

**DIRECTIONS:**

Each of the numbered items or incomplete statements in this section is followed by answers or completions of the statement. Select the ONE lettered answer or completion that is BEST in each case. Each multiple choice question is worth 2 points.

- The blood pressure (BP) of a hypertensive patient is 200/110 mmHg. The cardiac output is 6 liters/min and the heart rate is 60 beats per minute. The right atrial pressure is 0 mmHg. The stroke volume is:  
A. 120 ml  
B. 100 ml  
C. 1 liter/min  
D. 90 cm/sec  
E. None of the above
- The tough, outer layer of connective tissue that covers most of the eyeball is the:  
A. sclera  
B. eyelid  
C. eye socket  
D. choroid  
E. cornea
- During ventricular ejection, the ventricular cardiac muscle undergoes \_\_\_\_\_ contraction.  
A. isometric  
B. isovolumetric  
C. isotonic  
D. tetanic  
E. None of the above is correct.
- The slow depolarization pacemaker potential of a cardiac conducting fiber is due to which of the following?  
A. calcium ions  
B. potassium ions  
C. sodium ions  
D. both A and B  
E. both B and C
- When the heart is beating at rate of 75 times per minute, the duration of one cardiac cycle is \_\_\_\_\_ second(s):  
A. 60/75  
B. 75/60  
C. 1  
D. 3600/75  
E. cannot be determined from the information given
- An individual fascicle in a skeletal muscle is surrounded by:  
A. endomysium  
B. myofibrils  
C. perimysium  
D. epimysium  
E. paramyrium
- Which of the following animals would you expect to have a closed circulatory system.  
A. octopuses  
B. bivalve mollusks  
C. crayfish  
D. lobsters  
E. none of the above
- Which of the following is **NOT** part of the conduction system of the heart?  
A. AV node  
B. bundle of His  
C. SA node  
D. AV valve  
E. bundle branches
- An increase in the threshold of the autorhythmic cells of the heart is due to:  
A. parasympathetic activity  
B. sympathetic activity  
C. myogenic cells  
D. neurogenic cells  
E. none of the above
- This is the volume of blood pumped in a given time from each ventricle.  
A. stroke volume  
B. cardiac output  
C. end-diastolic volume  
D. end systolic volume  
E. cannot be determined
- Cortisol is secreted by the adrenal cortex in response to stress. In addition to its function in a stress response, it functions in negative feedback by:  
A. inhibiting the hypothalamus so that corticotropin releasing hormone (CRH) secretion is reduced  
B. inhibiting the anterior pituitary's ability to respond to CRH by reducing the pituitary's sensitivity to CRH  
C. Both a and b are correct.  
D. None of the above.

Smooth muscle uses which of the following as a source of calcium?

- A. caveoli  
☒ C. extracellular fluid  
E. Only two of the above are correct.
- B. sarcoplasmic reticulum  
D. All of the above
13. Which hormone, known to control development in insects, is **NOT** produced by neurosecretory cells.  
☒ A. Juvenile hormone  
C. Eclosion hormone  
E. none of the above
- B. Prothoracicotropic hormone (PTTH)  
D. Bursicon
14. \_\_\_\_\_ is the volume of blood in the left ventricle just before it begins to contract.  
A. stroke volume  
C. end-systolic volume  
E. ejection fraction
- ☒ B. cardiac output  
☒ D. end-diastolic volume
15. The pitch of a sound is determined by the \_\_\_\_\_ of vibrations, and in that respect is most similar to the \_\_\_\_\_ of light.  
A. amplitude; brightness  
C. frequency; brightness  
E. level; brightness
- B. amplitude; color  
☒ D. frequency; color
16. The \_\_\_\_\_ component of the \_\_\_\_\_ nerve innervates the sino-atrial node and atrioventricular node of the vertebrate heart.  
☒ A. sympathetic; cardiac  
☒ C. parasympathetic; vagus  
E. None of the above; the heart is myogenic
- B. parasympathetic; cardiac  
D. sympathetic; vagus
17. A vertebrate motor unit is:  
A. a muscle and the motor neurons that innervate it  
B. a muscle fiber and the motor neurons that innervate it  
☒ C. a motor neuron and the muscle fibers it innervates  
D. a motor neuron and the muscle it innervates  
E. None of the above.
18. Which of the following does **NOT** affect the tension that can be developed by a muscle fiber?  
☒ A. the number of motor units recruited  
B. the frequency of action potentials conducted by the motor neuron  
C. the length of the fiber at the onset of contraction  
D. diameter of the muscle fiber  
☒ E. All of the above affect tension development by a muscle fiber.
19. Hematocrit is:  
A. the oxygen-binding pigment found in red blood cells  
B. the circulatory fluid of arthropods  
C. the space inside arthropods filled with circulatory fluid  
☒ D. the packed cell volume of blood  
E. another name for red blood cells
20. At the onset of ventricular systole, the A-V valves snap shut. This closure is due to:  
☒ A. higher pressure in the atria relative to the ventricles  
☒ B. higher pressure in the ventricles relative to the atria  
C. higher pressure in the venae cavae relative to the atria  
D. higher pressure in the arteries (pulmonary and aorta) relative to the ventricles  
E. contraction of the small muscles which attach to the valves

