

For Office Use Only:

Part 1: ____ / 37.5

Part 2: ____ / 36

Part 3: ____ / 39

Score: ____ /112.5

Team Number: _____

Team Name: _____

Participant names: _____

2016-2017 Anatomy & Physiology Exam

Princeton Science Olympiad Invitational

Instructions: All questions are 1 point each unless otherwise noted. Partial credit may be awarded to short answer questions. **Only responses on the answer sheet will be graded.** Please write clearly. Time is not a tiebreaker; rather, select questions will be used to break ties. If you have any questions, please raise your hand quietly. Good luck!

Tiebreaker questions: 24, 41, 63



Part 1 - Nervous System:

1. Each of the following is true about an action potential except:
 - a. K⁺ repolarizes the cell by exiting through the voltage gated potassium channels
 - b. Na⁺ enters the cell during depolarization through voltage gated sodium channels
 - c. Na⁺/K⁺ pump is responsible for the depolarization/repolarization during an action potential
 - d. In the resting state, the Na⁺ concentration outside the cell is greater than inside the cell.
 - e. K⁺ exits the cells during the resting phase through leak channels
2. What is the name of the space between two neurons called?
 - a. Extracellular matrix
 - b. Synapse
 - c. Axon Hillock
 - d. Dendrite
 - e. Gap Junctions
3. Action potentials are normally carried in only one direction: from the axon hillock toward the axon terminals. If you experimentally depolarize the middle of the axon to threshold, using an electronic probe, then
 - a. no action potential will be initiated.
 - b. an action potential will be initiated and proceed only in the normal direction toward the axon terminal.
 - c. an action potential will be initiated and proceed only back toward the axon hillock.
 - d. two action potentials will be initiated, one going toward the axon terminal and one going back toward the hillock.
 - e. an action potential will be initiated, but it will die out before it reaches the axon terminal.
4. The minimum amount of stimulus required to create depolarization is called:
 - a. All or nothing principle
 - b. Threshold level
 - c. Resting potential
 - d. Graded potential
 - e. Hyperpolarized level
5. When several EPSPs arrive at the axon hillock from different dendritic locations, depolarizing the postsynaptic cell to threshold for an action potential, this is an example of
 - a. temporal summation
 - b. tetanus
 - c. spatial summation
 - d. the refractory state
 - e. graded potential
6. Which of the following is part of the rhomencephalon?
 - a. Thalamus
 - b. Parietal Lobe
 - c. Medulla oblongata
 - d. Amygdala

