory pancreatic duct
- 86) Pancreatic duct
- 87) Duodenojejunal flexure
- 88) Jejunum
- 89) Cytotoxic T cells
- 90) Cytotoxic enzymes
- 91) Antigen receptors
- 92) Antigen
- 93) Attacked cell or foreign cell