- ☒ Sympathetic stimulation of the heart increases cardiac output by:
- ☒ A. increasing heart rate
  - ☒ B. increasing the rate at which the pacemaker potential depolarizes to threshold
  - ☐ C. increasing the number of cross-bridges that can form during contraction
  - ☐ D. increasing the strength of contraction
  - ☒ E. All of the above are correct.
22. During the bending (power stroke) of contraction:
- ☒ A. ATP molecule binds to myosin cross bridge
  - ☐ B.  $P_i$  and ADP are released from myosin
  - ☒ C.  $P_i$  and ADP attach to actin
  - ☒ D.  $P_i$  and ADP attach to myosin
  - ☐ E. None of the above
23. At optimal muscle length when maximum tension can be developed:
- ☒ A. thin filaments do not overlap thick filaments
  - ☒ B. thick filaments become forced against Z lines
  - ☒ C. the central region of thick filaments is devoid of cross bridges
  - ☒ D. thin filaments from opposite sides of the sarcomere become overlapped
  - ☒ E. thin filaments are pulled out maximally from thick fibers
24. The plateau phase of the cardiac muscle action potential is due to:
- ☒ A. the movement of fewer sodium ions across the cell membrane
  - ☒ B. the calcium channels remain open longer than the sodium channels
  - ☒ C. the increased membrane permeability to potassium ion
  - ☒ D. a decrease in the amount of calcium diffusing across the membrane
  - ☒ E. an increased membrane permeability to sodium ions
25. Which of the following is true regarding the cardiac cycle.
- ☒ A. When the atria contract, the pressure within them rise and blood is ejected into the ventricles causing the semilunar valves to open.
  - ☒ B. The ventricles contract independently to ensure proper blood flow to the pulmonary and systemic circuits.
  - ☒ C. Since blood is returned to the right atrium first, it contracts before the left atrium.
  - ☒ D. As the ventricles begin to relax, intraventricular pressure falls below the pressures in the aorta and pulmonary trunk.
  - ☐ E. None of the above is true.
26. Which statement is **TRUE**?
- ☐ A. Each thin filament is surrounded by an array of six thick filaments: each thin filament is surrounded by three thick filaments.
  - ☒ B. Each thick filament is surrounded by an array of six thin filaments: each thin filament is surrounded by three thick filaments.
  - ☐ C. Each thick filament is surrounded by an array of five thin filaments: each thin filament is surrounded by six thin filaments
  - ☐ D. Each thick filament is surrounded by an array of five thin filaments: each thin filament is surrounded by a circular arrangement of four thick filaments.
27. Which process of muscle contraction requires energy expenditure?
- ☒ A. hydrolysis of ATP to detach troponin from myosin
  - ☒ B. power stroke - as the thin filaments slide over the thick filaments
  - ☐ C. moving calcium into the sarcoplasmic reticulum
  - ☐ D. All of the above
  - ☒ E. Answers A and C only