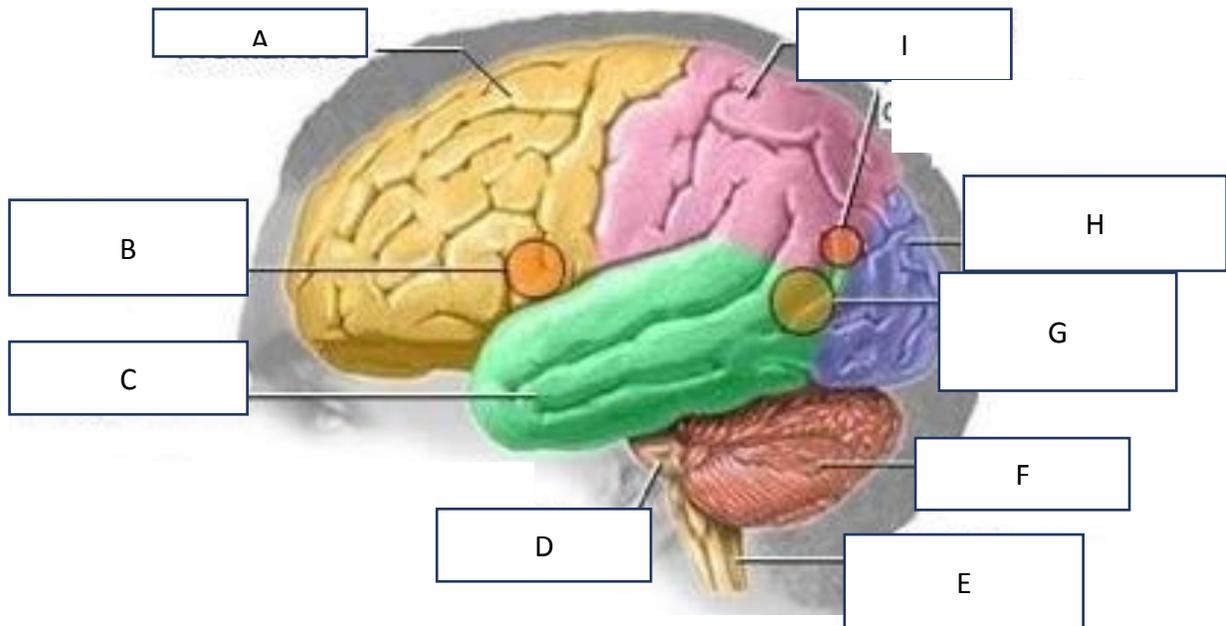
- e. Prefrontal cortex
7. Which part of the brain is continuous with the spinal cord?
- a. Cerebellum
 - b. Cerebrum
 - c. Diencephalon
 - d. Brain stem
 - e. Thalamus
8. Each of the following are part of the diencephalon except:
- a. Thalamus
 - b. Hypothalamus
 - c. Medulla oblongata
 - d. Epithalamus
 - e. Pineal Gland
9. Functions of Cerebellum include which of the following (you may select more than one):
(1.5 points, 0.5 points for each)
- a. Coordinate complex, skilled movements
 - b. Plays a role in cognition and language processing
 - c. Coordinate gross, automatic muscle movements and regulate muscle tone
 - d. Regulates formation functions in consciousness and arousal
 - e. Regulates posture and balance
10. Which brain structure communicates between the left and right hemispheres?
- a. Corpus Callosum
 - b. Basal Ganglia
 - c. Limbic System
 - d. Brain stem
 - e. Thalamus
11. Ciliated CNS neuroglia that line the cavities of the brain and spinal cord and play an active role in moving cerebrospinal fluid:
- a. Ependymal cells
 - b. Schwann cells
 - c. Oligodendrocytes
 - d. Astrocytes
 - e. Microglia
12. What is the correct sequence from the inside to the outside layer of the meninges?
- a. Pia mater, dura mater, arachnoid mater
 - b. Pia mater, arachnoid mater, dura mater
 - c. Arachnoid mater, dura mater, pia mater
 - d. Dura mater, pia mater, arachnoid mater
 - e. Dura mater, arachnoid mater, pia mater

13. A patient comes in and is only able to speak in short phrases, making it difficult for you to understand what the patient is intending to say. The patient is aware of the problem and is getting frustrated because of the communication problem. You also notice that the patient has weakness on the right side of their body. Their medical history shows that the patient had a stroke earlier. Which region of the brain do you suspect is affected?
- Frontal lobe
 - Corpus Callosum
 - Wernicke's area
 - Temporal Lobe
 - Broca's Area
14. Which of the following is an example of lower motor neuron dysfunction? Please choose from one of the following options.
- An individual sits in a relaxed position with her knee partially flexed. When her foot is pulled upward, the individual involuntarily and rhythmically moves her foot up and down.
 - An individual is told to relax her body. Despite attempts to relax, she experiences repeated, uncontrollable muscle spasticity.
 - An individual is told to lift her left arm, and she has difficulty doing so. Her left arm appears shriveled and shorter than her right arm.
 - A metal object is dragged along the bottom of an individual's foot and her toes go into extension away from the bottom of her foot.
15. If an individual were to sustain a significant injury to their right cerebral hemisphere, where might somatosensory loss of functioning occur? Please choose from one of the following options.
- Both sides of the body
 - Right side of the body
 - Left side of the body
 - There is no evidence that loss of functioning would occur.
16. An individual's EEG shows waves with a frequency of 8-13 Hz, indicative of wakefulness. Their EMG indicates a loss of muscle tone. Which stage of sleep is the person in?
- Stage 1
 - Stage 2
 - Stage 3
 - Stage 4
 - REM
17. Which of the following describes symptoms that would likely accompany a drug-induced increase in dopamine?
- anxiety, increased heart rate, increased blood pressure
 - pupil constriction, decrease in blood pressure, paranoia
 - anxiety, decreased heart rate, increased saliva flow
 - increased peristalsis, increased saliva production, increased heart rate
18. Cerebral palsy, which disrupts motor messages from brain to muscle, is usually due to damage of
- Cerebellum
 - Corpus callosum
 - Basal nuclei of gray matter

- d. Neocortex
- e. Basal nuclei of white matter

19. Identify TWO conditions that can be diagnosed through an EEG (or encephalographic wave form) and describe how it would work. (4 points; 1 for each disorder and 2 for description of EEG)

20. Answer the following questions with the letter pointing to the appropriate region and then name the region. (5 points; 1 point for each ID)



- a. A tumor in this region would lead to an uncoordinated gait.
- b. A stroke in this region would impair understanding of speech but speech itself would be unimpaired.
- c. This region is responsible for visual processing.

- d. This region is responsible for decision making, planning and motivation.
- e. This region is involved in autonomic functions of breathing, heart rate, and blood pressure.

21. Identify the drug responsible for the following effects: (3 points)

- a. In small doses, I reduce anxiety. But, I also reduce respiration, blood pressure and heart rate. At high doses, I can cause respiratory depression. Use of me can lead to excessive sedation, coma and even death. Tolerance occurs, so a person begins to use more of me. Because I dissolve easily in fat, I can cross the blood brain barrier easily.
- b. I can cause difficulty walking, blurred vision, slurred speech, slowed reaction times, impaired memory and with long term use, memory loss and dementia. Heavy use of me can also have a direct toxic effect on the heart and can damage it, leading to high blood pressure, cardiomyopathy, congestive heart failure, and stroke. Heavy use of me puts more fat into the circulation in your body, raising your triglyceride level.
- c. I am a central nervous system stimulant. In moderate doses, I can increase alertness; reduce fine motor coordination, cause insomnia, and cause headaches, nervousness and dizziness. In massive doses, I am lethal. I adversely affect cholesterol and other lipid levels, homocysteine, blood pressure, arrhythmias and stress levels, increasing the risk of heart disease. I am ingested most often through common beverages or chocolate.

22. Describe the mechanism by which nerve gas/nerve agents lead to paralysis. (2 points)

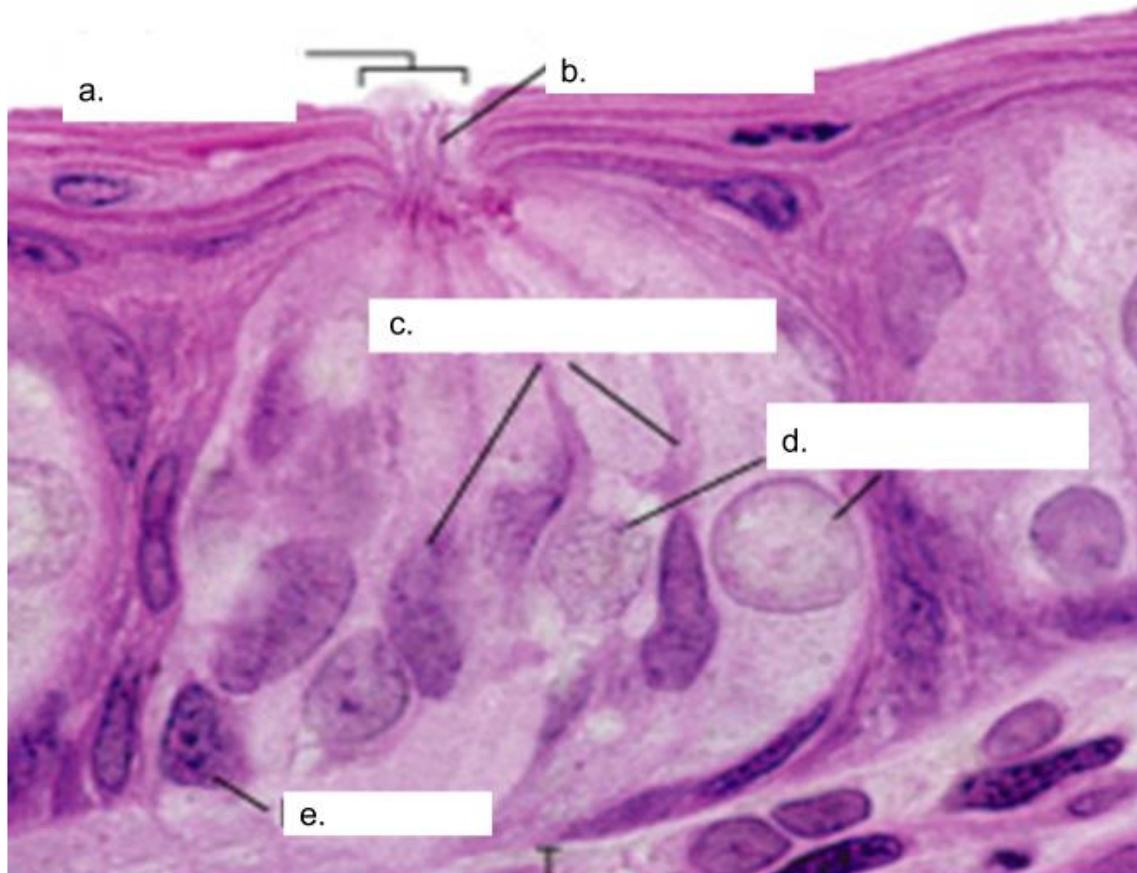
23. Describe the reflex arc that follows when you accidentally step on a needle. (2 points)