8. In an isotonic contraction, the muscle:
- ☒ A. changes length and moves the "load"
  - ~~B. does not change length but increases tension~~
  - ~~C. never uses energy~~
  - ~~D. muscle length and tension remain constant~~
  - ~~E. muscle length and tension changes~~
29. Which of the following is an important difference between the nervous system and the endocrine system?
- ~~A. The nervous system responds to danger, whereas the endocrine system responds to "normal" activities.~~
  - ☒ B. The speed of response is different.
  - ~~C. The chemicals that transmit the signal are different.~~
  - ~~D. The nervous system is involved with control, whereas the endocrine is involved with coordination.~~
  - ~~E. The nervous system is entirely electrical in nature, whereas the endocrine system is entirely chemical in nature.~~
30. The left ventricular wall of the heart is thicker than the right wall in order to:
- ~~A. accommodate a greater volume of blood~~
  - ~~B. expand the thoracic cage during diastole~~
  - ~~C. pump blood through a smaller valve~~
  - ~~D. pump more blood than the right ventricle~~
  - ☒ E. pump blood with greater pressure
31. Isovolumetric contraction:
- ~~A. occurs while the AV valves are open~~
  - ~~B. occurs immediately after the pulmonary valve closes~~
  - ~~C. only occurs in people with heart valve defects~~
  - ~~D. the pressure in the heart is at its peak~~
  - ~~E. occurs during systole while the AV valves close~~
32. Contractions of the papillary muscles:
- ~~A. close the atrioventricular valves~~
  - ~~B. close the semilunar valves~~
  - ~~C. eject blood from the ventricles~~
  - ☒ D. prevent the atrioventricular valves from projecting into the atria
  - ~~E. eject blood from the atria into the ventricles~~
33. Function(s) of smooth muscle include:
- ~~A. locomotion and manipulation~~
  - ~~B. moving blood through vessels~~
  - ~~C. squeezing and propelling substances through hollow organs~~
  - ~~D. None of the above~~
  - ☒ E. Two of the above
34. Due in part to the physical properties of the basilar membrane, the cochlea is tuned so that:
- ~~A. high amplitude sounds are perceived optimally at the base of the narrow end of the cochlea (toward the oval window)~~
  - ~~B. low amplitude sounds are perceived optimally at the base of the narrow end of the cochlea (toward the oval window)~~
  - ☒ C. high frequency sounds are perceived optimally at the base of the narrow end of the cochlea (toward the oval window)
  - ~~D. low frequency sounds are perceived optimally at the base of the narrow end of the cochlea (toward the oval window)~~

Sound traveling through air tends to bounce off water, due to the latter's lesser compressibility. You may have noticed how little conversation you can hear when you're submerged. However, even in normal hearing sound waves have to pass from air to liquid as sound is transmitted from the external ear to the inner ear. This is accomplished by:

- ☒ A. increasing the pressure on the oval window, relative to the tympanic membrane, thanks to the former's smaller area
  - ☒ B. increasing the force applied to the oval window, relative to the tympanic membrane, thanks to the lever action of the inner ear ossicles
  - C. having higher air pressure in the middle ear relative to the external ear so that the transmitted sound waves gradually increase strength en route to the inner ear
  - ☐ D. Both a and b are correct.
  - E. Both b and c are correct.
36. In the mammalian vestibular apparatus, the \_\_\_\_\_ are used to detect \_\_\_\_\_ while the \_\_\_\_\_ are used to detect \_\_\_\_\_.
- ☒ A. semicircular canals; angular acceleration; otolith organs; linear acceleration
  - B. semicircular canals; linear acceleration; otolith organs; angular acceleration
  - C. hair cells; linear acceleration; scale cells; angular acceleration
  - D. hair cells; angular acceleration; scale cells; linear acceleration
37. A tropic hormone is:
- A. one secreted at latitudes close to the equator
  - B. one whose function is to trigger cellular development
  - ☒ C. one whose function is to stimulate endocrine tissue to secrete hormones
  - D. None of the above.
38. Which of the following statements about the endocrine system is true?
- A. Each endocrine gland secretes a single type of hormone.
  - B. Each endocrine hormone is secreted by a single endocrine tissue.
  - C. Each endocrine hormone acts on a single target tissue.
  - ☒ D. Each endocrine hormone activates a single type of receptor.
  - E. Many endocrine tissues have other non-endocrine functions.
39. Downregulation refers to:
- ☒ A. the expression of fewer receptors at the cell surface as part of a negative-feedback mechanism
  - B. the decrease in cortisol secretion that occurs as an animal's metabolism slows down to its basal level
  - C. the increased production of soft feathers as winter approaches
  - D. All of the above.
  - E. None of the above.
40. Which of the following statements regarding closed circulatory systems is **FALSE**?
- A. They function in the transportation of nutrients, hormones, antibodies and salt throughout the various organ systems within the body.
  - ☒ B. In a closed circulatory system, blood pumped by the heart directly bathes individual cells
  - C. They function in thermoregulation.
  - D. They comprise a heart, arterial system, capillaries and a venous system.
  - E. They are made necessary by the large size of organisms that have them and the large distances between nutrient sources and cells.
41. In the context of the musculoskeletal system, an origin is:
- ☒ A. the site of insertion of a muscle into a bone that is relatively immobile
  - B. a mononucleate myoblast
  - C. the site of insertion of a muscle into a bone that is relatively mobile
  - D. a Z-line
  - E. none of the above