24. In which diagnostic process is cerebrospinal fluid removed and tested? What is the ideal location to perform the procedure and give an example of a disease in which such a procedure would be a useful diagnostic? (3 points; 1 for name of procedure, 1 for ideal location, 1 for example of disease) (**Tiebreaker #1**)

Part 2 - Sensory System:

25. What are the four modalities of somatic sensation?
 - a. Vibration, thermal, chemical, proprioceptive
 - b. Thermal, tactile, pain, and proprioceptive
 - c. Thermal, pain, chemical, vibration
 - d. Itch, tactile, pain, proprioceptive
26. What are the respective locations of cold and warm receptors in the skin?
 - a. Hypodermis & Dermis
 - b. Stratum Basale & Stratum Spinosum
 - c. Stratum Basale & Dermis
 - d. Dermis & Dermis
27. What are the three types of proprioceptors?
 - a. Muscle Spindles, Tendon Organs, and Joint Kinesthetic Receptors
 - b. Gamma Motor Neurons, Alpha Motor Neurons, Tendon Organs
 - c. Tendon Kinesthetic Receptors, Muscle Spindles, Gamma Motor Neurons
 - d. Nociceptors, Tendon Organs, Joint Kinesthetic Receptors
28. Patient Alpha reports having deep and sharp abdominal pain. Further examination reveals receptors in his skin and in his skeletal muscles, joints, and tendons, are NOT responsible for this pain. What type of pain is Patient Alpha suffering from?
 - a. Somatic Pain
 - b. Autonomic Pain
 - c. Visceral Pain
 - d. Diffuse nociceptive pain
29. What are the five primary tastes?
 - a. Sweet, sour, bitter, salty, acidic
 - b. Sour, bitter, salty, umami, spicy
 - c. Spicy, bitter, sour, salty, umami
 - d. Sweet, bitter, sour, umami, salty
30. Choose the answer that best describes olfactory supporting cells and their function
 - a. Squamous epithelial cells; Nourishes nearby olfactory receptor cells
 - b. Columnar epithelial cells; provides physical support & electrical insulation for olfactory receptor cells
 - c. Stratified columnar epithelial cells; nourishes and undergoes cell division to produce new olfactory receptor cells
 - d. Pseudostratified columnar epithelial cells; undergoes cell division to produce new olfactory receptor cells
31. Which cranial nerve is responsible for innervating supporting cells and olfactory glands?
 - a. Trigeminal Nerve
 - b. Glossopharyngeal Nerve
 - c. Accessory Nerve
 - d. Facial Nerve

32. Label the following diagram below: (5 points; 1 point each)



33. In a middle aged adult, rank the three types of papillae from least taste buds EACH to most taste buds EACH

- Fungiform, Foliate, Palate
- Filiform, Vallate, Foliate
- Foliate, Fungiform, Vallate
- Vallate, Palate, Linguale

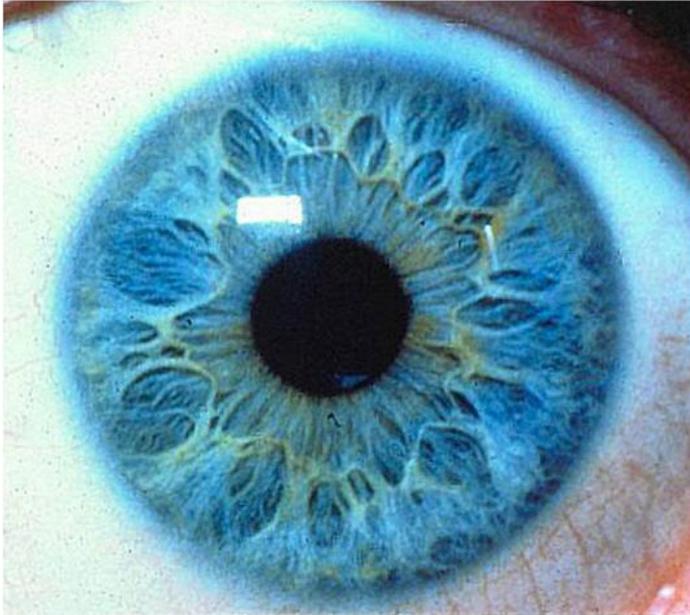
34. What is the function of the lacrimal gland?

- Produce lacrimal fluid containing essential salts
- Produce lysozyme to protect the eyeball from invading bacteria
- Produce fluid to moisten the eyeball
- A & C
- All of the above

35. Which nerve is responsible for stimulating the lacrimal gland?

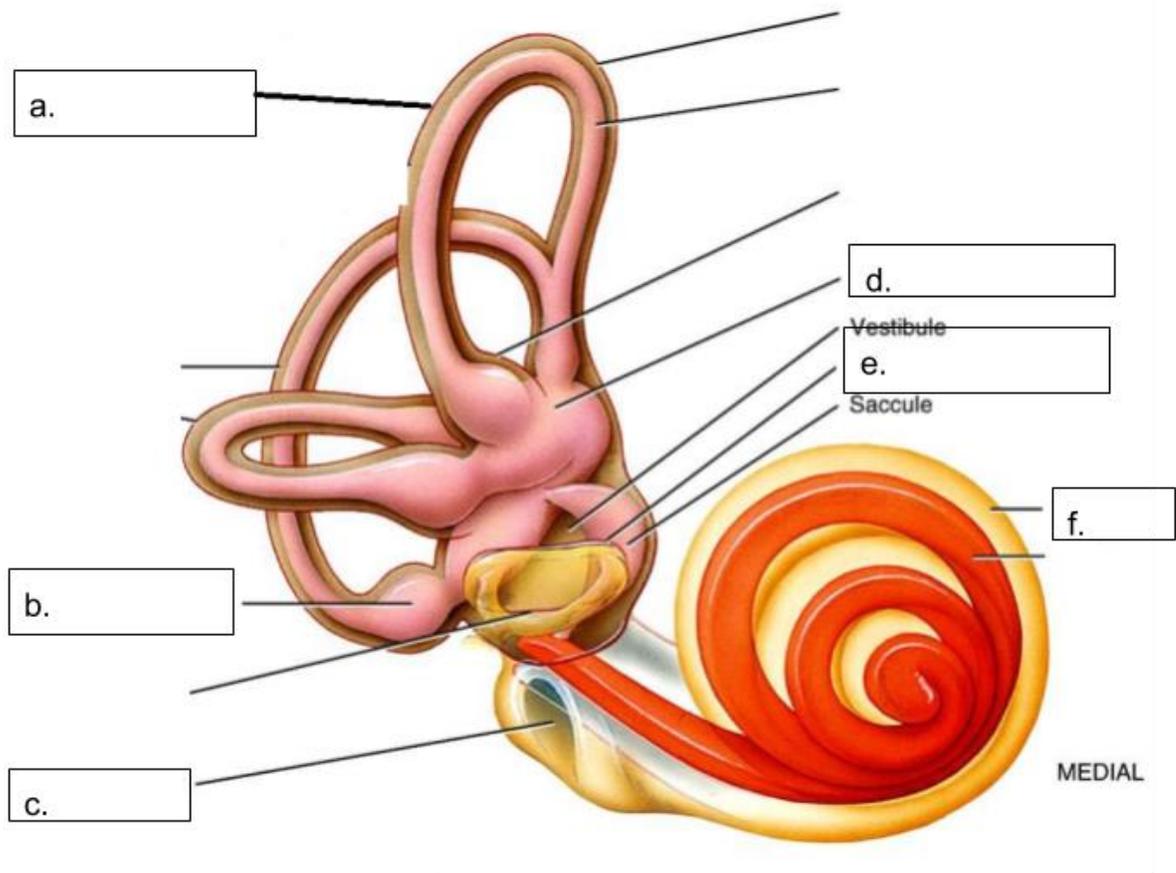
- Optic Nerve
- Accessory Nerve
- Facial Nerve
- Hypoglossal Nerve
- None of the above