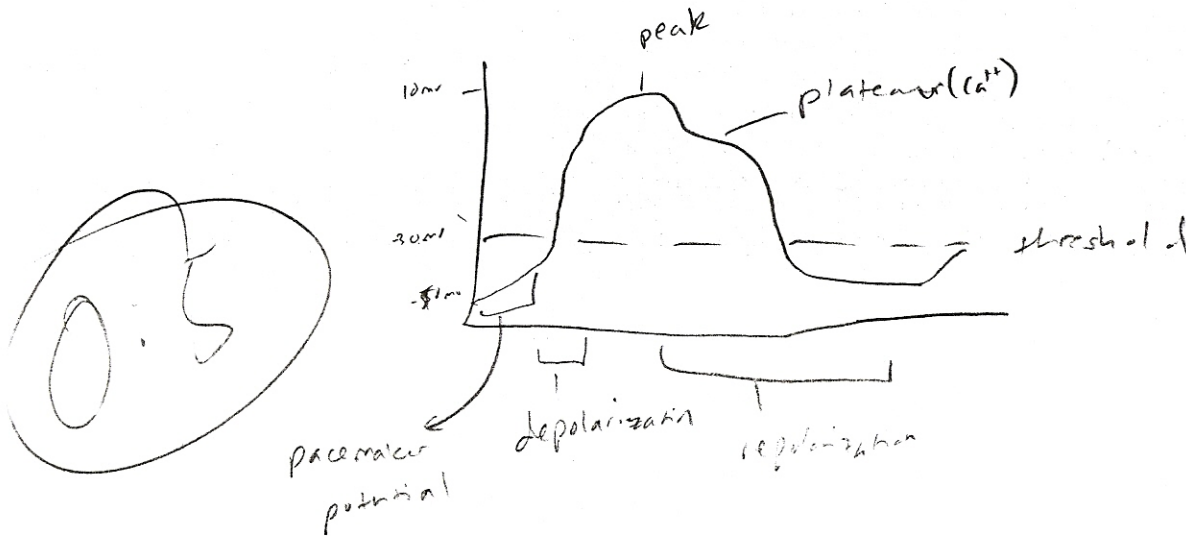


2. The ability of muscle to relax is based in part on the presence of:
- ☒ A. series of elastic elements that exert force in the direction opposite of the force generated during contraction
  - B. the depletion of ATP, and resulting unavailability of an energy source for contraction
  - C. the depletion of creatine phosphate and resulting unavailability of an energy source for contraction
  - D. the depletion of glucose and resulting unavailability of an energy source for contraction
  - E. none of the above.
43. An isometric contraction is a contraction in which:
- ☒ A. tension (or force) increases, but length stays the same
  - B. tension (or force) stays the same, but length increases
  - C. tension (or force) stays the same, and length stays the same
  - D. tension (or force) stays the same, but length decreases
  - E. tension (or force) decreases, and length decreases
44. The problem of electrical discontinuity caused in the normal heart by the connective tissue separating the atria from the ventricles is solved by:
- ☒ A. having the A-V node function as a secondary pacemaker
  - B. having an ectopic pacemaker
  - C. coordinating electrical activity in the atria with electrical activity in the ventricles by connecting them via the vagus nerve
  - D. coordinating electrical activity in the atria with electrical activity in the ventricles by connecting them via the bundle of His
  - E. coordinating electrical activity in the atria with electrical activity in the ventricles by connecting them via the Purkinje fibers
45. Which of the following statements most correctly describes the pathway of blood through the circulatory system in mammals?
- ☒ A. Deoxygenated blood enters the right atrium, travels to the right ventricle, exits via the pulmonary vein to get oxygenated at the lung, and returns to the left heart via the pulmonary artery.
  - ☒ B. Deoxygenated blood enters the right atrium, travels to the right ventricle, exits via the pulmonary artery to get oxygenated at the lung, and returns to the left heart via the pulmonary vein.
  - C. Oxygenated blood returning from the right lung enters the right atrium while blood from the left lung enters the left atrium; both atria drain to the left ventricle, which pumps blood to the rest of the body via the aorta.
  - D. Blood is pumped out of the left ventricle via the coronary arteries to the rest of the body, which explains why occlusion of said arteries can be fatal.
  - E. Blood is pumped out of the left ventricle into the aorta, from which the jugular vein branches and carries blood to the head.
46. The frequency of a sound is indicated to the nervous system by the:
- A. frequency of stereocilia vibration
  - ☒ B. number of rows of hair cells that are stimulated
  - ☒ C. region of the inner ear that is stimulated
  - D. movement of the perilymph in the cochlear duct
  - E. frequency of vibration of the tectorial membrane

## Short Answer Questions

Please answer these questions briefly. Label diagrams correctly, with lines pointing to the proper structures. Partial credit will be given where appropriate. Write legibly!! You can use the back of the last page to continue any question. Number them, please!!

47. Draw and completely label two (2) action potentials you would expect from a cell of the conducting pathway in heart. (5 points)



48. List five (5) hypothalamic hormones and the hormone(s) they cause to be secreted by the anterior pituitary, respectively. (5 points)

Hypothalamic Hormone	Anterior Pituitary Hormone
GnRH	LH, FSH
PRH	PRL
GHRH	GH
CRH	ACTH
TRH	TSH

9. List and define five (5) major categories of receptors. (5 points)

Mechano receptors - <sup>sense</sup> stretch/shearing of skin/organs/etc

Nociceptors - free nerve endings, <sup>sense</sup> pain

Chemoreceptors - <sup>sense</sup> chemical compounds that contact body

Thermoreceptors - hot/cold of skin

Proprioceptors - <sup>sense</sup> equilibrium in body

50. Trace a drop of blood from the location where blood pressure is lowest to the locations where blood pressure is highest. Include all blood vessels, chamber, valves, and major regions of the circulatory system (if appropriate). (6 points)

- vena cava (neg. b.p., retrograde motion)
- right atrium
- tricuspid valve
- right ventricle
- pulmonary semilunar valve
- pulmonary artery
- arterioles
- capillaries (lung)
- venules
- pulmonary vein
- left atrium

- left A/V valve
- left ventricle
- isovolumetric contraction (b.p. = highest)

51. Please complete only ONE of the following tables (A OR B). Circle the question you are answering. (5 points)

A. Activation of muscarinic receptors on the pacemaker cells leads to opening of potassium channels. What effect does this have on heart rate and why? Your answer should be phrased in terms of equilibrium, membrane and action potentials, at least.

B. A given hormone generally has the same effect on different target tissues. Is this statement **TRUE** or **FALSE**? Defend your answer!

Norepinephrine/epinephrine have different effects on tissues, depending on the type of adrenergic receptor ( $\alpha_1, \alpha_2, \beta_1, \beta_2, \beta_3$ ) that it binds with. For example, it constricts blood vessels, while dilating bronchioles. Effect depends on the hormone receptor.