36. Storytime! One day, when you wake up, you look into the mirror and your eye color has suddenly changed. Using the picture below, explain what chemical is responsible for your eye color, what is its concentration? (Note: just in case the color printer doesn't work, the eye color is blue)



- a. Melatonin, High
 - b. Melatin, Low
 - c. Melanin, Low
 - d. Melanin, High
 - e. Melatonin, Medium
 - f. None of the above
37. Describe the steps involved in transforming mechanical vibrations into electrical signals in a hair cell. Be sure to use the following terms in your response: **basilar membrane**, **endolymph**, **stereocilia**. Be as specific as possible, to get maximum credit. (4 points total)
38. What substance coats the thick, gelatinous, glycoprotein layer resting on hair cells in the saccule and utricle? What is the substance made of?
- a. Kinocilium, Calcium Sulfate
 - b. Otoliths, Calcium Sulfate
 - c. Otoliths, Calcium Carbonate
 - d. Otoholic Membrane, Calcium Carbonate

39. Label the diagram below. Each label is worth 1 point. (6 points total)



40. A patient presents with severe pain, a fever, and outward bulging of the eardrum. Detailed examination reveals that the throat and nose are also infected. Answer the following question: (5 points)

a. What disease is the patient suffering from, and where does it mainly affect? (2 points)

b. What is the primary cause of this infection in the ear? (1 point)

c. Why are children more susceptible than adults? (2 points)

41. A patient comes in reporting that she has trouble seeing at night, as well as in poorly lit places. Upon questioning, you find out that she did not have this condition when born, and

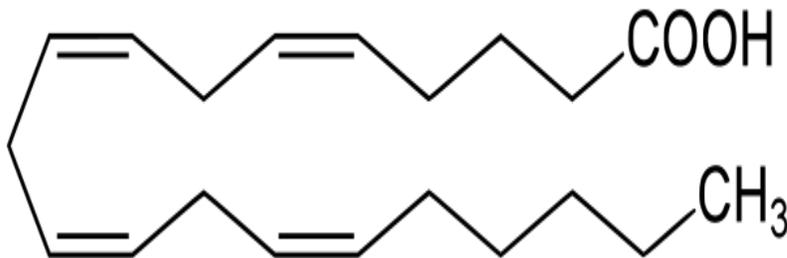
Part 3 - Endocrine System:

42. What is the difference between endocrine and exocrine glands? (Choose all that apply)
- Exocrine secretes into body cavities, while endocrine secretes into body lining
 - Endocrine gland tissue is typically more vascular than exocrine gland tissue
 - Exocrine glands include sudoriferous and parathyroid glands, and endocrine glands include the pineal and adrenal glands
 - Exocrine secretes into body ducts, while endocrine secretes into body cavities
43. Oxytocin is produced in the:
- Anterior Pituitary
 - Hypothalamus
 - Posterior Pituitary
 - Thyroid gland
44. Histamine is synthesized from the amino acid _____, while serotonin is derived from _____
- Tyrosine, Histadine
 - Histadine, Serine
 - Histadine, Tryptophan
 - Tyrosine, Tyrosine
45. Which hormone stimulates glucose production and inhibits protein synthesis?
- Insulin
 - Cortisol
 - Epinephrine
 - Aldosterone
46. What are the three major categories of water-soluble hormones?
- Steroid hormones, amine hormones, protein hormones
 - Amine hormones, thyroid hormones, eicosanoid hormones
 - Eicosanoid hormones, amine hormones, peptide hormones
 - Peptide hormones, amide hormones, eicosanoid hormones
47. The posterior pituitary secretes which hormone:
- Growth Hormone
 - Oxytocin
 - Prolactin
 - Thyroid Stimulating Hormone
48. What is the main action of insulin in adipose cells?
- Increased synthesis of triglycerides
 - Decreased glycogen synthesis
 - Increased metabolism
 - None of the above
49. Which of the following is not true of Insulin-like Growth Factors (IGFs)?
- IGFs increase uptake of amino acids into cells and accelerate protein synthesis to cause cells to grow
 - Increases lipogenesis in adipose tissue to stimulate growth
 - Somatotrophs begin a pathway that results in the release of IGFs
 - IGFs promote healing of injuries and tissue repair in adults

50. Hormone secretion is kept in balance through:
- Positive feedback
 - Wolff's law
 - Negative feedback
 - Starling's equilibrium
51. Interleukin - 2 is a cytokine secreted by helper T cells. IL-2 both activates nearby immune cells, but also stimulates the same cell that released it to proliferate. What type of signaling is IL-2 an example of?
- Autocrine
 - Holocrine
 - Paracrine
 - A&B
 - B&C
 - A&C
 - None of the above
52. All of the following are endocrine glands EXCEPT:
- adrenal glands
 - sebaceous glands
 - pineal glands
 - pituitary glands
53. Hormones that enter target cells and bind to receptors in the nucleus are called
- steroid hormones.
 - water soluble hormones.
 - peptide hormones.
 - second messengers.
54. The following type of hormone involves a second messenger called cyclic AMP:
- Lipid hormones
 - Non-lipid hormones
 - Prostaglandins
 - Cholesterol
55. Which of the following is/are not secondary messengers? (You may select more than response)
- Diacylglycerol (DAG)
 - Ca²⁺
 - Inositol Triphosphate (IP3)
 - All of the above are secondary messengers
56. Which of the following is correct about calcium level regulation? You may select more than one.
- Calcitonin, which increases blood calcium levels.
 - Calcitonin, which decreases blood calcium levels.
 - Parathyroid hormone, which increases blood calcium levels.
 - Parathyroid hormone, which decreases blood calcium levels.
 - A & C
 - A & D
 - B & C
 - B & D

57. Type I diabetes is:
- An autoimmune attack on the beta islet cells of the pancreas
 - An autoimmune attack on the alpha islet cells of the pancreas
 - Characterized by excessive thirst and excretion of large amounts of dilute urine
 - Due to the lack of cells' ability to respond to insulin
58. Which of the following accurately describes thyroid hormone?
- Binds to receptors on the inside of the cell
 - Binds to receptors on the outside of the cell
 - Derived from cholesterol
 - Released from the anterior pituitary
59. A patient has been increasingly thirsty and has to get up several times during the night to urinate. Her appetite has also increased significantly. Lab tests conducted show increased blood glucose levels, and urine tested positive for glucose and ketones. Her blood pH was also more acidic. Please answer the following questions: (3 points)
- Which condition does the patient suffer from? (1 point)
 - Describe the reason for elevated blood glucose levels. (1 point)
 - Why does the patient have fruity odor? (1 point)

60.



Above is an important precursor molecule to a class of hormones. Answer the following questions about it below: (5 points)

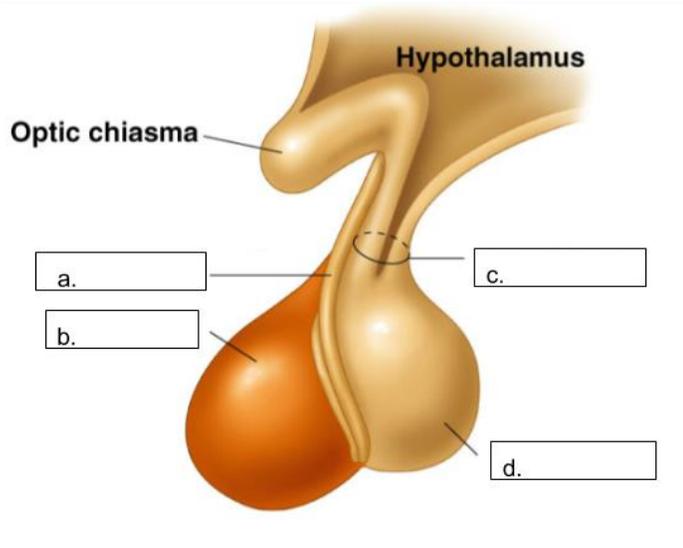
- Identify the precursor molecule: (1 point)

b. With cyclooxygenase and other enzymes, the molecule can be converted into prostaglandins and leukotrienes. What cells DO NOT secrete these hormones? (2 points)

c. What is the precursor molecule derived from? (HINT: It's a structure ALL **cells** have) (2 points)

61. Draw the feedback loop of insulin. What kind of feedback is it? (6 points)

62. Label the following diagram below: (Please be as specific as possible) (4 points, 1 point per label)



63. Patient Greenboy is sick and he needs your help! Upon performing a thorough examination, he has an enlarged thyroid gland, slightly protruding eyes, and red swollen skin on top of his shin and feet. Answer the following questions: **(Tiebreaker #3) (4 points)**

a. What disease does Patient Greenboy have, and what is it caused by? (2 points)

b. Explain the cause of his slightly protruding eyes. (2 points)